

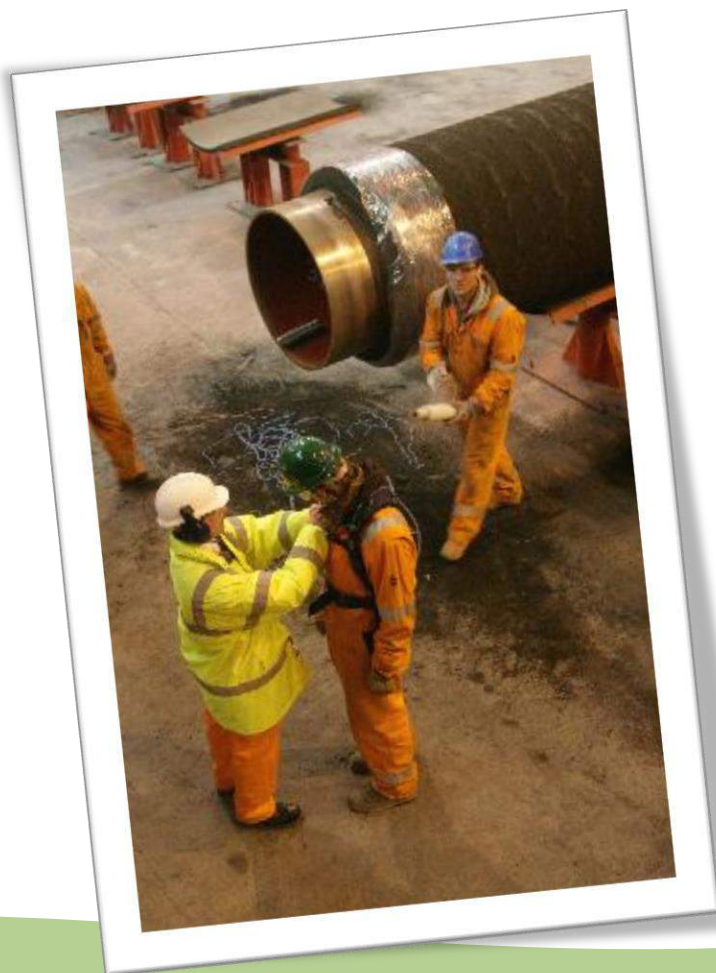
Assessing Environmental and Occupational Health Risks

Miranda Loh

Institute of Occupational Medicine

Karen Galea (IOM), Konstantinos Makris (CUT),
Anjoeka Pronk, Rob Stierum, Wouter Fransman (TNO)

What we do...



We are concerned with

- Risks to health in the workplace
 - health consequences of exposure to workplace hazards
- The effects of health on work
 - whether person's health has bearing on their fitness to do their job
- Risks to health in the environment
 - health consequences of exposure to hazards in the environment

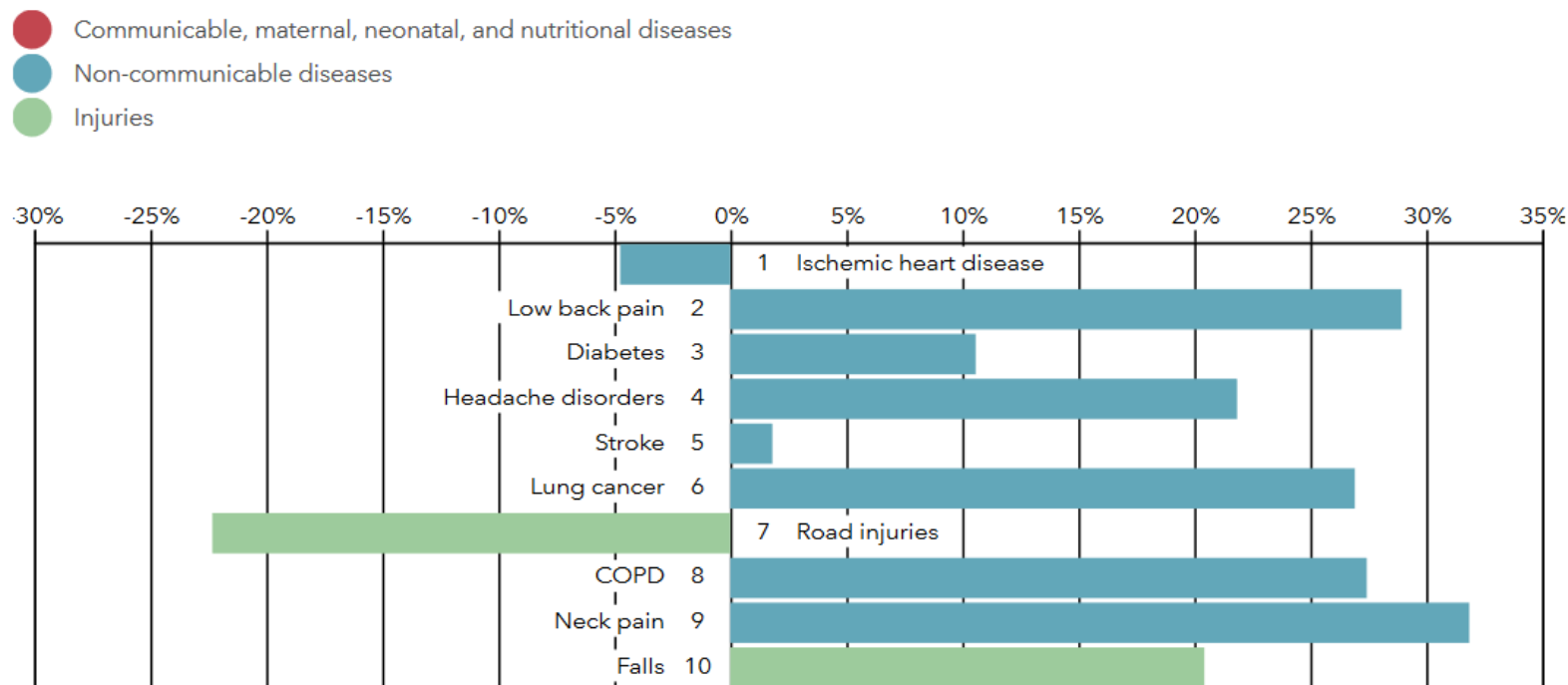
Environment and Health



Exposogas

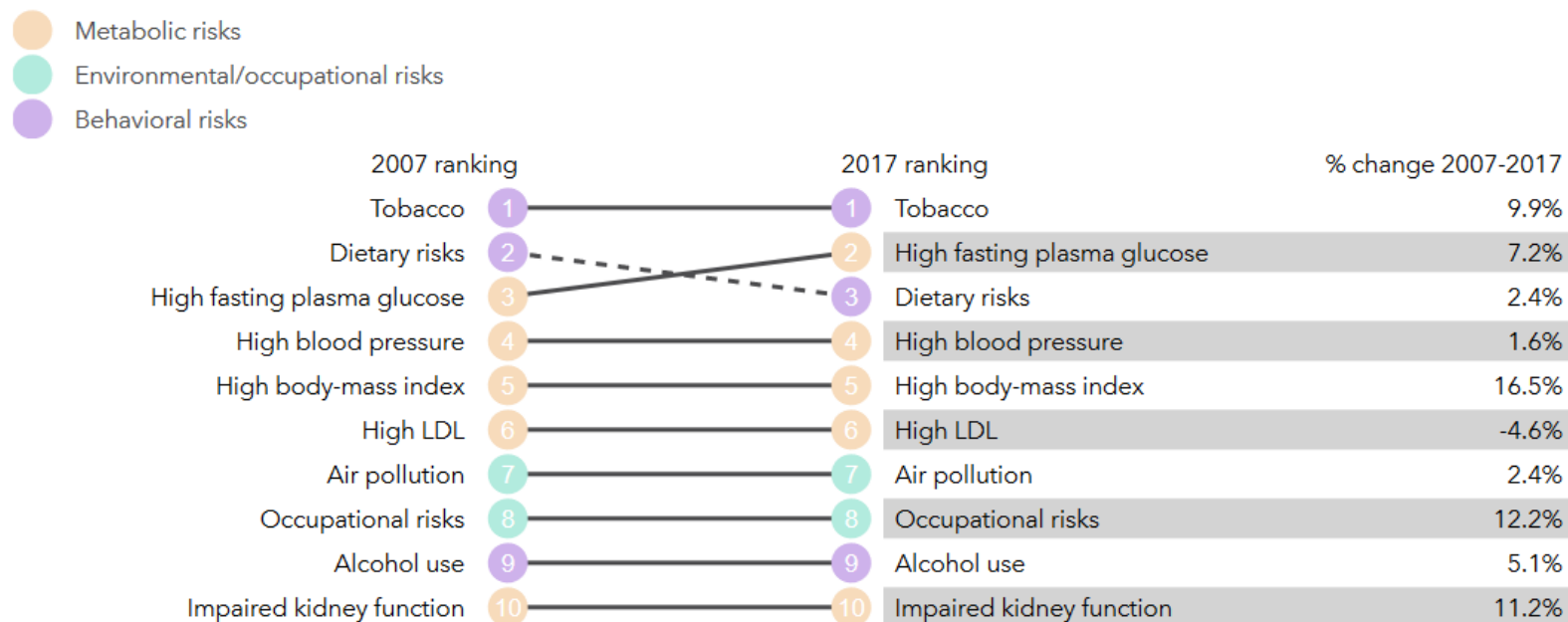
Cyprus Burden of Disease Estimates

What causes the most death and disability combined?



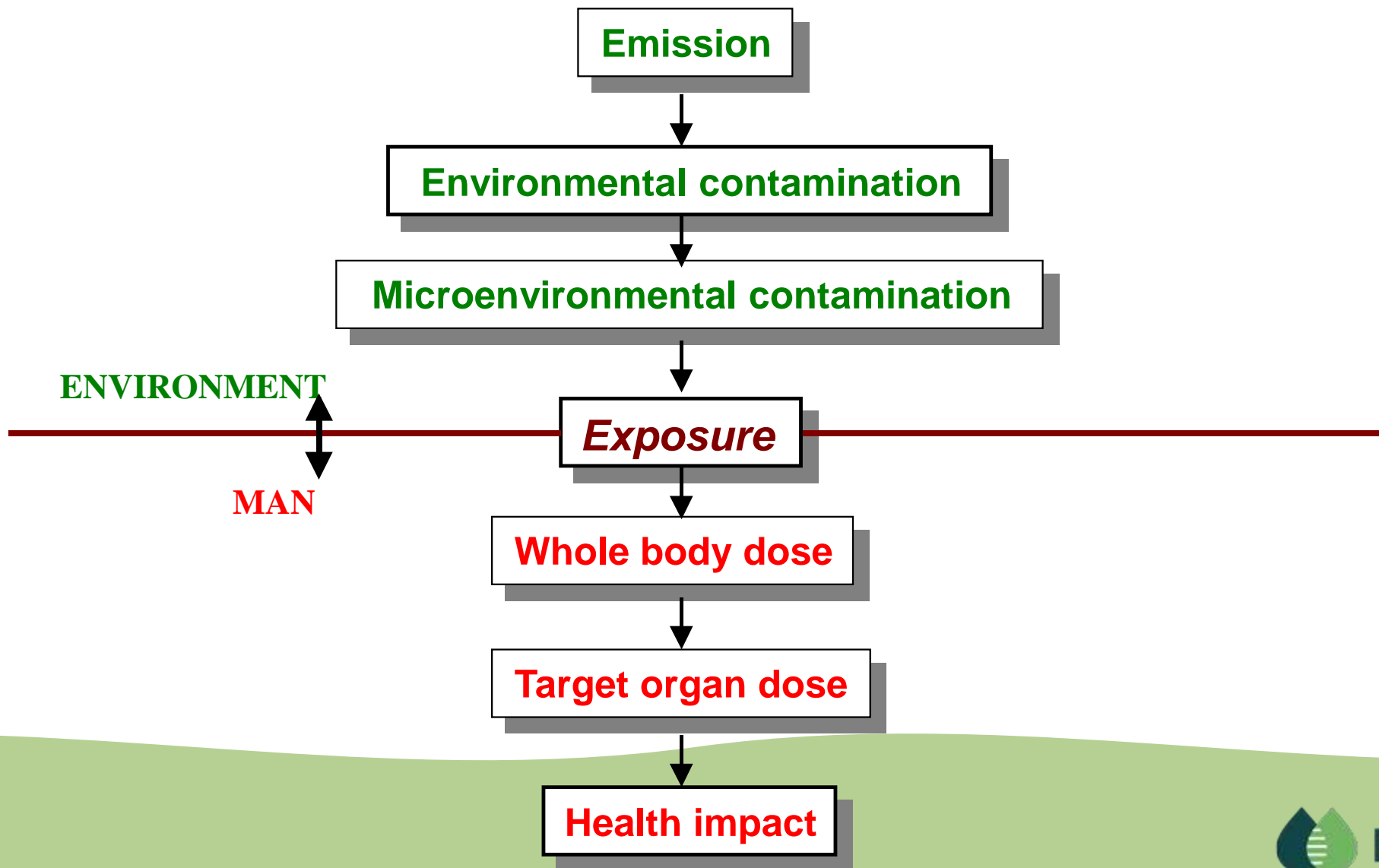
Top 10 causes of disability-adjusted life years (DALYs) in 2017 and percent change, 2007-2017, all ages, number

What risk factors drive the most death and disability combined?



Top 10 risks contributing to DALYs in 2017 and percent change, 2007-2017, all ages, number

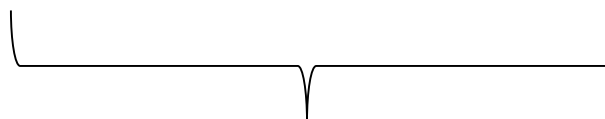
The Source to Health Impact Pathway



What do we need to know to assess exposure?



Exposure



Quantity of
environmental
factor



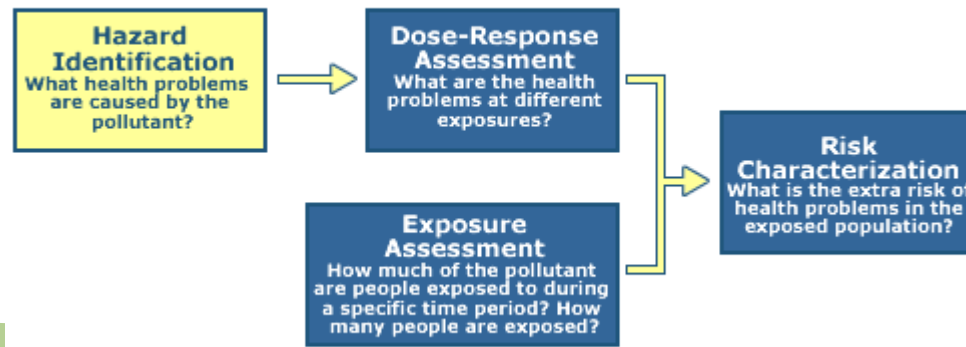
Amount of time in
contact with factor



Good exposure assessment essential for good risk assessment

Good risk assessment essential for good risk management

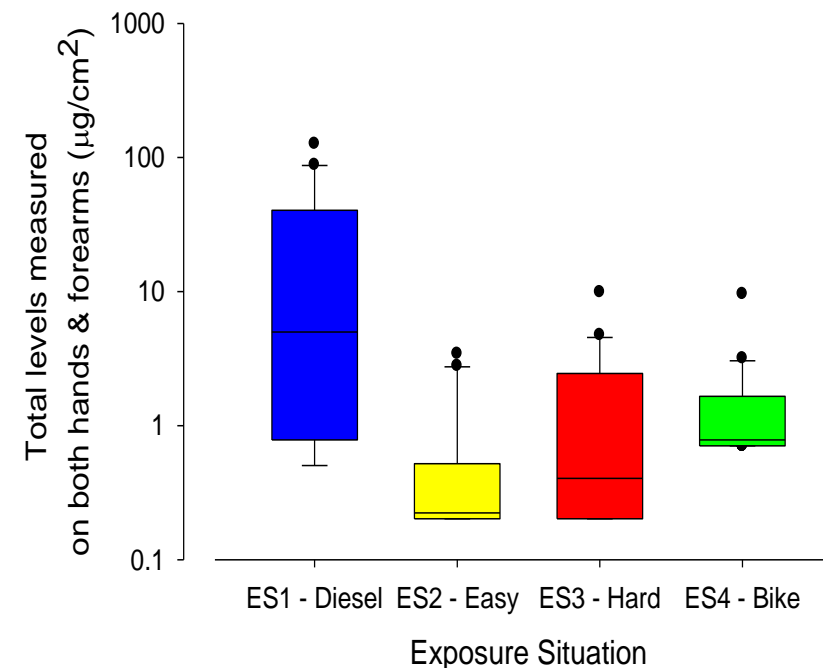
The 4 Step Risk Assessment Process



Examples of exposure assessment

Potential for dermal exposure from transfer of fuels and lubricants by consumers (Galea et al, 2014)

- 10 volunteers,
- Hands & forearms wiped
- Four exposure scenarios
 - Filling tank with diesel (ES1)
 - Adding lubricant to engine
 - Easy to reach (ES2)
 - Difficult to reach (ES3)
 - Lubricating bike chain (ES4)

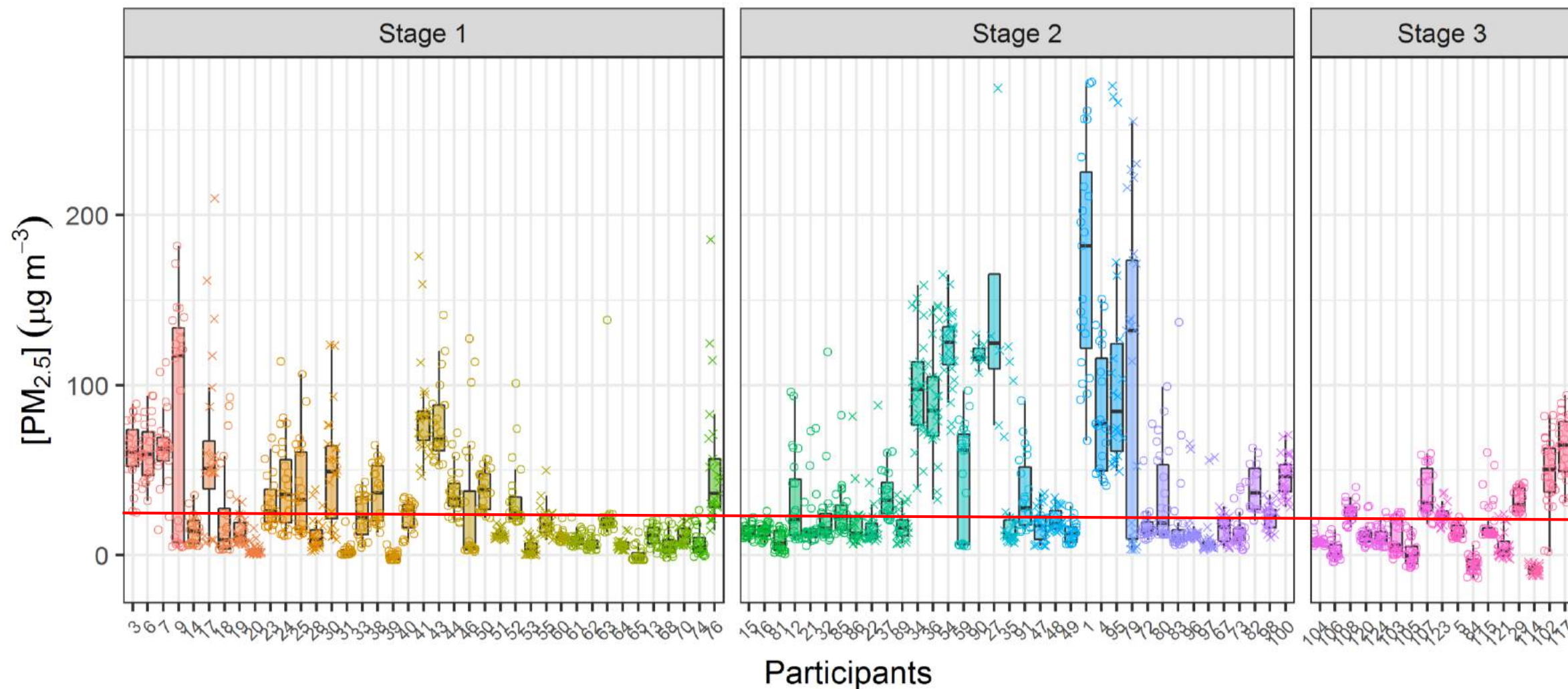


Overall, consumer exposures were found to be low and much lower than estimates predicted by models

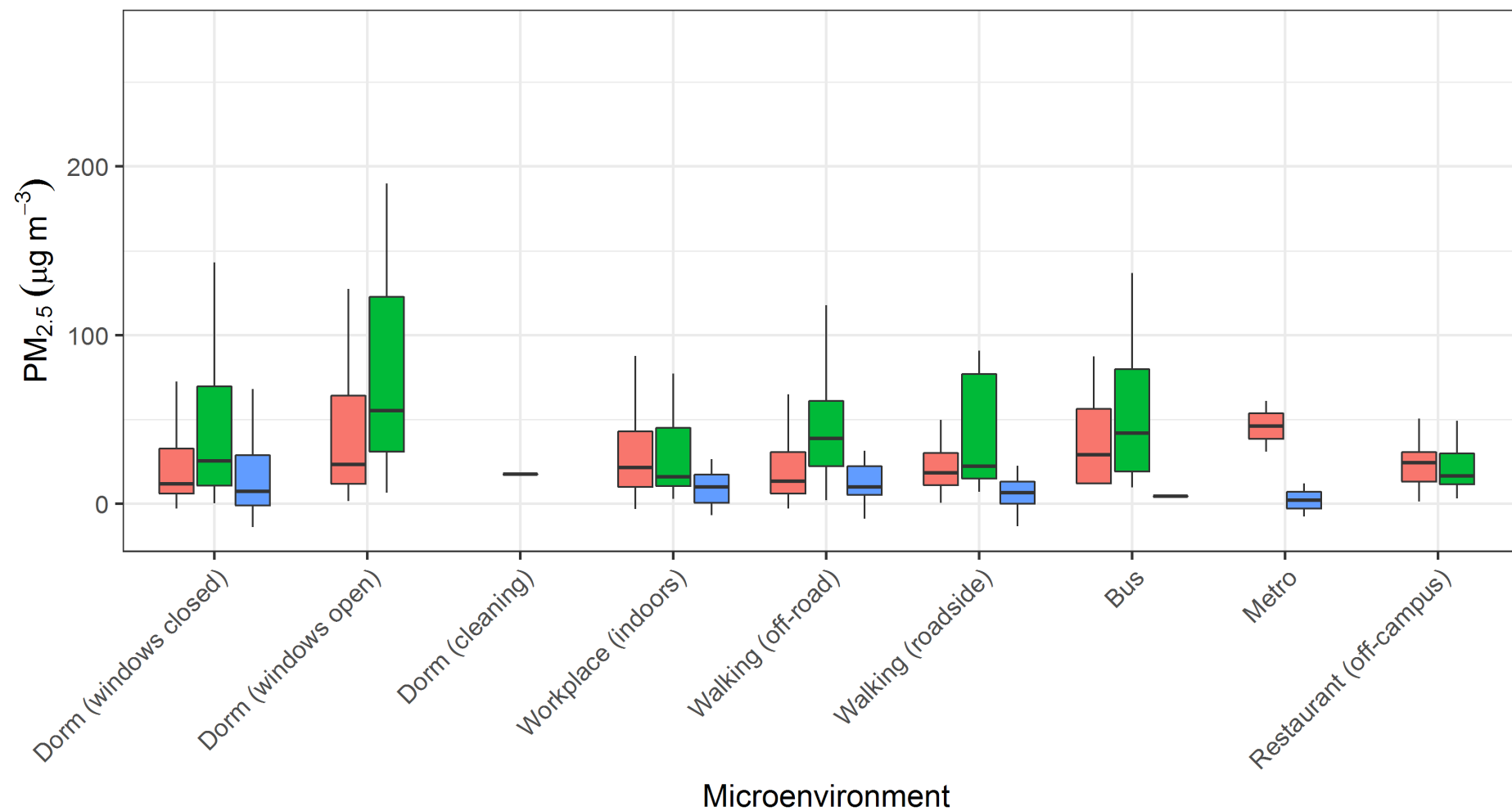
Air pollution and Health in Beijing

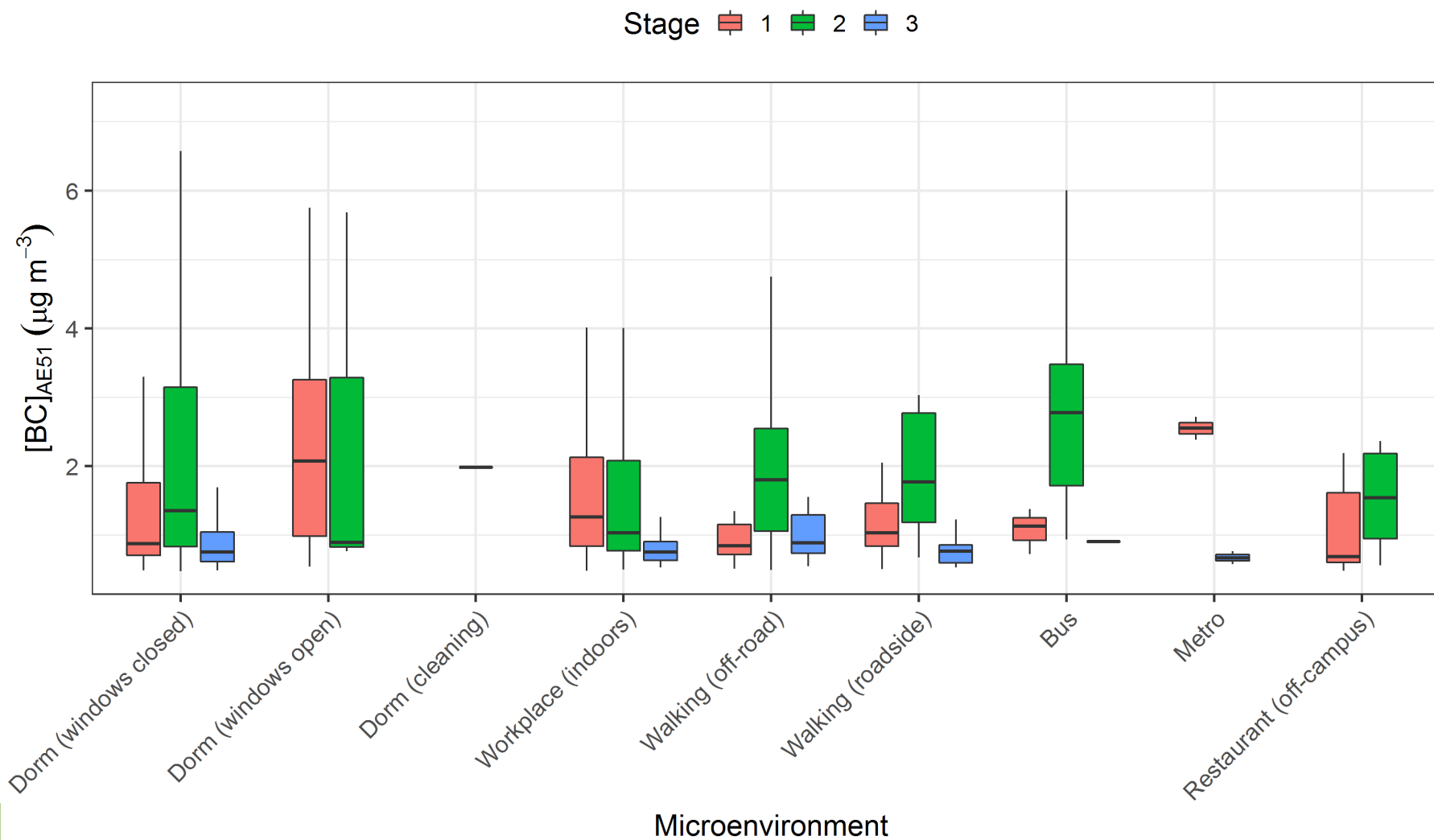
- Students were asked to wear portable air pollution samplers for 24 hours
- Measured particulate matter, black carbon, nitrogen dioxide, ozone





WHO recommends PM_{2.5} levels outdoors not exceed 25 $\mu\text{g/m}^3$ in a 24 hour period





One way a person might protect themselves



Mask testing

- Nine masks purchased from China
- Two stage protocol:
 - Test filtration efficiency of mask materials, and select the best four for further testing
 - Test the penetration into the breathing zone when mask being worn

$$Penetration (\%) = \frac{C_{in}}{C_{out}}$$

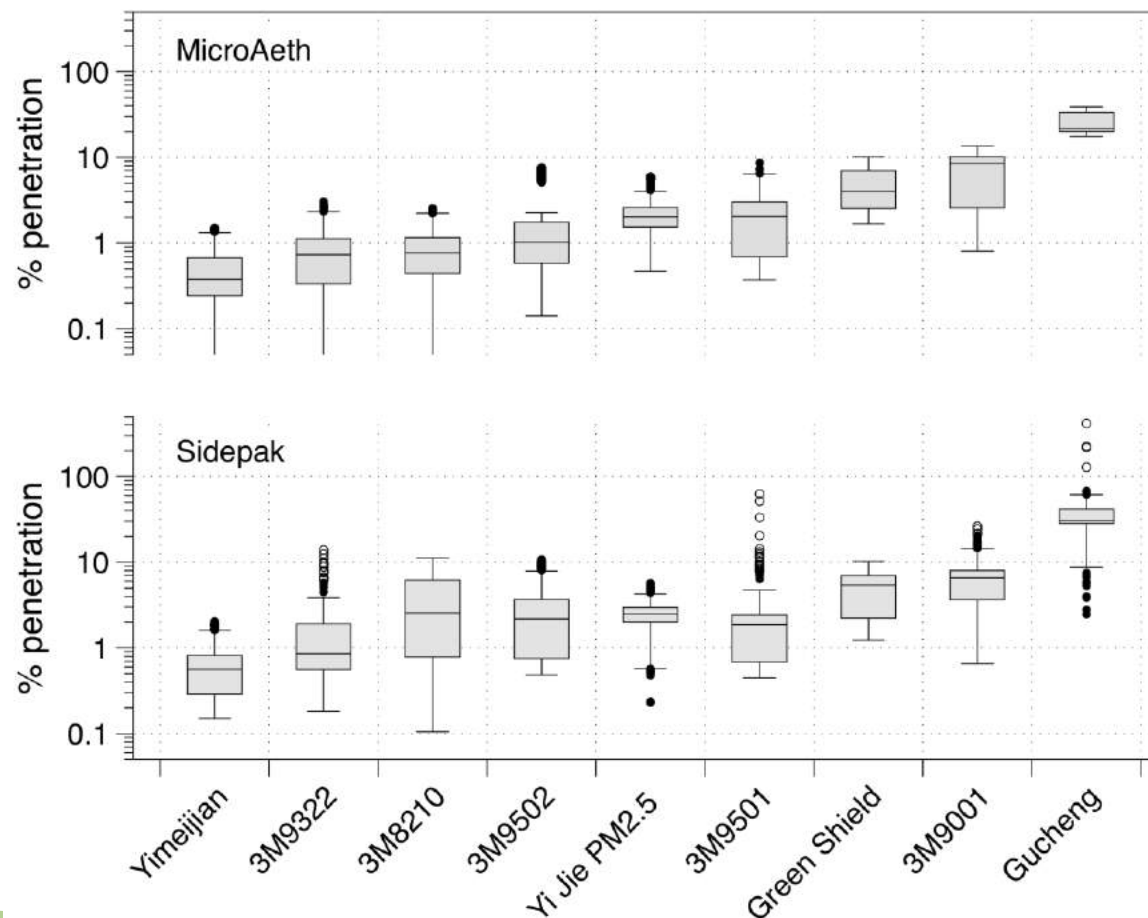
- Test aerosol diesel engine particulate measured as black carbon

Filtration Efficiency

- Material cut out and fit to sample holder
- 40 LPM, 80 LPM equivalent flow rates
- Target challenge concentration $100 \mu\text{g}/\text{m}^3$
- 30 minutes challenge
- 3 repeats
- Penetration ratio



Filtration results








40 LPM

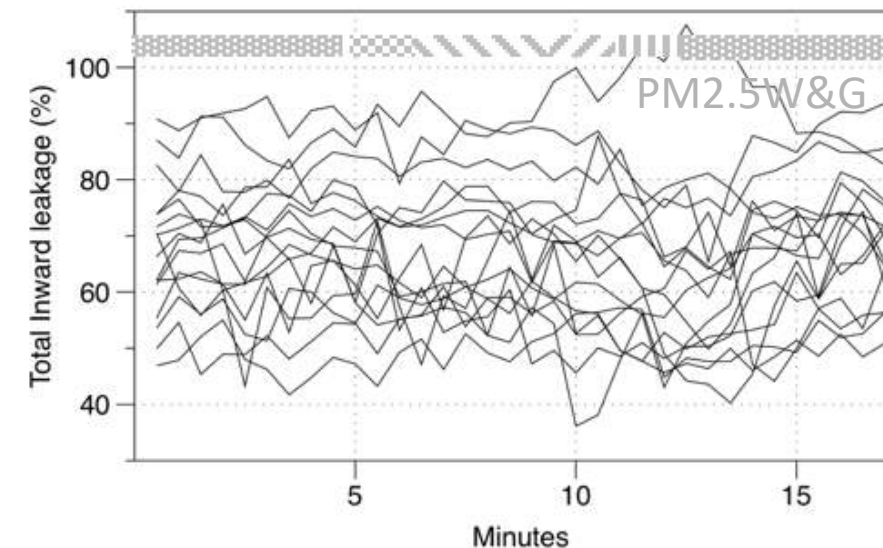
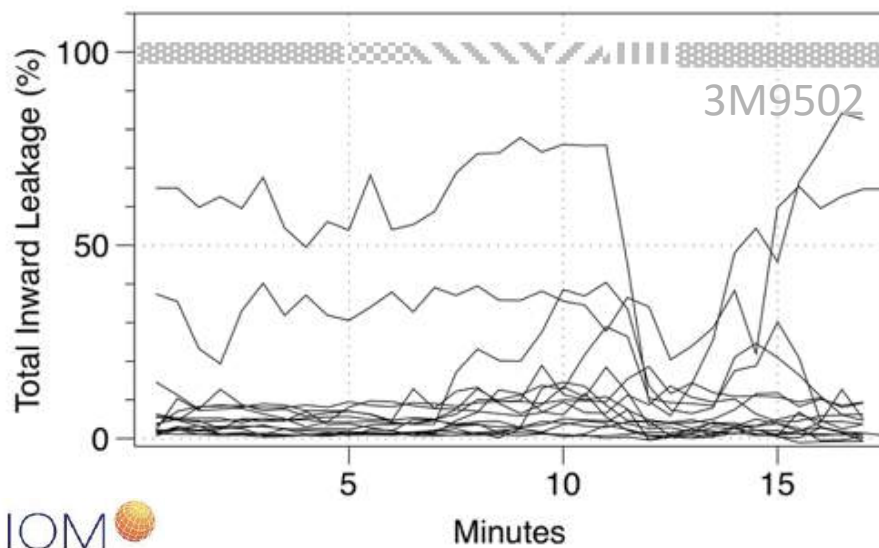
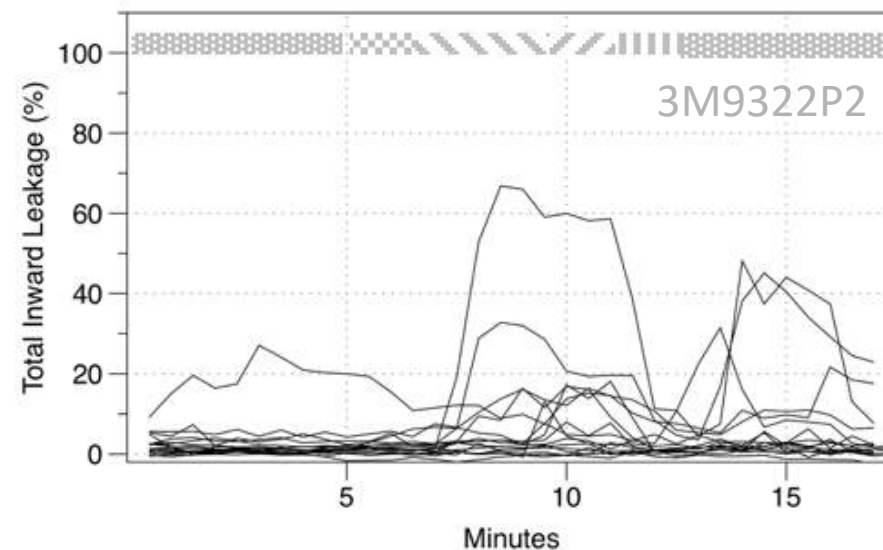
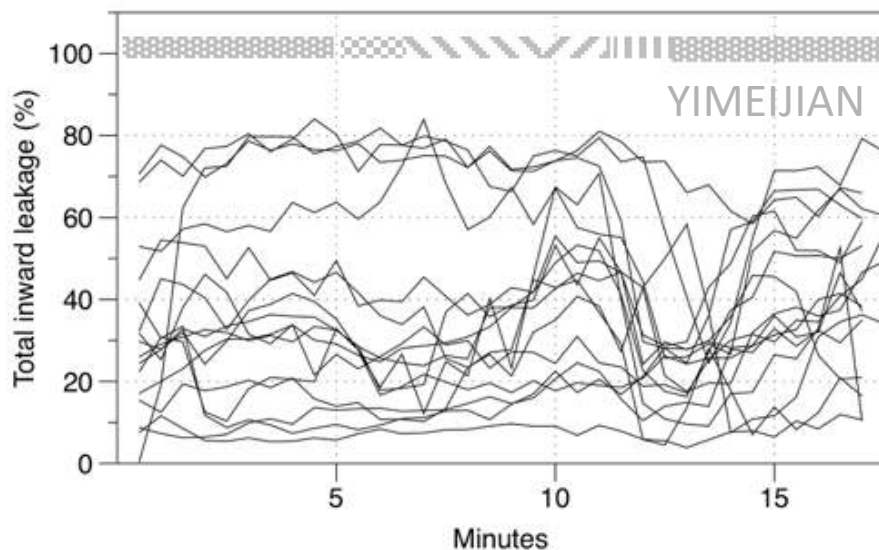
Laboratory facemask tests

- 4 masks chosen
- 10 volunteers
- Wore masks twice
- Sedentary and active test regimes
 - Based on fit testing exercises
 - About 20 minutes
- Total Inward Leakage (TIL)





-  breathing normally
-  deep breathing
-  Moving the head up and down or side to side
-  talking
-  bending over



Explanatory variables

	Variable	β	95% CI
Mask	3M9322	-	-
	3M9502	2.0*	1.2-3.3
	Yimei Jian	13.9*	8.5-22.7
	Yi Jie	26.7*	16.4-43.5
Activity	Talking	-	-
	Deep Breathe	1.0	0.9-1.2
	Stationary	1.1	0.9-1.2
	Bending	1.1*	1.0-1.3
	Head move	1.2*	1.1-1.3
	Constant	2.3*	1.6-3.3

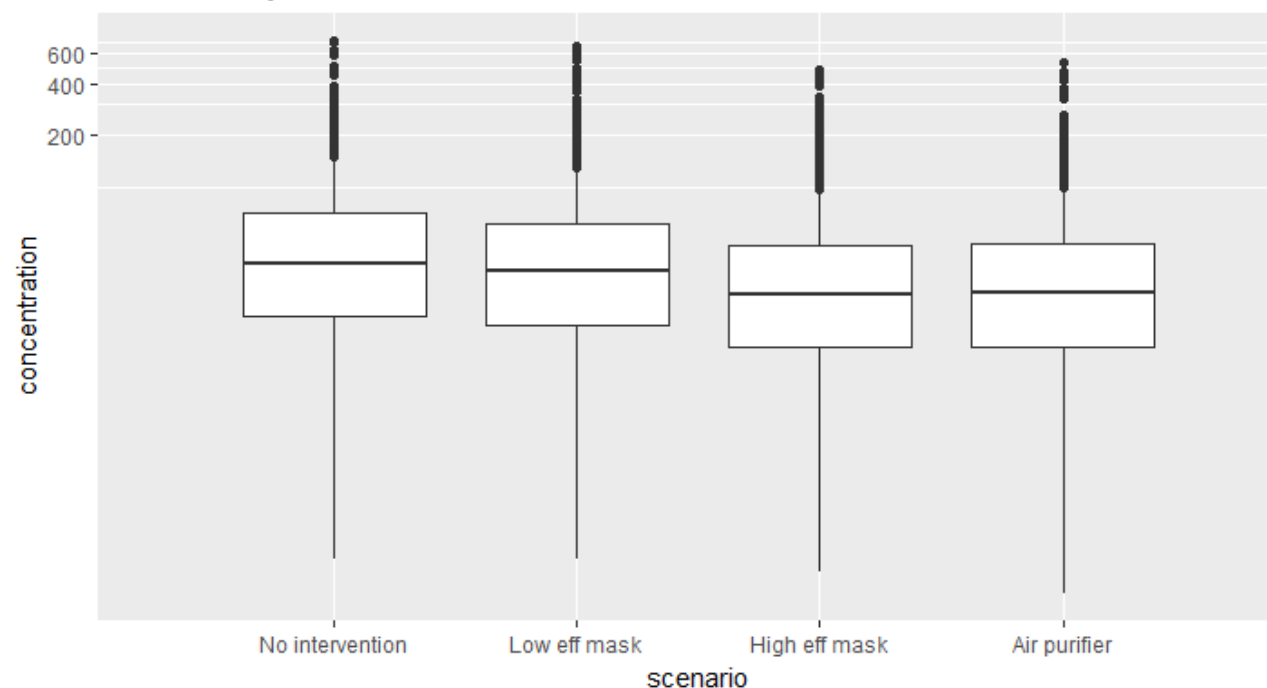
Cochrane-
Orcutt first-
order
autoregression
model

n=2,084, $R^2=0.11$

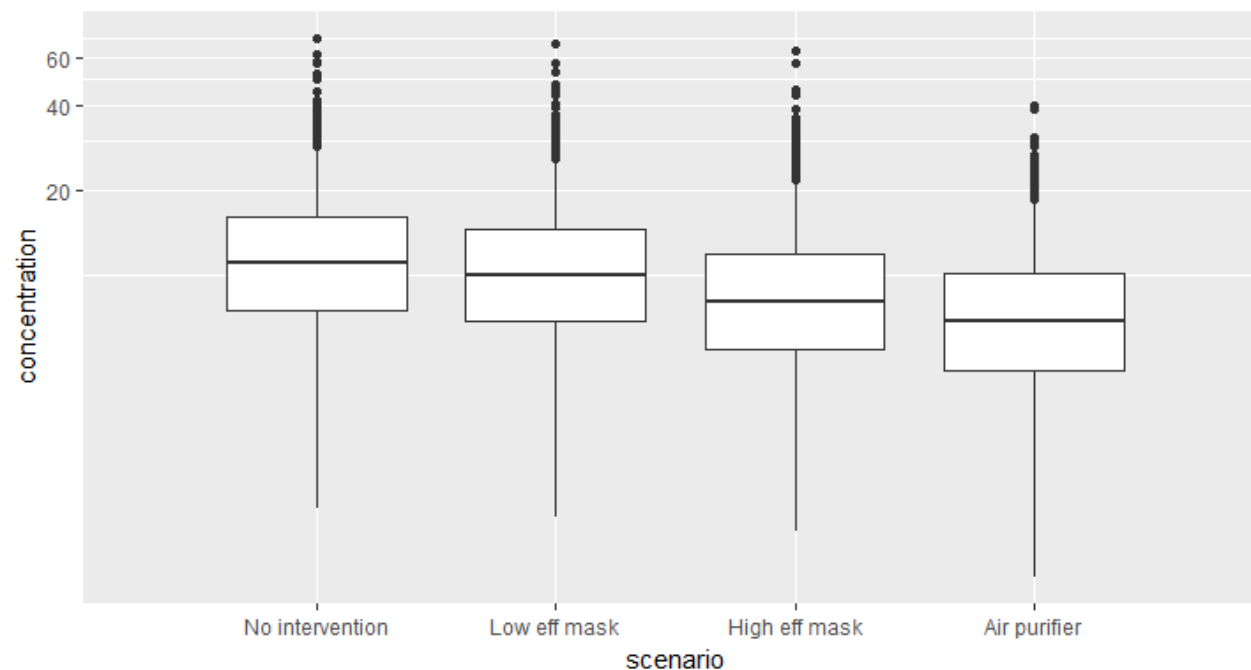
*indicates significant at $p < 0.05$

How exposure modelling can be used to examine different intervention scenarios

Chinese City Scenarios



European City Scenarios



Where is exposure research going?

Where are we now?

- GBD has provided a view of potential scale of pollution impacts
- Not comprehensive – many exposures unaccounted
 - Lack of exposure data
 - Lack of certainty in exposure-response
- Co-exposures
- Susceptibility



Two-thirds of deaths caused by
non-communicable diseases



Only about 10-30% due to genetic
variants alone



Much has been done to
characterise the human genome



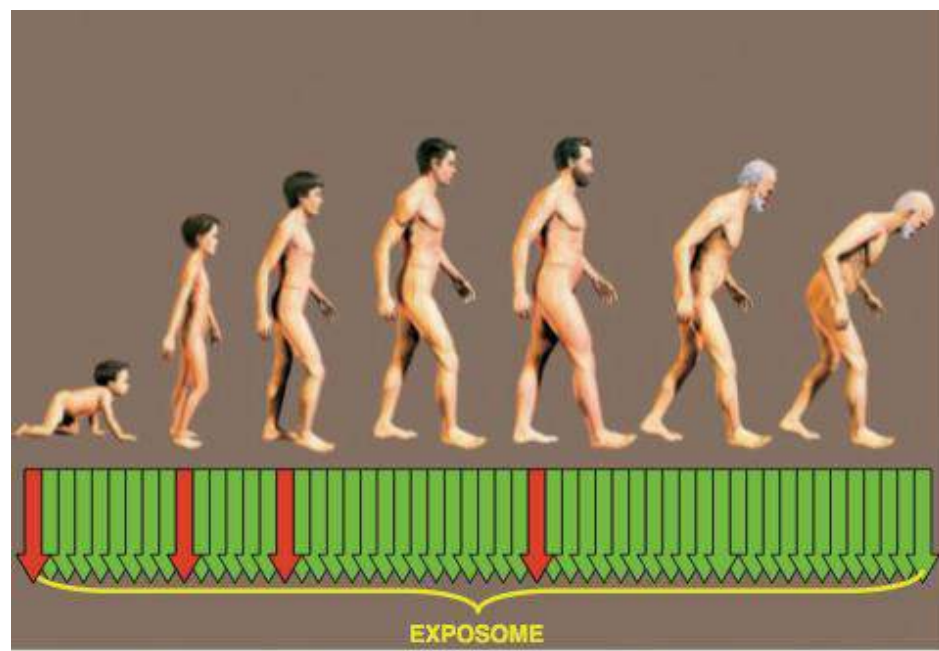
Exposure science has not yet caught
up to genomics

The **EXPOSOME** is composed of every exposure to which an individual is subjected from conception to death.

- Chris Wild

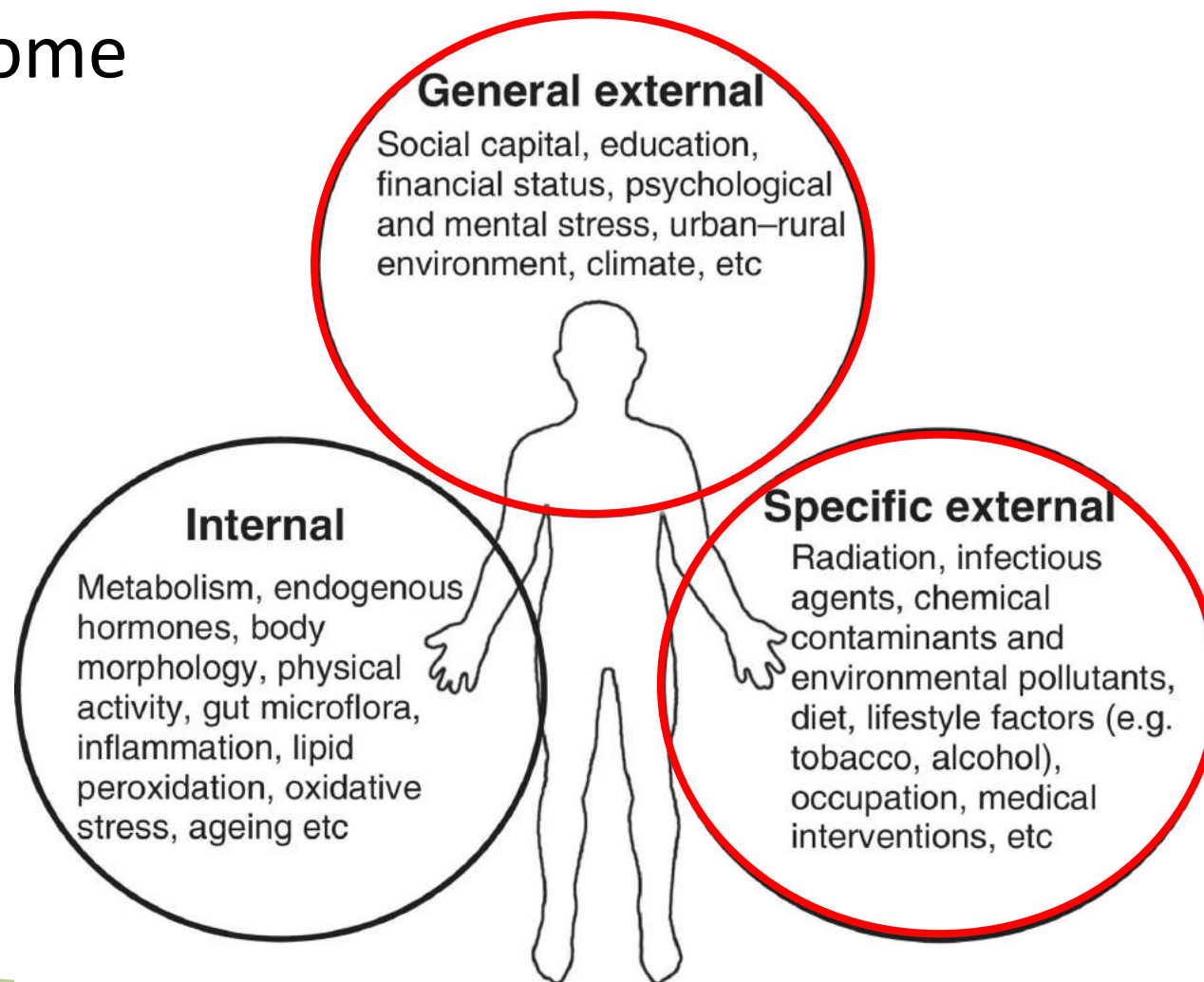
The Exposome...

Is longitudinal...



Wild, C. P. (2012). The exposome: from concept to utility. *International Journal of Epidemiology*, 41(1), 24–32.

External exposome



Wild C P Int. J. Epidemiol. 2012;41:24-32

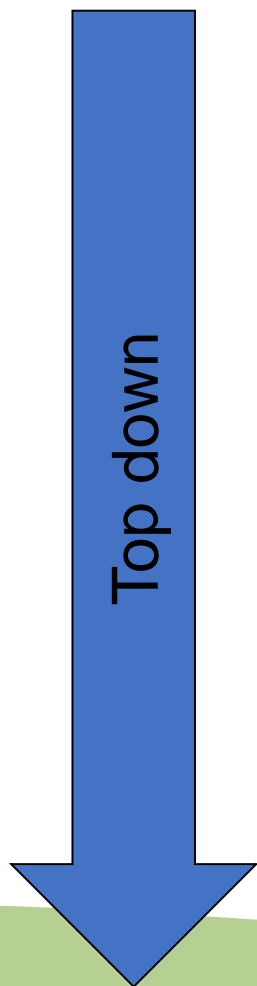
Exposome Research

- How different from traditional epidemiology?

(Stingone, J. 2017. Annu Rev Public Health, 38: 315-327)

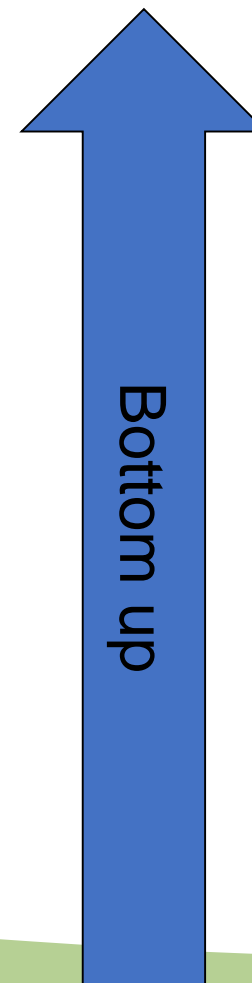
- Expanded and dynamic exposure assessment across multiple domains
- Integration of data on exposure and response across multiple scales of variation
- Use of high-dimensional information on multiple exposure-response relationships for data discovery

Top-down vs. Bottom-up



- Externally derived biomarkers
- Internally derived biomarkers

- Environmental samples
- Questionnaire data



Agnostic investigations...

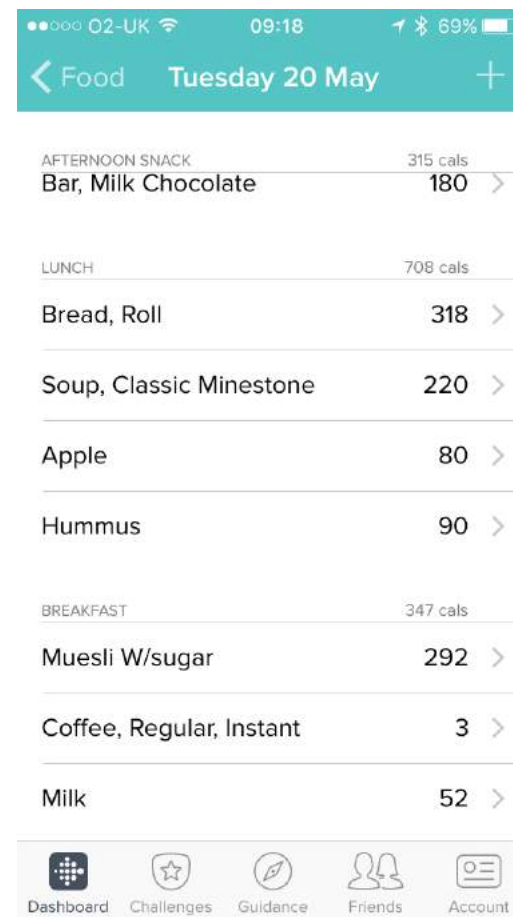
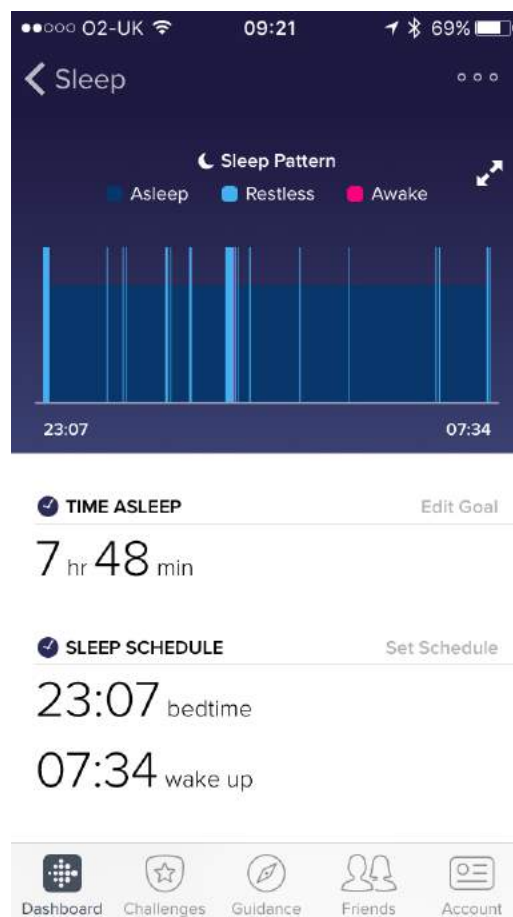
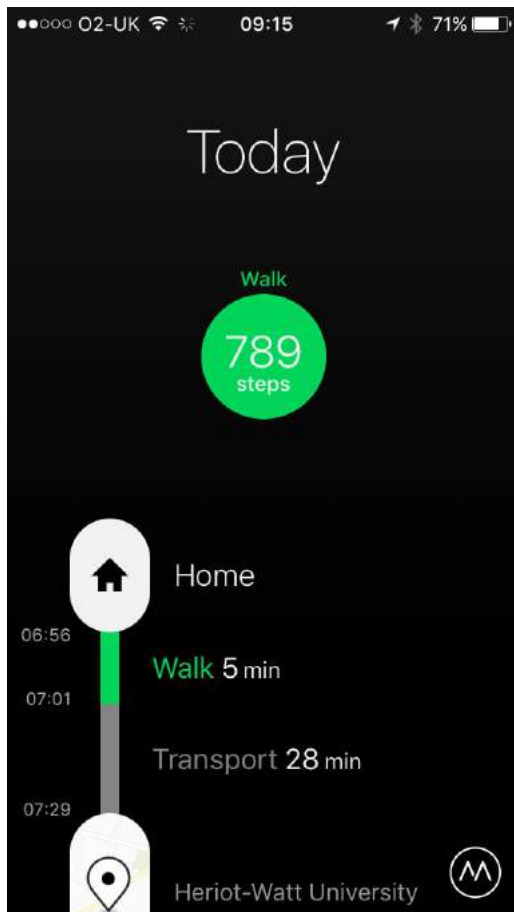
- Searching for potential causes without any prior hypothesis
- Approach lends itself to “omics” technologies
- Although other measurements can also contribute to this approach
- Follow-up with more focused epidemiological and mechanistic studies

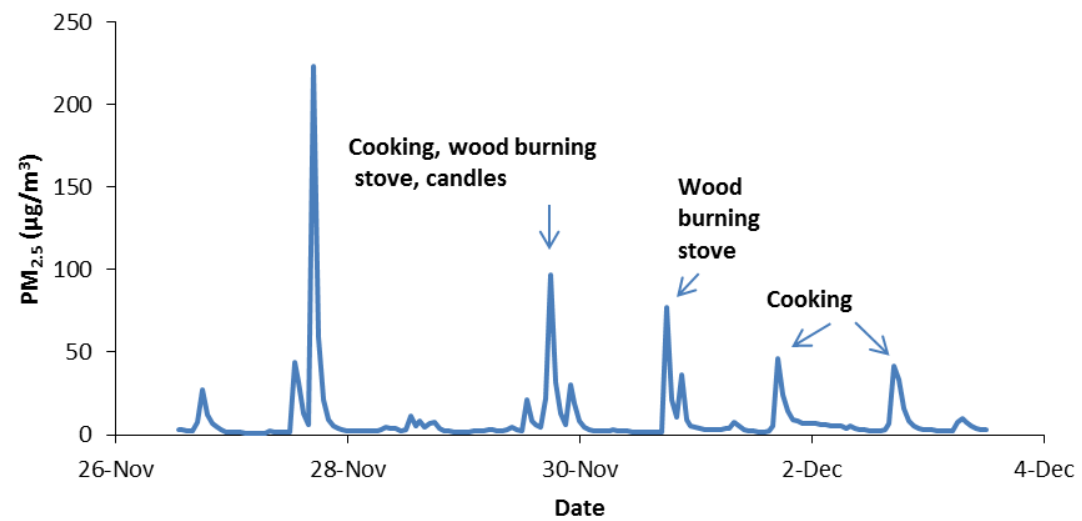
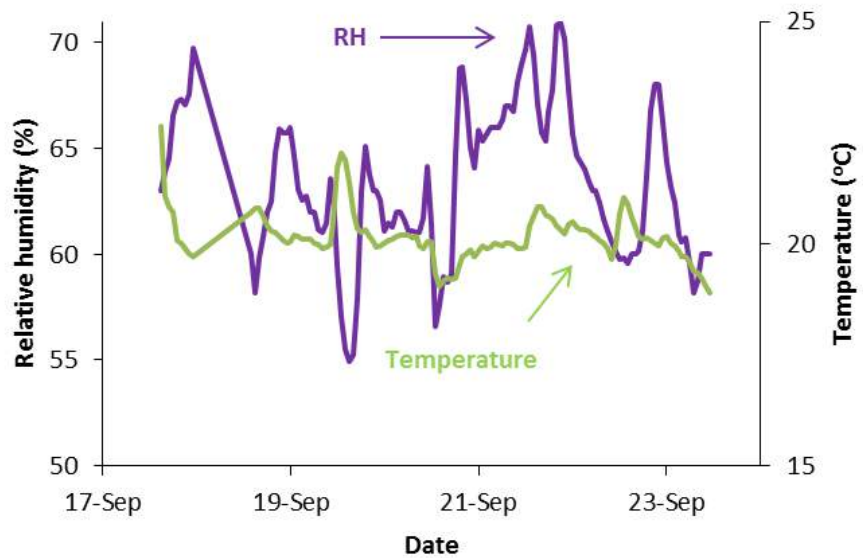
Omics technologies

Table 2. Major technologies that are currently being deployed in exposome research.

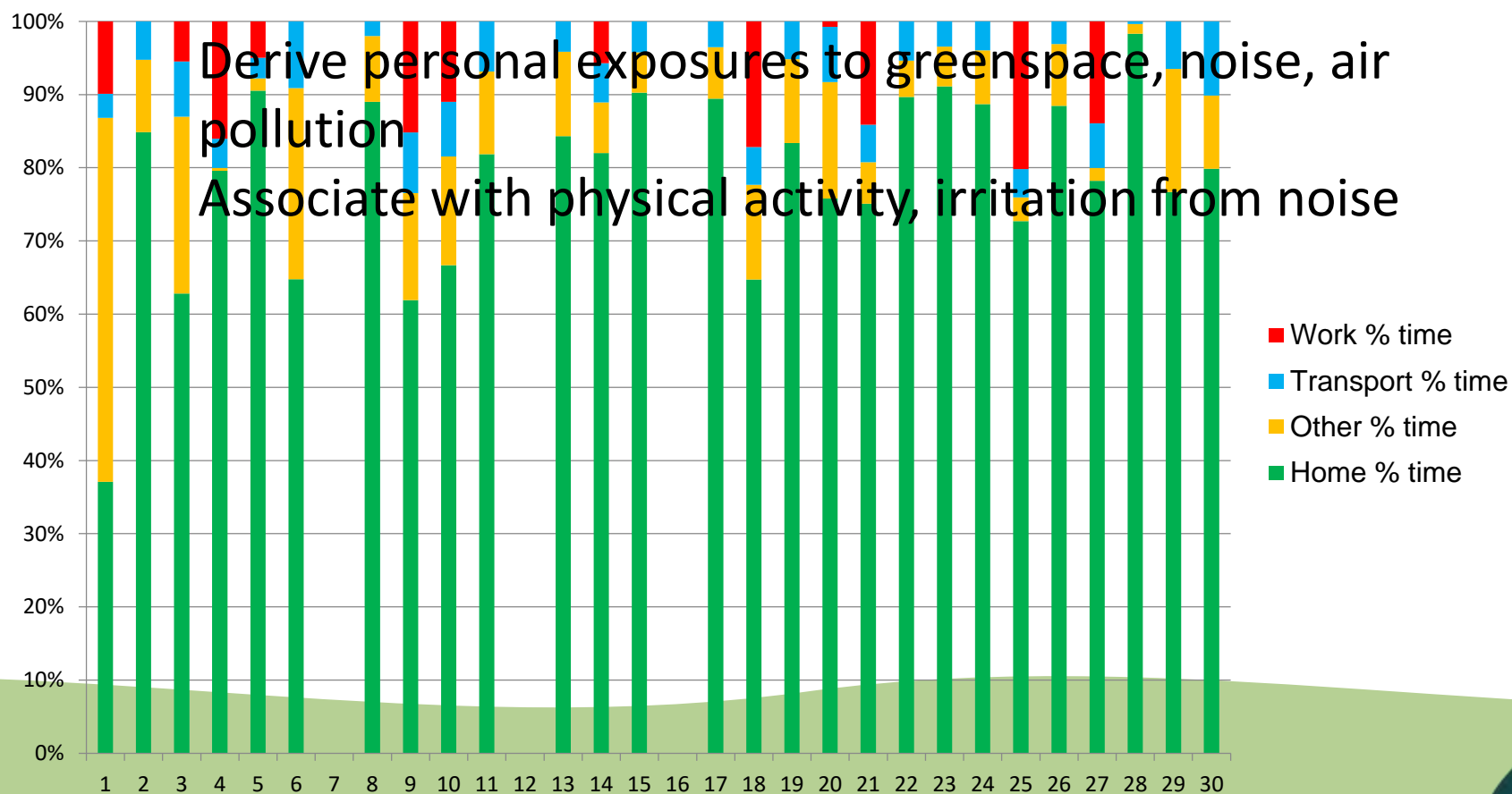
Approaches	What it measures	Specific technique	Coverage of "ome"	Throughput (low, medium, high)
Metabolomics	Metabolite signals, typically of > 10,000 endogenous and exogenous metabolites	NMR spectroscopy	Unknown, not all metabolites mapped yet	High
Epigenomics	DNA methylation	Chromatography-Mass spectrometry Illumina MethylationEPIC Bead Chip 850K DNA methylation array	Unknown, not all metabolites mapped yet Promoters, CpG islands, shores, open sea that has previously shown variability across tissues or disease states	Low to medium Medium to high
		Reduced Representation Bisulfite Sequencing (RRBS)	Restricts sequencing to areas of genome with high CpG content	Medium to high
		Whole-genome bisulfite sequencing	Full coverage of genome	Low to medium
Adductomics	Histone modifications Macromolecules covalently bound to endogenous macromolecules like DNA and protein	ChIP-seq High-resolution mass spectrometry	Coverage of whole genome across most cell types Allows detection of both known and unknown adducts	High High
Proteomics	Post-translational changes to proteins at the cellular level	Soft ionization mass spectrometry	Less targeted approach that allows capture of unknown proteins and protein complexes	Low to medium
		Antibody microarrays	Protein expression coverage based on probes available	Low
Transcriptomics	Nucleotide-level resolution of RNA expression	Hybridization-based technologies	Identification of any sequences included in array/technique	High
		RNA-seq	Full coverage of any RNA sequence in sample of interest, including low abundance transcripts	Medium
Genomics	Sequences and examines functions of genes	Next Generation Sequencing	Full coverage of genome	Medium to high
High-throughput screening	Receptor activity (e.g., estrogen, androgen, aryl hydrocarbon, G-protein signaling, ion channel activation)	Chemical Activated Luciferase gene eXpression (CALUX)	Selected receptors across wide range of media	High
		High content analysis	Phenotyping across many cell-based assays	Medium

'Smart' approaches



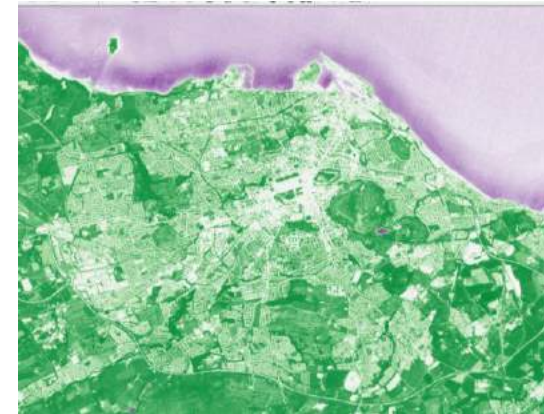


Moves App – Time spent in Microenvironments

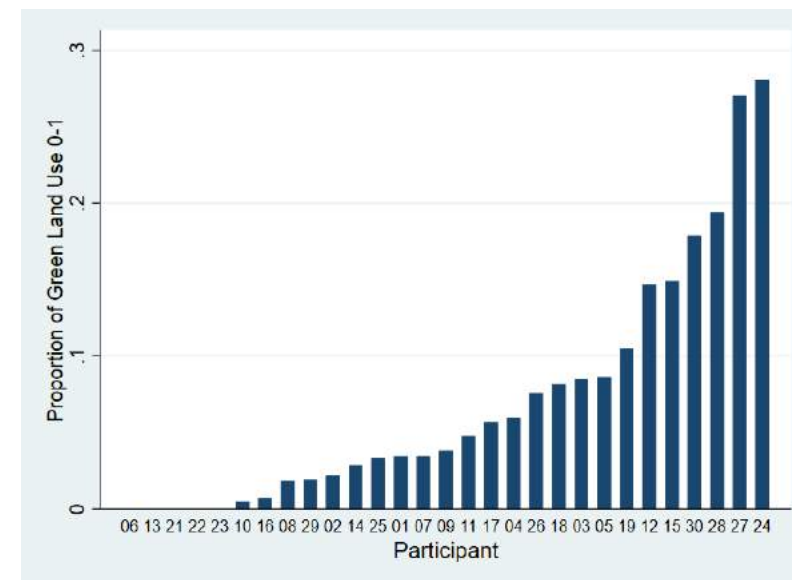
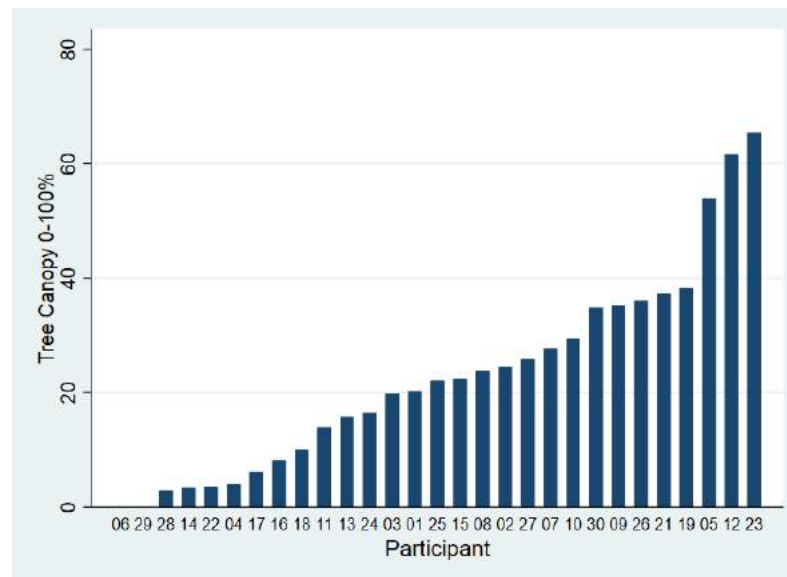
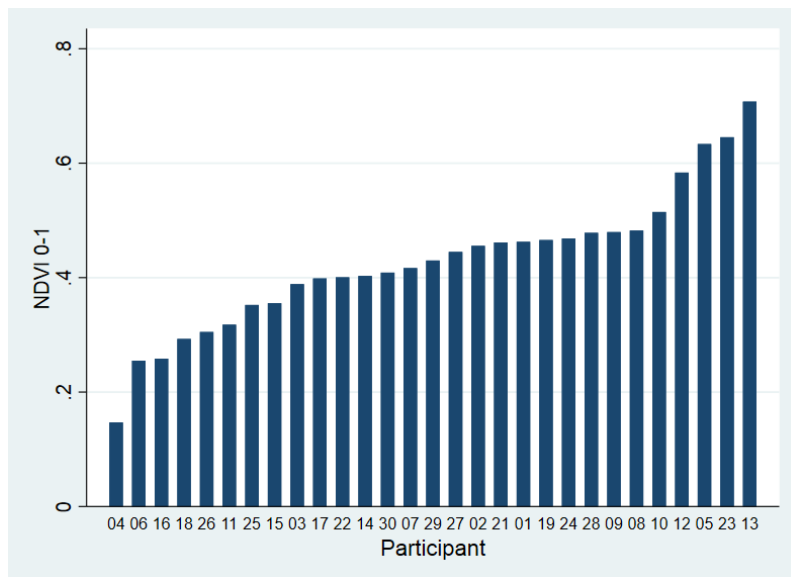


Greenspace

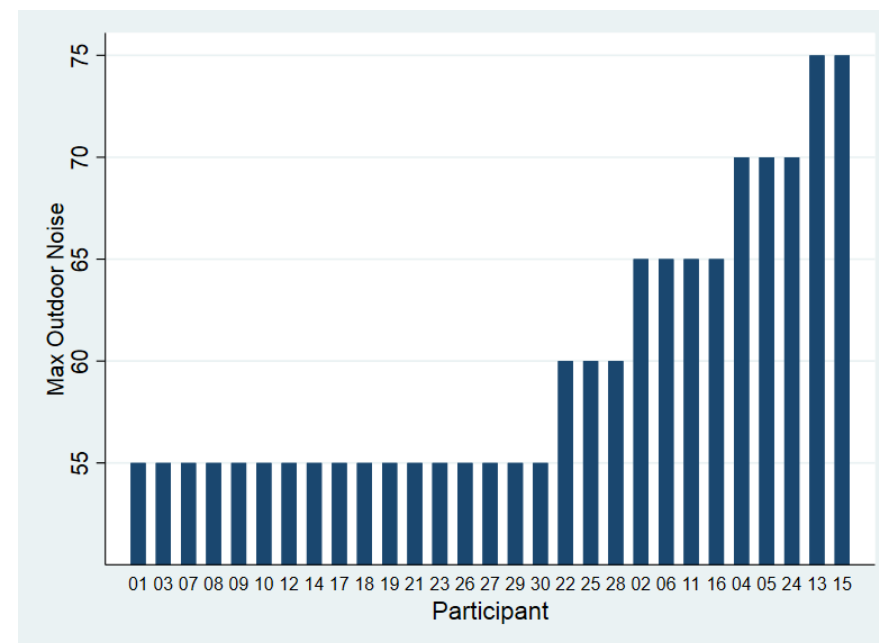
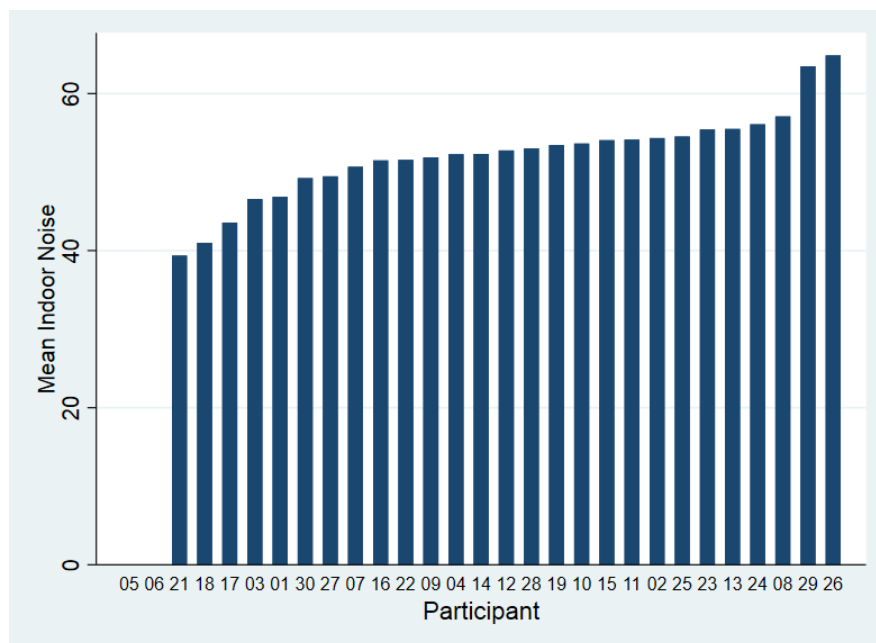
- NDVI was calculated using Sentinel-2 satellite images
 - Measures overall vegetation with values from -1 (water) to 1
- Tree canopy is the percentage of land that is covered by the tree canopy (0-100%), using Sentinel-2
- The proportion of green land use shows the amount of green land, e.g. parks, fields, within a 300 m buffer of home addresses, using Urban Atlas data.



Greenspace at home address



Noise at home address



Solutions: Evidence based urban management



Environmental zones



Increased walkability



Smartmobility 2017



Citizen engagement



Event safety



Promotion of healthy lifestyle



...and personalised prevention

Sensors for environmental quality & location



Self measurement health



Sensors lifestyle: diet & exercise



Health professional



Medication use



Support groups & family



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