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### **Interpreting patterns of differing effects of chronic conditions on self-assessed health**

Brown et al.<sup>1</sup> posited that chronic conditions would have a greater impact on self-assessed health in deprived neighborhoods than in neighborhoods that are not deprived and found support for that hypothesis in the fact that chronic conditions reduced rates of self-assessed health of good or better (HGB) – the three most favorable of the five response categories “poor,” “fair,” “good,” “very good,” and “excellent” – more in deprived neighborhoods (DN) and very deprived neighborhoods (VDN) than in not deprived neighborhoods (NDN). The authors’ reasoning for expecting chronic conditions to affect health more in deprived neighborhoods is entirely plausible. But the study’s findings cannot support the hypothesis that chronic conditions have a meaningfully greater impact on health in deprived neighborhoods, since the patterns of changes in rates of HGB in deprived and not deprived neighborhoods are to be expected regardless of the validity of the hypothesis.

In comparing the reductions in rates of HGB caused by various chronic conditions, Brown et al. do not make clear whether they are examining percentage reductions (i.e., where a reduction from 80% to 60% would be termed a percentage reduction of .25 or 25% (20/80) and which is also sometimes called a relative reduction) or absolute reductions (where the reduction from 80% to 60% would be called an absolute reduction of 20 percentage points). The observations to the effect that the reductions in HGB as a result of asthma/COPD (chronic obstructive pulmonary disorder) were not greater in DN and VDN than NDN are literally consistent only with reliance on absolute reductions in HGB as a measure of effect of chronic conditions, since the absolute reduction in HGB caused by asthma/COPD was slightly greater in NDN than DN or VDN while the percentage reduction in HGB was slightly smaller in NDN the DN or VDN. But the statement on the fifth page of the article that the absence of a greater reduction in HGB in deprived neighborhoods may have been a result of the smaller sample size for asthma/COPD suggests that the observations concerning the absence of a greater reduction related to percentage reductions, and merely meant that the differences between percentage reductions were not statistically significant. The use of odds ratios for the summary analyses of effects of neighborhood and chronic conditions on HGB, set out in Table 3 of the article, also suggests that the study was focused on percentage reductions, which would be the more common approach in a study such as this.

### **RELATIVE REDUCTIONS IN HEALTH GOOD OR BETTER AND RELATIVE INCREASES IN HEALTH LESS THAN GOOD**

In any case, I will initially assume that the discussion concerning comparisons of the effects of chronic conditions on HGB in the different neighborhoods involved percentage reductions in HGB. Assuming that is so, the study suffers from the failure to consider the statistical tendency whereby the rarer an outcome, the greater the relative difference in

experiencing it and the smaller the relative difference in rates of avoiding it.<sup>2-6</sup> The tendency can be illustrated with virtually any data set that allows one to examine the rates at which two groups fall above or below various points on a continuum of factors associated with some outcome. For example, published income data in the United States illustrate the way that reductions in poverty tend to increase relative demographic differences in poverty rates but reduce relative differences in rates of avoiding poverty.<sup>2,4</sup> Hypothetical test score data illustrate the way lowering a cutoff (or improving test performance such as to allow everyone just below the cutoff to pass at the existing cutoff) will generally increase relative differences in failure rates but reduce relative differences in pass rates.<sup>5,6</sup>

A corollary tendency is that a factor that causes a reduction in some outcome will tend to cause the group with the lower base rate to show a larger percentage reduction in its outcome rate, though a smaller percentage increase in its rate of avoiding the outcome. In the case of the Brown study, where the focus was on rates of HGB, DN and VDN had lower base rates than NDN. Therefore, solely for statistical reasons, one would expect chronic conditions to cause larger percentage reductions in rates of HGB in DN and VDN than in NDN, though smaller percentage increase in rates of failing to have HGB in NDN than VDN and DN. And, in fact, the figures in Table 4 of the Brown study reveal just such a pattern with respect to the effect of each of the chronic conditions studied, including asthma/COPD.

Studies of self-reported health usually focus on health less than good (HLG)[6] – the two least favorable response categories – the opposite of the focus of Brown et al. And the National Center for Health Statistics (NCHS) recommends that all disparities be measured in terms of adverse outcomes.[7] Thus, under the more common approach, and that recommended by NCHS, one would find that chronic conditions increased HLG more for NDN than for DN and VDN, in other words, a greater effect in NDN than DN and VDN.

That is not to say that the approach of measuring disparities in terms of the adverse outcome correct. Rather, neither approach can provide useful insight into differential effects of a factor on rates of experiencing some outcome without attempting to take into account the patterns of rate change that would be expected given differing base rates.[2,3,6] But because the patterns observed in the Brown analysis are consistent with the usual statistical patterns, it is not possible, on the basis of percentage changes, to validate or invalidate the authors' hypothesis.

A final point on percentage reductions is that there seems to be a common inclination to attach significance to the fact that a factor causes different percentage increases or decreases in the rates at which various groups experience an outcome. But there is no reason ever to expect a factor to have the same percentage effect on outcome rates of two or more groups with different base rates of the outcome (save by happenstance). For certainly there is no more reason to expect a factor to cause the same percentage decrease in each group's rate of one outcome (say, HGB) than there is to expect it to cause the

same percentage increase in each group's rate of the opposite outcome (HLG), and it is mathematically impossible to do both.

### **ABSOLUTE REDUCTIONS IN HEALTH GOOD OR BETTER**

As noted above, with the exception of asthma/COPD, in absolute terms chronic conditions caused greater reduction in HGB for DN and VDN than NDN. But if Brown et al. were measuring the effects of chronic conditions on HGB in terms of absolute reductions in HGB rates (which would be the same, save for direction, whether one examined HGB or HLG), it still would be important to consider certain statistical tendencies in appraising the results. I have in other places discussed the ways that absolute differences between the rates of two groups are affected by changes in prevalence of an outcome – that is, in terms of the changes in the absolute difference between rates of advantaged and disadvantaged groups rather than, as is more directly pertinent to the instant situation, in terms of the size of the absolute change in each group's rate. That discussion is of some complexity and involves different expectations depending on whether the change in prevalence of an outcome is in the direction that tends to reduce the difference between (a) the ratio of the advantaged group's rate of experiencing the favorable outcome to that of the disadvantaged group's rate of experiencing the favorable outcome and (b) the ratio of the disadvantaged groups' rate of experiencing the adverse outcome to the advantaged group's rate of experiencing the adverse outcome (in which case the absolute difference will tend to increase) or increase the difference between (a) and (b) (in which case the absolute difference will tend to decrease).[8] Rather than attempt to adjust such discussion to fit the terms of the instant setting, I will simply refer the reader to Table 1 of reference 6, and posit that the situation for individuals without chronic conditions in NDN is akin to that shown in Column 4 of Row L where the advantaged group's rate of experiencing the favorable outcome is 90% and the disadvantaged group's rate of experiencing that outcome is 78%. The effect of the chronic conditions studied by Brown et al. on rates of HGB is akin to the effect of moving the cutoff from Point L to Points K or J. In the case of moving the cutoff to Point K, for example, the advantaged group's rate of experiencing the favorable outcome would be reduced by 10 percentage points while the disadvantaged group's rate would be reduced by 15 percentage points. Moving the cutoff instead from L to J, the former figure would be 20 and the latter 27. Thus, the patterns are similar to those observed in the Brown study.

That is by no means to say that the distributions at issue in the Brown study are necessarily particularly similar to the hypothetical distributions reflected in Table 1 of reference 6. But it is to say that the patterns observed in the Brown study are akin to those one would expect in broadly similar circumstances where a factor causes a favorable outcome to decline for all groups. Thus, as with the patterns of larger percentage reductions in HGB caused by chronic conditions in the more deprived neighborhoods (or smaller percentage increases in HLG in those neighborhoods), the pattern of larger absolute reductions in HGB observed in the more deprived neighborhoods can neither support nor refute the authors' hypothesis.

## **REDUCTIONS IN ODDS OF HEALTH GOOD OR BETTER**

Inequalities in self-assessed health usually are measured in terms of odds ratios.[6] So the patterns of changes in odds that can be derived from Table 4 of the Brown study warrant a few words. The figures in Table 4 of the Brown study show that each of the individual chronic conditions reduces the odds of HGB more for NDN than for DN and VDN. Thus, like greater percentage reductions of HLG for NDN than DN and VDN, the greater decrease in the odds of HGB for NDN might be cited as showing a greater impact of chronic conditions on NDN than DN and VDN. But this pattern, too, is something to be expected in the circumstances solely for statistical reasons and hence is not by itself indicative of a meaningful differential effect.

Once again, Table 1 of reference 6 can illustrate the typical pattern, though, as with respect to absolute rate changes, the table approaches the issue from a different perspective. That is, the table focuses on changes in the ratio of the disadvantaged group's odds of experiencing an outcome to the advantaged group's odds of experiencing the outcome rather than the effect of a factor on each group's odds of experiencing an outcome.

Nevertheless, the patterns in the table can illustrate the typical effect of a factor that reduces favorable outcome rates on different groups' odds of experiencing the outcome in circumstances similar to those examined in the Brown study. Table 1, as well as Figures 3 and 4, of reference 6 show the way changes in the size of the odds ratio correspond inversely to changes in the absolute difference between the two groups' rates. That is, prevalence changes in a direction that tends to reduce the difference between (a) and (b) (with increasing absolute differences between the rates of two groups) tend to reduce differences measured in odds ratios. (The odds ratios in Table 1 are cast in terms of odds of the unfavorable outcome; but, regardless of which outcome the odds ratio focuses on, as an odds ratio moves towards 1.0, such move reflects a decline in the difference between the two group's odds.) Correspondingly, the disadvantaged group's odds of experiencing the unfavorable outcome decline more (which means that the disadvantaged group's odds of experiencing the favorable outcome decline less) than the odds of the advantaged group. Hence, were one to examine the effect of each chronic conditions in terms of its effect on the odds of HGB, the greater percentage reduction in the odds of HGB for NDN than for DN or VDN, being in the expected direction in the circumstances, ought not to be read as indicating, in a meaningful way, that chronic conditions affect NDN more than DN or VDN.

## **ANY CHRONIC CONDITION DATA**

The above discussion applies to each of the individual chronic conditions listed in Table 4 of the Brown study. The situation is somewhat different for the category "any chronic condition," the second row of Table 4. The figures in that row would suggest that, in a meaningful way, chronic conditions affected the health of individuals in DN and VDN more than individuals in NDN (as reflected both by the fact that having any chronic condition caused a greater percentage increase the rate of failing to have HGB, and a

greater percentage reduction in odds of HGB, for DN and VDN than NDN. A meaningfully greater effect on the more deprived neighborhoods would seem also to be suggested by the greater effect of any chronic conditions on the odds of HGB in DN and VDN than NDN shown near the bottom of Table 3.

However, despite a cooperative exchange with the principal author, I have been unable to resolve why the HGB rate for NDN (88.4%) for any chronic condition is so high. More specifically, I cannot understand how it could be higher than the highest figure for any of the individual chronic conditions (which is 88.3%). But if in fact the 88.4% figure is correct, then it is possible that, at least with respect to any chronic condition, the results of the study might indeed support the authors' hypothesis. The discussion above, as well as that concluding discussion in references 2 and 6, should nevertheless suggest that is difficult to be certain that what seem to be differential effects are other than the natural consequences of the way factors tend generally to affect different base rates.

### **COMPARISONS OF DN WITH VDN**

The points made with respect to comparisons of NDN with either DN or VDN in theory hold as well with respect to comparisons between DN and VDN, in which case the former would be the advantaged group. And for the most part the expected patterns do hold. But, in the case of diabetes, contrary to standard patterns, diabetes causes a greater percentage increase in rates of failing to have HGB, and a greater percentage reduction in the odds of HGB, for VDN than DN. As with the patterns observed with respect to any chronic conditions discussed in the preceding section, these departures from the standard patterns might be interpreted as indicating that, in a meaningful way, chronic conditions affected the health of individuals in VDN than DN. But, again, one ought to exercise caution in inferring meaningful differences on the basis of departures from expected patterns.

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