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Comparing health inequalities across time and place with an understanding of the usual correlations between various measures of difference and overall prevalences

In discussing circumstances where reliance on rate ratios or rate difference in under-five mortality rates may lead to different conclusions about the comparative size of health inequalities in different places or at different points in time, Moser *et al.*,[1] like the sources they reference, overlook the tendencies whereby binary measures of differences between rates tend to vary solely because of differences in the prevalence of an outcome. The most notable of these tendencies is that, for reasons inherent in the relationship between differing risk distributions of two groups, 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.[2-10]

For the same reasons, rates differences, sometimes termed absolute differences between rates, tend also to change as the prevalence of an outcome changes, though in a more complicated manner.[2,3,5,7-12] As an adverse outcome declines in prevalence, the absolute difference between rates tends initially to increase. It reaches a high point at approximately the intersection of (1) the (increasing) relative difference between rates of experiencing the outcome (measured in terms of the ratio of the disadvantaged group's rate of experiencing the outcome to the advantaged group's rate of experiencing the outcome (Ratio A)) and (2) the (decreasing) relative difference between rates of 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 (Ratio B)). Then it declines again as the outcome becomes rare.[7-12]

There are situations where the absolute difference will tend to change in the same direction as the relative difference in experiencing an outcome (while changing in the opposite direction of the relative difference in the opposite outcome), and situations where the absolute difference will tend to change in the opposite direction of the relative difference in experiencing the outcome (while changing in the same direction as the relative difference in the opposite outcome). In analyses of inequalities in healthcare outcomes and certain other outcomes that are neither nearly universal nor very uncommon, the identifications of expected patterns of changes can be complicated, particularly when patterns are observed during an overall period that encompasses smaller periods when Ratio A is larger than Ratio B and when Ratio B is larger than Ratio A, as discussed in references 8-12.

But in most situations involving differences between mortality rates of advantaged and disadvantaged groups (including those involved in the Moser study), Ratio A is substantially larger than Ratio B. Hence, absent some meaningful change in the relationship of the risk distributions of the two groups, overall declines in mortality – which tend to be the more common situation in most countries – will tend to reduce absolute differences. In those less common situations where mortality is increasing, the

absolute difference will tend to increase. In either case, the usual tendency will be for absolute differences to change in the opposite direction of relative differences in mortality rates – again, unless there occurs some meaningful change in the relationship of the risk distributions of the advantaged and disadvantaged groups.

(Differences measured in odds ratio tend to behave in a manner opposite to that of absolute differences.[8,9] Thus, the standard way differences measured by odds ratios tend to be correlated with prevalence can be of considerable consequence in the circumstances where researcher employs odds ratios as a measures of inequality and where an outcome is neither nearly universal nor very uncommon. But since discussion of odds ratios will complicate the following discussion while adding little of substance to it, further discussion of odds ratios here will be parenthetical.)

An appraisal of the comparative size of inequalities in different settings must be mindful of these tendencies. Rather than both providing useful information, as suggested by Moser et al. and a number of their references, neither the sizes of relative differences (in favorable or adverse outcomes) in different settings nor the sizes of absolute differences in those settings provide useful information unless considered in light of the tendencies described above.

One may nevertheless draw certain conclusions about meaningful changes in inequalities in things like under-five mortality, albeit usually with a certain degree of uncertainty.

The under-five mortality rates for the quintile with the highest wealth (HQ) and for the quintile with the lowest wealth (LQ) for the 22 countries in the Moser study can be derived from the information provided on relative and absolute differences in Moser's Table 1. These rates are shown in Table A, which may found by on the following web page: http://www.jpscanlan.com/images/Tables_for_Comment_on_Moser.pdf. Examining these rates and certain measures that can be derived from them, and which are also set out in Table A, we can draw the following inferences about meaningful changes in disparities.

The most obvious case where we can identify meaningful changes in inequality involves the uncommon situation where the rates of two groups change in opposite directions. There were 3 cases in the Moser study where the two groups' rates changed in opposite directions and which would seem obviously to indicate a meaningful change in inequality. In all 3 cases (Cameroon, Guatemala, Turkey) the HQ mortality rate increased while the LQ mortality rate decreased, thus indicating a decrease in inequality. Such change is shown by "inc" in column 15 of Table A, with the method of determination of direction of change indicated by "1" in column 16.

In the more common situations where rates of advantaged and disadvantaged groups change in the same direction, we can also, though with somewhat less certainty, identify meaningful changes in those instances where such changes are sufficient to cause departures from the standard patterns of directions of changes in measures of differences between rates. These are discussed below, with "MR" for mortality ratio (Ratio A in the

discussion several paragraphs above), "SR" for survival ratio (Ratio B in the discussion earlier), and "AD" for absolute difference between rates.

There were 15 cases where rates declined for both groups, and where typically MRs would increase, while SRs and ADs would decline. Among these, we can identify 10 changes in inequality on the basis of nonstandard changes in certain measures. These include 7 increases in inequality identified on the basis of 6 nonstandard increases in both SRs and ADs (Bangladesh, Benin, Ghana, Nicaragua, Uganda, Zambia) and 1 nonstandard increase in AD alone (Malawi); and 3 decreases in inequality identified on the basis of nonstandard decreases in MR (Columbia, Egypt, Mali). As to the remaining 5 cases where rates declined for both groups, no judgment can be made on the basis of nonstandard changes in measures since none were observed.

There were 4 cases where rates increased for both groups, and where typically MRs would decrease, while SRs and ADs would increase. In all 4 cases we can identify changes in inequality based on nonstandard changes in measures. These include 2 cases of increases in inequality identified on the basis of nonstandard increases in MRs (Kazakhstan, Zimbabwe) and 2 cases of decreases in inequality identified on the basis of nonstandard decreases in SRs and ADs (Haiti, Tanzania).

These changes are also recorded in Table A with the methodology of such identifications indicated with a "2."

With regard to method 2, it should be recognized that there can occur meaningful changes in inequality without such change being sufficient to cause a nonstandard change in any of the measures, as discussed in several of the references and as illustrated, for example, in Tables IV and V of reference 6. Hence, we have the 5 cases where, while method 2 fails to provide information as to the nature of any meaningful changes in inequality, it is possible that such changes did occur but simply were not sufficient to cause a departure from the standard pattern of change for any measure.

In these cases, however, we may nevertheless identify meaningful changes on the basis of comparison of the estimated size of the difference between rates (in terms of standard deviations between the means of hypothesized normal distributions), as discussed in references 9 and 10. Reference 10 employs such approach to determining the directions of changes over time in social inequalities in smoking and overweight in Sweden and social inequalities in mortality in a number of European countries, as well as in comparing the sizes of inequalities in mortality in those countries. (Reference 10 also addresses the implications of changes in odds ratios.) Because with regard to the 5 countries as to which no identification of a change in inequality could be made with method 2, this method would be attempting to identify changes that are too small to be identified by method 2, the method would seem to involve somewhat more uncertainty than method 2.

Such method enables us to identify an increase in inequality in 3 cases (India, Namibia, and Vietnam), an extremely small decrease in 1 case (Nepal) and no change in 1 case

(Peru). Such results are indicated in column 15 of Table A, with the method of identification indicated by a "3" in column 16. Column 8 show the size of estimated difference between hypothesized means at both the initial and final points in time for all countries examined in the Moser study, including those as to which directions of change were determined by methods 1 and 2. With regard to those countries, it may be noted that the results as to direction of change in inequality that would be derived through method 3 match the results derived from the other methods. That the results of method 3 comport with those of the other methods might be seen as offering some evidence of the validity of both methods 3 and 2 (the validity of method 1 being self-evident). But, given that the same conception of the nature of underlying risk distributions informs both methods, the strength of such evidence may be limited. Contrary results, however, would seem to call into seriously into question the validity – or at any rate the utility – of these methods, at least in circumstances of substantial overall changes in prevalence.

Moser et al. also ranked the various countries on the basis of relative and absolute differences between mortality rates. For reasons already discussed, such rankings are problematic.

Alternative rankings according to method 2 would be quite complex, though an effort is made with respect to comparisons of overall mortality rates in Norway and Sweden in Section A.2 of reference 10. Further with respect to any cross-country comparisons, it should be borne in mind that, whereas in a variety of places I have noted that the general tendencies whereby, for example, the rarer an outcome, the greater tends to be the relative difference in experiencing it would apply to comparisons of settings defined geographically as well as temporally and other ways, it is likely that the levels of inequality will vary in different countries. And, for any level of prevalence the larger the inequality the greater are the relative difference in experiencing an outcome, the relative difference in avoiding the outcome, and the absolute difference (as well as the difference measured in odds ratios). Thus, only when the level of inequality is the same can we expect that level of prevalence to generally control the ranking according to any measure.

Method 3, however, can be employed to rank inequality across countries with different levels of prevalence (and this can done with respect to the Moser data, which compares the bottom and top quintiles, without the confounding aspects of the fact that advantaged and disadvantaged groups comprised varying proportions of the populations in the countries discussed in several places in reference 10 and in the study to which it responds). Table B ranks the countries in the Moser study according to that method. The final column indicates the ranking from the prior year.

As discussed in references 9 and 10, methods 2 and 3 involve elements of speculation as to characteristics of the underlying distributions that make it difficult to be highly confident as to the accuracy of the results. Nevertheless, these methods would seem plainly superior to methods that rely on binary measures without regard to the ways such measures tend to affected by the overall prevalence of an outcome.

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