On Unjust Health Inequalities

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- "[Economics, Epidemiology, etc.] only begin to get interesting when we consider a world of **heterogeneous** individuals." (Modeling the Benefits of Insurance)
- "…**heterogeneities** capture the generic observation that when populations are partitioned by some variable of interest, significant health differences are frequently found ... Comparing these sub-populations may then provide clues to determine the causal factors in differences in health, without simultaneously implying (or denying) that these differences represent '**inequalities**' in the sense of indicators of **injustice**." (Health, Hierarchy and Hominids)
- (rather than making completely unrealistic theoretical assumptions) "**go and find out**"

Bob Evans

Plan of the Presentation

- disjoint approaches to “unjust” health inequalities
  - moral philosophy – discuss sources of health inequality; but generally no data
  - standard empirical methods – describe “the gradient” statistically; look for correlates; but generally no moral reasoning, just “gradient bad”
- HealthPaths simulation model approach
  - bring together moral reasoning (the “sources” of health inequality) and “causal” empirical analysis
  - use empirical results in order to simulate counter-factuals – specifically *“what if” unjust sources of health inequality were removed?*

Health Inequalities – Conventional Approaches to Observation

- health status by socio-economic status (e.g. income, education) or other factors (e.g. gender, race, geography)
- mortality rates by small area average income

- these approaches are essentially cross-sectional, and treat health status while living separately from mortality
- this analysis
  - brings together health status and mortality
  - looks at full life-cycles, not age groups

Health Inequalities – Various Definitions

- "inequalities in health" = Gini coefficient of (age-standardized) ages at death (LeGrand, 1987)
  - note: focus on ***univariate*** distribution, nothing on SES
- "Equity has long been considered an important goal in the health sector. Yet inequalities between the poor and the better-off persist." (World Bank, 2007)
  - note: inequity = inequality; and presumes inequity is entirely about the SES gradient; a ***bivariate*** relationship
- health equity = "the absence of systematic disparities in health … between social groups who have different levels of underlying social advantage/disadvantage" (Braveman & Gruskin)
  - note: "social groups" ⇒ categorical variable

"Beware of the Mean"

- well-intentioned population health interventions that improve population health overall may have the unintended consequence of increasing health inequality, e.g.
  - smoking cessation campaigns
  - asthma management information to patients

Moral Philosophy and Unjust Health Inequalities – Various Definitions

- health inequality is unjust (= unfair = inequitable) if due to factors related to unequal opportunities or amenable to policy interventions (Asada, Hausman)
- "health inequalities .. plausibly attributed to freely undertaken personal choices are fair" (Deaton)
  - skydiving? but what about Médecins Sans Frontières?
- what really matters is overall well-being, where health is only one component; health inequalities are only unjust if they are not compensated in other domains of well-being (Deaton)
  - OK, focus only on interventions unlikely to have noticeable effects on other domains of well-being

HealthPaths – Main Ideas / Innovations

- focus on determinants of HALE = health-adjusted life expectancy (a complex “dependent variable”)
- beyond conventional population attributable fractions, and categorical attribution (as in GBD)
- build on heterogeneous individual-level life course trajectories
- focus on functional health (vs diseases, biomarkers – recall Bob Evans, “disease as epiphenomenon”)
- include co-morbidity & competing risks explicitly
- tight coupling between (“extreme”) statistical estimation and microsimulation modeling

HealthPaths Construction and Use

- use longitudinal Statistics Canada's National Population Health Survey + mortality follow-up
- estimate multiple co-evolving individual health and health-related dynamic relationships, generalizing concept of risk function
- incorporate into HealthPaths microsimulation model
- use counter-factual simulations to assess relative importance to ΔHALE of major health determinants,
- use a *visual/graphical metric* for health inequalities
- focus: estimate and display impacts of three ameliorable = unjust sources of health inequalities on the univariate distributions of LE and HALE

Risk Factors / Events and Health States Included

Ordinal Variables

- Vision
- Hearing
- Speech
- Mobility
- Dexterity
- Emotion
- Cognition
- Pain

Functional Health summarized via HUI

- Income Decile
- Leisure Activity
- Daily Activity
- Smoking

Binary Variables

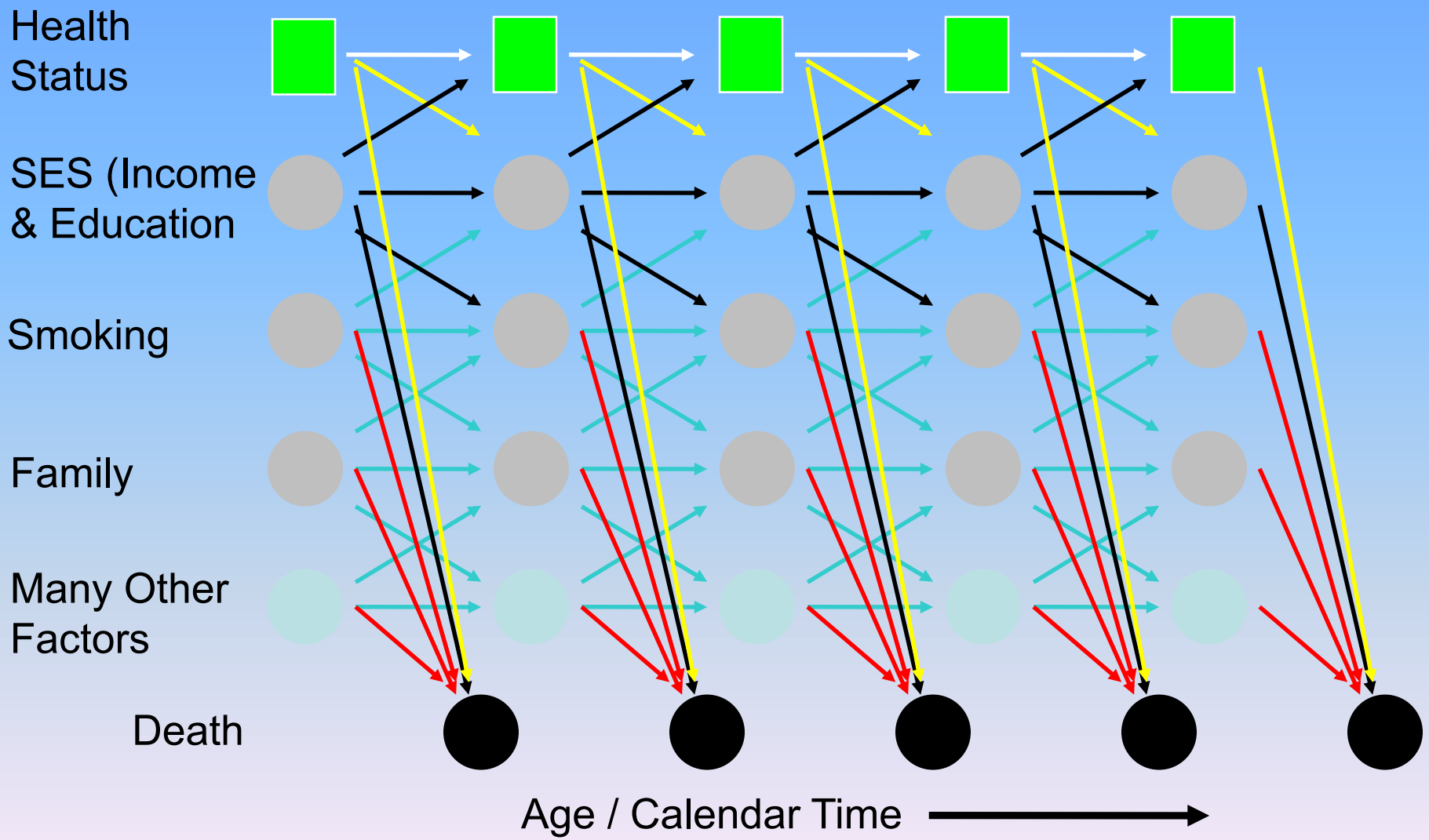
- Employed this Year
- Family Member
- Institutional Resident
- High School Graduation
- Community College
- University Graduation
- Mortality

Quantitative Variables

- Body Mass Index
- Sense of Mastery
- Sense of Coherence
- Years of Daily Smoking

Step 1: Estimation Using NPHS, Multiple Equations for Co-Evolving and Mutually Interacting Factors

(n.b. not all possible arrows shown)



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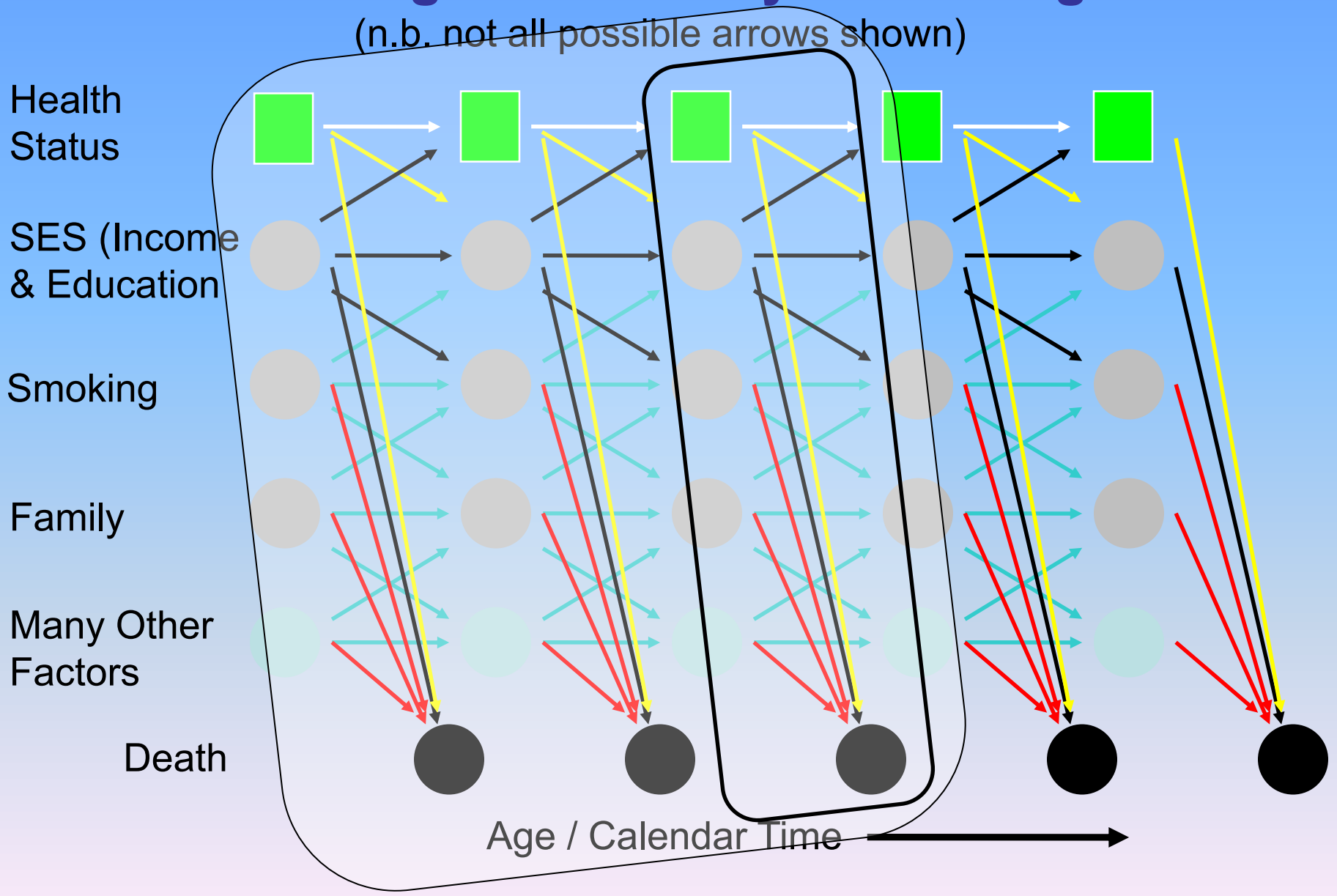

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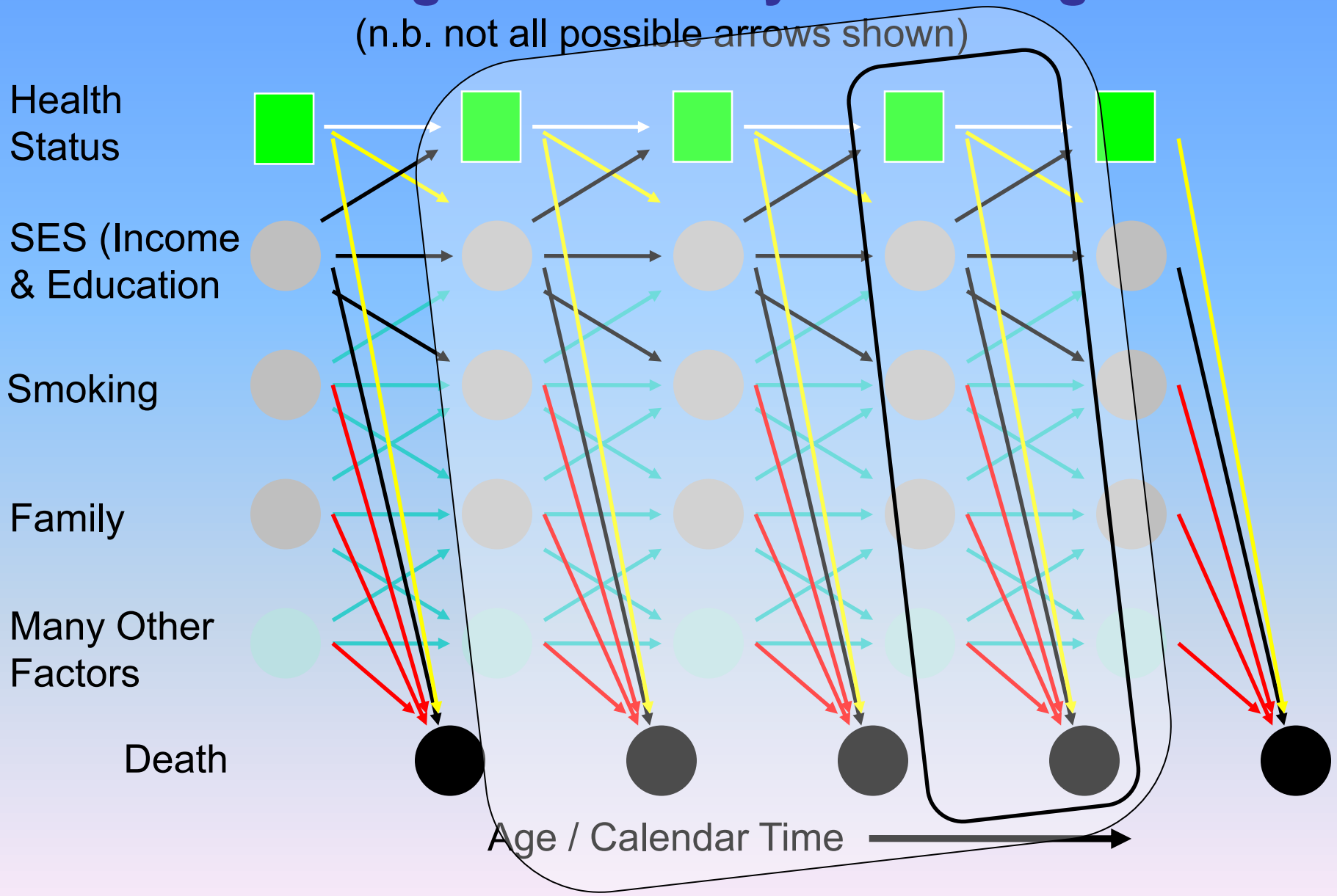

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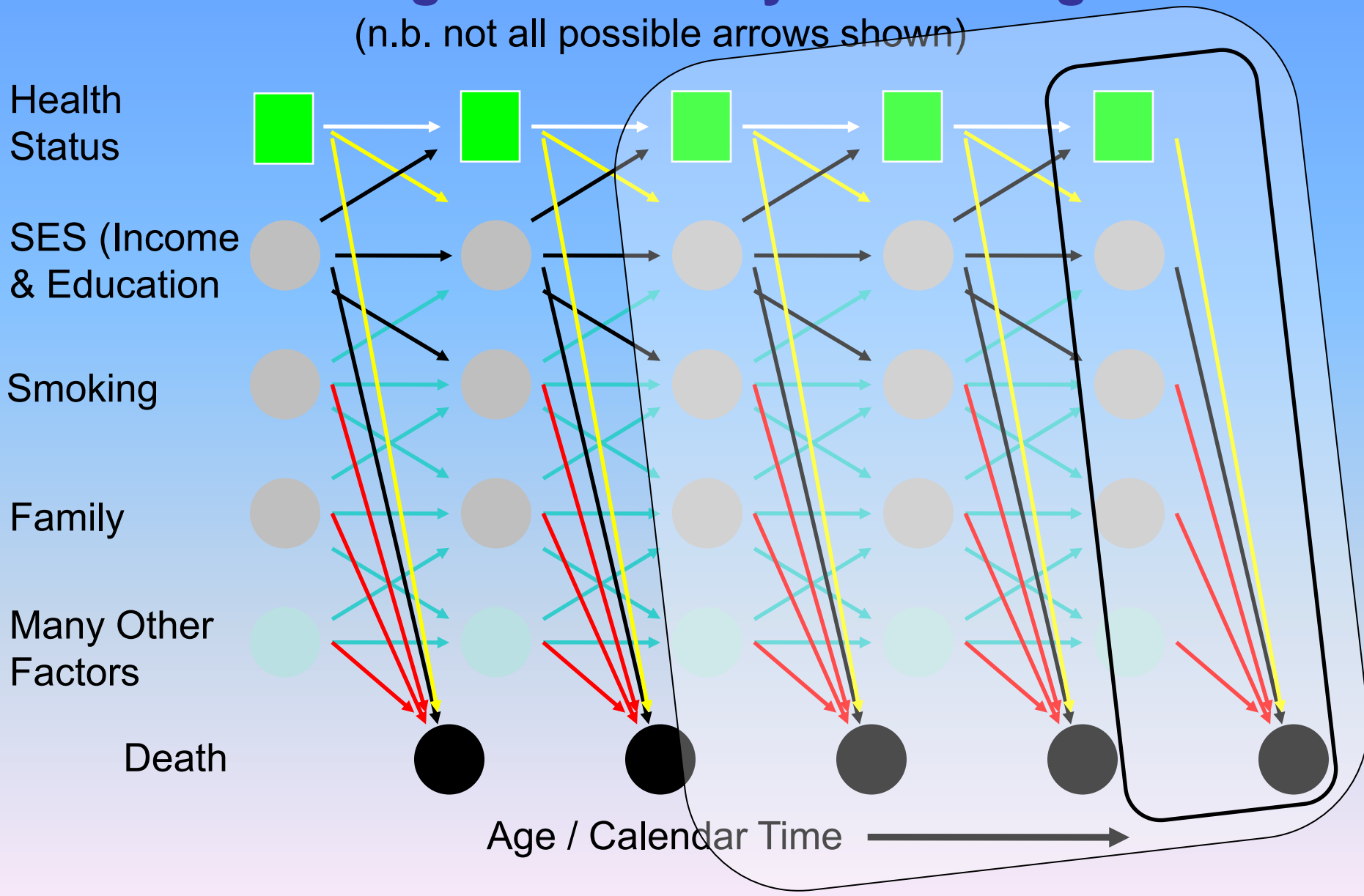
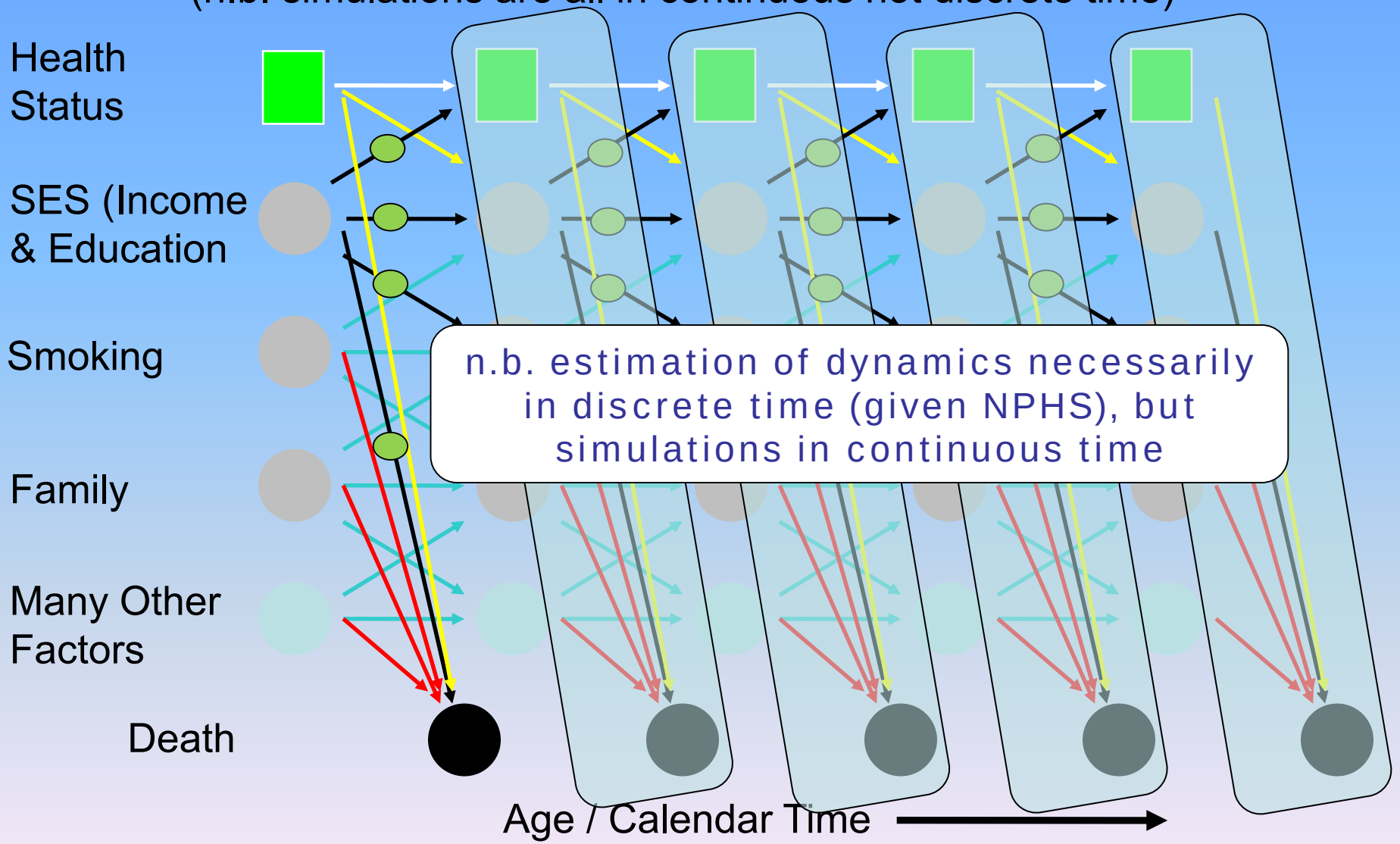
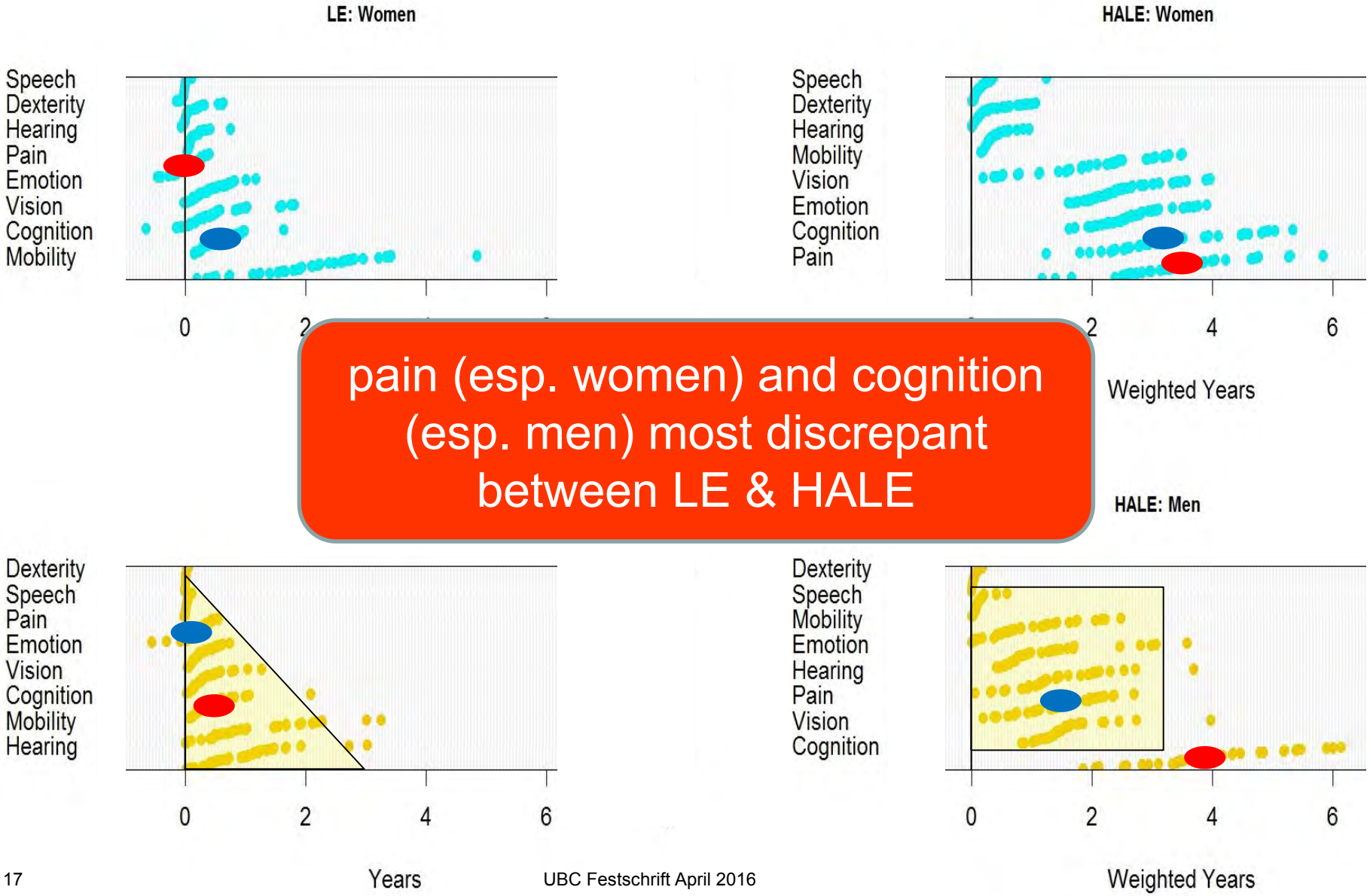


Step 2: Recursive Simulations, Both Baseline and Counterfactual "Knockout" or Knock To

(n.b. simulations are all in continuous not discrete time)



Functional (HUI) Health Impacts, LE and HALE, Men and Women



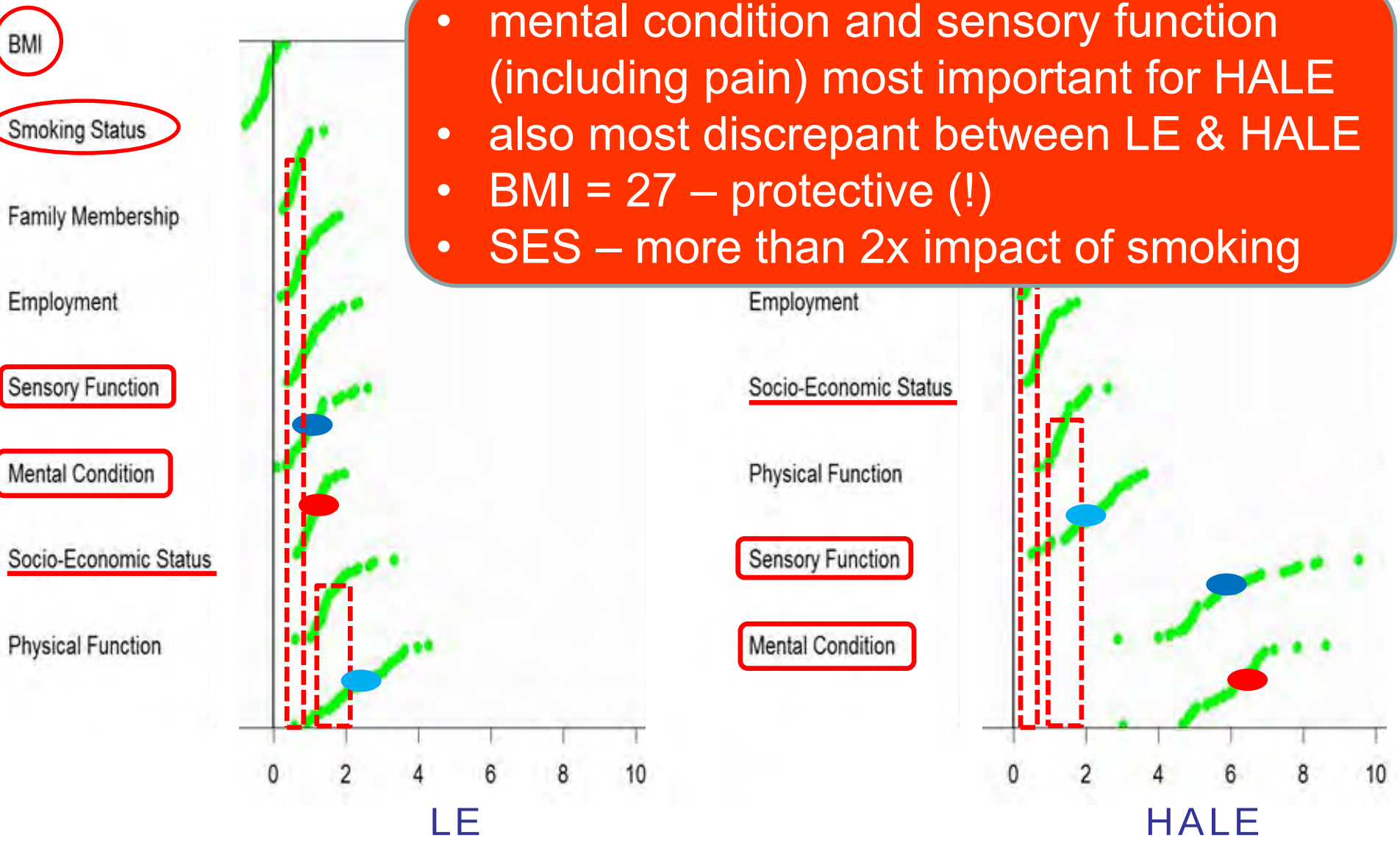
Results for Composite Risk Factors

- BMI, smoking, family membership, employment – used directly
- Socio-Economic Status (SES) = Education + Income
- Physical Function = Leisure + Daily Non-leisure + Mobility + Dexterity
- Mental Condition = Sense of Coherence + Sense of Mastery + Emotion + Cognition
- Sensory Function = Vision + Hearing + Speech + Pain

Composite scenarios fix a set of variables at 'optimal' scores (eg. for SES, everyone is a university graduate with income always in the top decile)

Composite Risk Factor Impacts
(both sexes, 40 replicates each)

- mental condition and sensory function (including pain) most important for HALE
- also most discrepant between LE & HALE
- BMI = 27 – protective (!)
- SES – more than 2x impact of smoking



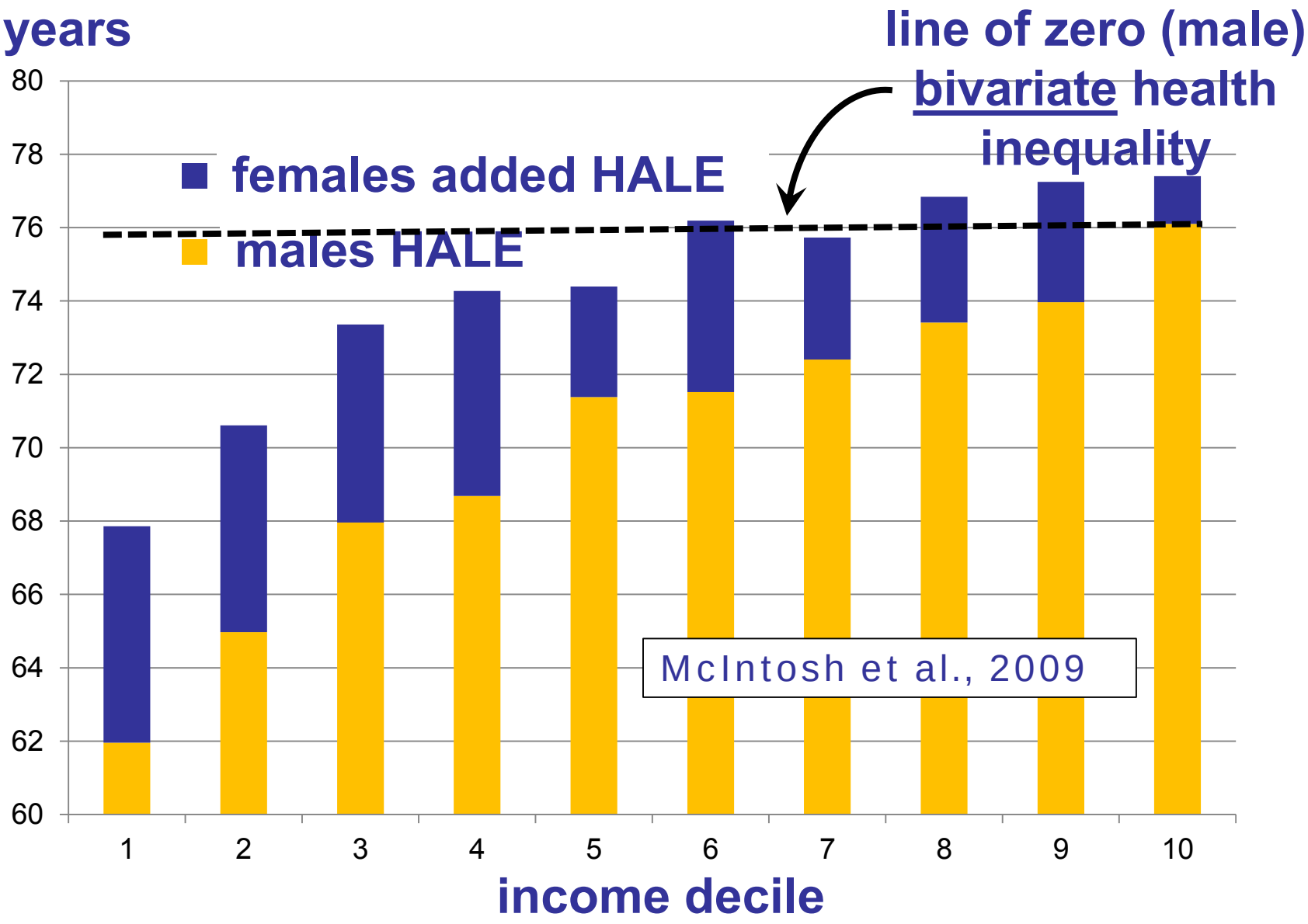
Digression on BMI

- Flegal et al. (JAMA, 2005) “overweight was not associated with excess mortality” (NHANES)
- Flegal et al. (NEJM, 2013) “Grade 1 obesity overall was not associated with higher mortality, and overweight was associated with significantly lower all-cause mortality.” (meta-analysis)
- Tomiyama et al. (I.J.Obesity, 2016) “Using BMI categories as the main indicator of health, an estimated 74,936,678 US adults are misclassified as cardiometabolically unhealthy or cardiometabolically healthy.” (NHANES)

Measuring Health Inequalities

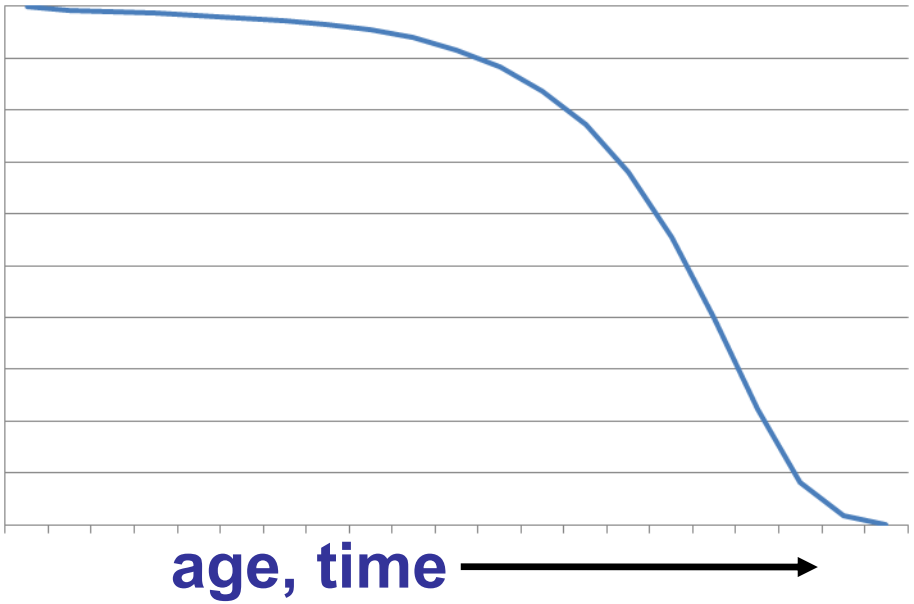
- important to distinguish univariate and bivariate approaches
  - major argument between Murray and Marmot
  - e.g. Wolfson and Rowe (2001); Asada (2013)
- most prevalent – bivariate distributions, especially SES gradients
- rather unusual – univariate distribution
  - e.g. Legrand (1987, 1989)
- but if we want to compare SES with other unjust sources of health inequalities, we need a metric or approach that is independent of SES

Conventional SES Gradient and Bivariate Health Inequality



Conventional Survival Curve and Univariate Health inequality

i.e. zero univariate health inequality = zero variance in the distribution of ages at death (for LLs) or at the ends of health-adjusted life lengths (for HALLs)

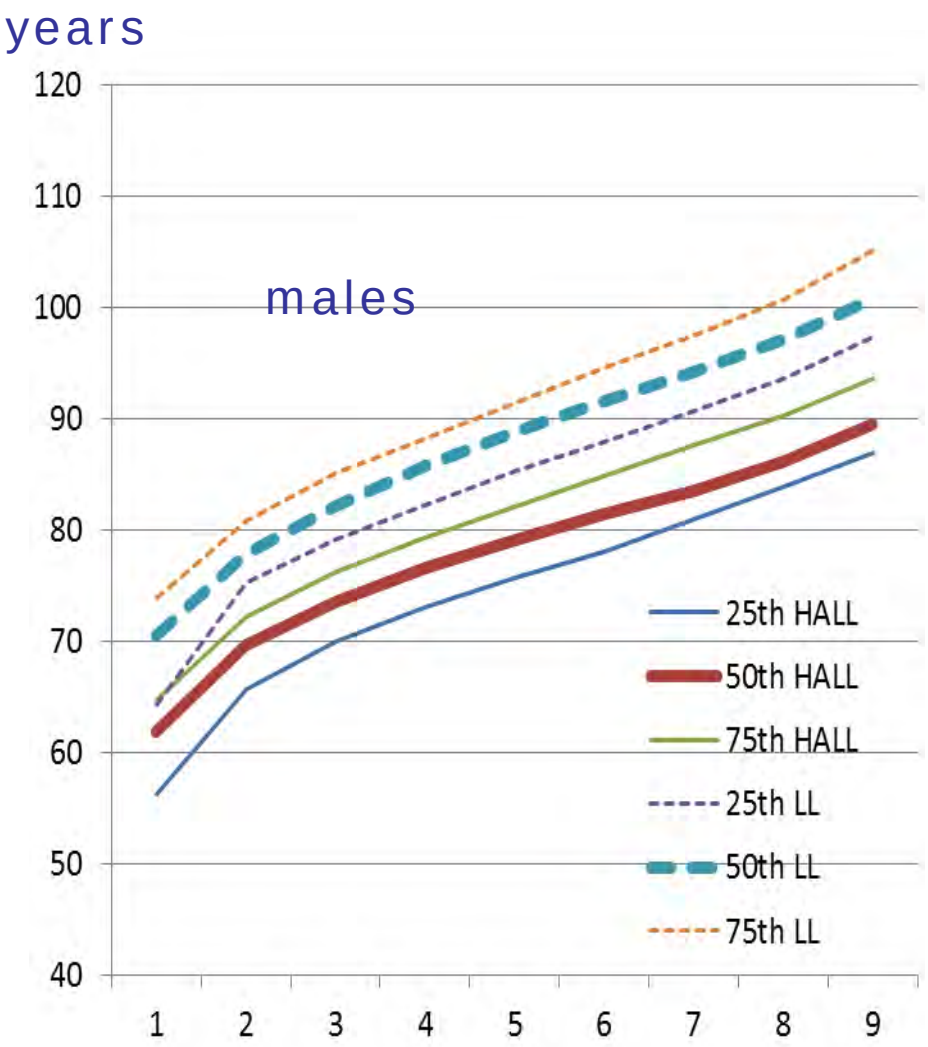


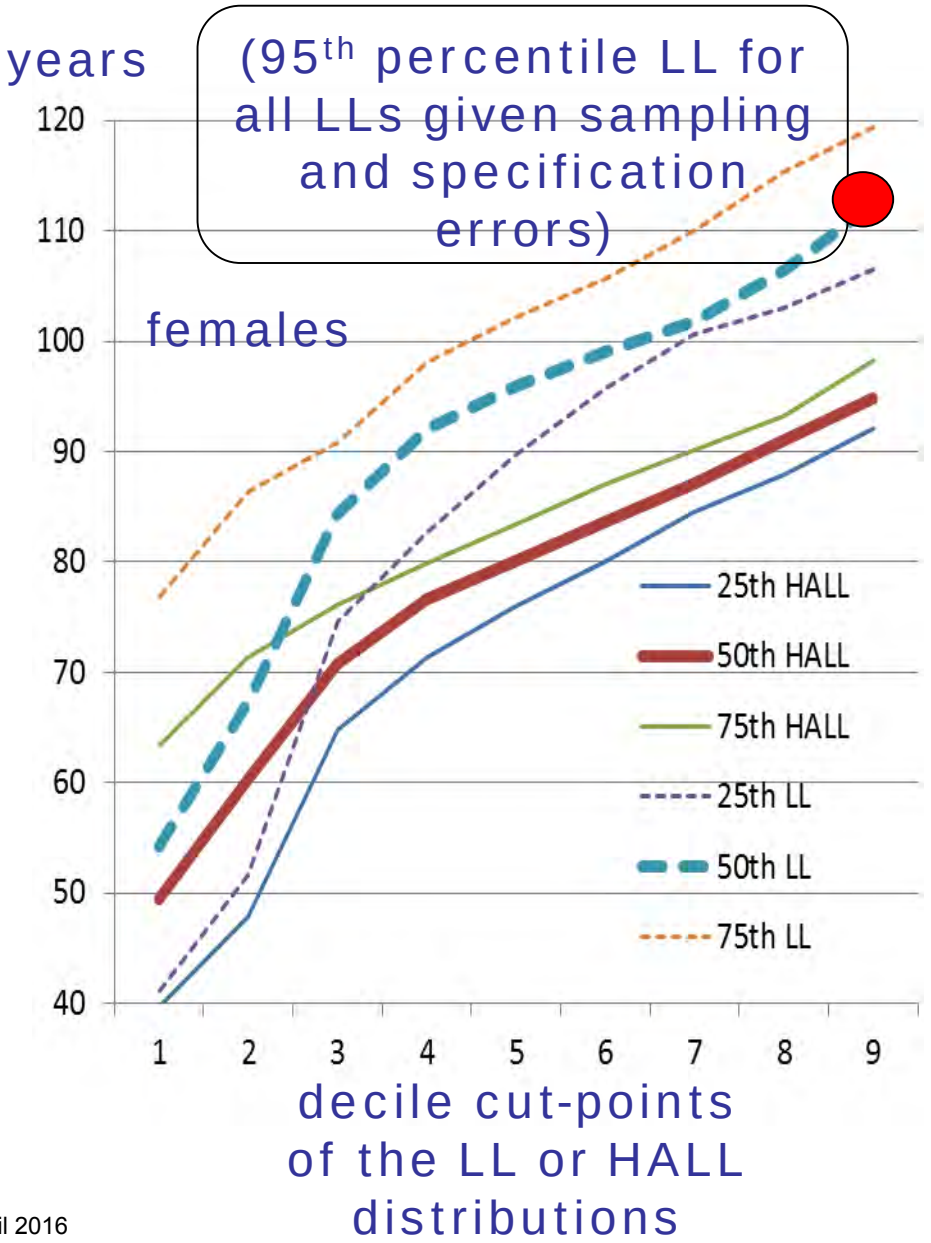
line of zero univariate health inequality

when comparing two univariate distributions, lower health inequality = larger increases in LLs or HALLs at lower levels of LL or HALL

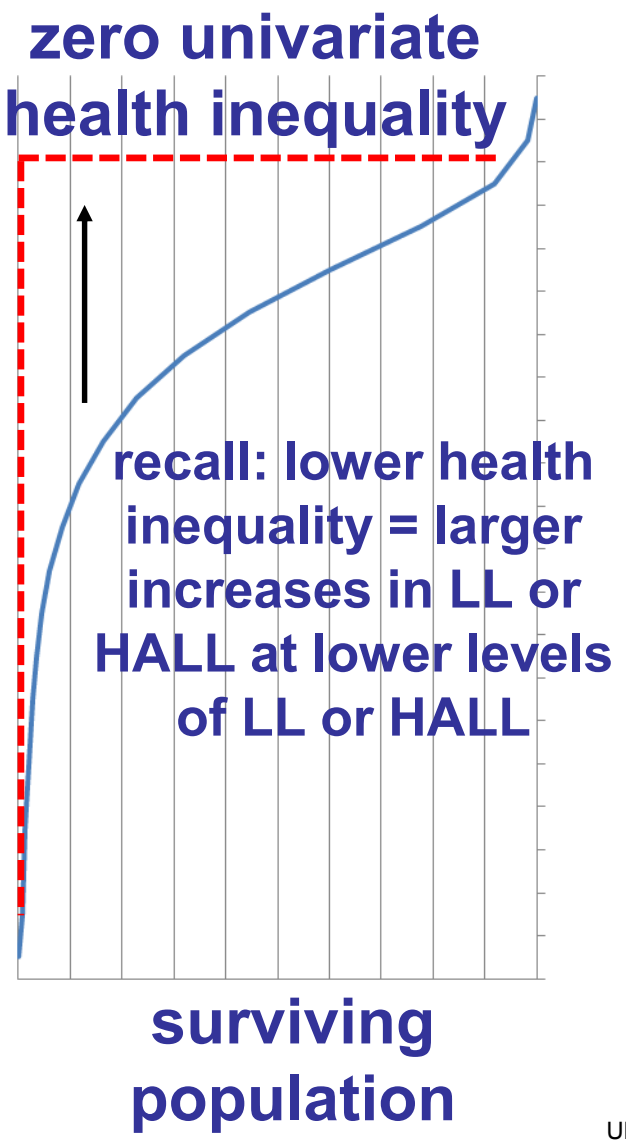
surviving population

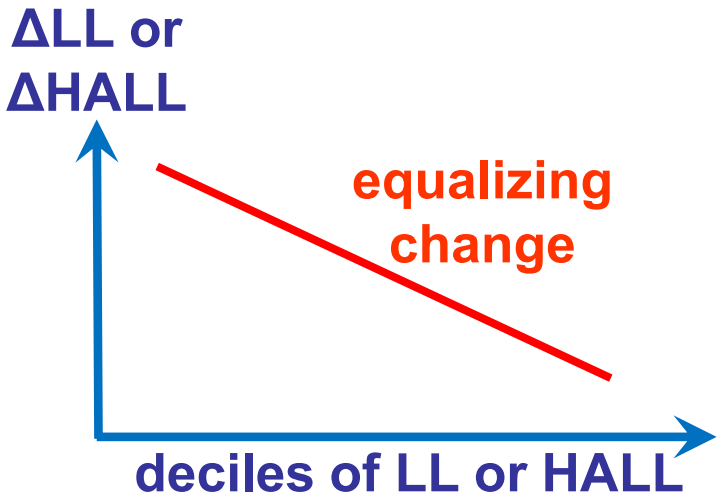
Baseline LLs (dashed) and HALLs (solid, vertical) by Decile (horizontal), Quartile Distributions for 40 Replicates

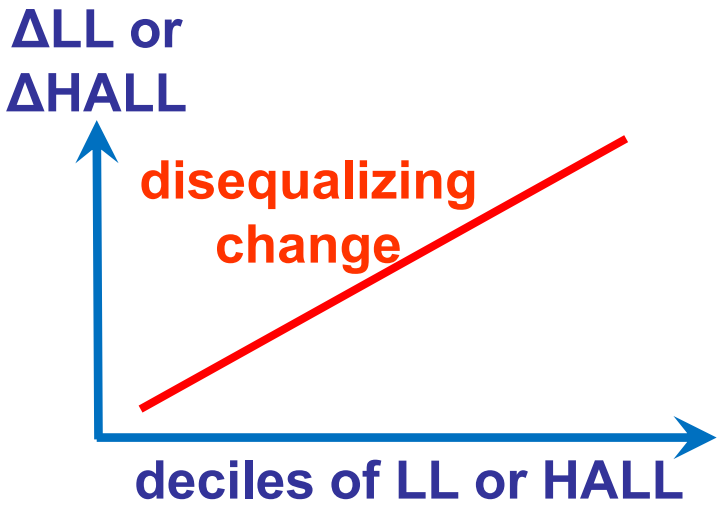




Changes in (Rotated) Survival Curves and Univariate Health inequality

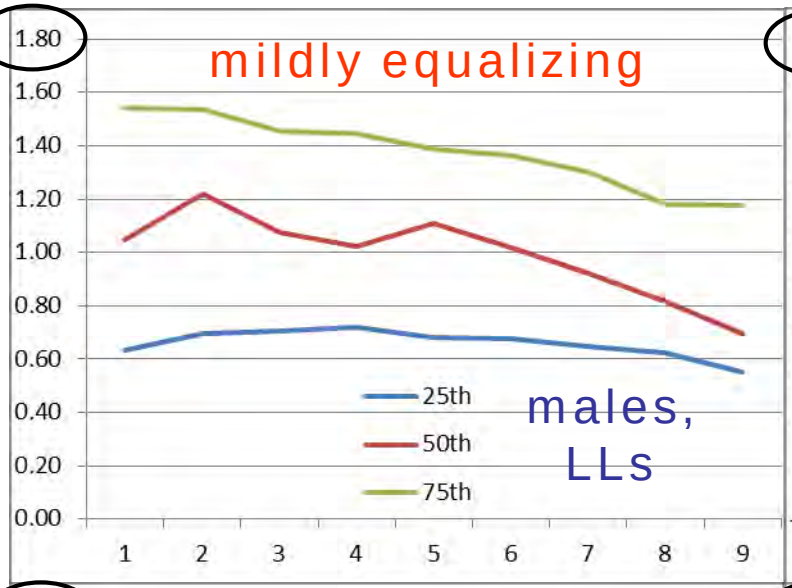


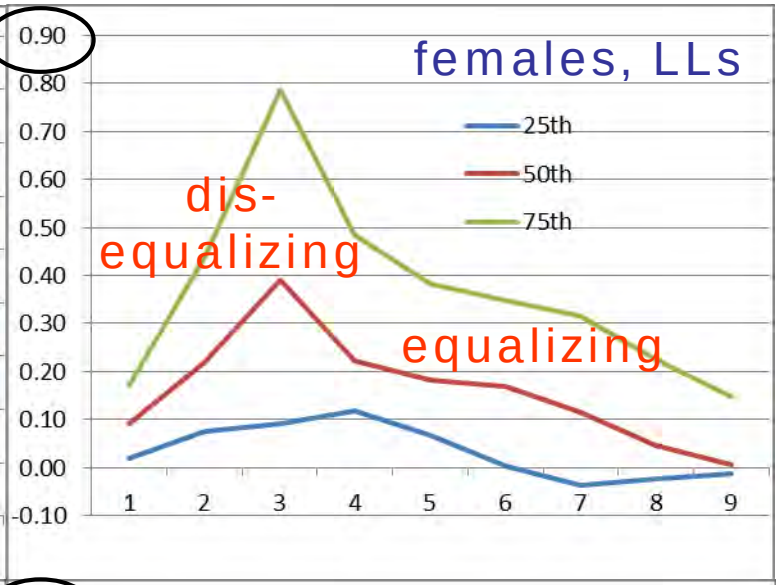




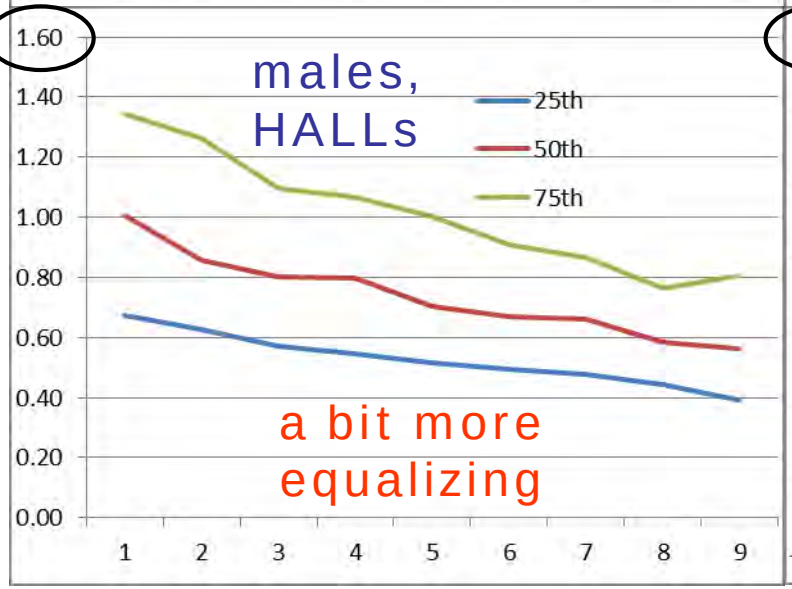
No Smoking Scenario Compared to Baseline

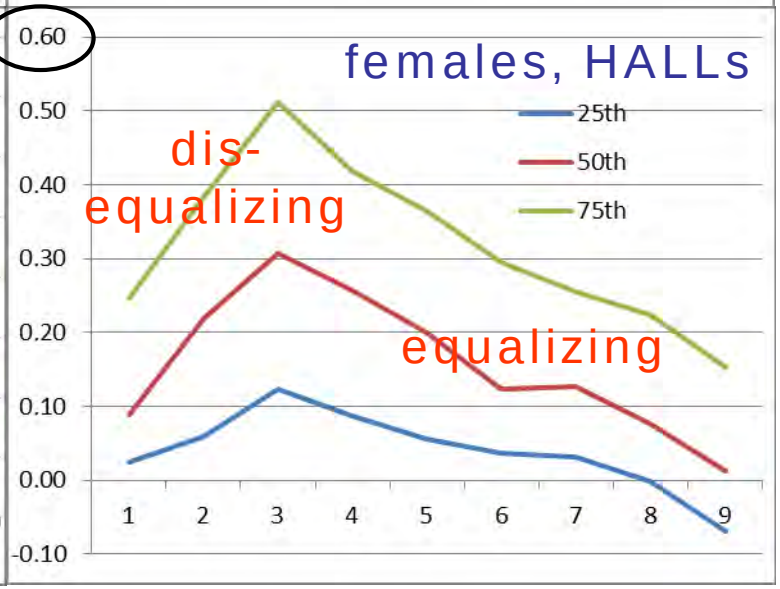
ΔLLs years





ΔHALLs years





horizontal axes: decile cut-points of the LL or HALL distributions

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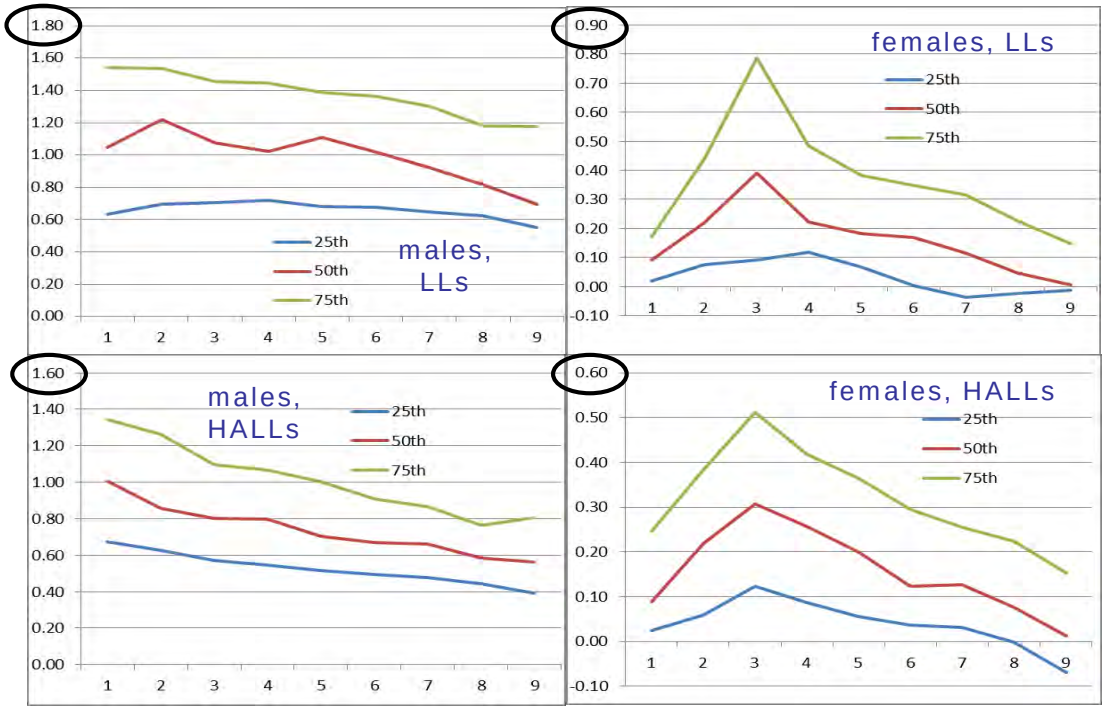


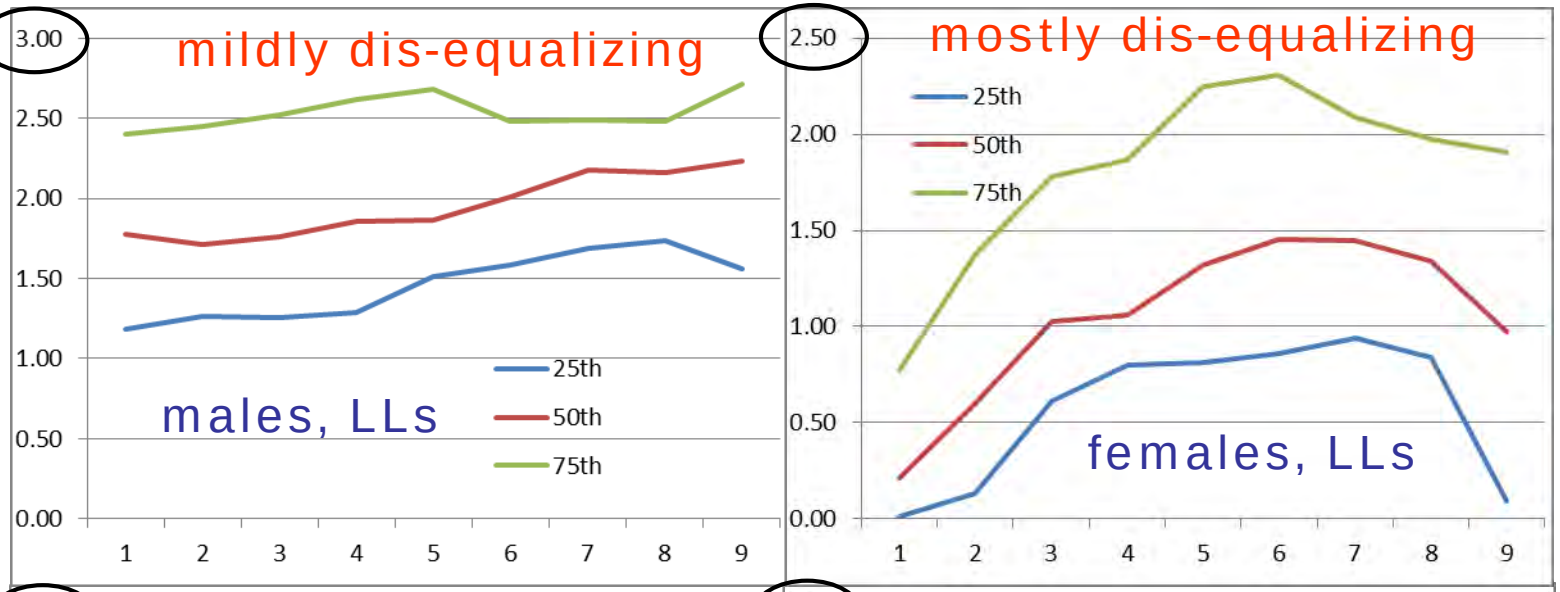
horizontal axes: decile cut-points of the LL or HALL distributions

- **for men, the lower one's** *lifetime* health (i.e. the **lower one's LL or HALL),** the greater the likelihood of being a smoker (e.g. lifetime cumulative pack-years), so eliminating smoking is associated with greater increases in health **the poorer one's health**

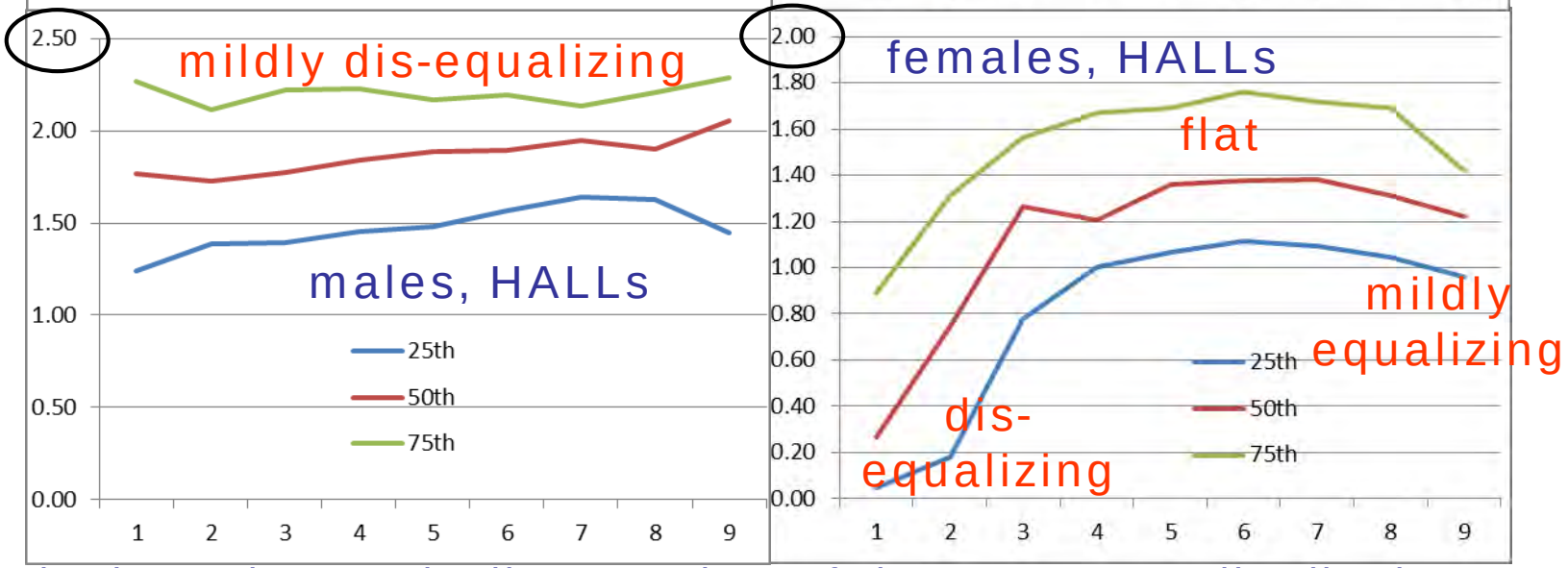
- for women, implication is that smoking is uncommon at the lowest levels of health (i.e. LL and HALL), and most common in mid levels, so eliminating smoking is associated with the greatest health improvements in the lower-middle of the lifetime health distribution

Top SES Scenario Compared to Baseline

ΔLLs years

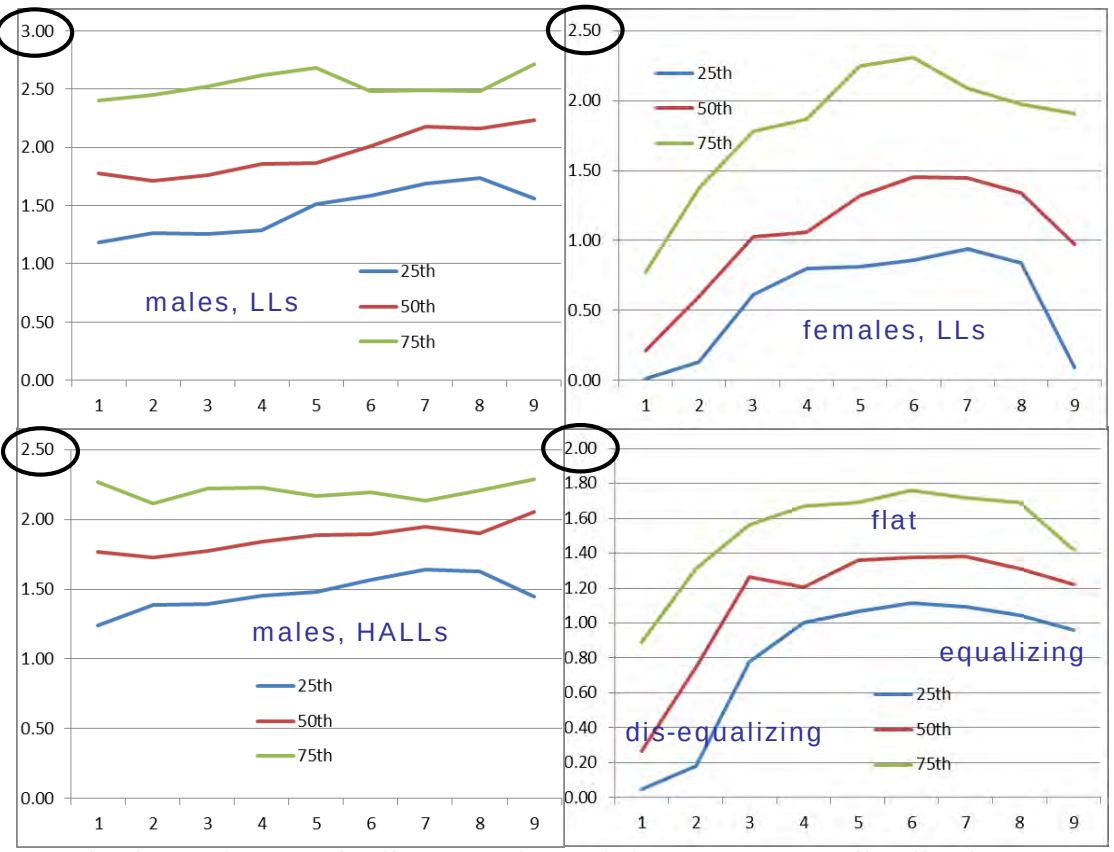


ΔHALLs years



horizontal axes: decile cut-points of the LL or HALL distributions

Top SES Scenario Compared to Baseline



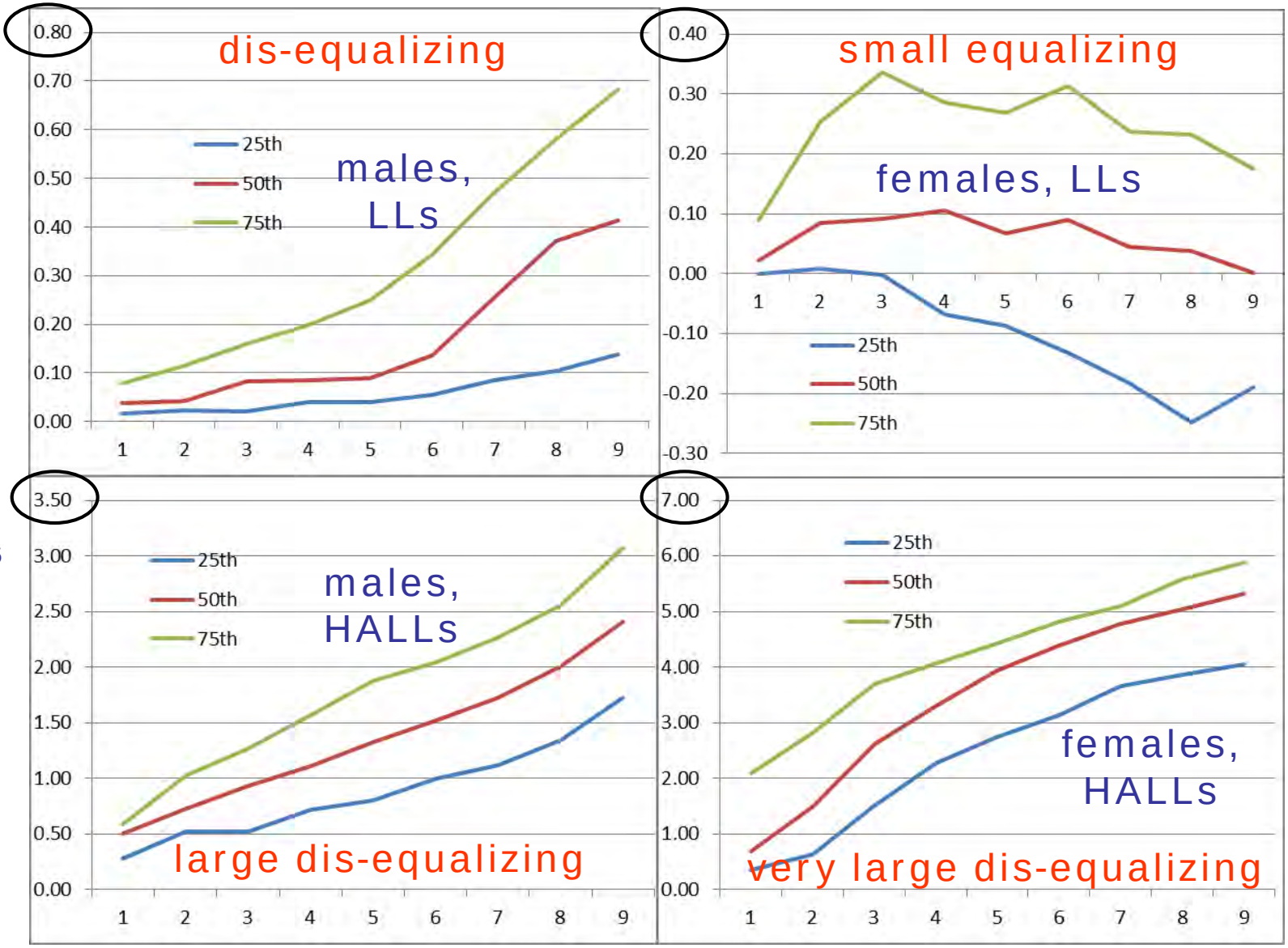
horizontal axes: decile cut-points of the LL or HALL distributions

- for men, a counter-factual with SES always at the top category (education & income) throughout life is associated with ~ 2 year increase in lifetime health (both LL and HALL)
- this improvement is fairly evenly spread throughout the health distribution, but still dis-equalizing
- for women, improving SES at the lowest levels of health has little impact; it is most important at the 3rd to 8th deciles
- thus, having top SES for women is dis-equalizing, then flat, and then equalizing as one moves up **women's lifetime health** spectrum

No Pain Scenario Compared to Baseline

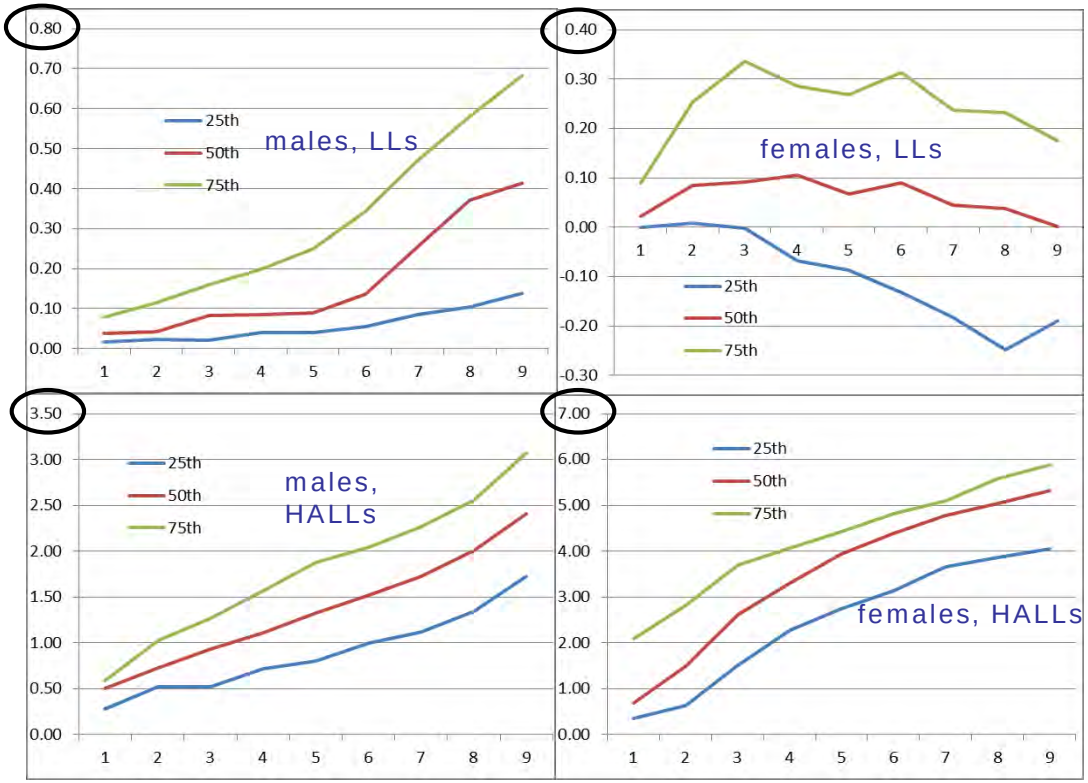
ΔLLs years

ΔHALLs years



horizontal axes: decile cut-points of the LL or HALL distributions

No Pain Scenario Compared to Baseline



horizontal axes: decile cut-points of the LL or HALL distributions

- for both men and women, eliminating pain has quite modest impacts on LL
- it has far larger impacts on HALLs – e.g. median of ~4 years for women
- **the lower one's** *lifetime* health, the smaller is the impact of eliminating pain
- poorer lifetime health must more often be associated with other serious functional limitations, e.g. sensory, cognitive, and mobility rather than pain
- thus eliminating pain is generally of greater benefit for those with better lifetime health
- hence, eliminating pain is *dis-equalizing*

Concluding Comments

- focus has been on full lifecycle HALE as the key "bottom line" health indicator, beyond LE
- understanding impacts of health determinants requires more than piecemeal epidemiology
  - need a coherent network of estimated dynamic relationships embodied in a microsimulation model
- assessing "justness" of health inequalities entails using uni- not bivariate measures
- some surprising and counter-intuitive results
  - yes, eliminating smoking would be generally equalizing
  - improving SES generally neutral for men, disequalizing for women in poorer lifetime health
  - eliminating pain: small effects on LE, but large and highly disequalizing impacts on HALE, more for women