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Problems with the measurement of changes in health inequalities over time using dichotomous variables and possibilities using continuous variables

Ferrie et al.[1] explored non-acute morbidity among the Whitehall study group, measuring changes over time in differences in factors like self-rated health less than good (measured in odds ratios) and systolic blood pressure (measured in rate differences). The study found the differences to be stable with some indication of a tendency to widen.

With regard to its use of dichotomous variables, the study suffered from the failure to recognize the way such variables are affected by the prevalence of an outcome. In general, the rarer an outcome, the greater the relative difference in rates of experiencing it (though the smaller the relative difference between rates of avoiding it).[2-7] Thus, while the abstract observes that “[d]espite an overall decline in mortality rates, the social gradient in mortality has increased over the past two decades,” in fact one should expect declining mortality to result in increased relative difference in mortality rates (though decreased relative differences in survival rates).

But whereas relative differences in experiencing an outcome and relative differences in avoiding the outcome tend to change consistently (though in opposite directions) as the prevalence of an outcome changes, odds ratios, which Ferrie et al. used for measuring differences in dichotomized variables like self-rated health, change in a less predictable manner. Odds ratios tend to approximate the relative difference in experiencing an outcome when an outcome is rare and the relative difference in avoiding the outcome when the outcome is close to universal. In the case of more common outcomes, however, a decrease (or increase) may, solely because of the decrease, tend to either increase or decrease the odds ratio. More specifically, as can be derived from Table 1 and Figures 1-3 of reference 6, as an outcome declines in prevalence from the point of being almost universal (and where the relative difference in experiencing it will tend to be small and increasing while the relative difference in avoiding it will tend to be large and declining), the odds ratio will tend to decline up to the point where the (increasing) relative difference in experiencing the outcome approximates the (declining) relative difference in avoiding it, and thereafter will increase again as the outcome become increasingly rare.

Thus, when an outcome is declining one usually will observe increasing relative difference in experiencing the outcome, and that need not reflect a meaningful worsening of the relative situation of disadvantaged groups (though a decline in the relative difference might indicate an improvement). The same holds for odds ratios with respect to rare outcomes. But for more common outcomes like health fair or poor, longstanding illness, and GHQ caseness, a decrease in the prevalence of the outcome can lead to either an increase or a decrease in the odds ratio, without such odds ratio change being other than solely a consequence of change in prevalence. Unfortunately the Ferrie study presented prevalence rates only for the third of the three points in time being examined, thus precluding the reader from determining whether prevalences were increasing or

decreasing. Thus, one cannot evaluate the implications of changes in prevalence. But, in any case, measuring changes of health inequalities with dichotomous variables is usually problematic. That is so with respect to relative differences and more so with respect to odds ratios. The Ferrie study does reference some situations where certain outcomes were increasing for some grade categories and decreasing for others. Those would seem to be meaningful changes. But usually one cannot draw such inference from a change in the odds ratio.

The approach employed by the authors for measuring changes in differences in factors like average blood pressure level, however, does suggest possibilities for measuring changes in certain aspects of health inequality in ways that might not be affected by changes in prevalence. It would seem, however, that appraisals of changes in inequalities should be based on a comparison of the effects sizes of the difference at the points in time being compared (i.e., the difference between averages divided by the pooled standard deviation) rather than the difference itself. Such an approach might also be applied to self-assessed health if the assessment were made using a continuous measure rather than the categorical measures typically employed. But it is questionable whether it could be applied to seemingly continuous measures of self-assessed health, such as SF-36 scores recently used by Chandola et al. [8] to measure changes in health inequalities as a population ages, which scores are actually functions of categorical responses. For it seems that, like relative difference in dichotomous variables, such scores could be affected solely by changes an overall improvements or declines in health, just as longevity differences can be affected solely by overall changes in mortality (such as illustrated in Table 2 of reference 6).[9]

One problem with such an approach, however, concerns the implications of smoking. For reasons explained above, as smoking declines, one should expect larger relative decreases among groups that smoke less (advantaged groups) than among those that smoke more (disadvantaged groups), though a larger relative increase in rates of non-smoking among the latter than the former.[2-7]. But to the extent that changes in relative rates of smoking (or not smoking) are simply the standard consequences of a decline in smoking, according to the reasoning in references 2-6, such changes should not be regarded as a meaningful worsening or improvement of the relative well-being of disadvantaged groups. Yet, given the importance of smoking as a risk factor, even changes in differential smoking patterns that would not in themselves be regarded as changing health inequality would likely cause some change in the effect size of the difference between average blood pressure levels, for example, or other continuous measures of health. In such circumstances, whether the changes in effect size on such measures should be regarded as meaningful changes in health inequalities is a difficult issue.

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