Measuring Social Inequality

Advanced Social Epidemiology PhD Course

Sam Harper

University of Copenhagen
2021-10-11 to 2021-10-15

Part 2: Measuring the "Inequality" in Social Inequality

2. Measuring Inequality

2.1 Conceptual Issues

2.2 Absolute and Relative Inequality

2.3 Simple vs. Complex Measures

2.4 Weighting

2.5 Reference Points

2. Measuring Inequality

2.1 Conceptual Issues

2.2 Absolute and Relative Inequality

2.3 Simple vs. Complex Measures

2.4 Weighting

2.5 Reference Points

Why monitor health inequalities?

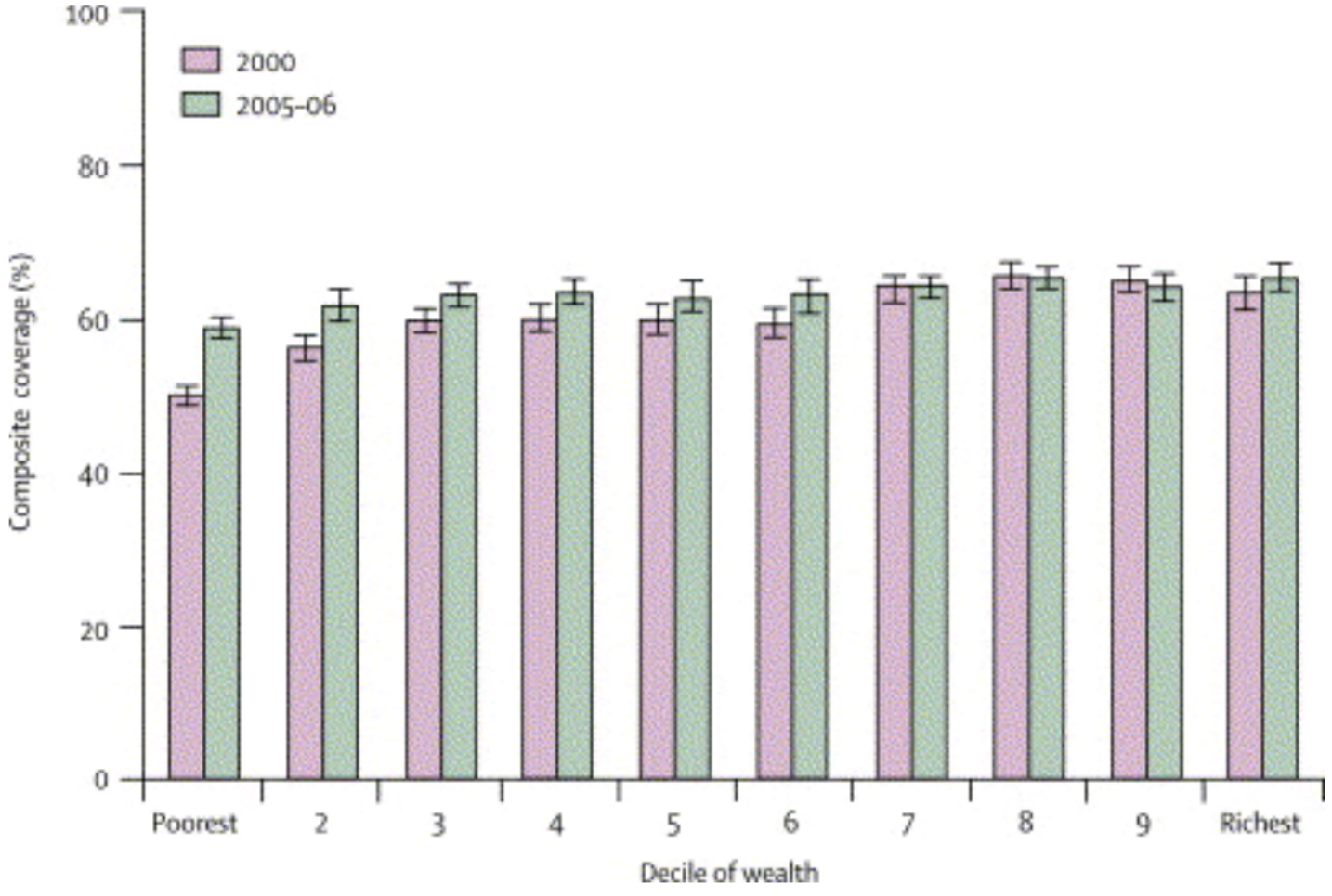
Surveillance

- Natural complement to monitoring overall health
- Essential for detecting important changes in risk

Impact

- Opportunity to evaluate etiological explanations for health inequalities
- Evaluating the distributional impacts of public health interventions and medical innovations
- Crucial for measuring the responsiveness of health care systems to those most in need

> "inequalities in composite coverage [of interventions] have been greatly reduced over the past 5 years, since coverage has increased the most in the poorest states and for the poorest deciles of the population."



Gakidou et al. *Lancet* (2006)

Inequalities in health are based on *observations*

We are relatively good at measuring inequalities.

- Poor people die younger than rich people
- Low social class infants have lower birth weight
- Smokers get more lung cancer than non-smokers
- Women live longer than men

Inequities in health are based on *ethical judgements*

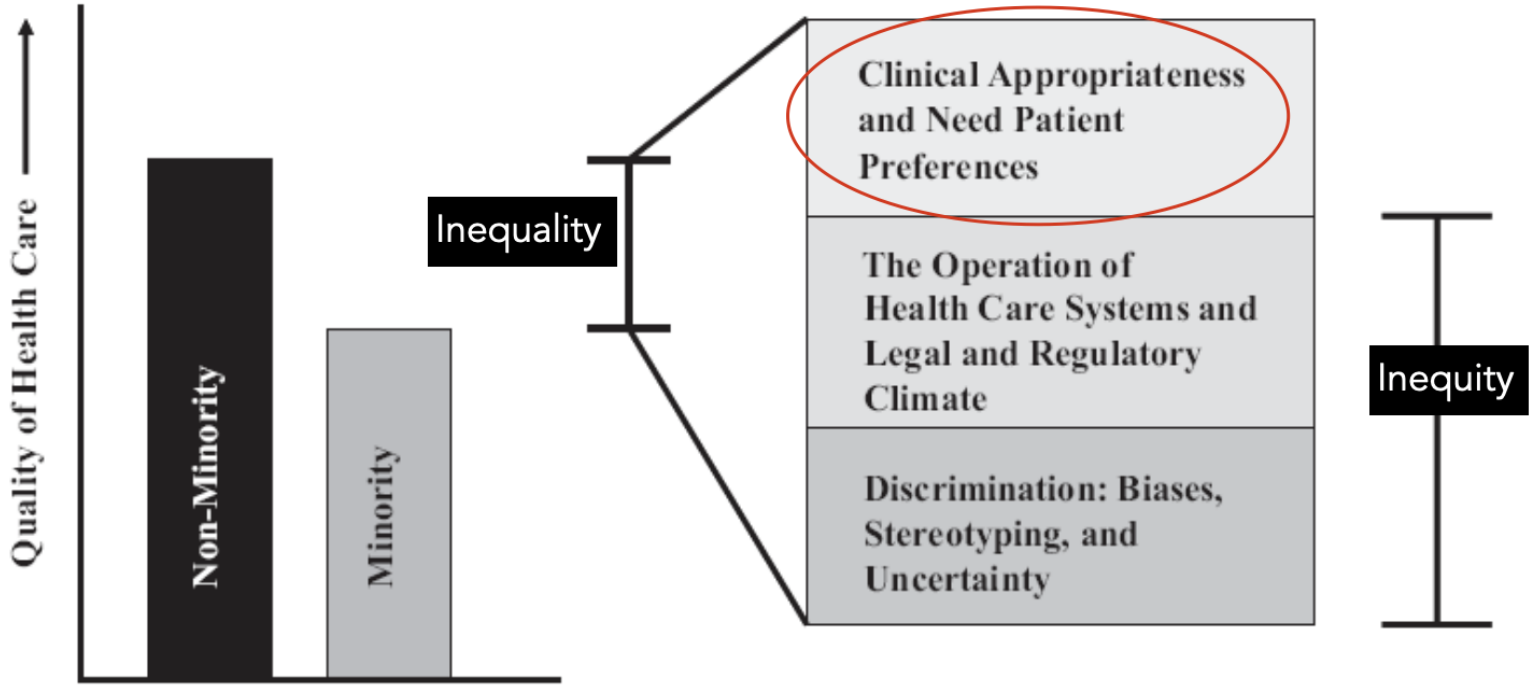
Inequities are much harder to measure

- Should poor people die younger than rich people?
- Should low social class infants have lower birth weight?
- Should smokers get more lung cancer than non-smokers?
- Should women live longer than men?

Anatomy of an Inequality

- How much of inequality is *unfair*?
- How would you know?

Figure 1: Differences, Disparities, and Discrimination: Populations with Equal Access to Health Care.



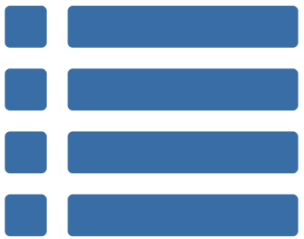
Adapted from McGuire et al. *Health Services Research* 2006

Inequality is an ambiguous concept

Different measures of inequality emphasize different concepts.

> “If a concept has some basic ambiguity, then a precise representation of that ambiguous concept must preserve that ambiguity…This issue is quite central to the need for descriptive accuracy in inequality measurement, which has to be distinguished from fully ranked, unambiguous assertions.”
>
> Amartya Sen, On Economic Inequality, 1997

Measuring inequality: Some issues to consider



1. What to measure? Total vs. Social Group Inequality
2. Scale: Is inequality relative or absolute?
3. Simple or complex measures of health inequality?
4. Weighting: Who counts, and for how much?
5. Reference points for measuring inequality: Different from what?

What should we measure?

Total Health Inequality

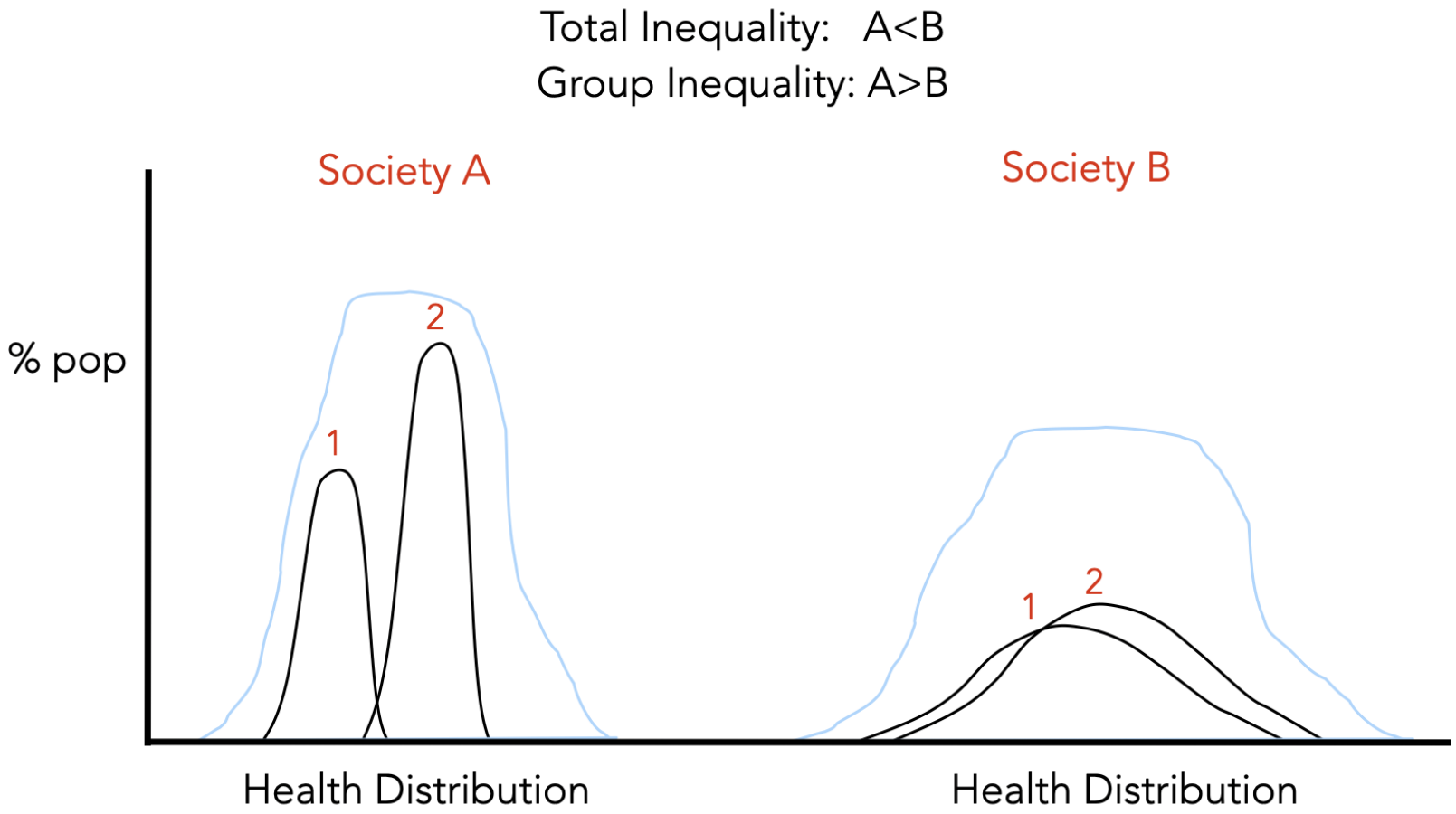
- complement to measurement of average health
- measured across all individuals
- avoids normative choice of social groups
- facilitates unambiguous comparisons over time/place

Social Group Differences in Health

- measured across normatively important social groups
- particular social groups chosen a priori
- provide insights into causal processes linking health and social position

Health Inequality Between Whom?

- Which society has more inequality?
- Which one is worse from the perspective of inequality?



Asada 2002

POLICY FORUM

DEMOGRAPHY AND INEQUALITY

The case for monitoring life-span inequality

Focus on variation in age at death, not just average age

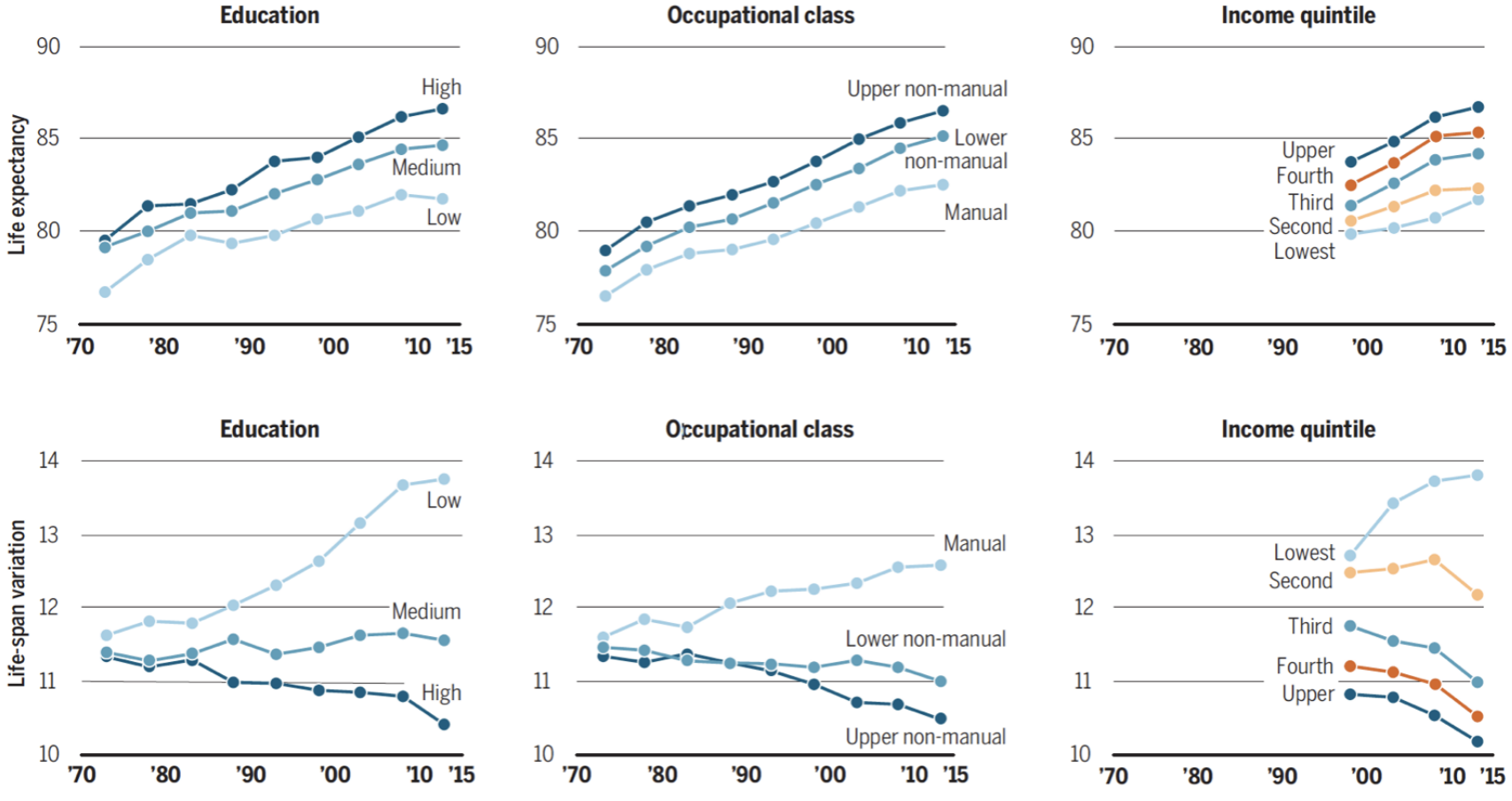
By **Alyson A. van Raalte[1], Isaac Sasson[2], Pekka Martikainen[1,3,4]**

for instance, the standard deviation, Gini coefficient, or interquartile range. To illus-

- Life-span variation reflects uncertainty in the risk (timing) of death.
- People are generally willing to pay to reduce uncertainty.
- Heterogeneity is crucial for accurate forecasts in insurance and annuity markets, and should be measured.
- Monitoring life-span variation may facilitate early detection of adverse mortality developments and warrant social interventions at younger ages.

Trends in life expectancy and life-span variation for Finnish females, 1971–1975 to 2011–2014

Life expectancy is the average age at death, and life-span variation is the standard deviation, conditional upon survival to age 30, with age-specific death rates frozen at those observed in the given year. See supplementary materials for data and methods, including trends for males (which are qualitatively similar), and robustness checks using alternative measures of life-span variation.



van Raalte (2018)

2. Measuring Inequality

2.1 Conceptual Issues

2.2 Absolute and Relative Inequality

2.3 Simple vs. Complex Measures

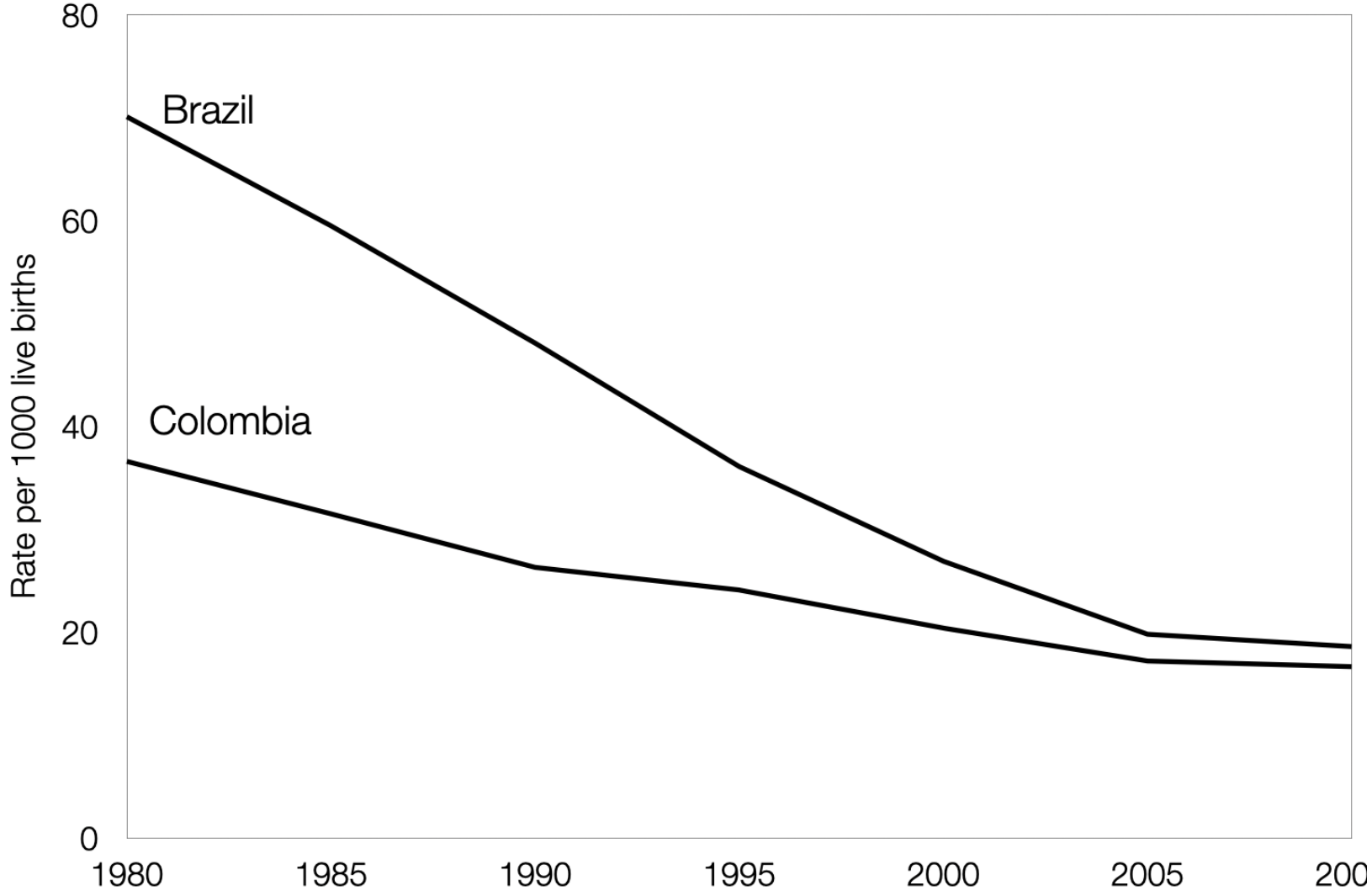
2.4 Weighting

2.5 Reference Points

Easy case

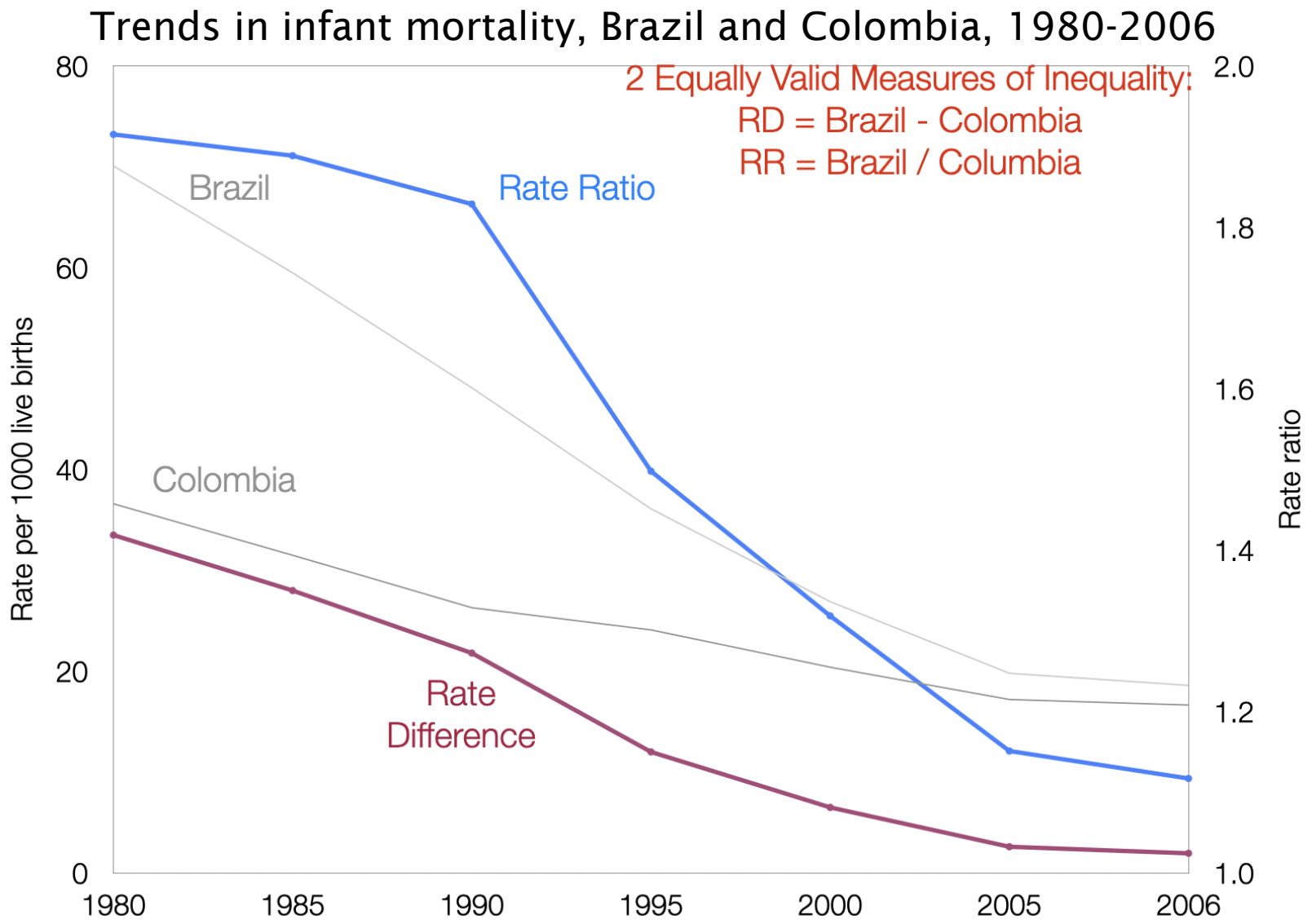
Evidence of clear progress

Trends in infant mortality, Brazil and Colombia, 1980-2006



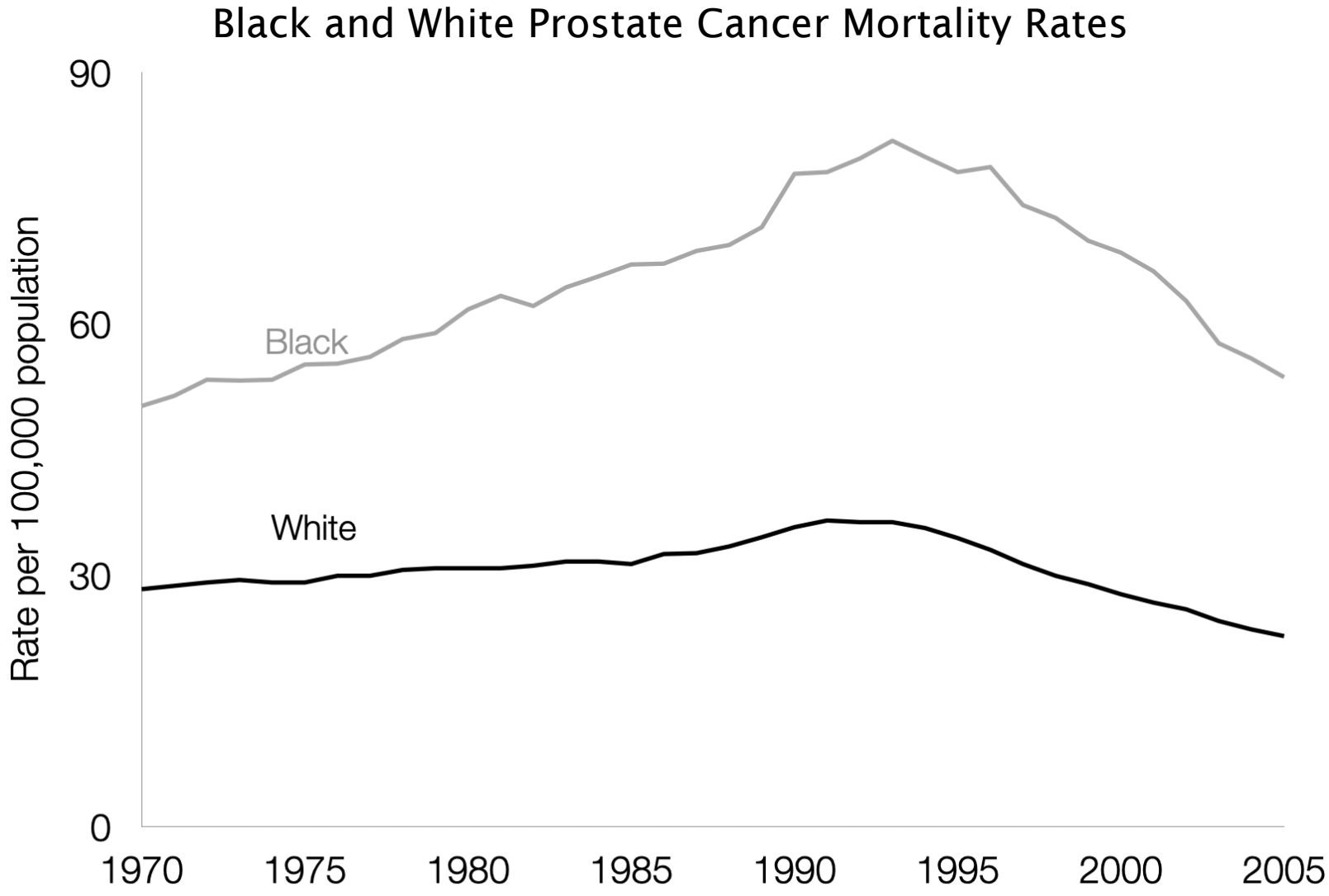
Easy case

Evidence of clear progress



Harder case

Are black-white inequalities in prostate cancer mortality increasing or decreasing?

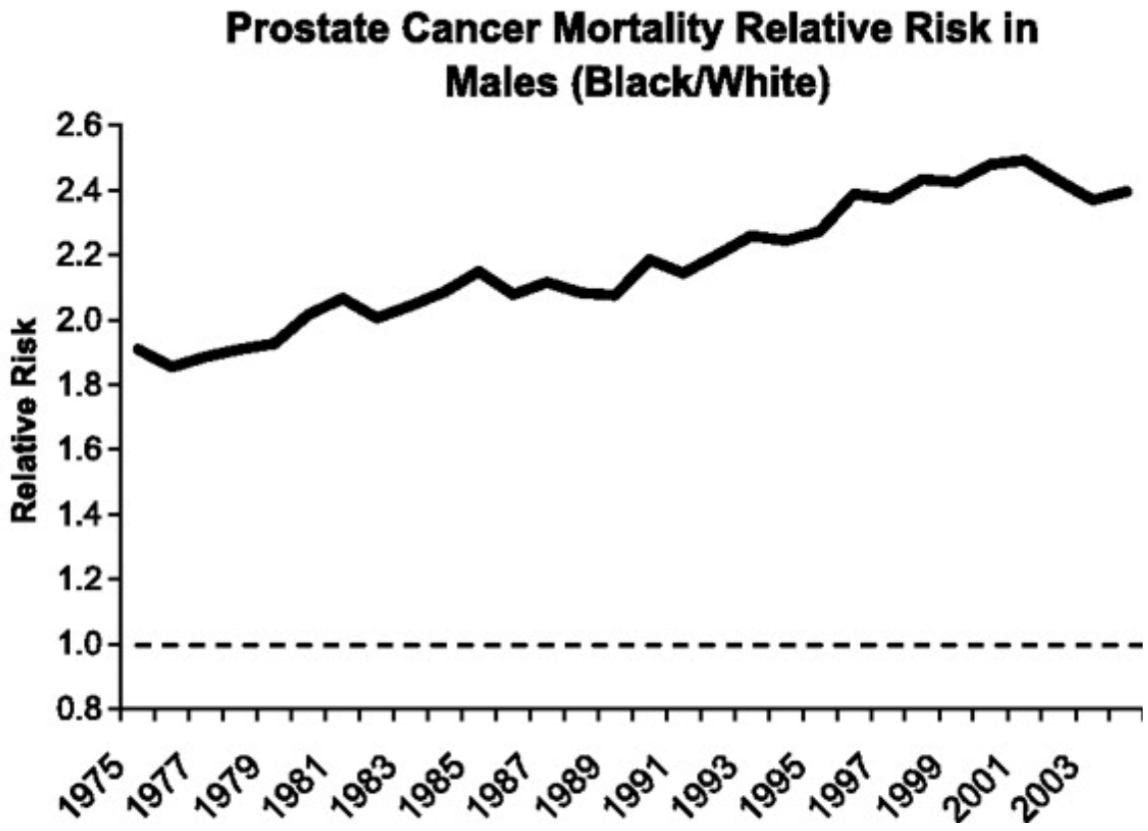


Source: US NCI SEER*Stat Database

Recent Trends in Black-White Disparities in Cancer Mortality

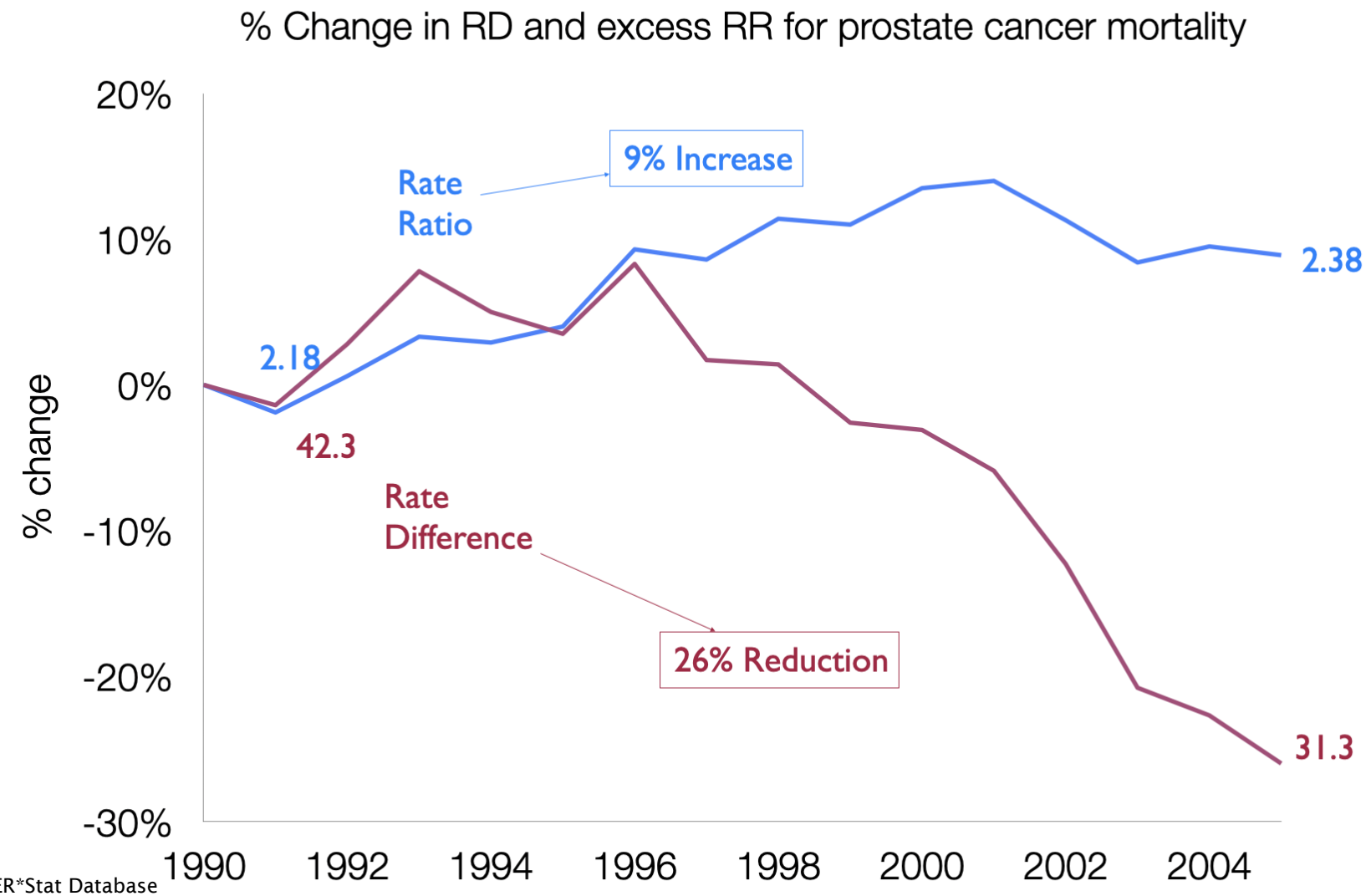
John Oliver L. DeLancey, Michael J. Thun, Ahmedin Jemal, and Elizabeth M. Ward

Cancer Epidemiol Biomarkers Prev 2008;17(11). November 2008



"…racial disparities in mortality from cancers potentially affected by screening and treatment increased over most of the interval since 1975."

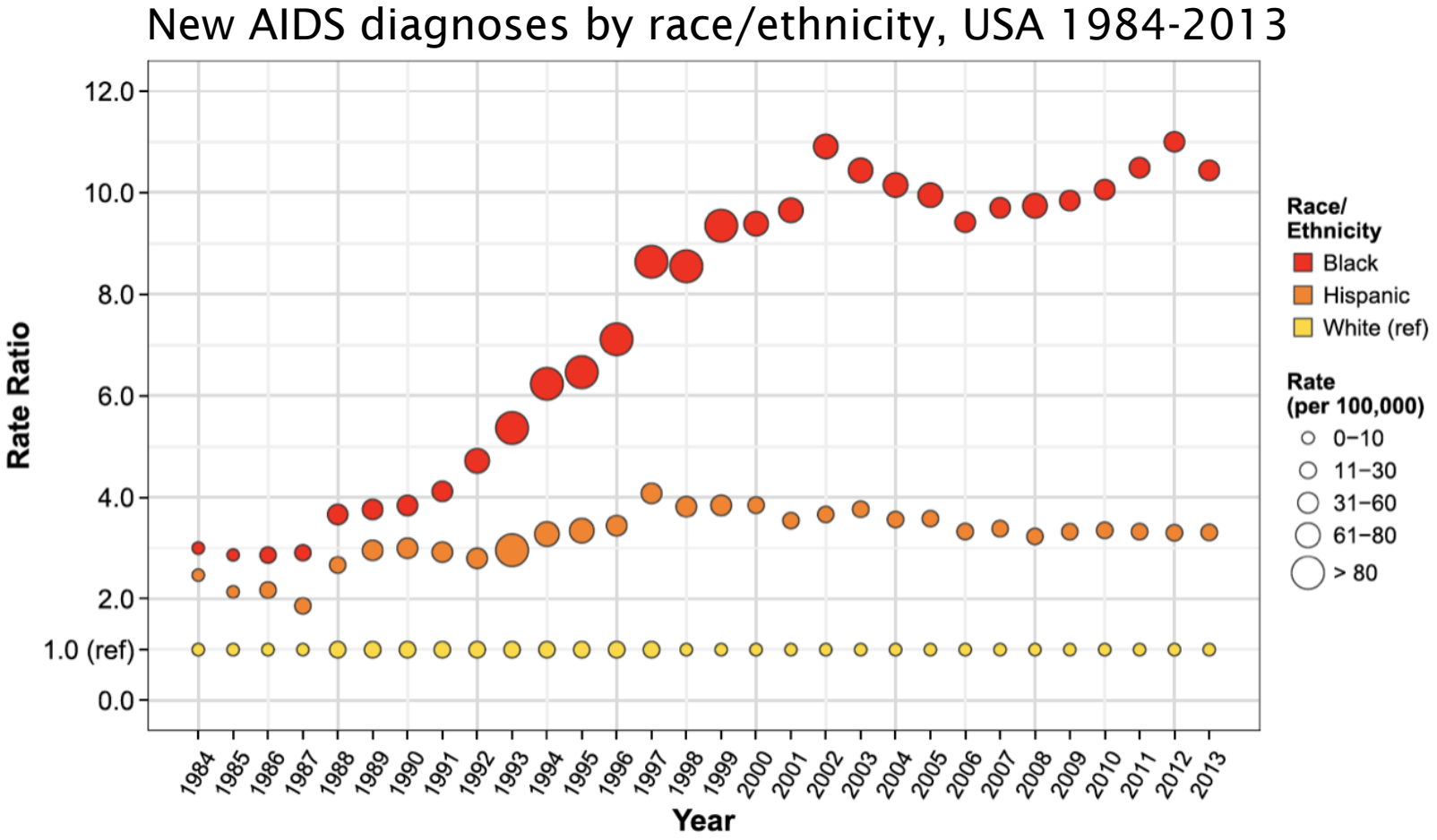
DeLancey (2008)



Source: US NCI SEER*Stat Database

"Racial disparities rose sharply from 1984 to the early 2000s for Blacks...concerningly, we documented a significant increase from 2006 to 2013."

On what scale?



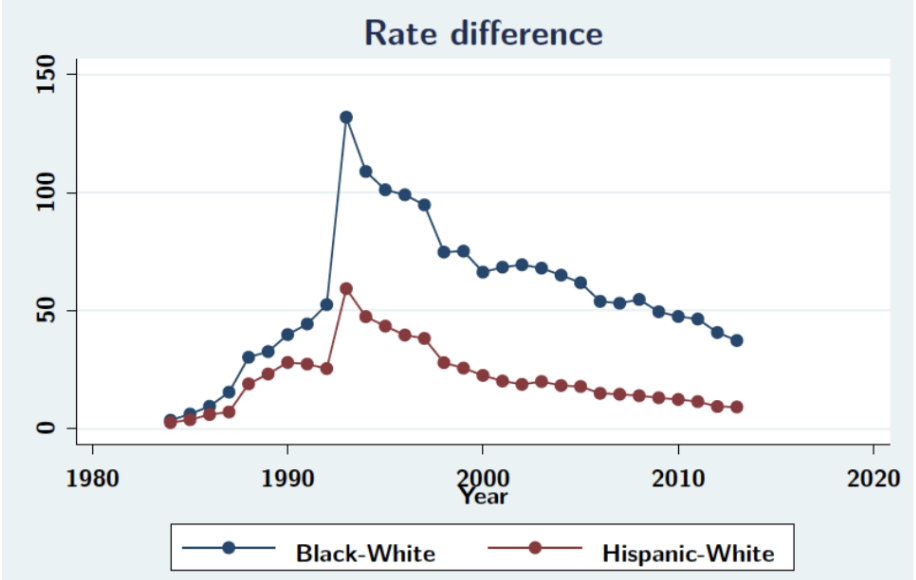
Chapin-Bardales et al. 2017

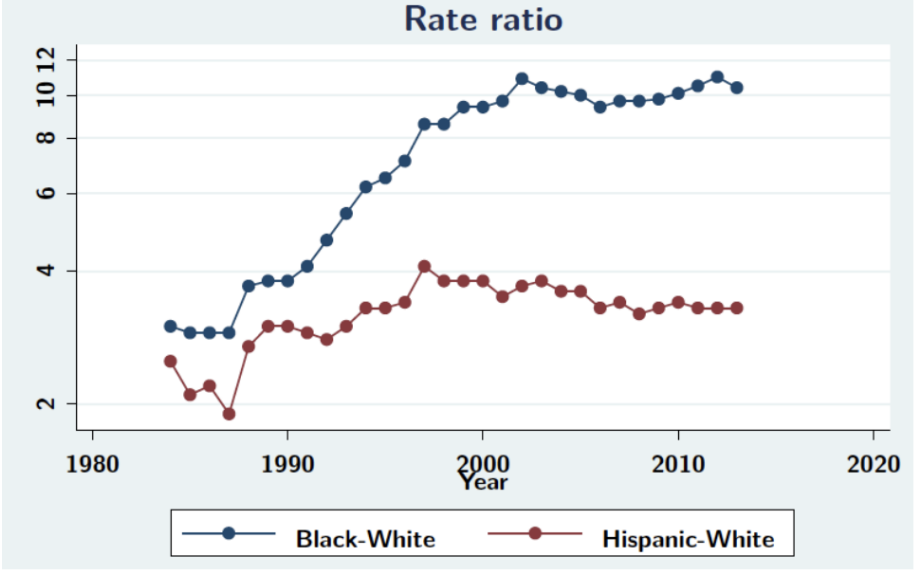
Failure to consider the scale on which inequalities are measured can have dramatic impacts on study conclusions.

- Steep declines on absolute scale.
- Increases on relative scale.

This also has broad implications for thinking about explanations for inequality trends.

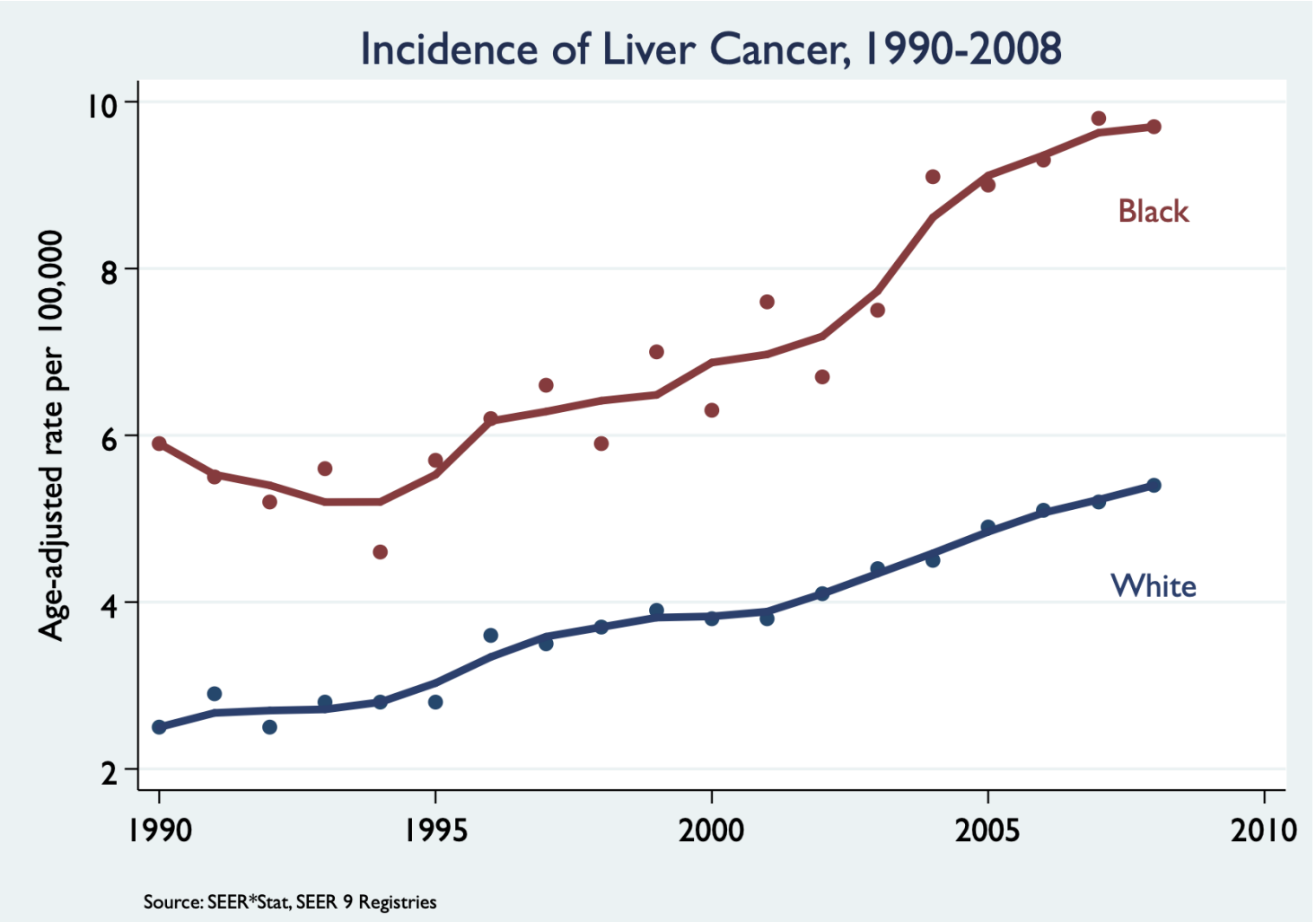
- Did the introduction of antiretrovirals exacerbate or mitigate inequalities?





What if underlying rates are increasing rather than decreasing?

Does this also present similar problems for interpreting inequality trends?

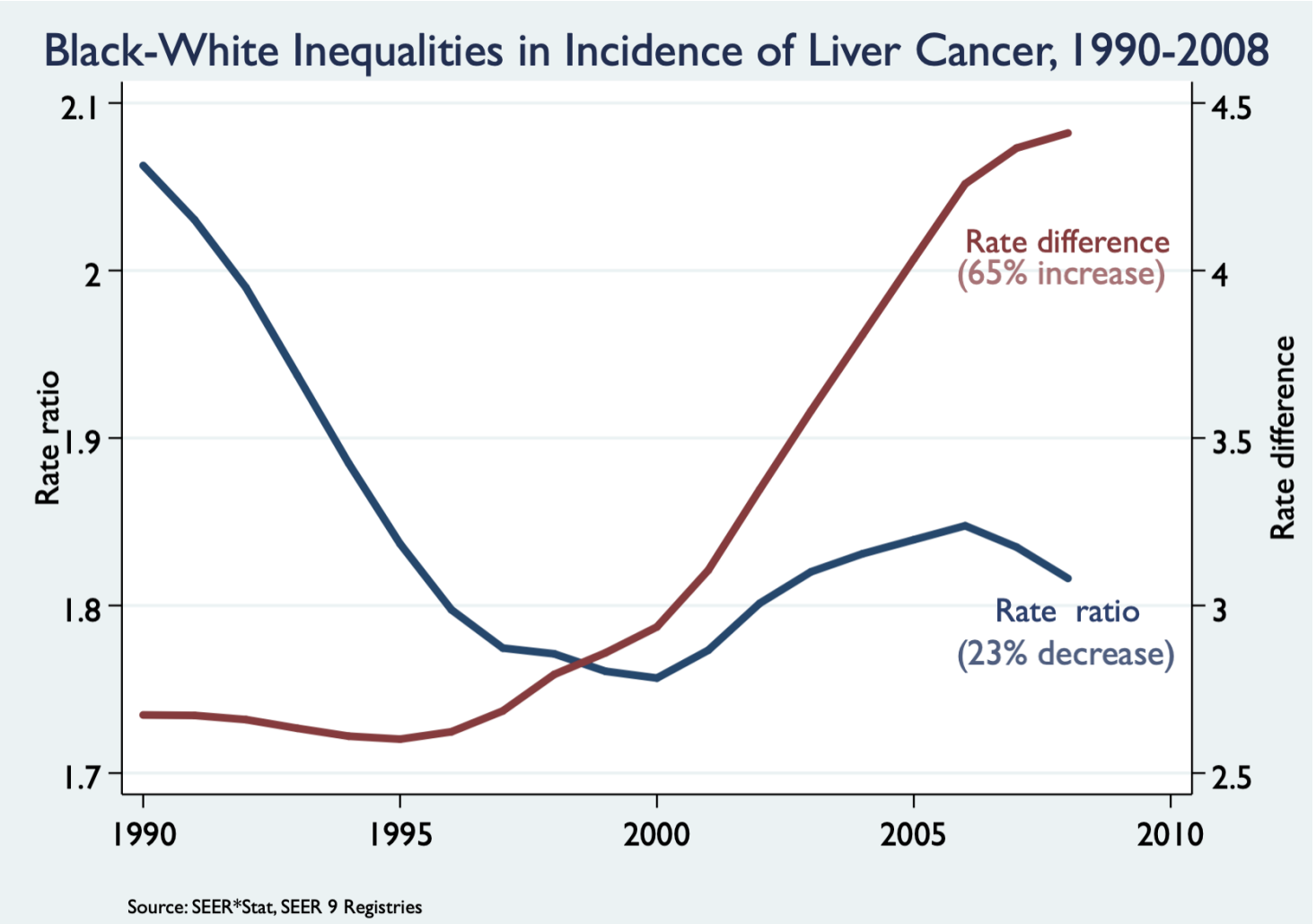


Source: US NCI SEER*Stat Database

What if underlying rates are increasing rather than decreasing?

Does this also present similar problems for interpreting inequality trends?

Yes



Source: US NCI SEER*Stat Database

The prior examples are not isolated.

Guidance from WHO and researchers to report **both** absolute and relative inequalities since the 1990s.

We found systematic biases toward reporting only relative measures.

Table 2| **Frequency of absolute and relative effect measures**

	No	Percentage (95% CI)
Abstract		
No measure reported	206	60 (55 to 65)
Only relative measure	122	35 (30 to 41)
Only absolute measure	13	3.8 (1.8 to 5.8)
Both relative and absolute measures	3	0.9 (0.0 to 1.9)
Full text		
Only relative measure	258	75 (70 to 80)
Absolute risks not reported	119	46 (40 to 52)
Absolute risks reported	139	54 (48 to 60)
Only absolute measure	61	18 (14 to 22)
Both relative and absolute measures	25	7.3 (4.5 to 10)

Among 344 papers on social inequalities published in 2009

King, Harper, Young *BMJ* (2012)

Question for Discussion:

Are absolute or relative inequalities more important?

Inequality is an ambiguous concept

> “There is no economic theory that tells us that inequality is relative, not absolute. It is not that one concept is right and the other wrong. Nor are they two ways of measuring the same thing. Rather, they are two different concepts.”
>
> Martin Ravallion, World Bank Economist, 2004

2. Measuring Inequality

2.1 Conceptual Issues

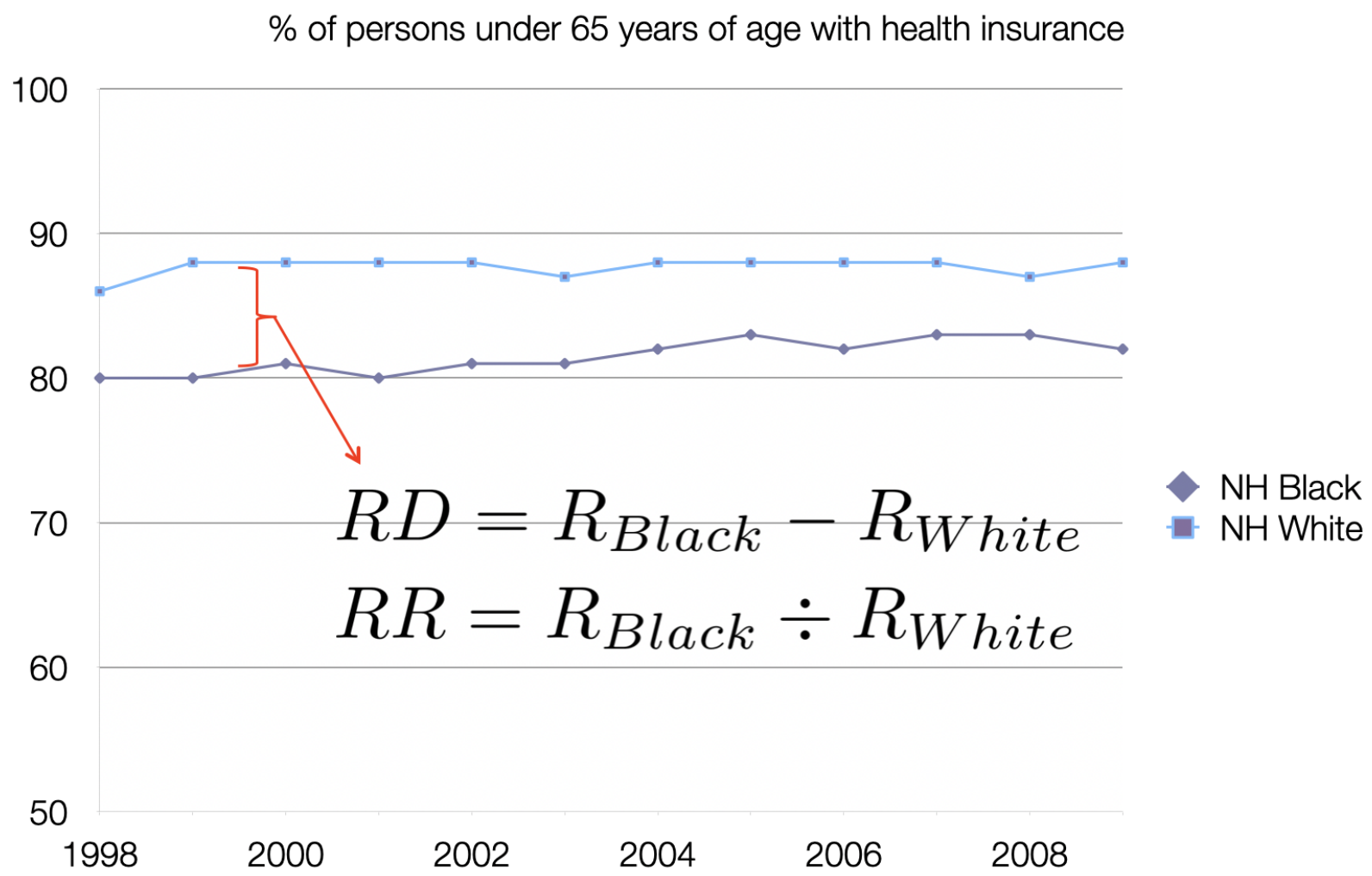
2.2 Absolute and Relative Inequality

2.3 Simple vs. Complex Measures

2.4 Weighting

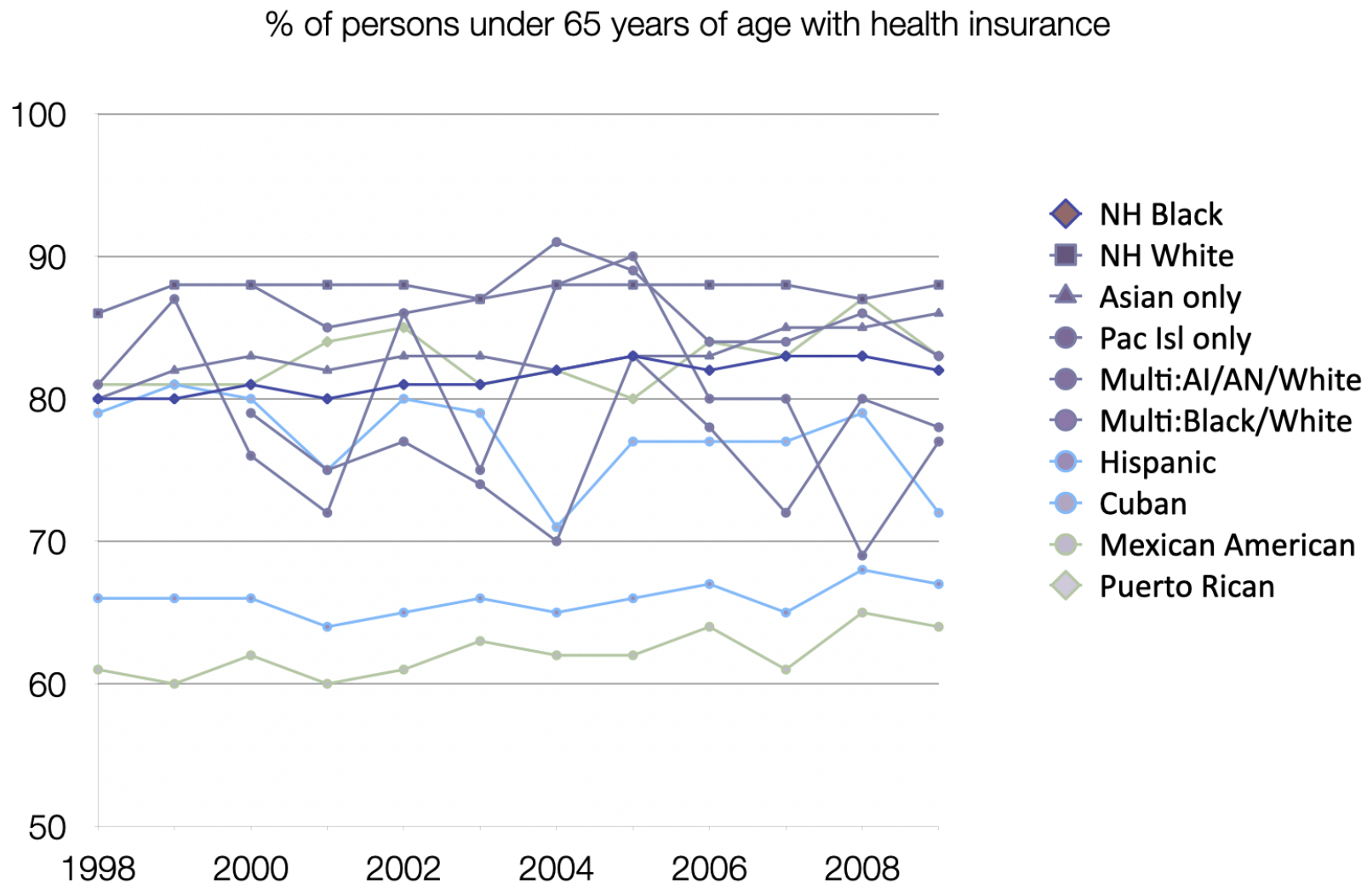
2.5 Reference Points

Pairwise comparisons work well for a few groups



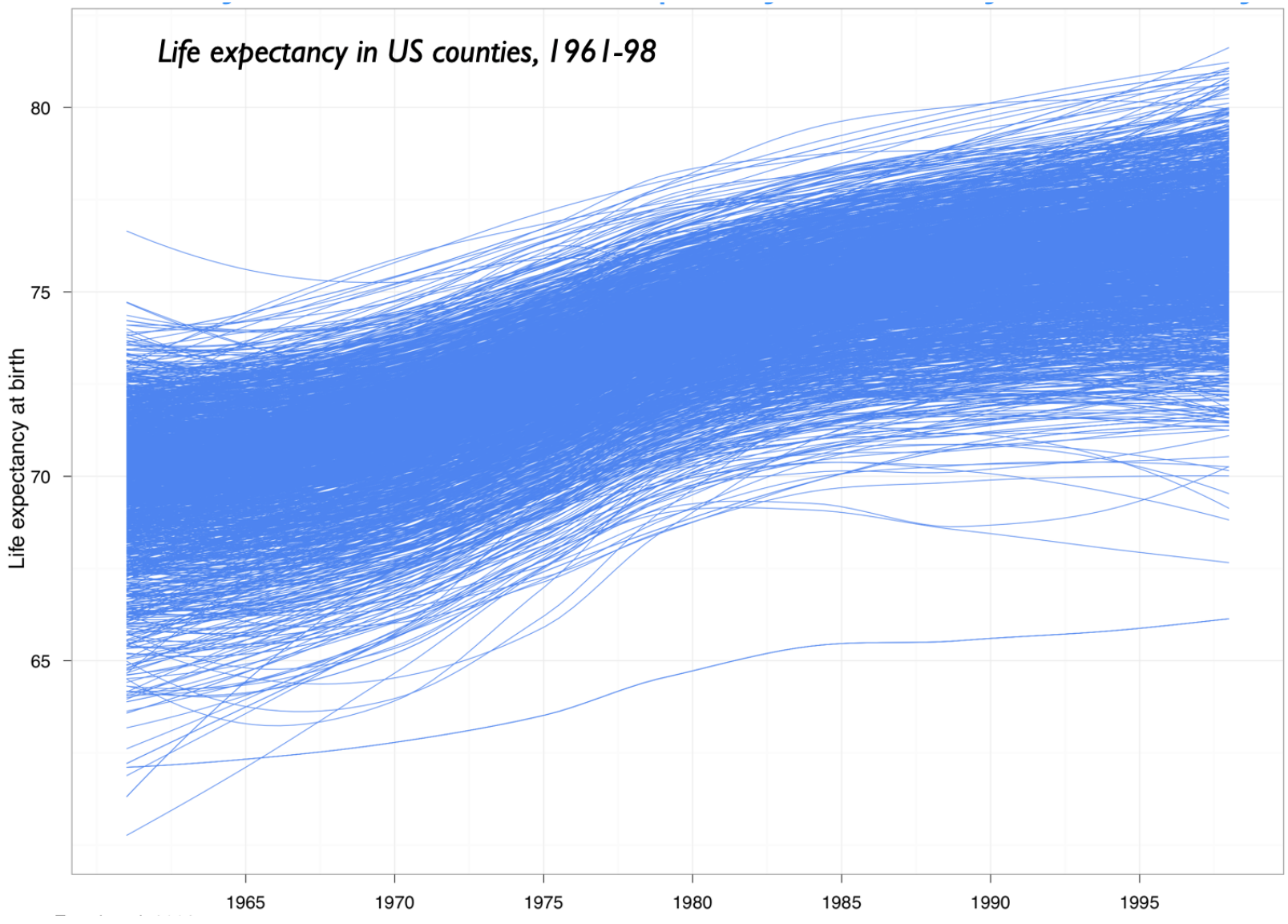
Source: Data2010

Additional groups make summary measures appealing



Source: Data2010

Summary measures definitely needed



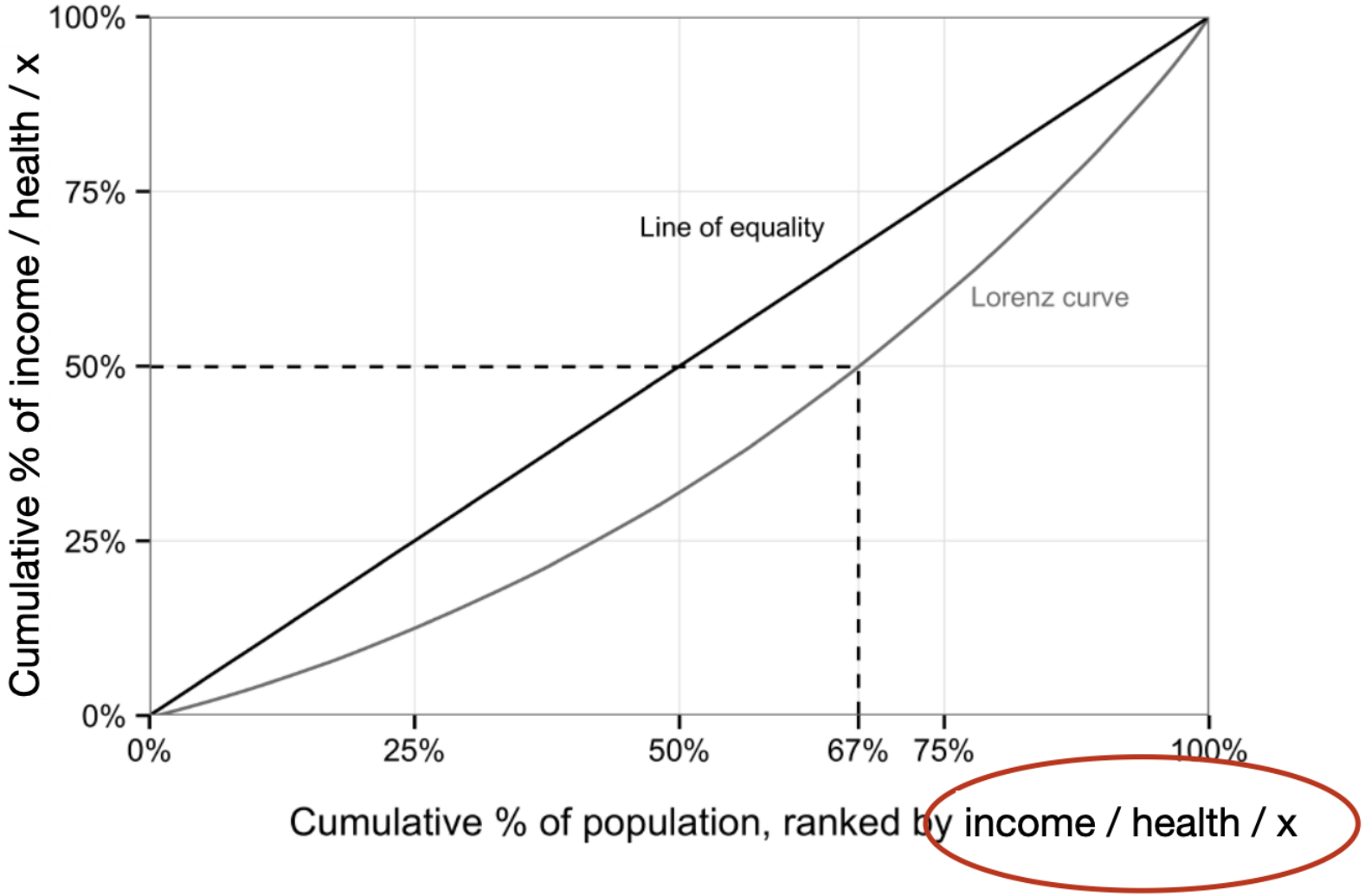
Ezzati et al. (2008)

Range-type measures: ignore the entire distribution

- Does A or B have 'more' inequality?
- Do you have a preference for A or B?

Moving beyond simple comparisons

- More complex measures look at the entire distribution.
- E.g., Lorenz curve for income, health, or any X:



Moving Beyond Binary Comparisons

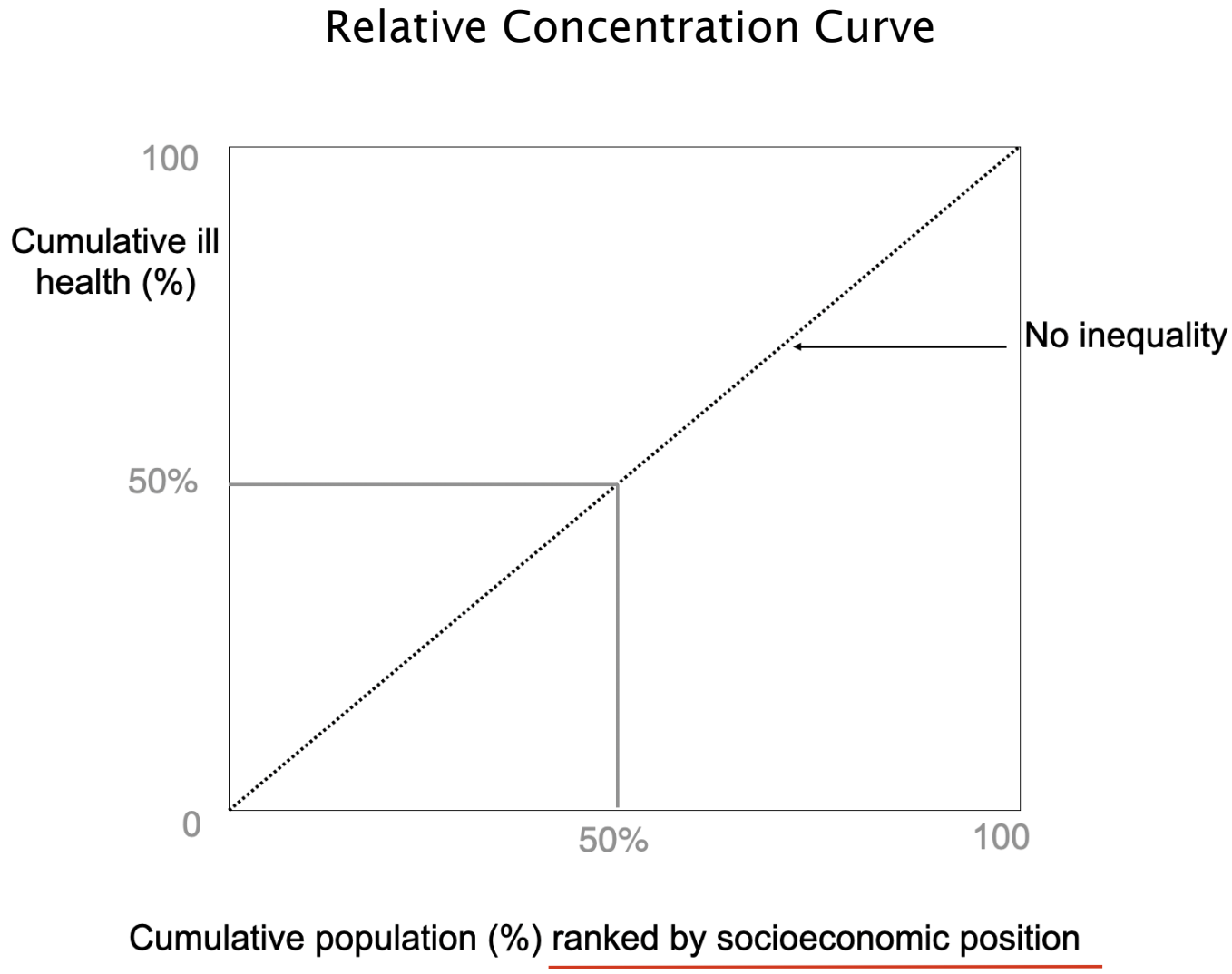
Let's rank each education group by where they stand in the population distribution

Distribution of Socioeconomic Position in a Hypothetical Population

Education Level	%	Cumulative %	Range	Midpoint
None	11.93	11.93	00.00 – 11.93	5.97
<Primary school	15.04	26.97	11.93 – 26.97	19.45
Primary school	26.86	53.83	26.97 – 53.83	40.40
Secondary school	16.05	69.88	53.83 – 69.88	61.86
Beyond Secondary	30.12	100	69.88 – 100.0	84.94

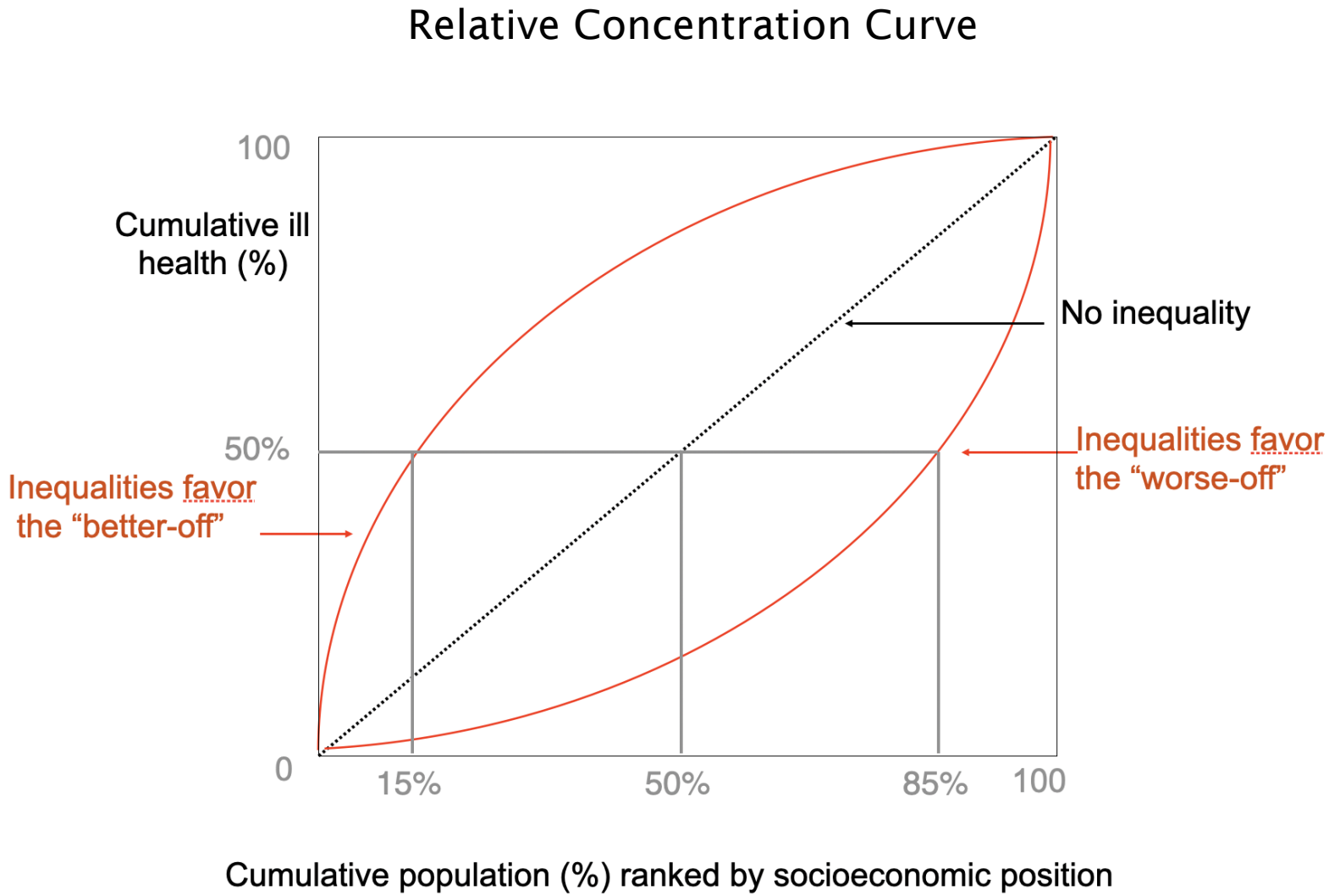
Summarizing across SEP

- First rank the population by SEP
- Then count up the proportion of disease each group accounts for.



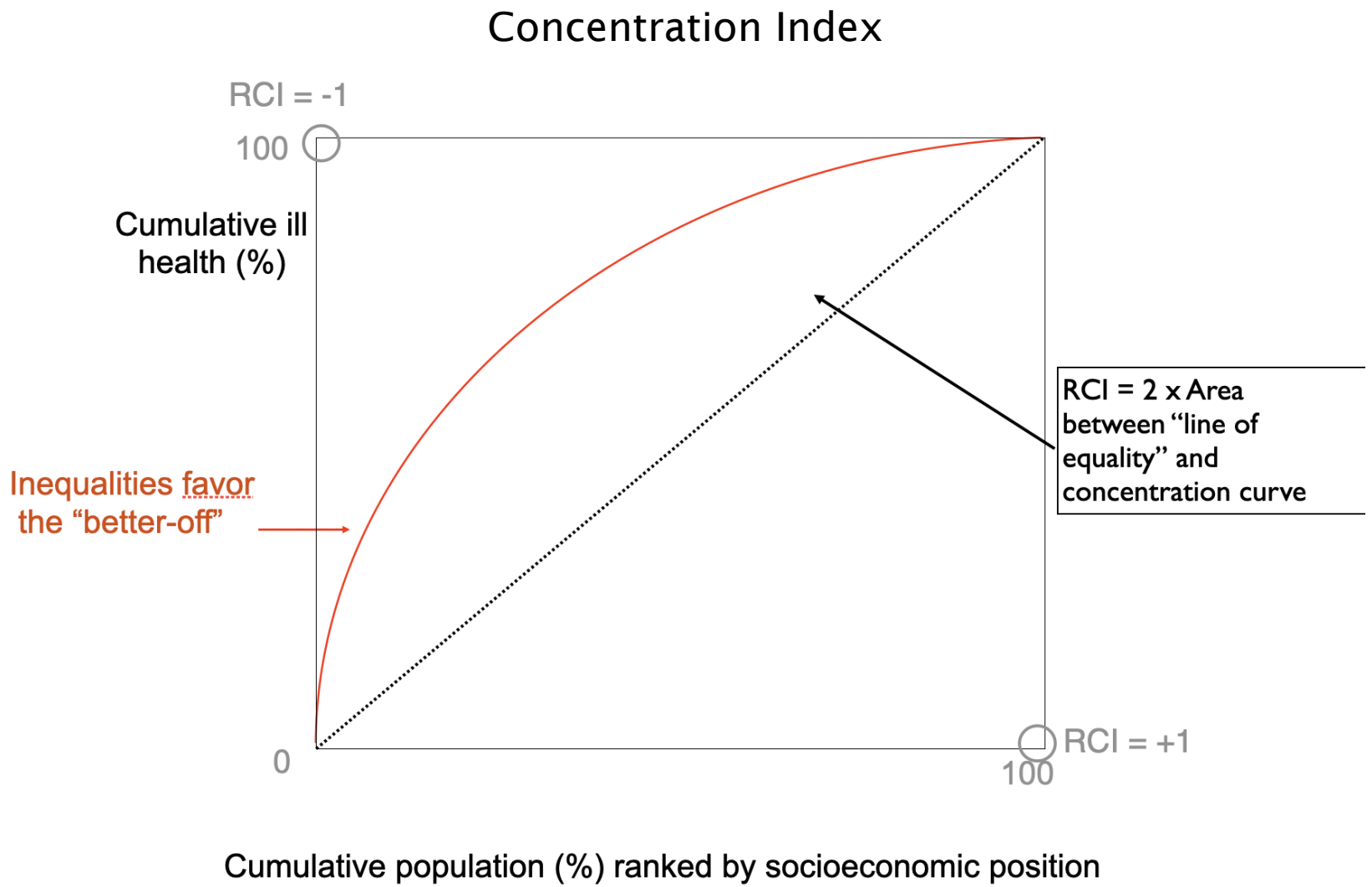
Summarizing across SEP

- Diagonal = no inequality
- Curve above diagonal: ill-health concentrated among poorer.
- Curve below diagonal: ill-health concentrated among richer.



Summarizing across SEP

- Concentration Index measures the extent to which disease is 'concentrated' among different SEP groups.



Formula for writing the Concentration Index

One way of writing the CI is:

$$RCI = \frac{2}{n\mu} \sum_{i=1}^{n} y_i R_i - 1$$

where μ is the mean of y_i (e.g., smoking status), R_i is the fractional rank of the *i*th person in the socioeconomic (i.e., income) distribution.

The Absolute Concentration Index multiplies *RCI* by the mean smoking rate:

$$ACI = \mu * RCI$$

Kakwani et al. (1997)

Example of Relative and Absolute CI

1965: Smoking increases with education = + RCI

2003: Smoking decreases with education = - RCI

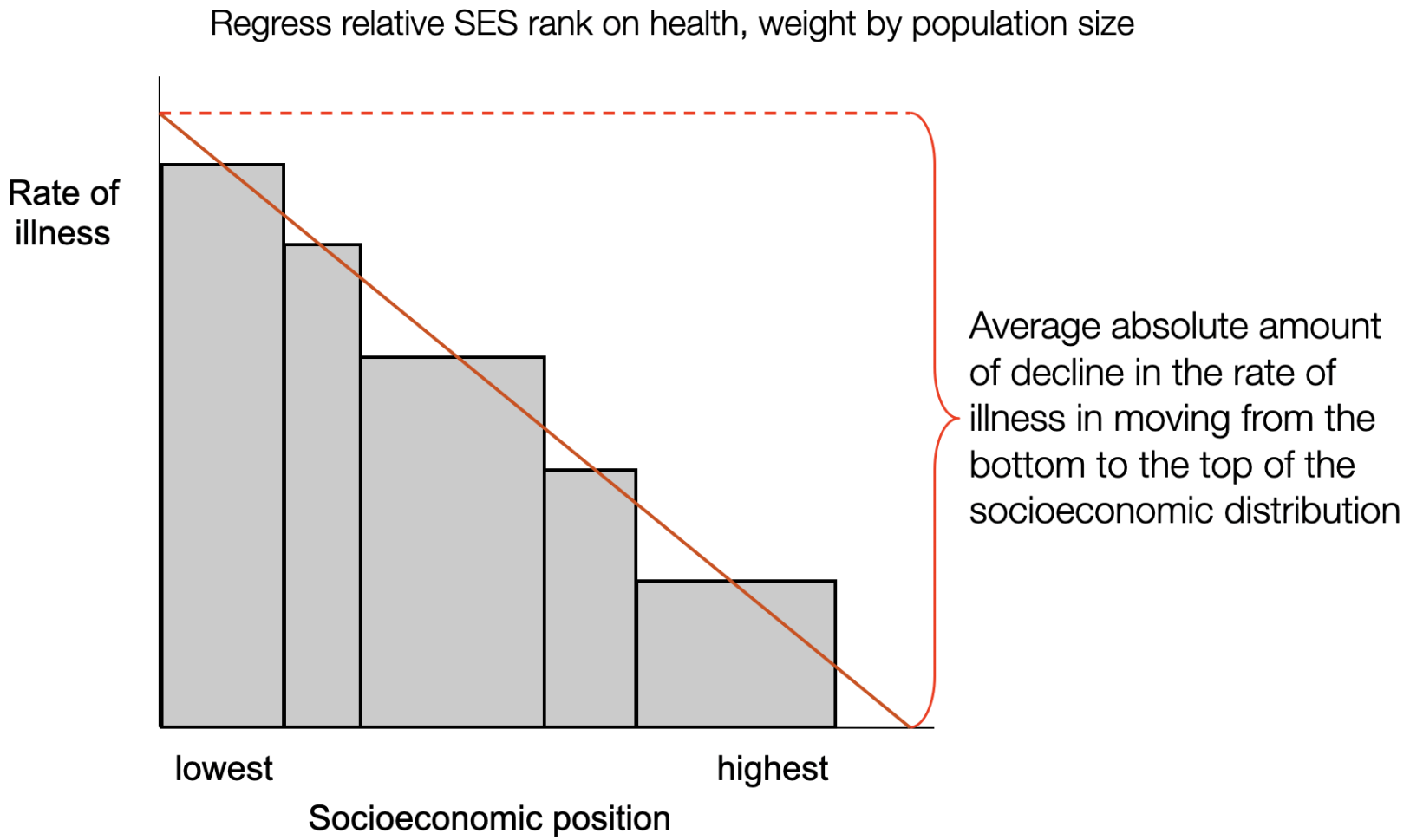
TABLE 6.2. EDUCATIONAL INEQUALITY IN CURRENT SMOKING AMONG FEMALES, 1965 AND 2003.

Education	Smoking Prevalence	Population Share	Relative Rank	RCI
1965				
<12 years	23.8%	0.267	0.133	0.008
12 years	38.7%	0.568	0.551	0.121
13–15 years	37.1%	0.079	0.875	0.026
16+ years	35.0%	0.086	0.957	0.029
Total	34.3%	1.0		0.184
		Relative Concentration Index →		**0.074**
		Absolute Concentration Index →		**0.025**
2003				
<12 years	21.7%	0.165	0.083	0.003
12 years	24.0%	0.299	0.315	0.023
13–15 years	20.2%	0.304	0.616	0.038
16+ years	9.5%	0.232	0.884	0.020
Total	19.1%	1.0		0.083
		Relative Concentration Index →		**−0.132**
		Absolute Concentration Index →		**−0.025**

Note: Authors' calculations of the 1965 and 2003 NHIS.

Slope and Relative Index of Inequality

- Conceptually similar to CI
- Correlation between SEP rank and health.



Relationship between rank-based measures

Calculating SII

Regress health outcome (e.g., smoking) on midpoint of socioeconomic categories, weighted by proportion in the population:

$$y = \beta_0 + \beta_1 Rank + \epsilon$$

Slope Index of Inequality = β_1

Measures the average expected change in y when moving from the bottom (0) to the top (1) of the SEP rank distribution.

Relation to the RCI

There is a specific parallel with the RCI.

If we transform the outcome variable from y to $2\sigma^2_{Rank} * (y/\mu)$ and run the following regression:

$$2\sigma^2_{Rank} * (y/\mu) = \beta_0 + \beta_1 Rank + \epsilon$$

Then β_1 = Relative Concentration Index.

Example (Stata) for calculating SII and RII

```
clear
input class pop smokers
1 165 36
2 299 72
3 304 61
4 232 22
end
```

	class	pop	smokers	rate	rank
1	1	165	36	.2181818	.0825
2	2	299	72	.2408027	.3145
3	3	304	61	.2006579	.616
4	4	232	22	.0948276	.884

```
/* regress smoking rate on rank */
reg rate rank [fw=pop], cformat(%4.3f)
------------------------------------------------------------------------------
        rate |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        rank |    -0.166      0.003   -48.73   0.000       -0.173      -0.160
       _cons |     0.274      0.002   140.41   0.000        0.270       0.278
------------------------------------------------------------------------------
```

The coefficient on the “rank” variable is the estimated change in the rate of illness (e.g., smoking) as one moves from the bottom to the top of the class distribution (decreases by 17 percentage points).

Relative Index of Inequality (RII)

'Original' RII

$RII = \beta_1 / \bar{y}$

RII = -16.6 / 19.1 = -87%

This indicates that as one moves from the bottom (0) to the top (1) of SEP distribution the outcome (smoking) decreases by 87%

Kunst-Mackenbach modification

$RII_{KM} = \beta_0 / (\beta_0 + \beta_1)$

RII_{KM} = 27.4 / 10.8 = 2.5

Interpreted as the ratio of health for the bottom vs. the top of the socioeconomic distribution (analogous to more traditional RR used in epidemiologic studies).

Pamuk (1985), Kunst and Mackenbach (1995)

The measure may matter!

Table 3.9 Education-based inequality in contraceptive prevalence (modern methods) in the Philippines, DHS 1993 and 2008

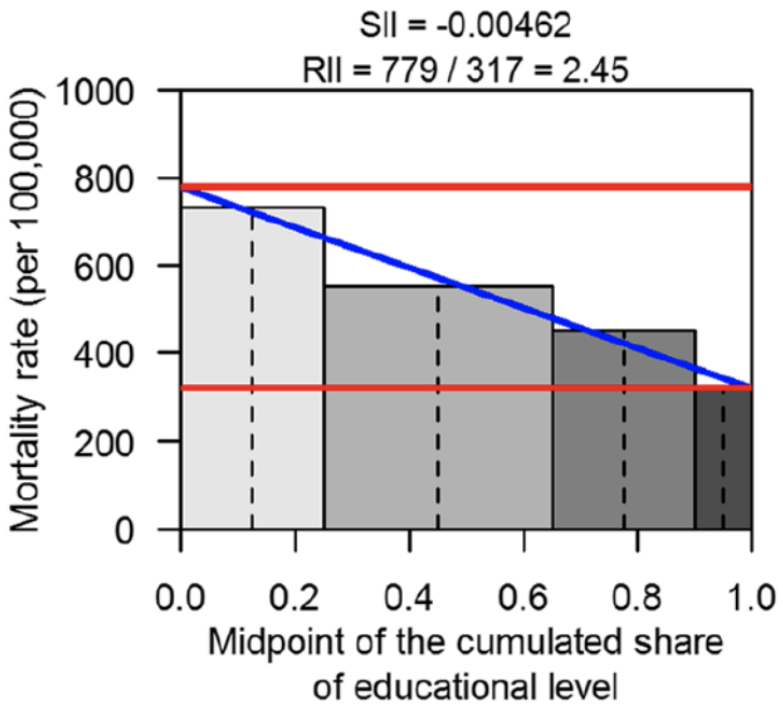
Survey year	Simple measures of inequality		Complex measures of inequality	
	Difference (secondary school or higher – none) (percentage points)	Ratio (secondary school or higher / none)	Slope index of inequality (percentage points)	Concentration index
1993	20.8	3.9	15.7	0.08
2008	27.1	4.1	14.3	0.04

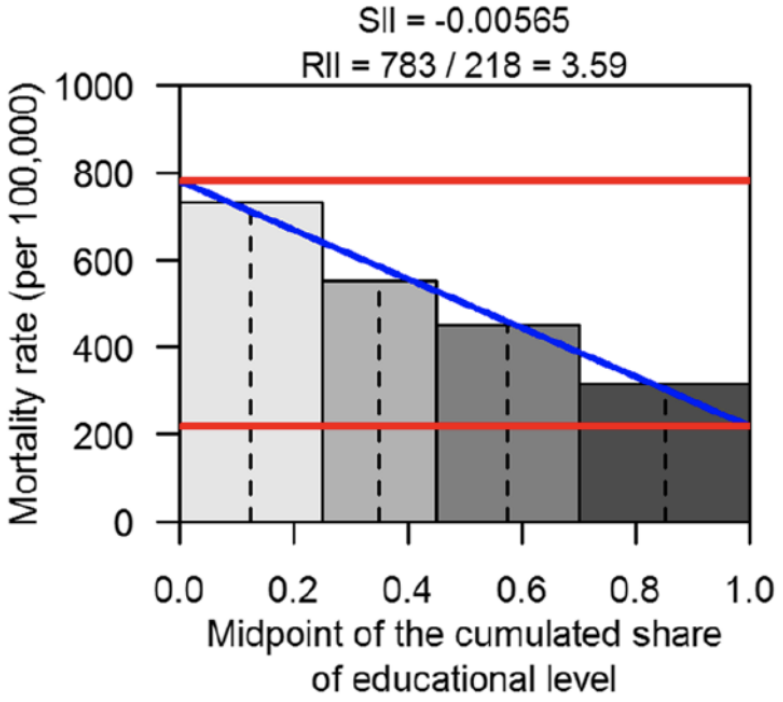
Using complex measures to account for population shifts is particularly important when health inequality monitoring is carried out to assess the effects of social policy. Broad social policies that are successful in alleviating poverty, increasing educational opportunities or creating jobs can result in a decrease in the size of disadvantaged subgroups. Evaluating the impact of such policies on health inequality is often of interest to those involved in the policy-making process. In order to generate measures that can be compared across time, health inequality monitoring should be sensitive to such changes in population characteristics.

Hosseinpoor (2013)

Two mechanisms for changing inequality

Size of social groups will also change SII/RII without mortality change. Increasing the size of higher educated groups (e.g., larger share with higher education) increases inequality:





Renard (2019)

2. Measuring Inequality

2.1 Conceptual Issues

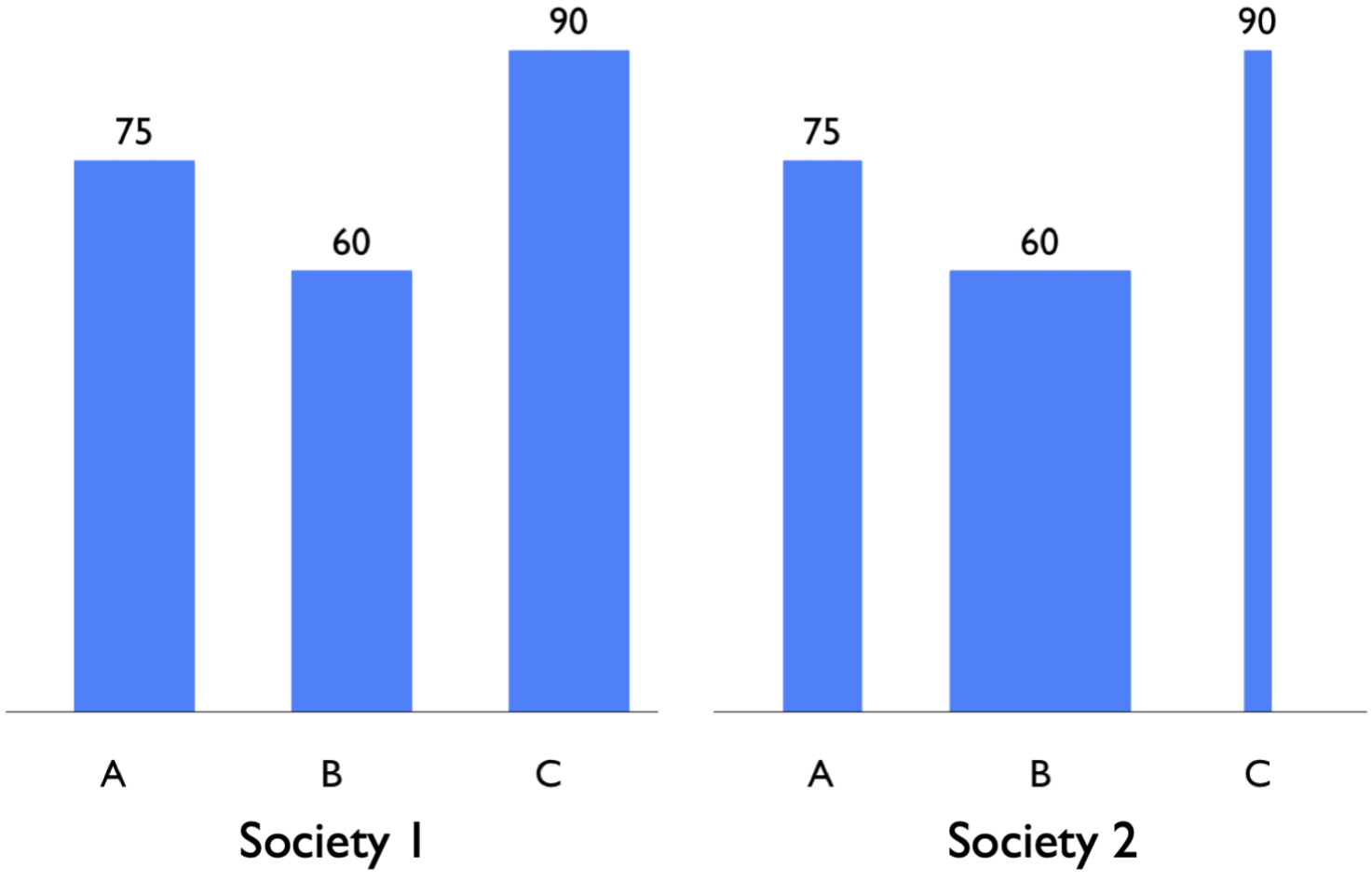
2.2 Absolute and Relative Inequality

2.3 Simple vs. Complex Measures

2.4 Weighting

2.5 Reference Points

Is the amount of inequality the same in these two societies?



No way to 'rank' ethnicity

Groups differ in size

Should we account for it?

How to summarize this variation by ethnicity?

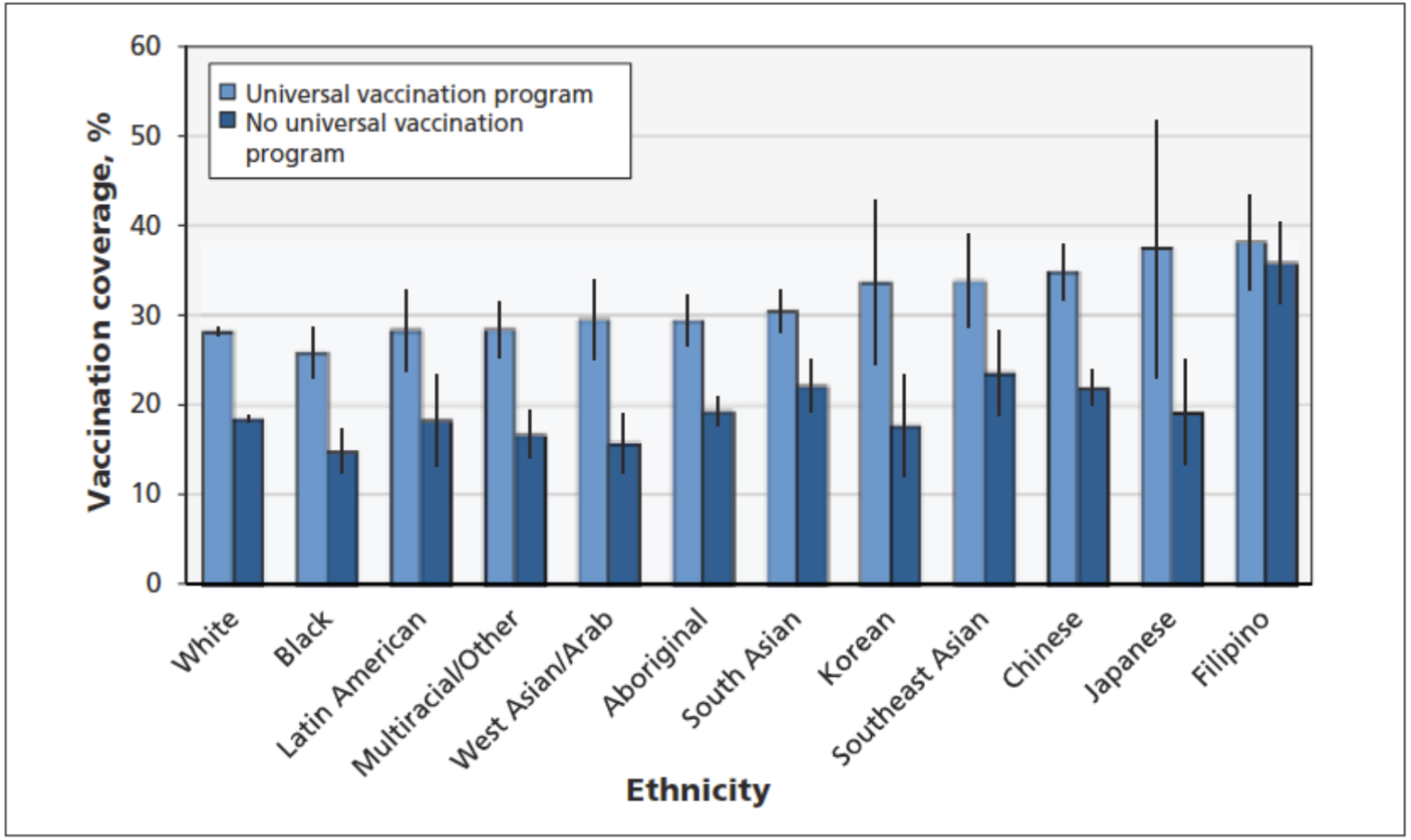


Figure 2: Influenza vaccine coverage, by ethnic group and availability of a universal influenza vaccination program, in Canadians aged 12–64 years without chronic diseases (2003–2009). Error bars represent 95% confidence intervals.

Quach et al. (2012)

Index of Disparity

Measures the mean deviation of the group rates from some reference point as a proportion of that reference point

$$ID = \sum_{j=1}^{J}(|y_j - y_{ref}|/n)/y_{ref}$$

Where y_j is the rate in group j, y_{ref} is the rate for the reference point, and J is the number of groups, or the number of groups minus 1 if one of the groups is the reference point.

Note that ID has a few important but potentially modifiable characteristics:

- Measures relative inequality
- Does not account for population size of groups
- Uses best observed health as reference level

Interpretation is also a little awkward: the average deviation across social groups as a proportion of the reference level

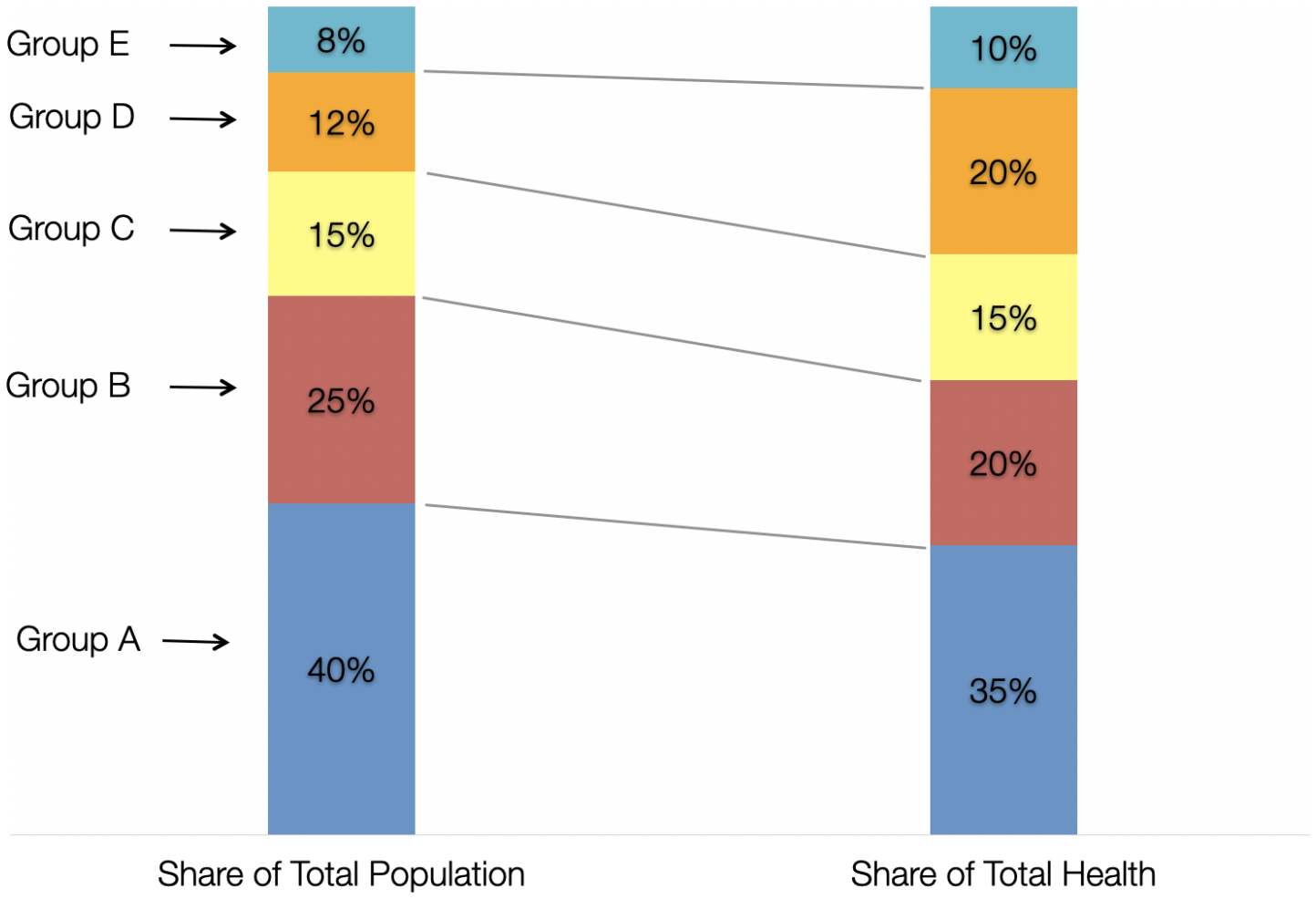
Are there alternatives?

Pearcy and Keppel (1999)

Inequality as 'Disproportionality'

Compares shares of health or disease with shares of the population.

Perfect equality: %pop = %health



Alternative: Mean Log Deviation

- weights by pop
- measures difference in log shares

Sensitive to 'transfers' at different points of health distribution.

Mean Log Deviation

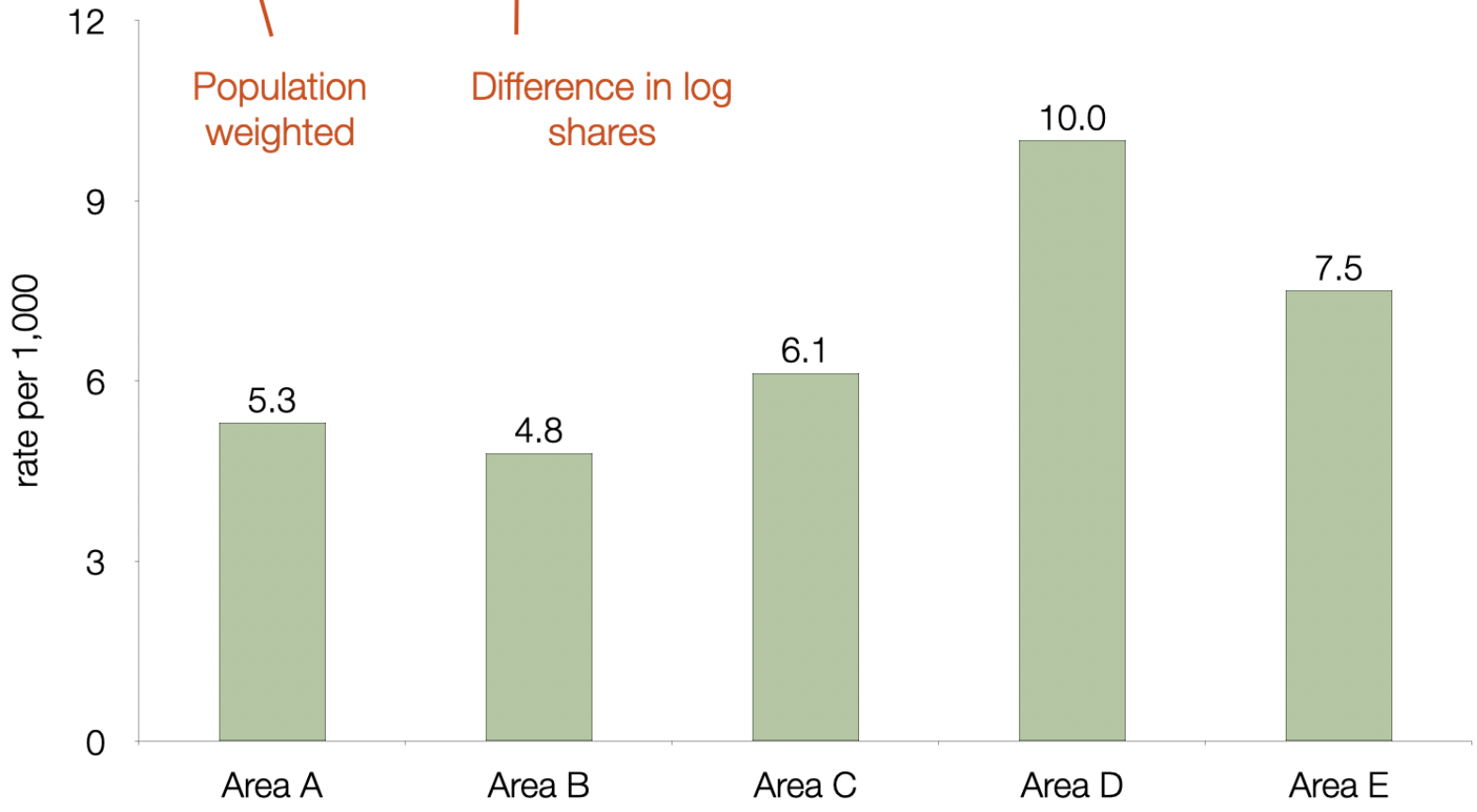
$$\sum_{j=1}^{J} p_j \left[ln\left(p_j\right) - ln\left(s_j\right) \right]$$

Population weighted

Difference in log shares

Index of Disparity

$$\sum_{j=1}^{J} \left(\left| y_j - y_{ref} \right| / n \right) / y_{ref}$$



Does it matter?

Ezzati et al.:
"There was a steady increase in mortality inequality across the US counties between 1983 and 1999, resulting from stagnation or increase in mortality among the worst-off segment of the population."

Geographic inequalities in life expectancy

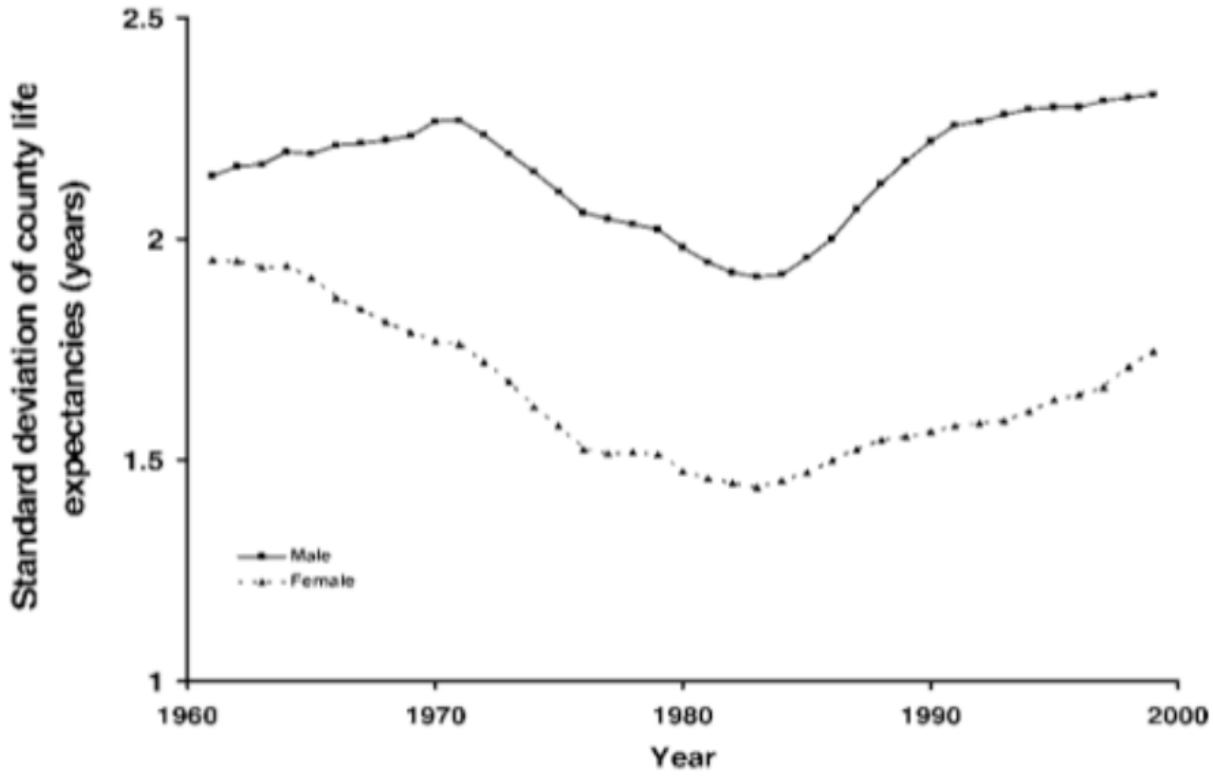


Figure 1. SD of Life Expectancies of the 2,068 County Units in the United States by Sex

Inequality in family income (e.g., as measured by the Gini coefficient) declined in the United States between the 1920s and 1970s, and has increased after that period [49,50].
doi:10.1371/journal.pmed.0050066.g001

Compared weighted to unweighted inequality measures

Across:

- counties
- states
- regions

TABLE 1
Comparison of Population-Weighted and -Unweighted Measures of Geographic Inequality in Life Expectancy at Birth in the United States, 1969–1973 and 1999–2003

Geographic Unit	Units	Life Expectancy at Birth		Measure of Health Inequality	
				Unweighted	Weighted
		Min.	Max.	Index of Disparity	Mean Log Deviation
1969–1973					
Census region	4	70.2	72.2	1.67	0.050
Census division	9	69.7	72.4	1.80	0.072
State	51	65.9	74.3	4.36	0.137
County[a]	3,087	56.2	85.0	16.77	0.423
1999–2003					
Census region	4	76.2	78.5	1.61	0.074
Census division	9	74.7	78.7	2.02	0.097
State	51	73.0	80.7	4.43	0.150
County[b]	3,140	62.0	96.1	20.35	0.379
% Change, 1969–73 to 1993–2003					
Census region				−3.6%	+48.0%
Census division				+12.2%	+34.7%
State				+1.6%	+9.5%
County				+21.2%	−10.4%

Different direction!
Different magnitude
Different direction!

Harper et al. (2010)

2. Measuring Inequality

2.1 Conceptual Issues

2.2 Absolute and Relative Inequality

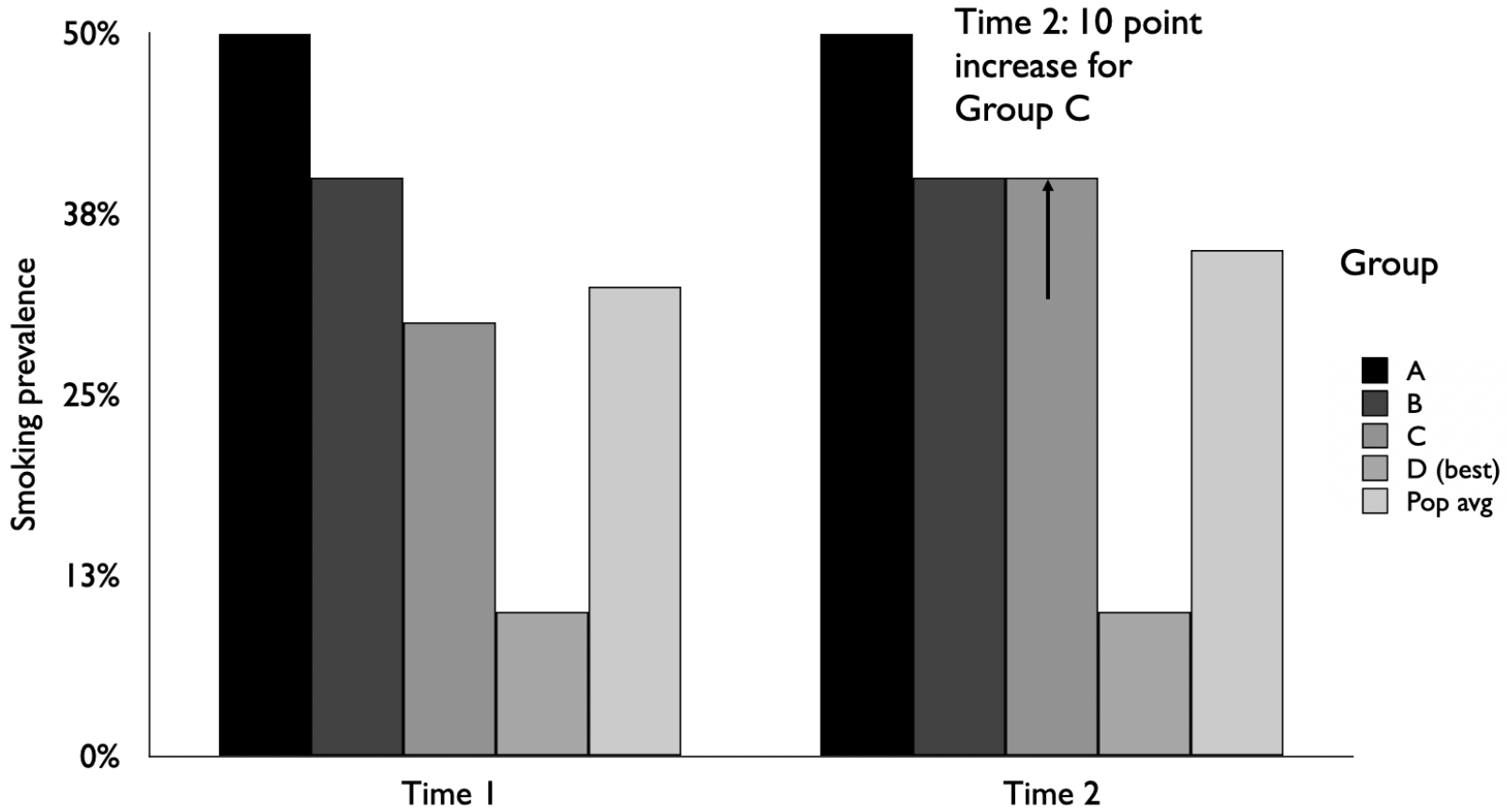
2.3 Simple vs. Complex Measures

2.4 Weighting

2.5 Reference Points

Changes in Index of Inequality Using Different Reference Points

	Time 1	Time 2	%Change
Index of Disparity (Reference=Best rate)	300.0	333.3	+11.1%
Index of Disparity (Reference=Avg rate)	38	35.7	-7.1%



Conclusions

Measures of health inequality are not value neutral.

- Scale of measurement (absolute/relative)
- Weighting: how much and to whom?
- Reference points: different from what standard?

The choices above have an important impact on our judgments of both the magnitude of health inequality and whether health inequalities are worsening or improving.

Monitoring health inequalities requires both precise measurement and value judgments—they are inseparable.

A suite of health inequality measures is likely necessary to provide a complete description of the magnitude of inequality.

Break! 

15:00