[The material below is a comment posted on *Journal Review* on January 14, 2008, (http://www.journalreview.org/view_pubmed_article.php?pmid=12850975&specialty_id=). The compression function of the *Journal Review* site altered the formatting of the tables. The version below contains the original formatting.]

Title: Comparing the size of inequalities in dichotomous measures in light of the standard correlations between such measures and the prevalence of an outcome

In exploring the implications of whether health inequalities are measured in terms of relative or absolute differences, Boström and Rosén [1] cite a 2000 article of mine styled "Race and Mortality,"[2] stating that the article "discusses racial disparities in infant mortality in the USA and shows that inequalities in infant mortality between blacks and white increase if measured in quotients, while the absolute rates are decreasing for blacks and whites." While it is true that my article showed that the absolute rates had decreased for both blacks and whites (as well as that the absolute difference between rates had decreased), the article said nothing about the ways inequalities measured in absolute terms might differ from those measured in relative terms, and, indeed, did not mention absolute differences between rates at all. The actual point of the article (and the several prior works it referenced [3,4,5]) concerned the ways that relative differences in experiencing or avoiding an outcome tend to change as the overall prevalence of an outcome changes. In particular, the article explained, the rarer an outcome, the greater tends to be the relative difference between rates of experiencing it and the smaller tends to be the relative difference between rates of avoiding it. Thus, Race and Mortality's treatment of the way choice of measure would tend to affect the interpretation of whether a disparity was increasing or decreasing involved the choice between the relative difference for an outcome (e.g., mortality) and the relative difference for the opposite outcome (e.g., survival).

In explaining why declining mortality tended to accompanied by increasing relative differences in mortality rates but declining relative differences in survival rates, the article also explained that neither the increase in one disparity nor the decline in the other need indicate a meaningful change in the relative health of advantaged and disadvantaged groups – that is, a change that is not a function of the overall change in prevalence but that instead reflects a change in the relationship of the two groups' underlying distributions of factors associated with the outcome at issue.

Finding that relative differences in certain adverse outcomes (smoking and mortality) usually increased during a period of overall decline in such outcomes and that relative differences in an adverse outcome (overweight) usually declined during a period of overall increase in the outcome, Boström and Rosén note that "[i]t is also evident that increasing gaps in health between different social groups are not always a bad thing and that decreasing gaps are not always a positive sign of health development." There is wisdom in this observation. But, failing to recognize the central point of Race and Mortality, the observation overlooks both that the patterns examined in the study tend to be systematic and that increasing or decreasing relative differences in adverse outcomes do not necessarily reflect changes in health inequalities in any meaningful sense.

Race and Mortality also discussed the way relative differences in experiencing an adverse outcome will tend to be higher in a population where the outcome is comparatively rare than in a population where the outcome is more common, while the relative difference in avoiding the outcome will tend to be smaller in the population where the outcome is rarer. This was overlooked by Boström and Rosén in their discussion of the comparatively large relative differences in mortality in countries, like Sweden, with low overall mortality rates.

As noted, Race and Mortality did not discuss absolute differences as at all. But implicit in the distributional relationships underlying the way relative differences in experiencing and avoiding an outcome tend to change as an outcome changes in prevalence is the tendency for absolute differences also to change as the prevalence of an outcome changes.[6-13] As an adverse outcome declines from the point of being almost universal to being less so, the absolute difference initially will tend to increase. It will tend to reach a high at approximately the point where the (increasing) relative difference in experiencing the outcome (measured in terms of the rate of the disadvantaged group to that of the advantaged group) equals the (decreasing) relative difference in avoiding the outcome (measured in terms of the ratio of the advantaged group's rate of avoiding the outcome to the disadvantaged group's rate of avoiding the outcome).[10-13] For ease of reference, and thinking terms of a decreasing adverse (increasing favorable) outcome, let us term the first ratio "Ratio ADV" (for the ratio of the adverse outcome rates) and the latter "Ratio FAV" (for ratio of the favorable outcome rates).

The difference measured in odds ratio, another measure of difference concerning dichotomous variables sometimes employed in health inequalities research, tends to behave in exactly the opposite manner of the absolute difference.[7-9,10-12] That is, such differences is initially large when one outcome is almost universal, then tends to decline as the overall prevalence of the outcome declines, reaching a low point at approximately the intersection of Ratios ADV and FAV. Thereafter, as the outcome continues to decline, the difference measured in odds ratios tends to increase again. (For precision, I use the phraseology "difference measured in odds ratios" rather than simply "odds ratio." The size of a difference measured in odds ratios will be the same regardless of whether one examines the favorable or the adverse outcome. But, depending on the measurement approach and which group's odds is used as the denominator, the size of the difference will be a function of the extent to which the odds ratio is either greater than one or less than one. In various illustrations of the pattern of changes in differences measured in odds ratios (as in references 7-9, 12-13), I have typically used the ratio of the disadvantaged group's odds of experiencing the adverse outcome to the advantaged group's odds of experiencing that outcome.)

These tendencies are inherent in the shapes of differing distributions of factors associated with experiencing or avoiding an outcome. They can be illustrated with almost any data set that allows one to examine various points on a continuum of factors associated with some outcome, including hypothetical test data, income data, and data on distributions of factors such as systolic blood pressure. Only when these tendencies and their basis are understood and in some manner taken into account is it possible to meaningfully compare the size of inequalities in different settings.

Section A below reanalyzes the data in Boström and Rosén's Tables 1 through 3 in light of the considerations discussed above. Before explaining the approaches in that analysis, however, I note that Boström and Rosén's addressing of the size of health inequalities in Sweden, and their more general discussion of possibilities for relative and absolute differences to support different perceptions of the comparative sizes of inequalities was to some extent prompted by a notable 1997 *Lancet* article [14] that surprised many by finding that, despite being comparatively egalitarian societies, Sweden and Norway had comparatively large health inequalities, measured in terms of relative differences in mortality rates, and by commentary thereon that had emphasized that, by contrast, these countries had comparatively small absolute differences between mortality rates.[15] The *Lancet* article is also addressed in references 7-9 of this comment and items D16, D17, and D19 at http://www.jpscanlan.com/homepage/measuringhlthdisp.html. It thus warrants note that two of the authors of that study recently collaborated on an article addressing Race and Mortality's analysis of the way relative differences in adverse outcomes tended to be rarer in settings where the outcomes were uncommon.[16]. The authors did not address the reasoning of Race and Mortality and were evidently unaware of recent works applying that reasoning to absolute differences. But, examining the issue mainly empirically, and offering explanations for observed patterns that are somewhat different from the explanations in Race and Mortality and related works, the authors nevertheless concluded that both relative and absolute differences tend to change systematically as the prevalence of an outcome changes. Thus, regardless of the extent to which the authors may disagree with the reasoning of Race and Mortality or more recent treatments on these issues, their recent work would seem also to call into question the conclusions of the 1997 *Lancet* article.

Using two approaches, Section A.1 below examines the data on smoking and overweight in Sweden, and the data on mortality in seven European countries, set out in Boström and Rosén's Tables 1 through 3, in an attempt to appraise the size of health inequalities at different points in time with recognition of the tendencies described above. Approach 1 draws inferences concerning meaningful changes based on departures from the standard patterns of changes, an approach previously discussed in references 7 and 8. Approach 2 draws inferences concerning changes over time by identifying the size of the difference between means of the distributions of factors associated with an outcome in terms of proportions of a standard deviation in each of two points in time, assuming normality of the underlying distributions. Section A.2.,using Approach 2, evaluates the size of inequalities in mortality in the seven European countries listed in Boström and Rosén's Table 3.

Approach 1 might be characterized as drawing inferences while taken certain tendencies inherent in normal distributions into account, and thereby determining whether there has been a meaningful change in the difference between the two distributions of factors associated with the outcome. Approach 2, rather than taking the tendencies into account, attempts to inferentially identify the specific differences between the distributions at each point in time. Approach 1 is limited to identifying meaningful changes in inequalities in circumstances where the change in the relationship of the risk distributions of two groups is sufficient to cause a departure from the standard patterns of changes in the various measures as the outcome increases or decreases in overall prevalence. As shown in Tables IV and V of reference 10, and as should be logically evident as well, modest meaningful increases or decreases in inequality may occur without affecting the standard patterns of directions of changes of the common measures of differences between rates. Approach 2, however, has the potential to identify meaningful changes in inequalities, even when there is no departure from the standard patterns of changes in the measures, as in the case of the modest increase in inequality in mortality in Sweden shown in Table 4.b.1 below.

The accuracy of either approach is substantially affected by the extent to which each group's distribution of factors associated with the outcome tends to be normal. Since it is unlikely that the risk distributions will be perfectly normal, and possible that they will depart significantly from the normal or at least exhibit occasional irregularities, the validity of the conclusions drawn by either method will invariably be somewhat uncertain. Sometimes, and perhaps often, the conclusions will be sufficiently suspect to raise a question as to whether the effort to appraise changes in inequalities over time is a worthwhile endeavor. And, of course, it will be in the circumstance of the modest changes that are detected solely by Approach 2 that even small imperfections in the approach may be of considerable consequence.

A further complexity is added by the role of absolute minimums. These are discussed with respect to their implications for Approach 1 in references 2, 7, and 8 (at 13-14 addressing the issue with respect to pattern of social inequalities in infant mortality in Sweden). The existence of such minimums would also have implications with respect to efforts to measure inequalities based on the size of differences in the average in the (unseen) distributions of factors underlying each group's risk of experiencing an outcome. Indeed, it would suggest that the underlying distributions of consequence are in fact distributions of factors associated with risks in excess of the absolute minimums.

In any case, issues about the reliability of Approach 1 have been explored elsewhere.[7,8]. Section B below attempts to explore some of the issues concerning the reliability of Approach 2 in circumstances involving other than perfectly normal distributions. Regardless of the ultimate value of either approach, however, the tendencies described above will tend to have a sufficient role in almost every setting that there is no point in attempting to appraise changes in inequalities over time while ignoring those tendencies.

Certain other qualification of the analyses below warrant mention. First, Boström and Rosén point out that the proportion the advantaged and disadvantaged groups comprise of the total population will change over time, noting, for example, that the proportion of the Swedish population comprised by manual workers or the poorly-educated had grown smaller during the period examined thereby causing such group to be more negatively selected at the latter point in time than at the former point in time. This is an important consideration, for such compositional changes potentially undermine even an otherwise accurate evaluation of the changes in the relative situation of the groups defined by occupation or education. Further, the consideration goes not merely to analyses of change over time by occupation or change over time by education (and contrasts between the two). It also goes to comparisons of the sizes of inequality by country, a subject in Boström and Rosén's Table 3, since the disadvantaged and advantaged groups whose rates are being compared will comprise different proportions of the total population within each country.

The implications of differences in the proportions of the populations comprised by advantaged and disadvantaged groups in different settings would seem an argument for generally appraising changing inequalities over time between the top and bottom deciles, quintile, or quartiles, according to income, as suggest by Carr-Hill for example.[17] At a minimum, such implications would seem reason always to indicate the proportion of the total population that the advantaged and disadvantaged groups comprise in each setting.

At any rate, even assuming that findings as to the direction of certain changes identified in the analysis that follows are entirely accurate, the meaning of such findings will be subject to question due to changes in the proportions the advantaged and disadvantaged groups comprise of the total population. Indeed, in the case of the modest increase in mortality inequality in Sweden shown under Approach 2 in Table 4.b.1 below, it seems that such increase could well be less than might be expected to occur solely because of the negative selectivity associated with the declining proportion of the population comprised by blue-collar workers. This raises the possibility that there in fact occurred a decline in inequality as would be measured, say, by comparison of groups defined by the top and bottom quintiles of the population, but the impact of which was outweighed by the impact of the negative selectivity (even allowing the possibility of a decline in the positive selectivity of white-collar workers due to the growth in the proportion of the population comprised by such workers).

The importance of the considerations regarding proportions groups being compared comprise of the total population, however, turns somewhat on the purpose of the analysis of inequality. If the purpose is to examine the impact of education *qua* education or the effects of the rigors of manual labor, changes in the proportion of the population comprised by well-educated and poorly-educated groups, or manual and non-manual workers, would seem of limited consequence. But usually educational and occupational categories are used as proxies for social class, and in such circumstances the compositional considerations raised by Boström and Rosén seem to apply completely.

The fact that the proportions various social classes make up of the total population may change over time is at times offered as a reason for employing summary measures of health inequalities, such as the gini coefficient, the concentration index, and the relative index of inequality, which endeavor to take into account the proportions each class makes up of the total population. Whether or not these approaches entirely address the compositional issue, however, each measure tends to change solely because of a change in the prevalence of the outcome and hence each suffers from the same problems as those undermining analyses based on measures like rate ratios and absolute differences between rates.

That is, as discussed in references 7 and 8, for a measure to reliably identify changes in relative health that are not solely functions of changes in the overall prevalence of some outcome, it is necessary that the measure remain constant when there occurs simply on overall change in prevalence akin to that effected by reducing a cutoff point on a test. Not only would the Gini coefficient change as the cutoffs are altered, however, but the Gini coefficient for the favorable outcome and the adverse outcome would change in opposite directions. This is illustrated in Table 1 below, which is based on the data in Table 1 of reference 8 (which is premised on a .5 standard deviation between group means), assuming that the advantaged and disadvantaged groups each comprise 50% of the total population. The columns of the table are (1) the advantaged group's failure rate at each point (column 1 of Table 1 in reference 8), (2) the Gini coefficient for falling below each point, and (3) the Gini coefficient for falling above each point. Other summary measures raise similar issues.

Table 1: Gini Coefficients for Falling Below and Above Each Point Defined by the Advantaged Group's Failure Rate in Table 1 of Reference 8.

(1)	(2)	(3)
99%	.002	.309
97%	.005	.276
95%	.009	.257
90%	.017	.228
80%	.032	.190
70%	.048	.162
60%	.064	.139
50%	.080	.117
40%	.097	.096
30%	.120	.079
20%	.147	.058
10%	.185	.035
5%	.216	.021
3%	.236	.014
1%	.272	.006

However, it also warrants note that while differences in the proportions advantaged and disadvantaged groups comprise of the total population in different settings may render analysis of inequalities by socioeconomic status problematic, similar problems generally are not present with respect to analyses of inequalities according to race.

Second, when Approach 1 suggests, even in strong terms, that there has occurred a meaningful change in inequality, it needs to be recognized that such change commonly will be much smaller than that suggested by changes in measures such as relative differences in adverse outcomes. That is, for example, the ratio of smoking rates of poorly-educated men to smoking rates of highly-educated men in Sweden increased from 1.56 to 3.35 between 1888/89 and 1998/99. In other words, an excess risk of 56% increased to one of 235%, more than quadrupling. As shown in Section A.1.a below, on the basis of the nonstandard increase in non-smoking ratio and absolute difference between rates, we can infer that there likely occurred a meaningful change in smoking inequality. But some part of the increase in the ratio of smoking rates, perhaps a substantial part, would have occurred even in circumstances where there occurred no meaningful change in inequality. Thus, regarding the excess risk as quadrupling would not be warranted (though Approach 2 does show that the change was in fact quite large).

Further, while the changes in inequality indicated by Approach 2 are unaffected by the consideration in the prior paragraph, some explanation may be warranted as to the meaning of the differences measured by such approach. Such measure is simply the difference between means of hypothesized distributions of factors divided by the standard deviation. (The hypothesis assumes equal standard deviations and hence does not raise a question as to whether the denominator should be the pooled standard deviation or the standard deviation for the advantaged or disadvantaged group – an issue of potential consequence when the standard deviations of the distributions differ and the groups differ in size.) A difference of .50 standard deviations, which underlies Table 1 of reference 8, and many of the illustrations in various of the other references, would mean that approximately 31% of the disadvantaged group falls above the mean of the advantaged group, or, since the discussion here is more focused on the adverse outcome, approximately 69% of the disadvantaged group falls below the mean of the advantaged group. The estimated .13 standard deviation differences in Sweden in 1980-84, which is shown in Table 4.b.1, and which underlies the 1.50 Ratio ADV and 1.0017 Ratio FAV shown for that period, would mean that almost 55% of blue collar workers would fall below the mean for white collar workers; the estimated .17 standard deviation differences in Sweden in 1990-94 shown in the table, and which underlies the 1.64 Ratio ADV and 1.0016 Ratio FAV for that period, would mean that almost 57% of blue collar workers would fall below the mean for white collar workers.

A. Analyses of Data in Boström and Rosén's Table 1-3

Section A.1 below analyzes the data in Boström and Rosén's Tables 1 through 3 with respect to changes over time. Section A.2 analyzes the data in Table 3 with respect to the comparative size of inequalities in different countries.

With respect to all analyses, Approach 2 is based on the deriving of estimates of the difference between means of hypothetical underlying continuously-scaled distributions by means of matching rates of advantaged and disadvantaged to tables listing values within certain areas of normal curves. The values in terms of fractions of a standard deviation are typically carried to two decimal places based on the closest match. The instances where the value is carried to three places simply involve situations where a value fell evenly between two points in a reference table. The use of three decimal points thus should not be interpreted to reflect great exactness in the analysis. And, of course, small irregularities in the actual distributions may have serious consequences at even at two decimal places (and perhaps one as well).

While I think that the methodology is essentially correct, it is possible that I have overlooked certain nuances. But any technical problems, while perhaps very important to the accuracy of conclusions about small changes, have little bearing on the broader issues.

A.1. Analyses of Data in Boström and Rosén's Tables 1 through 3 with Respect to Changes over Time.

A.1.a. Changes in Smoking Inequalities over Time

With regard to Approach 1's analysis of smoking inequalities, since smoking declined in prevalence, the standard pattern of change in the ratios of rates of experiencing that outcome (Ratio ADV) would be an increase, while the standard pattern of change in the ratio of experiencing the opposite outcome (Ratio FAV) would be a decrease. Also with respect to Approach 1, since, Ratio ADV is larger than Ratio FAV, and declines in smoking tend toward increasing the difference between these ratios, the standard pattern of change would be an increase in the difference between rates measured by odds ratios and a decline in the absolute difference between rates.

A summary of the results of the smoking analyses is set out in Table 2a.

Table 2a: Summary of Patterns of Changes in Smoking Inequalities
Men by Occupation
–Approach 1 – change in inequality not apparent
–Approach 2 – change in inequality not apparent
Men by Education
–Approach 1 – change in inequality not apparent
–Approach 2 – change in inequality not apparent
Women by Occupation
Approach 1 – apparent decrease in inequality
Approach 2 – apparent decrease in inequality
Women by Education
–Approach 1 – apparent increase in inequality
–Approach 2 – apparent increase in inequality

Detailed analyses underlying the summary results shown in Table 2.a. are set out in Table 2.b.

Table 2b: Changes in Smoking Inequalities
1. Men by Occupation
Blue-collar
–1988/89 – 314 (per thousand)
–1998/99 – 223

White-collar
–1988/89 – 199
–1998/99 – 132
Ratio ADV (smoking)
–1988/89 – 1.58
–1998/99 – 1.69 (increase – standard)
Risk FAV (non-smoking)
–1988/89 – 1.17
–1998/99 – 1.12 (decrease – standard)
Odds ratio
–1988/89 – 1.84
–1998/99 – 1.89 (increase – standard)
Absolute difference
–1988/89 – 115
–1998/99 – 91 (decrease – standard)
Estimated difference between averages of underlying distributions
–1988/89 – .37 standard deviations
–1998/99 – .365 standard deviations (negligible change)
Interpretations
–Approach 1 – change in inequality not apparent
–Approach 2 – change in inequality not apparent

2. Men by Education
Poorly-educated
–1988/89 – 327 (per thousand)
–1998/99 – 265
Highly-educated
–1988/89 – 209
–1998/99 – 79
Ratio ADV (smoking)
–1988/89 – 1.56
–1998/99 – 3.35 (increase – standard)
Ratio FAV (non-smoking)
–1988/89 – 1.18
–1998/99 – 1.25 (increase – NONSTANDARD)
Odds ratio
–1988/89 – 1.84
–1998/99 – 4.20 (increase – standard)
Absolute difference
–1988/89 – 118
–1998/99 – 186 (increase – NONSTANDARD)
Estimated difference between averages of underlying distributions
–1988/89 – .36 standard deviations
–1998/99 – .785 standard deviations (increase)
Interpretations
–Approach 1 – apparent increase in inequality

–Approach 2 – apparent increase in inequality

3. Women by Occupation
Blue-collar
–1988/89 – 328 (per thousand)
–1998/99 – 263
White-collar
–1988/89 – 184
–1998/99 – 153
Ratio ADV (smoking)
–1988/89 – 1.78
–1998/99 – 1.72 (decrease – NONSTAMDARD)
Risk FAV (non-smoking)
–1988/89 – 1.21
–1998/99 – 1.15 (decrease – standard)
Odds ratio
–1988/89 – 2.16
–1998/99 – 1.98 (decrease – NONSTANDARD)
Absolute difference
–1988/89 – 144
–1998/99 – 110 (decrease – standard)
Estimated difference in average
1988/89 – .475 standard deviations
1998/99 – .385 standard deviations (decrease)
Interpretations
–Approach 1 – apparent decrease in inequality
–Approach 2 – apparent decrease in inequality

4. Women by Education
Poorly-educated
–1988/89 – 310 (per thousand)
–1998/99 – 277
Highly-educated
–1988/89 – 147
–1998/99 – 92
Ratio ADV (smoking)
–1988/89 – 2.11
–1998/99 – 3.01 (increase – standard)
Risk FAV (non-smoking)
–1988/89 – 1.24
–1998/99 – 1.26 (increase – NONSTANDARD)
Odds ratio
–1988/89 – 2.61
–1998/99 – 3.78 (increase – standard)
Absolute difference
–1988/89 – 163

–1998/99 – 185 (increase – NONSTANDARD)
Estimated difference in average
–1988/89 – .55 standard deviations
–1998/99 – .735 standard deviations (increase)
Interpretations
–Approach 1 – apparent increase in inequality
–Approach 2 – apparent increase in inequality

A.2.a. Changes in Overweight Inequalities over Time

With regard to Approach 1's analysis of overweight inequalities, since overweight increased in prevalence, the standard pattern of change in the ratio of rates of experiencing that outcome (Ratio ADV) would be a decrease, while the standard pattern of change in the ratio of experiencing the opposite outcome (Ratio FAV) would be an increase. Also with respect to Approach 1, since, Ratio ADV is larger than Ratio FAV, and increases in overweight tend toward reducing the difference between these ratios, the standard pattern of change would be a decrease in the difference between rates measured by odds ratios and an increase in the absolute difference between rates.

A summary of the results for overweight is set out in Table 3.a.

Table 3.a. Summary of Patterns of Changes in Overweight Inequalities
Men by Occupation
–Approach 1 – apparent decrease in inequality
–Approach 2 – apparent decrease in inequality
Men by Education
–Approach 1 – apparent decrease in inequality
–Approach 2 – apparent decrease in inequality
Women by Occupation
–Approach 1 – apparent increase in inequality
–Approach 2 – apparent increase in inequality
Women by Education
–Approach 1 – apparent decrease in inequality
–Approach 2 – apparent decrease in inequality

Detailed analysis underlying the summary results shown in Table 3.a. are set out in Table 3.b.

Table 3.b. Changes in Overweight Inequalities
1. Men by Occupation
Blue-collar
–1988/89 – 421 (per thousand)
–1998/99 – 525
White-collar
–1988/89 – 317
–1998/99 – 452

Ratio ADV (overweight)
–1988/89 – 1.33
–1998/99 – 1.16 (decrease – standard)
Ratio FAV (non-overweight)
–1988/89 – 1.18
–1998/99 – 1.15 (decrease – NONSTANDARD)
Odds ratio
–1988/89 – 1.57
–1998/99 – 1.34 (decrease – NONSTANDARD)
Absolute difference
–1988/89 – 104
–1998/99 – 73 (decrease – NONSTANDARD)
Estimated difference in average
–1988/89 – .28 standard deviations
–1998/99 – .195 standard deviations
Interpretations
–Approach 1 – apparent decrease in inequality
–Approach 2 – apparent decrease in inequality

2. Men by Education (overweight)
Poorly-educated
–1988/89 – 414 (per thousand)
–1998/99 – 479
Highly-educated
–1988/89 – 275
–1998/99 – 375
Ratio ADV (overweight)
–1988/89 – 1.51
–1998/99 – 1.34 (decrease – standard)
Ratio FAV (non-overweight)
–1988/89 – 1.24
–1998/99 – 1.23 (decrease – NONSTANDARD)
Odds ratio
–1988/89 – 1.86
–1998/99 – 1.66 (decrease – standard)
Absolute difference
–1988/89 – 139
–1998/99 – 122 (decrease – NONSTANDARD)
Estimated difference in average
–1988/89 – .375 standard deviations
–1998/99 – .32 standard deviations (decrease)
Interpretations
–Approach 1 – apparent decrease in inequality
–Approach 2 – apparent decrease in inequality

3. Women by Occupation
Blue-collar
–1988/89 – 304
–1998/99 – 405
White-collar
–1988/89 – 212
–1998/99 – 277
Ratio ADV (overweight)
–1988/89 – 1.43
–1998/99 – 1.46 (increase – NONSTANDARD)
Ratio FAV (non-overweight)
–1988/89 – 1.13
–1998/99 – 1.22 (increase – standard)
Odds ratio
–1988/89 – 1.62
–1998/99 – 1.78 (increase – NONSTANDARD)
Absolute difference
–1988/89 – 92
–1998/99 – 128 (increase – standard)
Estimated difference in average
–1988/89 – .29 standard deviations
–1998/99 – .35 standard deviations (increase)
Interpretations
–Approach 1 – apparent increase in inequality
–Approach 2 – apparent increase in inequality

4. Women by Education
Poorly-educated
–1988/89 – 316 (per thousand)
–1998/99 – 373
Highly-educated
–1988/89 – 141
–1998/99 – 267
Ratio ADV (overweight)
–1988/89 – 2.24
–1998/99 – 1.40 (decrease – standard)
Ratio FAV (non-overweight)
–1988/89 – 1.26
–1998/99 – 1.17 (decrease – NONSTANDARD)
Odds ratio
–1988/89 – 2.81
–1998/99 – 1.63 (decrease – standard)
Absolute difference
–1988/89 – 175
–1998/99 – 106 (decrease – NONSTANDARD)

Estimated difference in average
–1988/89 – .60 standard deviations
–1998/99 – .30 standard deviations (decrease)
Interpretations
–Approach 1 – apparent decrease in inequality
–Approach 2 – apparent decrease in inequality

A.1.c Changes in Mortality Inequalities in Seven Countries

With regard to, Approach 1, since mortality declined in prevalence in all countries, the standard pattern of change in the ratio of rates of experiencing that outcome (Ratio ADV) would be an increase, while the standard pattern of change in the ratio of rates of experiencing the opposite outcome (Ratio FAV) would be a decrease. Also with respect to Approach 1, since Ratio ADV is larger than Ratio FAV, and declines in mortality tend toward increasing the difference between these ratios, the standard pattern of change would be an increase in the difference between rates measured by odds ratios and a decline in the absolute difference between rates.

A summary of the results of an analysis of changes in mortality inequalities in the seven countries in Boström and Rosén's Table 3 is set out in Table 4.a.

Table 4.a. Summary of Patterns of Changes in Mortality Inequalities in Seven Countries

1. Sweden
–Approach 1 – change in inequality not apparent
–Approach 2 – apparent increase in inequality
2. Denmark
–Approach 1 – change in inequality not apparent
–Approach 2 – change in inequality not apparent
3. Finland
–Approach 1 – apparent increase in inequality
–Approach 2 – apparent increase in inequality
4. Norway
–Approach 1 – apparent (small) increase in inequality
–Approach 2 – apparent (small) increase in inequality
5. England & Wales
–Approach 1 – apparent increase in inequality
–Approach 2 – apparent increase in inequality
6. Ireland
–Approach 1 – apparent increase in inequality
–Approach 2 – apparent increase in inequality
7. Spain
–Approach 1 – apparent increase in inequality
–Approach 2 – apparent decrease in inequality

Detailed analysis underlying the summary results shown in Table 4.a. are set out in Table 4.b.

Table 4b: Changing Inequalities in Mortality by Occupation

a. Sweden
Blue-collar
–1980-84 – 510 (per 100,000)
–1990-94 – 410
White-collar
–1980-84 – 340
–1990-94 – 250
Ratio ADV (mortality)
–1980-84 – 1.50
–1990-94 – 1.64 (increase – standard)
Ratio FAV (survival)
–1980-84 – 1.0017
–1990-94 – 1.0016 (decrease – standard)
Odds ratio
–1980-84 – 1.50
–1990-94 – 1.64 (increase – standard)
Absolute difference
–1980-84 – 170
–1990-94 – 160 (decrease – standard)
Estimated difference in average
–1980-84 – .14 standard deviations
–1990-94 – .17 standard deviations
Interpretations
–Approach 1 – change in inequality not apparent
-Approach 2 – apparent increase in inequality

2. Denmark
Blue–collar
–1980-84 – 620 (per 100,000)
–1990-94 – 570
White-collar
–1980-84 – 430
–1990-94 – 390
Ratio ADV (mortality)
–1980-84 – 1.44
–1990-94 – 1.46 (increase – standard)
Ratio FAV (survival)
–1980-84 – 1.0019
–1990-94 – 1.0018 (decrease – standard)
Odds ratio
–1980-84 – 1.44

–1990-94 – 1.46 (increase – standard)
Absolute difference
–1980-84 – 190
–1990-94 – 180 (decrease – standard)
Estimated difference in average
–1980-84 – .125 standard deviations
–1990-94 – .12 of a standard deviations
Interpretations
–Approach 1 – change in inequality not apparent
–Approach 2 – change in inequality not apparent

3. Finland
Blue-collar
–1980-84 – 740 (per 100,000)
–1990-94 – 690
White-collar
–1980-84 – 470
–1990-94 – 360
Ratio ADV (mortality)
–1980-84 – 1.57
–1990-94 – 1.92 (increase – standard)
Ratio FAV (survival)
–1980-84 – 1.0027
–1990-94 – 1.0033 (increase – NONSTANDARD)
Odds ratio
–1980-84 – 1.57
–1990-94 – 1.92 (increase – standard)
Absolute difference
–1980-84 – 270
–1990-94 – 330 (increase – NONSTANDARD)
Estimated difference in average
–1980-84 – .16 standard deviations
–1990-94 – .23 standard deviations
Interpretations
–Approach 1 – apparent increase in inequality
–Approach 2 – apparent increase in inequality

4. Norway
Blue-collar
–1980-84 – 520 (per 100,000)
–1990-94 – 430
White-collar
–1980-84 – 370
–1990-94 – 280
Ratio ADV (mortality)
–1980-84 – 1.41

–1990-94 – 1.54 (increase – standard)
Ratio FAV (survival)
–1980-84 – 1.001508
–1990-94 – 1.001506 (decrease – standard; arguably, no change – NONSTANDARD)
Odds ratio
–1980-84 – 1.41
–1990-94 – 1.54 (increase – standard)
Absolute difference
–1980-84 – 150
–1990-94 – 150 (no change – NONSTANDARD)
Estimated difference in average
–1980-84 – .12 standard deviations
–1990-94 – .145 standard deviations
Interpretations
–Approach 1 – apparent (small) increase in inequality
–Approach 2 – apparent (small) increase in inequality

Note: With respect to the interpretation of Approach 1 for Norway, it should be recognized that not only are changes in nonstandard directions suggestive of a meaningful change, the absence of a change in the standard direction, particularly in the face of large overall changes, is also suggestive of a meaningful change in inequality. The failure of a measure to change at all, however, would seem suggestive of a smaller meaningful change than a change of the measure in the nonstandard direction.

5. England & Wales
Blue-collar
–1980-84 – 530 (per 100,000)
–1990-94 – 460
White-collar
–1980-84 – 390
–1990-94 – 300
Ratio ADV (mortality)
–1980-84 – 1.36
–1990-94 – 1.53 (increase – standard)
Ratio FAV (survival)
–1980-84 – 1.0014
–1990-94 – 1.0016 (increase – NONSTANDARD)
Odds ratio
–1980-84 – 1.36
–1990-94 – 1.54 (increase – standard)
Absolute difference
–1980-84 – 140
–1990-94 – 160 (increase – NONSTANDARD)
Estimated difference in average
–1980-84 – .10 standard deviations
–1990-94 – .15 standard deviations

Interpretations
–Approach 1 – apparent increase in inequality
–Approach 2 – apparent increase in inequality

6. Ireland
Blue-collar
–1980-84 – 620 (per 100,000)
–1990-94 – 540
White-collar
–1980-84 – 470
–1990-94 – 320
Ratio ADV (mortality)
–1980-84 – 1.32
–1990-94 – 1.69 (increase – standard)
Ratio FAV (survival)
–1980-84 – 1.0015
–1990-94 – 1.0022 (increase – NONSTANDARD)
Odds ratio
–1980-84 – 1.32
–1990-94 – 1.69 (increase – standard)
Absolute difference
–1980-84 – 150
–1990-94 – 220 (increase – NONSTANDARD)
Estimated difference in average
–1980-84 – .10 standard deviations
–1990-94 – .175 standard deviations
Interpretations
–Approach 1 – apparent increase in inequality
–Approach 2 – apparent increase in inequality

7. Spain
Blue-collar
–1980-84 – 540
–1990-94 – 510
White-collar
–1980-84 – 380
–1990-94 – 260
Ratio ADV (mortality)
–1980-84 – 1.42
–1990-94 – 1.96 (increase – standard)
Favorable risk ratio (survival)
–1980-84 – 1.0016
–1990-94 – 1.0025 (increase – NONSTANDARD)
Odds ratio
–1980-84 – 1.42
–1990-94 – 1.97 (increase – standard)

Absolute difference
–1980-84 – 150
–1990-94 – 220 (increase – NONSTANDARD)
Estimated difference in average
–1980-84 – .12 standard deviations
–1990-94 – .22 standard deviations
Interpretations
–Approach 1 – apparent increase in inequality
–Approach 2 – apparent decrease in inequality

A.2. Comparison of the Size of Inequalities in Seven Countries

Using Approach 1, the comparison of the size of inequalities among seven countries is more complicated than the analysis of a change across time in each country. Using Approach 1, however, one might attempt to draw certain conclusions, for example, based on the fact that, since mortality is generally lower in Sweden than in Norway, in the absence of any difference in underlying health inequality one would expect a smaller Ratio FAV in Sweden than in Norway. In fact one observes the opposite, suggesting smaller inequality in Norway than Sweden (a result consistent with that suggested by Approach 2).

However, the analysis below is limited to Approach 2. Table 4.c lists the seven countries according the size of inequality as measured by Approach 2 in the latter period examined.

Table 4.c. Comparison of Size of Inequalities in Seven Countries under Approach 2..
Denmark – .120 standard deviations
Norway – .145 standard deviations
England & Wales – .150 standard deviations
Sweden – .170 standard deviations
Ireland – .175 standard deviations
Spain – .220 standard deviations
Finland – .230 standard deviations

Again, however, both approaches are subject to uncertainty because the underlying distributions cannot be directly observed and because the advantaged and disadvantaged groups may comprise different proportions of the total population in each country.

B. Issues Regarding the Validity of Approach 2

The section briefly explores some issues concerning the potential validity of Approach 2. An encouraging aspect of the results described in Section A.1 is that, consistent with theory, while in some cases Approach 2 shows a meaningful change where Approach 1 does not, in no case does Approach 1 show a meaningful change where Approach 2 does not. Also, in no case do the two approaches indicate changes in opposite directions. Further, the general nature of the results of Approach 2 seems intuitively in accord with the results of Approach 1. But this hardly means that Approach 2 will necessarily be useful in most circumstances one will encounter in reality. Below are some illustrations, based on data where we have some direct evidence of the underlying distributions, that bear on the potential validity of Approach 2.

Table 5 is based on Table 1 of reference 7, which shows rates at which blacks and whites in the United States fall below various ratios of the poverty line. Bear in mind that the point of Table 1 of reference 7, as well as Table 1 of reference 8, is to illustrate the way measures of differences between rates tend to change solely because of a change in the prevalence of an outcome. Those tables show how each of the conventional measures of differences between outcome rates changes solely because of a change in prevalence and hence that a change in such measure cannot by itself indicate a meaningful change in the relative well-being of two groups. The same holds with respect to the difference between means of the underlying distributions which is the focus of Approach 2. Thus, with respect to the information on black and white income, the validity of the approach would turn on the degree to which such difference does not change as one moves up or down the rows in Table 1 of reference 7.

The columns in Table 5 reflect (1) ratio of the poverty line, (2) white rate of falling below that ratio, (3) black rate of falling below that ratio, (4) estimated difference in the underlying distributions according to Approach 2. For ease of reference, in the subsequent discussion, the final item may be referred to as EES (for estimated effect size of the difference between means of the hypothesized underlying distributions).

Table 5. Difference between Hypothesized Underlying Means of Blacks and Whites Derived from Reference to the Rates of Falling Various Ratios of the Poverty Line (based on data in Table 1 of reference 7).

(1)	(2)	(3)	(4)
600	.794	.919	.575 standard deviations
500	.716	.869	.555 standard deviations
400	.606	.785	.520 standard deviations
300	.456	.660	.530 standard deviations
250	.375	.579	.535 standard deviations
200	.284	.484	.530 standard deviations
175	.239	.436	.550 standard deviations
150	.192	.374	.545 standard deviations
125	.149	.309	.540 standard deviations
100	.108	.248	.560 standard deviations
75	.072	.178	.535 standard deviations
50	.044	.117	.520 standard deviations

There is relatively little variation in the difference in means derived on the basis of the rates at which blacks and whites fall below each point. This suggests that Approach 2 may be reliable in some circumstances. But here we are dealing with income distributions that, while not perfectly normal, probably do not depart very much from normal. And even here, of course, were one to infer that there had been a meaningful improvement in the relative situation of blacks based on the decrease in EES (from .560

to .520) in the case of a decline in poverty that brought out of poverty everyone initially between the poverty line and 50 percent of the poverty line, that would seem to be a mistake, just as it would be a mistake to draw the opposite inference on the basis of an increase in the ratio of the black poverty rate to the white poverty rate that would be observed in such circumstances.

Figure 7 of reference 13 shows how actual data on black and white systolic blood pressure (SBP) levels (based on men age 55-64 in the 1999-2000 and 2001-2002 NHANES samples) tend generally to reveal the patterns of differences in rates of falling above and below certain levels that one finds in normal data. Table 6 below shows how the same data would translate into differences between distributions derived from the rates of falling below each point. The columns correspond in concept to those in Table 5.

Table 6. Difference between Hypothesized Underlying Means Systolic Blood Pressure of Blacks and Whites Men 55-64 in NHANES 1999-2000 and 2001-2002 Samples

(1)	(2)	(3)	(4)
100	.976	.981	.090 standard deviations
110	.903	.961	.470 standard deviations
120	.606	.785	.520 standard deviations
130	.456	.660	.530 standard deviations
140	.375	.579	.535 standard deviations
150	.284	.484	.530 standard deviations
160	.239	.436	.550 standard deviations
170	.192	.374	.545 standard deviations
180	.149	.309	.540 standard deviations
190	.108	.248	.560 standard deviations

The black sample is quite small, which likely accounts for some of the irregularity shown in Figure 7 of reference 13. For the same reason, little can be made of patterns of differences between means at close SBP levels. We can see that the difference at 160 is larger than the difference at 120. But it is not much larger and generally the differences between derived means at each level above 110 are akin to those observed in Table 5. Thus, envision the situation where it was possible to reduce the SBP of everyone with SBP below 160 to 120 (or 140). Figure 7 of reference 13 reflects the reasons that it would be a mistake to regard the changes in standard measures occasioned by such reduction as reflecting an increase or decrease in inequality. Whether reliance on the EES would similarly lead to a mistaken understanding would depend on whether the several one-hundredths of a standard deviation differences between EES figures are deemed trivial or not.

Finally with respect to the data underlying Table 6, it warrants note that the actual difference between black and white average SBP is .63 of the white standard deviation, .49 of the black standard deviation and .56 of the pooled standard deviation. Thus, the EES values are at least close to the value based on the pooled standard deviation. But it is hard to know whether there is any significance to such fact given the extent to which the pooled standard deviation is a function of the size of the black and white samples.

An additional issue arises with efforts to examine patterns of rates of control of some adverse condition in circumstances where the analysis focuses on a universe defined by the need for control, as, for example, in the case of control of blood pressure among hypertensive patients. The distributions of these restricted universes will generally depart substantially from the normal even when they are drawn are distributions that are perfectly normal.

As shown in Figures 6 and 8 of reference 13, in these cases, it would seem that changes in prevalence would nevertheless be accompanied by patterns of changes in relative differences in experiencing or avoiding an outcome and absolute differences between rates – but not differences measured in odds ratios – similar to those observed with respect to the overall population. But the matter is somewhat different when one attempts to derive EES values based on hypothesized normal distributions within these restricted subpopulations.

Table 7 shows the effects of further lowering the cutoff on the group defined by the point where 30% of the advantaged group falls below the point. The three columns are (1) the reference point based on proportions of the advantaged group within the limited population falling below various points within that population, (2) the disadvantaged group's rate of falling below the point, and (3) the EES.

Table 7. Difference between Hypothesized Underlying Means between Portions of Two Normal Distributions Defined by Point Below Which 30 Percent of Advantaged Group Falls.

(1)	(2)	(3)
.966	.976	.145 standard deviations
.955	.968	.140 standard deviations
.898	.928	.160 standard deviations
.802	.855	.190 standard deviations
.705	.776	.220 standard deviations
.603	.692	.240 standard deviations
.496	.599	.270 standard deviations
.401	.508	.285 standard deviations
.302	.405	.285 standard deviations
.201	.302	.315 standard deviations
.100	.171	.330 standard deviations
.050	.097	.350 standard deviations
.030	.064	.356 standard deviations
.010	.025	.380 standard deviations

The implications of the figures in Table 7 are as follow. If approximately 10% of the population within this universe was enabled to pass the test, the EES would be .160 standard deviations. If 50% was enabled to pass, the EES would be .270 standard deviations. If 90% was enabled to pass the test, the EES would be .350. In all, EES values would range between .145 and .380 standard deviations, even though there would in fact be no meaningful change in the situation of the two groups – that is, no change reflecting anything other than the modification of a cutoff. Thus, it would seem, Approach 2 is not useful for identifying meaningful changes within this abbreviated portion of two normal distributions.

Table 8 is based on the same data on blacks and whites age 55-64 with SBP above 139 that underlies Figure 8 of reference 13. It thus shows the EES implications of serially bringing SBP under control within the population requiring control.

Table 8. Difference between Hypothesized Underlying Means Systolic Blood Pressure of Blacks and Whites Men 55-64 in NHANES Sample with Systolic Blood Pressure Above 139.

–(1)—–(2)—–(3)——(4)
150 – .492 – .710 – .595 standard deviations
160 – .198 – .402 – .600 standard deviations
170 – .095 – .245 – .600 standard deviations
180 – .043 – .156 – .715 standard deviations
190 – .014 – .111 – .965 standard deviations

Table 8 shows that the initial EES would be .595 standard deviations when the SBP of those initially below 150 was brought below 140. The EES value would change little as the SBP of those with SBP below 170 and 180 was also controlled. But it would seem doubtful that this particular absence of change would suggest that EES is an effective means of distinguishing meaningful changes from those that merely reflect changes in overall prevalence of some outcome, given what Table 7 shows with respect to a similarly restricted segment of a perfectly normal distribution. In any case, as programs for controlling SPB grew increasingly successful such as also to bring under control those with SBP initially as high as 179 or 189, to the extent that the increase in EES values (from .600 to .715 and .965) would be interpreted as reflecting meaningful changes in the two groups distributions, such interpretation would seem to be mistaken (though it also warrants note that the small size of the black sample makes the numbers at that level very unreliable). .

At any rate such are the issues raised by this particular approach to identifying meaningful changes in dichotomous measures. To the extent that this approach, or even Approach 1, appears tortuous and problematic, such fact would seem an argument for not attempting to measure inequalities with dichotomous measures. But it is not an argument for relying on standard measures while ignoring the common effects of changes in prevalence on such measures.

One factor perhaps not reflected in the discussion above involves the nature of the changes that one might be attempting evaluate through the use of an uncertain measure such as EES. The changes in mortality inequality identified by Approach 2 in Table 4.b, for example, seem on their face small enough to raise questions as to the value of studying them, or at least questions as to the weight to be accorded such findings, in the face of uncertainty about whether one in fact is identifying meaningful changes (meaningful in the sense of being other than reflections of a change in prevalence rather than in the sense of being important). But we might look at the matter differently if inequality, measured in a reasonable if speculative matter, showed changes that were apparently more substantial.

Consider the seemingly very small increase in inequality in Norway analyzed in Table 4.b.4 (from an EES of .12 to .145). But let us instead use the same approaches to analyzing the mortality rates in Norway shown in Table 1 of Rogenrud and Zahl.[18] Such an analysis is set out in Table 9 below, based on comparisons of changes in mortality between men in the bottom and top income quartiles between 1980 and 1990 (a comparison approach that obviates the compositional problem addressed by Boström and Rosén and discussed above).

Table 9. Analysis of Changes in Inequalities between Bottom and Top Income Quintiles among Norwegian Men, 1980-1990, Based on Table 1 of Rogenrud and Zahl.
Lowest income quartile
–1980 – 1580 (per 100,000)
–1990 – 1500
Highest income quartile
–1980 – 1220
–1990 – 640
Ratio ADV (mortality)
–1980-84 – 1.39
–1990-94 – 2.34 (increase – standard)
Ratio FAV (survival)
–1980-84 – 1.003702
–1990-94 – 1.00877 (increase - NONSTANDARD)
Odds ratio
–1980-84 – 1.41
–1990-94 – 1.54 (increase – standard)
Absolute difference
–1980-84 – 364
–1990-94 – 863 (increase– NONSTANDARD)
Estimated difference in average
–1980-84 – .10 standard deviations
–1990-94 – .32 standard deviations
Interpretations
–Approach 1 – apparent increase in inequality
–Approach 2 – apparent increase in inequality

The increase in inequality revealed by this analysis of the Rogenrud and Zahl data would seem important enough to warrant examination even allowing that both Approaches 1 and 2 involve a considerable amount of uncertainty.

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