

The Mismeasure of Association: The Unsoundness of the Rate Ratio and Other Measures That Are Affected by the Prevalence of an Outcome

James P. Scanlan

Abstract for Methods Workshop to be given on September 5, 2014, to the University of Minnesota's Minnesota Population Center and Division of Epidemiology and Community Health of the School of Public Health

There are four standard measures of association between two outcome rates (proportions): (1) relative (percentage) differences between rates of experiencing the outcome; (2) relative differences between rates of avoiding the outcome; (3) absolute (percentage point) differences between the outcome rates; and (4) odds ratios. None of these measures provides a sound basis for quantifying the strength of an association, because, for reasons inherent in the underlying risk distributions, each measure tends to be systematically affected by the prevalence of an outcome.

The rarer an outcome the greater tends to be the relative difference in experiencing it and the smaller tends to be the relative difference in avoiding it. Thus, for example, as mortality and poverty decline, relative differences in experiencing those outcomes tend to increase while relative differences in avoiding them tend to decrease; as rates of appropriate healthcare increase, relative differences in receipt of such care tend to decrease while relative differences in failing to receive such care tend to increase; relaxing mortgage lending criteria or public school discipline standards tends to increase relative differences in adverse lending and discipline outcomes while reducing relative differences in the corresponding favorable outcomes. Similarly, among populations where adverse outcomes are comparatively rare (e.g., persons with high education or high income, British civil servants, inhabitants of states like Minnesota and Massachusetts or countries like Norway and Sweden), relative differences in adverse outcomes tend to be larger, while relative differences in favorable outcomes tend to be smaller, than among populations where adverse outcomes are more common.

Absolute differences and odds ratios also tend to change as the prevalence of an outcome changes, though in a more complicated way than the two relative differences. Roughly, as uncommon outcomes become more common absolute differences tend to increase; as common outcomes become even more common absolute differences tend to decrease. Further, as the prevalence of an outcome changes, the absolute difference tends to change in the same direction as the smaller relative difference. Difference measured by odds ratios tend to change in the opposite direction of absolute differences.

The only theoretically sound way to quantify the strength of the forces causing outcome rates to differ is to derive from the rates the difference between means of the underlying distributions.

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