Measuring reduction in disparity among several rates

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Abstract

The Healthy People 2010 initiative challenges us to measure progress toward the reduction of disparities among subgroups in the population. Pair-wise comparisons provide specific information about absolute or relative differences between rates. Changes in disparity between two groups can be measured by comparing the disparity between rates at one point in time with the disparity between comparable rates at a second point in time. However, when there are more than two groups, it can be difficult to draw a general conclusion about changes in disparity over time based on a series of pair-wise comparisons.

Summary measures can be used to quantify the differences among several rates, both at a point in time and over time. Summary measures can also be used to compare the degree of disparity across indicators, areas, and populations; and under some constraints across population domains. The mean deviation is a measure of the average of absolute differences between group rates; the index of disparity expresses the mean deviation relative to (as a percent of) the total population rate; and the average of ratios is a measure of the average of relative differences.

Measures of disparity among several groups are described as extensions of the techniques used to measure differences between two groups. The significance of choosing a reference point for measuring disparity, the estimation of reliability for summary measures, and the need to interpret summary measures in terms of underlying rates are discussed.

Keywords: Disparity, minority health, Healthy People 2010

Introduction

The overwhelming majority of the literature on racial and ethnic differences in health status is based on pair-wise comparisons—comparisons of one rate with another. Most often one race/ethnic group is compared with another, the rate for each group is compared with the rate for the total population, or the rates for other groups are compared with the rate for the "best" group (North Carolina Division of Public Health, 2000; La Veist, Bowie &Cooley-Quille, 2000). These comparisons lead to conclusions about how the rate for one group compares with another rate. Such comparisons have frequently provided the motivation for public health intervention.

When there are more than two groups, however, pair-wise comparisons may not lead to a straightforward conclusion about how differences in race/ethnic specific rates at one point in time compare with differences in rates at a second point in time. It is not often that all differences in rates among groups will change to the same extent or in the same direction. It is difficult to reach a conclusion about how differences have changed when some differences are increasing and others are decreasing. Summarizing the differences among group rates provides a means for determining whether the disparity among three or more groups is changing over time.

A similar problem arises when one attempts to compare the racial and ethnic disparity in one indicator with the racial and ethnic disparity in another indicator. Comparison of two series of pair-wise comparisons may not lead to an unambiguous conclusion about how the differences in the first indicator compare with the differences in the second indicator. In a manner similar to changes over time, summarizing disparity among groups provides a basis for drawing conclusions about the relative degree of racial and ethnic disparity among different indicators of health status, geographic areas, and populations.

Measurement Issues

Before examples of pair-wise and group comparisons are shown, there are several methodological issues related to choice that should be briefly discussed. These are the choice of the referent, absolute or relative comparisons, and measurement of adverse or favorable events.

Referent

The referent is a population group, or some other standard against which a groups are compared to measure disparity. The numeric position of the referent to other groups, naturally, affects the size of the disparity estimate. Referents at the outside of the distribution of the group rates (i.e. best group rate or a target rate) will frequently maximize disparity estimates. In contrast referents nearer to the middle of the distribution of group rates (i.e. mean of group rates or total population rate) will usually minimize the disparity estimate.

Absolute or Relative Comparisons

Disparity can be estimated in absolute terms such as the numeric difference between two rates. Or, it can be estimated in relative terms such as the percent difference or ratio, where the numeric difference is expressed relative to a standard such as another group rate, the mean, or a target rate. These two types of comparisons provide fundamentally different types of information. An absolute comparison gives the magnitude of the difference, and some indication of how many lives could be improved if the difference were reduced or eliminated. A relative comparison, instead, indicates by how many times or by what percent one group differs from another group or standard. Although a relative difference gives no indication of how many lives could be improved by reducing a difference; it is frequently preferred for assessing change over time and across indicators of health.

Adverse or Favorable Events

Health can be measured as the rate at which an event either does or does not occur. Either one will yield identical estimates of disparity if an absolute comparison is made. However, the same is not true for relative comparisons. As a rate moves away from the midpoint of the distribution of possible rates, the standard of a relative comparison has a greater effect on the interpretation of the result depending on whether adverse or favorable events are measured. Suppose x and y have 70 % and 75%, respectively, of some favorable event. Then x and y would have 30 % and 25 %, respectively of that same event in adverse terms. The absolute difference is the same (5 %) either way, but the relative difference in favorable events is ~ 6.7 % while the relative difference in adverse events is 20 %.

Pair-wise Comparisons

Comparisons between two groups predominate in discussions and reporting of disparity. Some examples will show the differences between absolute and relative comparisons at two points in time. After this, differences in interpretation of change in absolute and relative estimates of disparity are described. In Table 1 are tuberculosis case rates for the United States for 1991 and 2001 by race and ethnicity. There is considerable variation in rates among race-ethnic groups in 1991, with rates ranging from a low of 4.1 per 100,000 for White non-Hispanics to 41.9 per 100,000 for Asians and Pacific Islanders. A similar range in rates (1.7 to 30.5) in 2001 is shown. Inspection of the table reveals that tuberculosis rates have declined sharply for most groups. The largest decline (58.5 %) was observed for White non-Hispanics, and the smallest (27.2 %) for Asians and Pacific Islanders.

Table 1. Tuberculosis Cases and Case Rates per 100,000 Population by race and ethnicity: United States, 1991 and 2001; and percent change by group over the 11-year period.

	1991	2001	Percent Change
Total Population	10.4	5.8	-44.2
White non-Hispanic	4.1	1.7	-58.5
Black non-Hispanic	31.9	14.2	-55.5
Hispanic	22.9	11.9	-48.0
Asian and Pacific Islander	41.9	30.5	-27.2
Native American	16.2	9.4	-42.0

Yet, this does not tell us how the differences between rates have changed. An absolute difference was taken between each group and White non-Hispanics to estimate disparity in 1991 and 2001. A percent difference was also calculated assess change over time (Table 2.)

The interpretation of change over time in disparity between White non-Hispanics and the other race and ethnic groups is very similar to that observed in the change in rates in Table 1. So, we might conclude that disparity has declined over the eleven year period.

Table 2 Absolute differences between White non-Hispanics (best group rate) as referent and other population groups, 1991 and 2001. Percent change for 11-year period shown for each group.

Absolute Differences	1991	2001	Percent Change
White non-Hispanic (ref)	- -	- -	
Black non-Hispanic	27.8	12.5	-55.0
Hispanic	18.8	10.2	-45.7
Asian and Pacific Islander	37.8	28.8	-23.8
Native American	12.1	7.7	-36.4

However, if we choose to make relative comparisons, the interpretation is different. In Table 3 percent differences are shown between White non-Hispanics and other race or ethnic groups. In contrast to a conclusion of declining disparity between race and ethnic groups for tuberculosis that is seen in Table 2, based on relative differences we can see that the estimates of disparity are increasing. The explanation of this seeming inconsistency is simply that although absolute differences between rates are declining, the rate for the reference group declined more than any of the other groups. So, the relative difference between the referent (White non-Hispanics) and other groups increases.

Table 3. Percent differences between White non-Hispanics (best group rate) as referent and other population groups, 1991 and 2001. Percent change for 11-year period shown for each group.

Percent Differences	1991	2001	Percent Change
White non-Hispanic	- -	- -	
Black non-Hispanic	678.0	735.3	8.4
Hispanic	458.5	600.0	30.9
Asian and Pacific Islander	922.0	1694.1	83.8
Native American	295.1	452.9	53.5

At a given point in time, similar conclusions regarding the size of the estimate of disparity are obtained whether absolute or relative comparisons are made. In 1991 the largest absolute and relative differences were found between White non-Hispanics and Asian and Pacific Islanders. The smallest differences were found between White non-Hispanics and Native Americans. The same relationships can be seen in 2001.

Summary Comparisons

The above examples are straightforward. In this case it is not difficult to draw general conclusions about changes in disparity over time for *all groups* based on a series of pair-wise comparisons. From Table 3 we can conclude that disparity increased for all groups. This would not be the case if one or more of the race or ethnic groups had rates that declined faster than that for the referent group. If this occurs then we must specify which groups experienced an increase in disparity, and which had a decrease in disparity.

If the objective is to describe disparity among a number of groups, or how disparity has changed over time for a number of groups - summarizing disparity may be a desirable activity. This may be especially important when the number of indicators of health is large, as is the case in Healthy People 2010.

The examples given below summarize differences between groups to estimate disparity among all race-ethnic groups. The summary estimates are extensions of the statistics given above. An extension of the absolute difference between groups is the mean deviation. A summary relative statistic, the index of disparity, is the mean deviation of the groups from the referent expressed as a percent of the referent. This is similar to a coefficient of variation based on absolute differences rather than squared differences. It can also be expressed more directly as the mean of the sum of the percent differences between groups and some referent.

$$\left(\sum_{i=1}^{n} PDi \Big/ N \right)$$

The results for summary estimates of disparity are illustrated in Table 4. The rates for White non-Hispanics, which had the best rate (from Table 1 above), and the mean of all race-ethnic group rates are used as reference points in these examples. We noted previously that referents at or near the outside of the distribution of group rates tend to maximize estimates of disparity compared to referents drawn from within the distribution.

In Table 4, the mean deviation from the best group rate (White non-Hispanics) is about twice as large as the mean deviation from the mean of the group rates. The effect is even more pronounced when a relative measure is used to estimate disparity. The index of disparity using the best group as a referent varies from 13 times larger (1991) to 17 times larger (2001) than the index of disparity using the mean as a referent.

Different interpretations of change in summary estimates of disparity are obtained depending on whether absolute or relative comparisons are made. Because the best group is at the lower end of the distribution of group rates, and declined faster than the average, its use as a referent results in a much larger increase in the estimate of disparity than when the mean is used as a referent.

Table 4 Tuberculosis Cases and Case Rates per 100,000 Population for White non-Hispanics (best group rate), and the arithmetic mean of race-ethnic group rates: United States, 1991 and 2001; and percent change by group over the 11-year period. Mean deviation and Index of disparity from each referent for 1991 and 2001, and percent change in estimates of disparity.

	1991	2001	Percent Change
White non-Hispanic (best group rate)	4.1	1.7	-58.1
Mean of race/ethnic groups	23.4	13.5	-42.2
Mean deviation (best group as referent)	24.2	14.8	-38.8
Mean deviation (mean as referent)	10.8	7.0	-35.1

Index of Disparity (best group as referent)	594.6	868.7	46.1
Index of Disparity (mean as referent)	46.2	51.9	12.2

Significance of disparity estimates

Point estimates of disparity for pair-wise comparisons
For pair-wise comparisons, estimating the significance of the point estimate is straightforward. For absolute differences the comparison is directly made by a test of significance between rates. With relative comparisons we assume that if difference between the two rates is significant, then the percent difference is significant.

Estimates of change in disparity for pair-wise comparisons
Estimating the significance of change in disparity for pair-wise comparisons is not as straightforward as for point estimates of disparity. We assume that the difference between the referent and another group rate at Time 0 is a point estimate of disparity at Time 0, with pooled variance of the referent and the other group. The same conditions would hold at Time 1. Thus, an estimate of the significance of change in disparity over time between two groups would be the difference between the difference at Time 0 and the difference at Time 1, with the pooled variance of this second order difference equal to the sum of the pooled variances from Time 0 and Time 1.

Estimates of change in disparity for summary comparisons
Estimating the significance of change in disparity for a summary comparisons requires a different solution. The variance of the mean deviation, or of an index of disparity (as described above) can be obtained through a 'bootstrap' procedure. Given point estimates of group rates for which disparity is to be summarized, and estimates of variance for those rates, a set of random normal distributions of each input rate can be generated. From this set of generated distributions of group rates, 'bootstrap' estimates of the mean deviation or index of disparity can be calculated along with variance estimates for these. With these a Z-test of difference between rates can be calculated in the usual manner.

Discussion

Disparity can and should be measured in different ways for different purposes. When the focus is on a particular population group, a pair-wise comparison with a reliable referent is most appropriate. At other times the focus may be on summarizing disparity between all groups in a population domain using a summary statistic; where the domain is defined in terms of race and ethnicity, or education, or income.

Different types of comparisons provide different kinds of information. Absolute differences between pairs of groups, and the mean deviation of groups within a domain provide information about the number of events that separate groups. Relative statistics such as a percent difference between two groups, or an index of disparity give a sense of how much worse (or better) groups in a domain are compared to some referent.

At times, interest is on how big disparity is at some point in time. In this case, absolute and relative statistics provide similar information. When it is desired to assess how disparity varies across indicators at a point in time, or how disparity changes over time, then relative statistics are more appropriate. Additionally, when comparisons are made across indicators it is important to be aware of when indicators are measured in terms of adverse and favorable events. When relative comparisons are made, it is important to ensure that indicators are of the same type of event, or can be converted to the same type of event.

Finally, there is a need to recognize that summary statistics of disparity do not provide all relevant information. Summarizing disparity provides an efficient means to describe how much disparity exists among a number of groups. It also allows comparisons of how disparity among a number of groups varies over time. But summarizing disparity does not provide information about changes in rates for individual groups. In the examples shown in this paper, all groups experienced declining rates, but the values of the referent declined more than the other group rates. There are also many examples where there is a mixture of declining and increasing rates, that may suggest different conclusions regarding change in disparity. It is for this reason that it is important to consider the underlying group rates in assessment of change in summary statistics of disparity.

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