

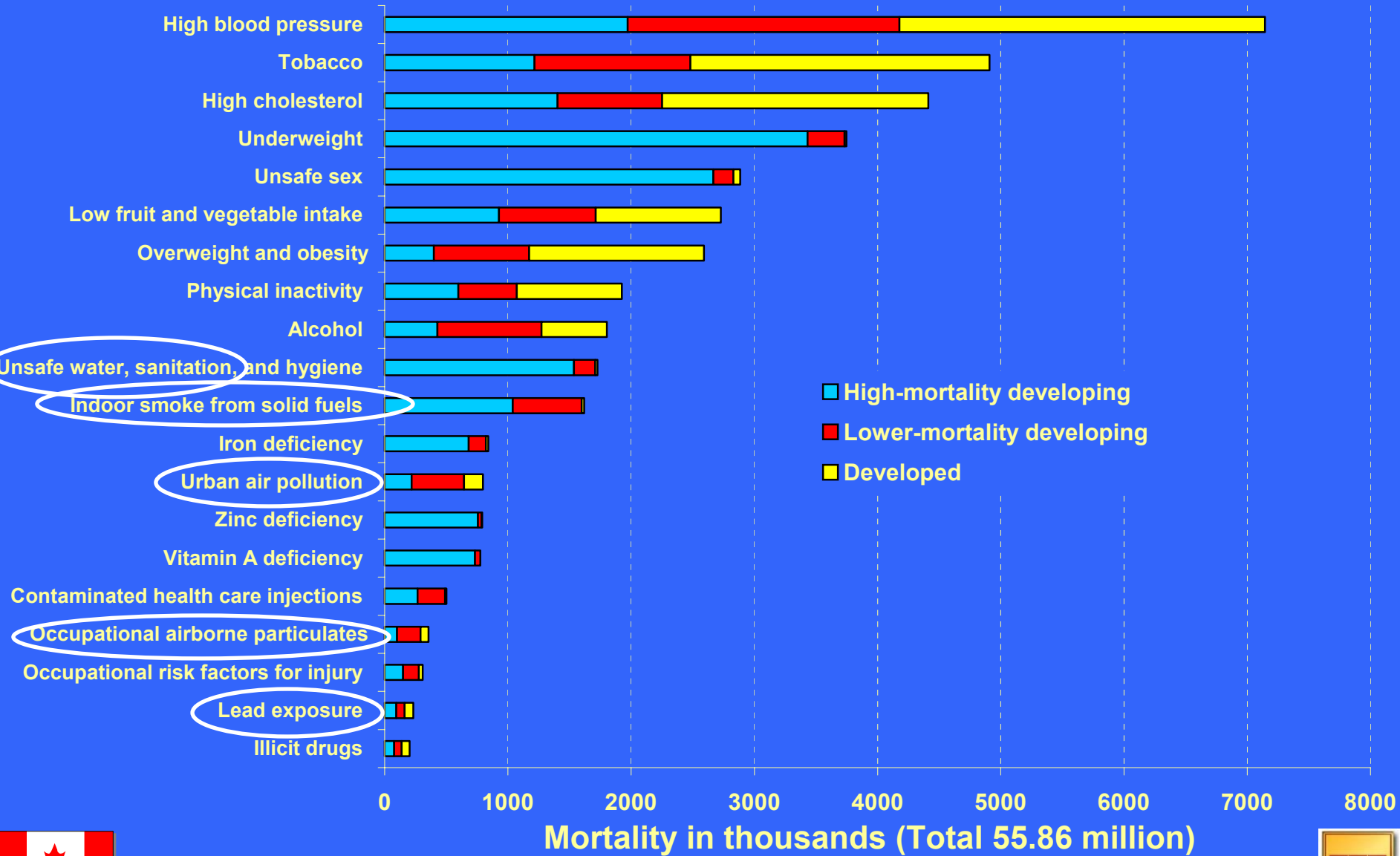
The “Environmental Burden of Disease” – Prospects for Canada

- concepts of “burden of disease”
- causal attribution in general – how?
- the (physical) environment in particular
- some specifics for Canada

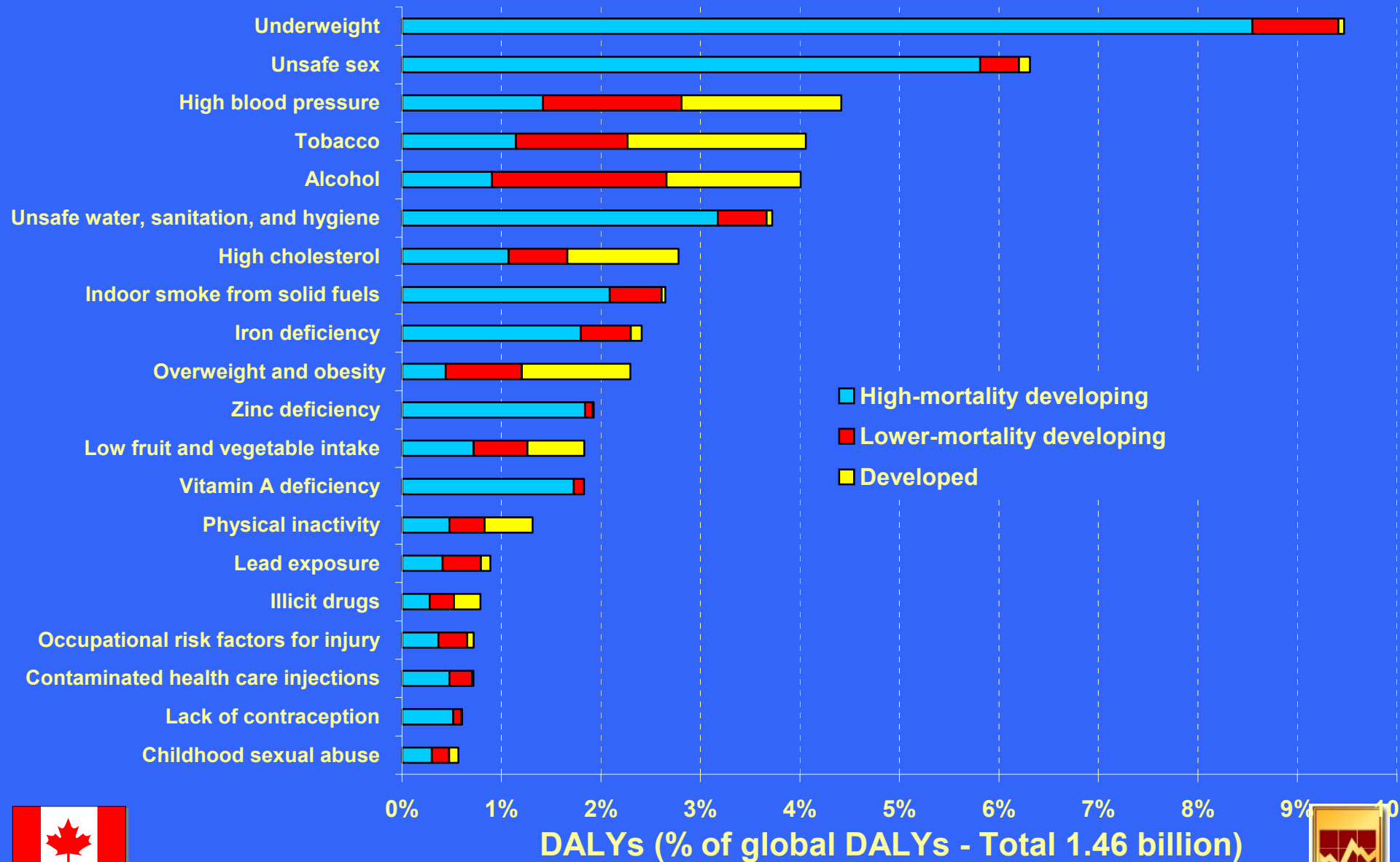
Michael Wolfson, Statistics Canada



Mortality attributable to leading risk factors



Burden of disease attributable to leading RFs



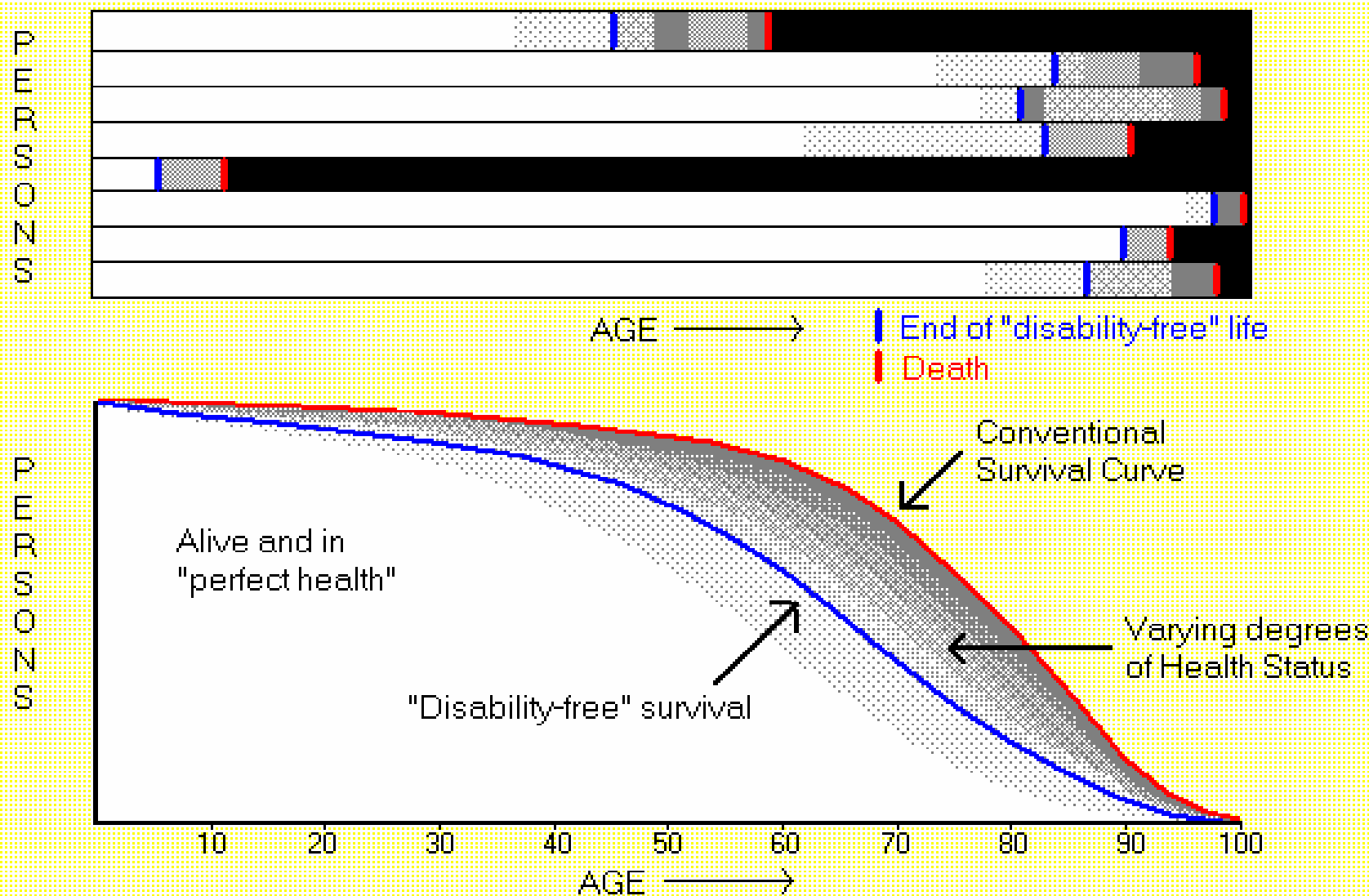
Key Points / Questions re Burden of Disease or RF

- need a metric
 - HALE = Health Adjusted Life Expectancy
 - vs DALY (arbitrary discounting / max LE)
 - vs YLL (max LE, non-fatal outcomes)
 - vs death counts (ignores how long survival would have been)
- need to think about time
 - ideally embedded in real calendar time
 - but most analyses are timeless (steady state, ignore history and prospect)



System of Health Statistics: Population

Connections to Survival Curves



Key Points / Questions re Causal Attribution: WHO GBD Spreadsheet Model Underlying Assumptions

- every death has exactly one (bio-medically defined ICD) disease “cause”
- each disease (working back) has a duration and disability index (weight)
- each risk factor “causes” a given (fixed) proportion of the incident cases of one or more diseases



Basic CRA framework and goals

Risk factor levels

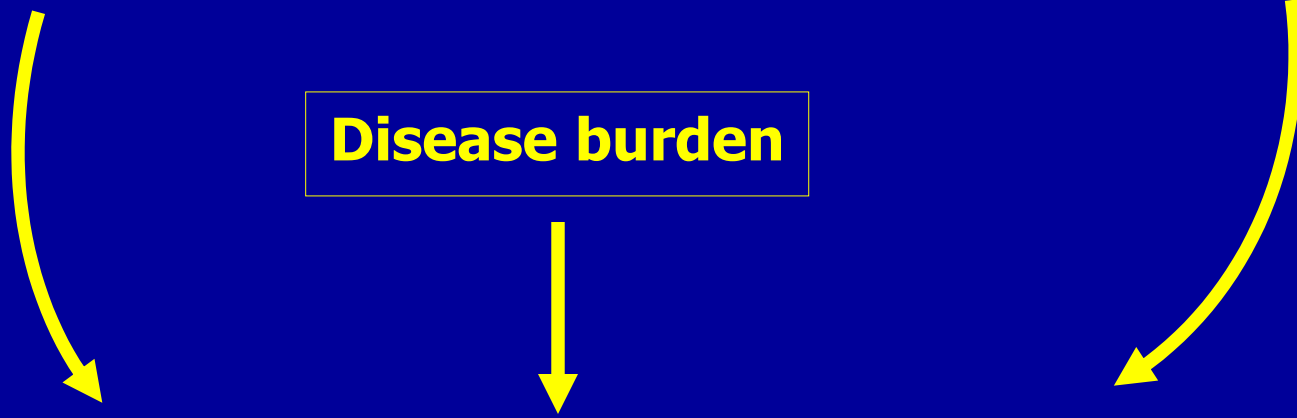
- current distribution
- counterfactual distribution(s)

Risk factor-disease relationships

- risk accumulation
- risk reversal

Disease burden

Attributable burden in 2000
Avoidable burden in 2010 & 2020

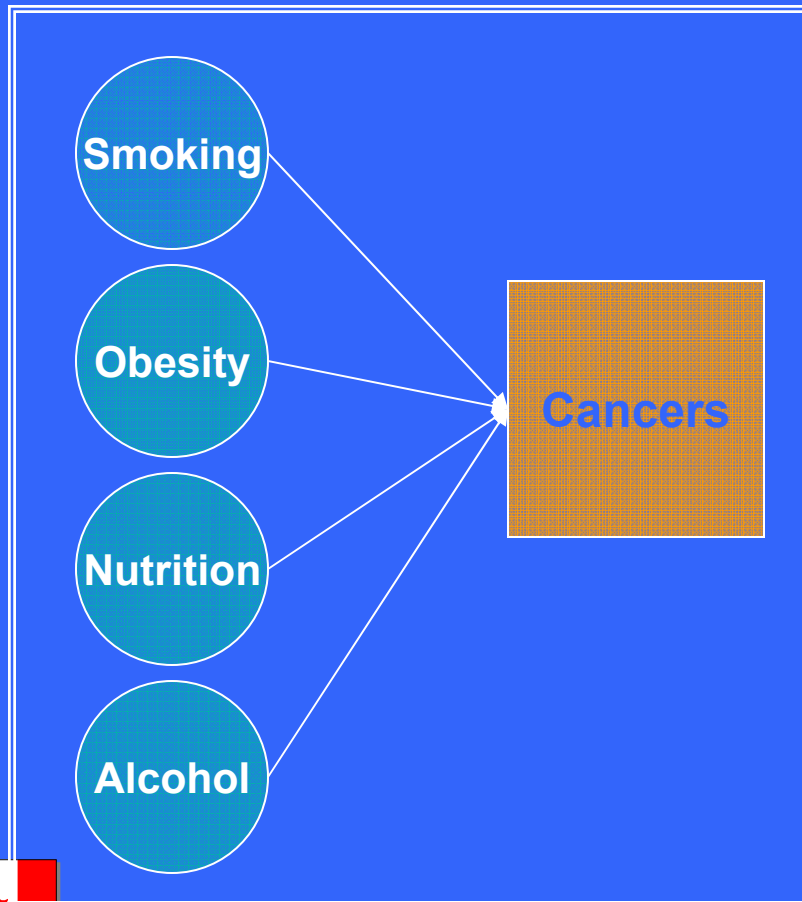


Simple (Spreadsheet) Models

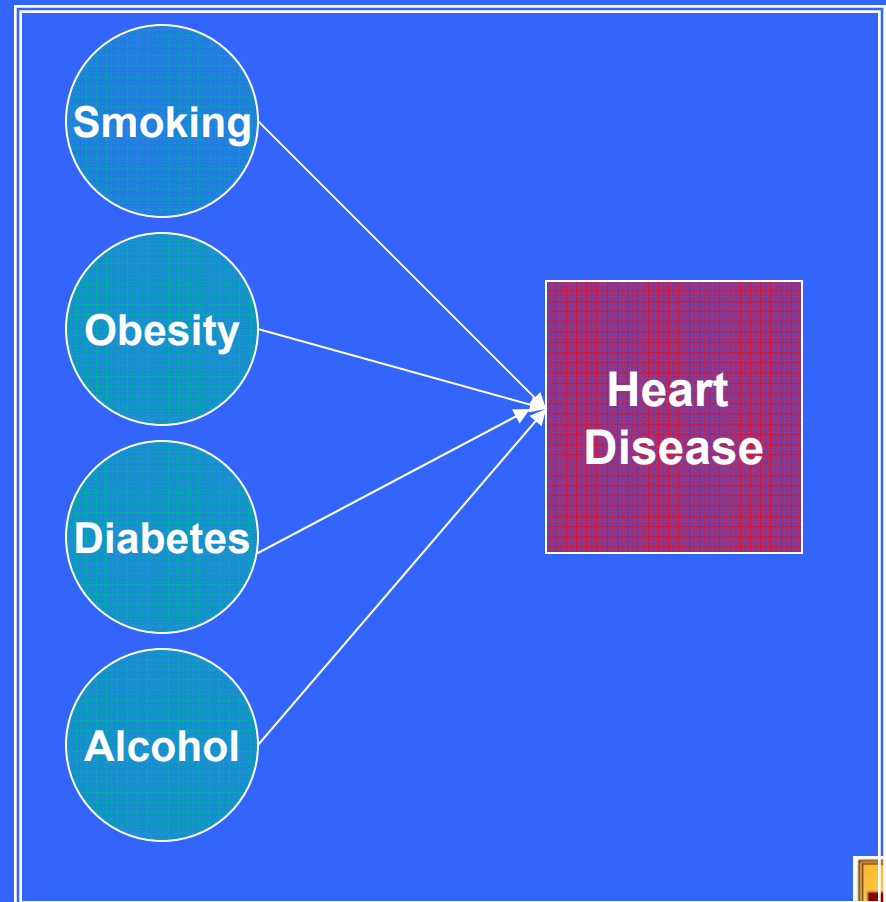
The Workbook Approach

(selected risk factors)

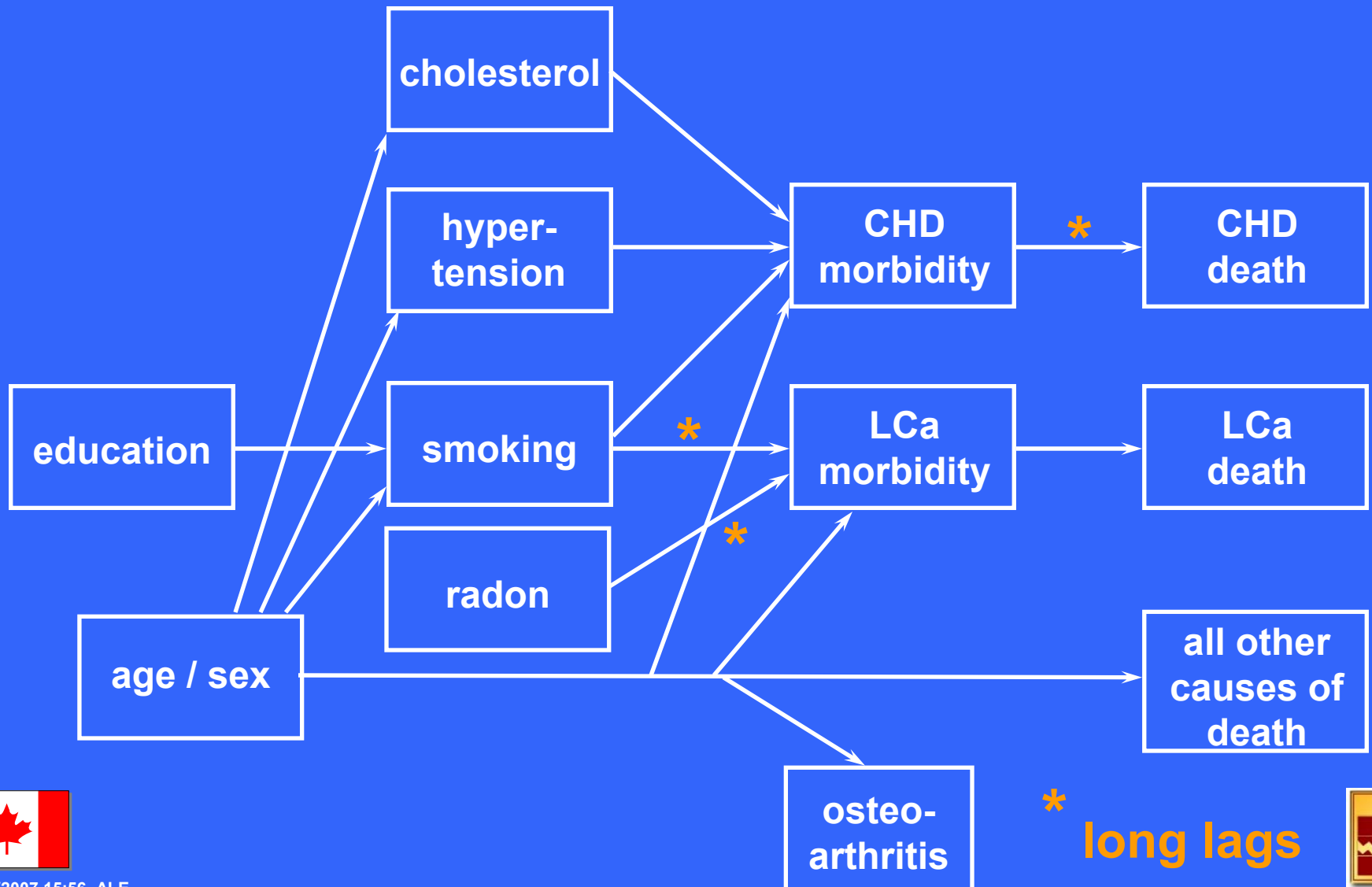
Cancer Model



Heart Disease Model



Closer to Actual “Web of Causality” Multifactorial, Lags, Competing Risks



Quantifying the Effects of Causes

- the “Burden of Disease” is the difference between
 - level of disease (or LE or HALE) actually observed, and
 - what would be observed if the specified disease (or in this case, environmental risk factor) were absent
 - \Rightarrow essential to construct a (complete) counterfactual or hypothetical version of reality
 - \Rightarrow (at least implicitly) a quantified web of causality + a simulation model



Challenge: “Requisite Variety”

- i.e. what is the minimum level of detail / richness / complexity (i.e. “variety”) needed to generate plausible and useful counter-factual realities / simulations
- (with thanks to Stafford Beer)

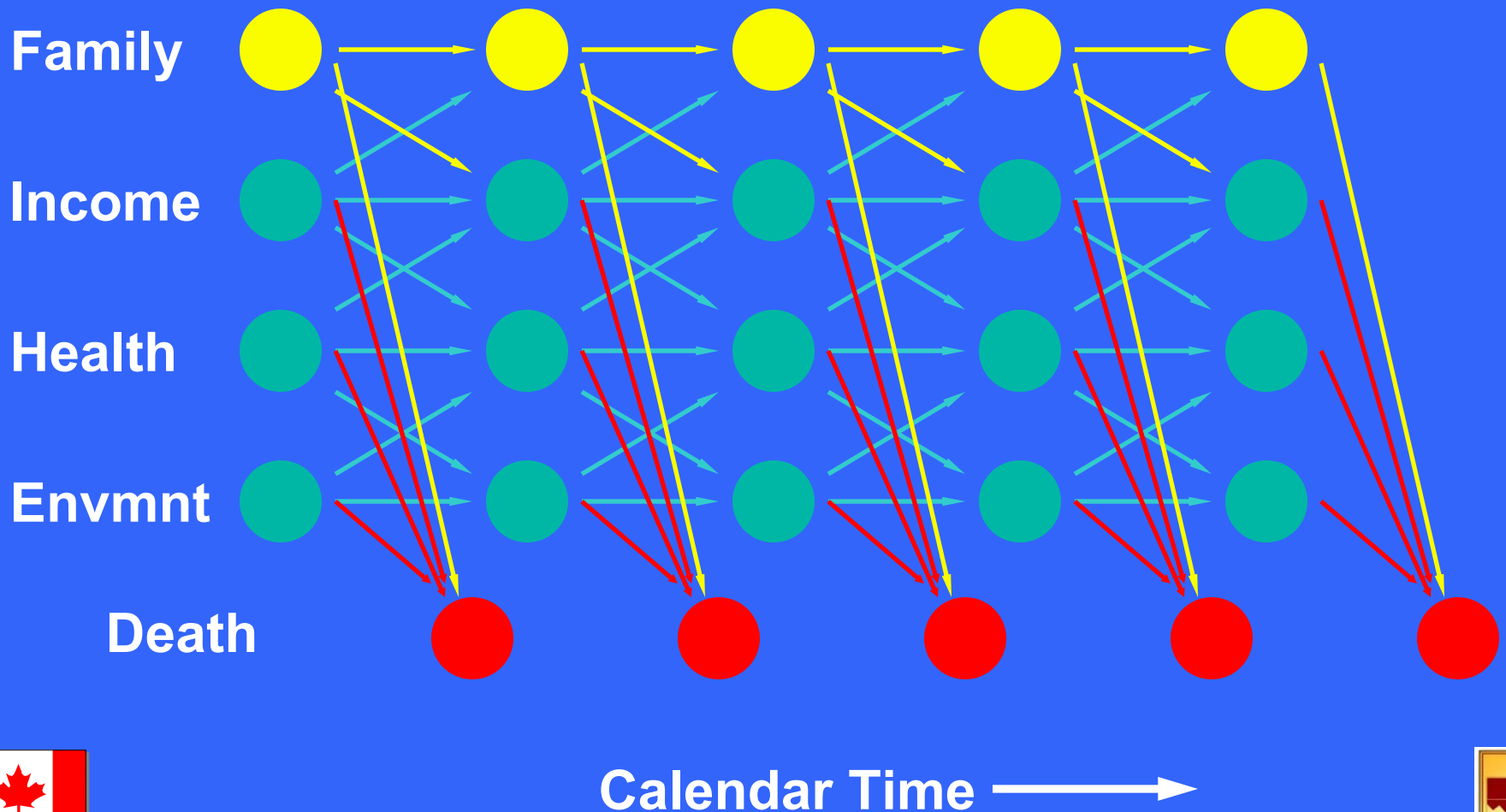


Axioms for Requisite Variety in GBD-Type Analyses

- the “web of causality” should account for (important) multi-factorialness ⇒
 - include explicit competing risks, co-morbidity
 - important covariates as “confounders” – *not*
 - simple scalar attributable fraction inadequate; use full info from multivariate risk function
- health and disease unfold over time ⇒
 - a life course perspective is essential
 - analysis embedded in real calendar time
- individuals are heterogeneous and effects may well be non-linear ⇒ microanalytic rather than cell-based methods

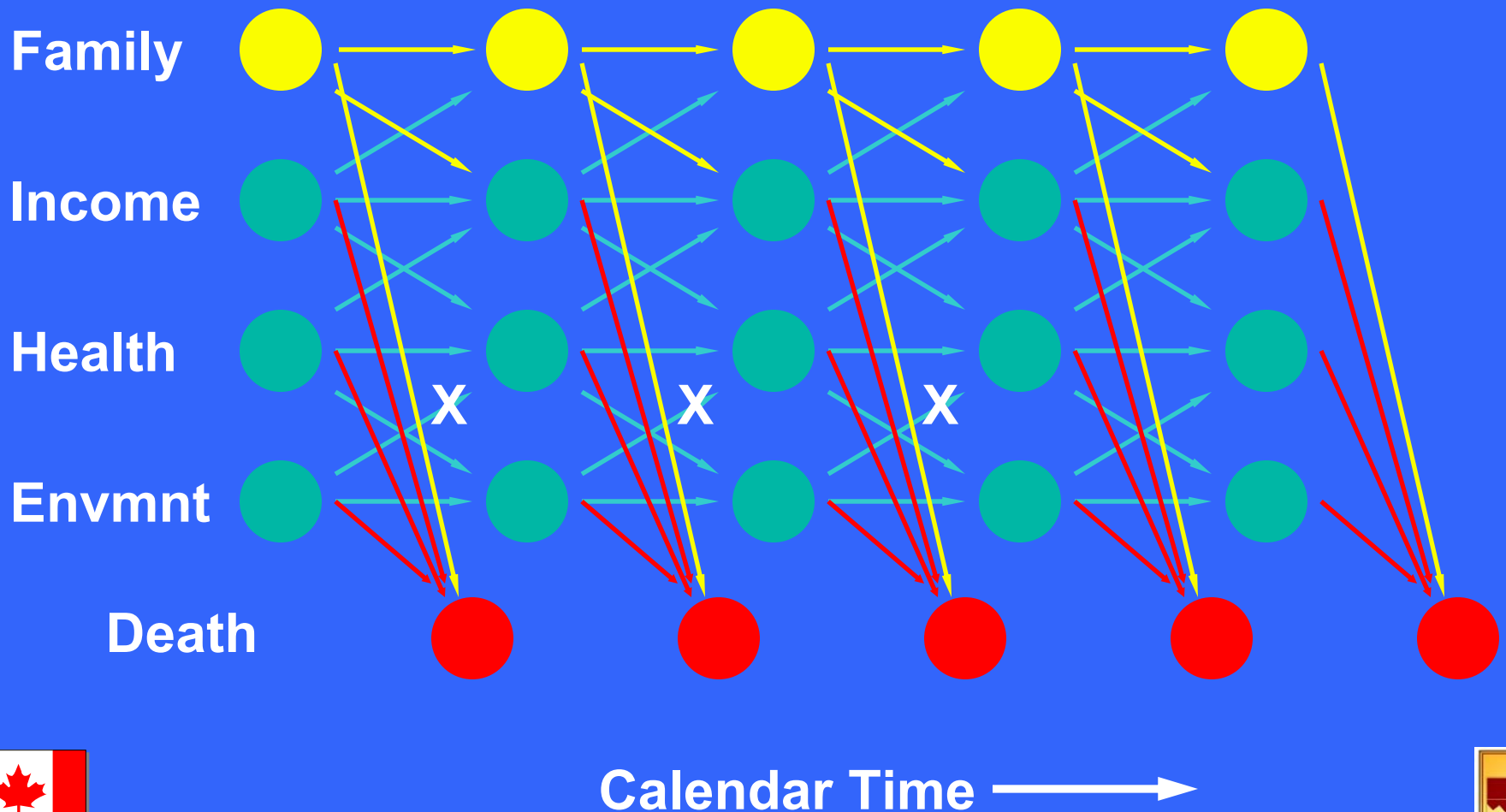


“Web of Causality” with Requisite Variety (arrows illustrate logical possibilities and not strength of influence; first order only)



Complex “Web of Causality”

explicit construction of counter-factual, “knock out” one pathway, then assess (simulate) impact



Calendar Time →



Environmental Risk Factors – Requirements for “Attributable” GBD

- well-estimated multivariate risk functions for disease
- good population estimates of (the joint distribution of) prevalences or exposures by level over time (joint with other significant factors, e.g. SES, Framingham risk factors)
- an appropriate “counter-factual builder” = microsimulation model, e.g. Statistics Canada’s POHEM (POpulation HEalth Model)



Estimating the Health Burden of Environmental Toxins in Canada

- relative risks – from published literature
- population exposures – better primary data collection
 - note Canadian Health Measures Survey
- disease → morbidity → health status → mortality model – can build on POHEM
- n.b. global warming does NOT fit well into this framework

