Odds ratios and Relative risk

Odds ratios

Quite often the outcome of interest in a study is a "yes or no" event, such as "died", "got disease x", "dropped out of school", "committed a violent act", and so on. In studies like this, the interest focuses on the *probability* of the event happening, and how that probability changes under different conditions. For example, we might want to know if the probability of getting lung cancer changes with the amount of exposure to second hand smoke. A recent paper in *Science*,[1] widely reported in the press, compared the probabilities of adolescents committing an "act of violence" among those who watched less than 1 hour, 1 to 3 hours and more than 3 hours of TV each day.

Statisticians usually compare two probabilities using *odds ratios*. It's an odd scale to measure things on, but it has a lot of nice mathematical properties, and it's become something of a standard. Usually odds ratios are reported along with a confidence interval: for example

OR=1.57 (95% CI 1.13 − 2.16)

and in many studies, including the television violence study just mentioned, the odds ratio is adjusted for other important variables that may also be related to the conditions of interest.

The odds ratio is a way of assessing how the probability of the event changes as the condition of interest changes. If the odds ratio, or the adjusted odds ratio, is equal to 1, then the probability does not change. In the example above, from[1], the condition is either "1 to 3 hours of TV per day" or "more than 3 hours of TV per day". The odds ratio is bigger than 1, showing an increase in the probability of the outcome of interest ("committed a violent act") and the confidence interval does not include the value 1, so we know that the observed effect is not due to noise in the data.

But how big an effect is it? Epidemiologists use this very rough rule of thumb:

- An odds ratio of 4 or more is pretty strong and not likely to be able to be explained away by some unmeasured variables.

- An odds ratio bigger than 2 and less than 4 is possibly important and should be looked at very carefully.

- An odds ratio bigger than 1.5 and less than 2 is interesting and worth investigating further but not convincing in just one study.

- An odds ratio between 1.0 and 1.5 is at best suggestive of lines for further research.

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[1]29 March 2002, Volume 295, p.2468: Johnson, J.G. et al.; see also aaas.org/news/releases/tvViolenceIntro.shtml

Relative risk

Studies of events which are relatively unlikely in the whole population, (most cancers fall in this class, for example) often call the odds ratio by another name: *the relative risk.*[2]

If the relative risk is equal to 1, then there is no (apparent) increase in the probability of disease, due to the risk factor. If the relative risk is greater than 1, then exposure to the risk factor does increase the probability of disease, and if the relative risk is less than 1, exposure decreases the probability of disease. As with the odds ratio, the relative risk can only be estimated, and there is always an associated margin of error.

In the original smoking and lung cancer studies, the relative risk for lung cancer identified with smoking was 9, for one-pack-a-day smokers, and 30 for two pack-a-day-smokers. In a toxic waste site study,[3] the relative risk for birth defects identified with proximity to a toxic waste sight was 1.12, a 12% increase in risk relative to the risk for those living more than one mile from a toxic waste site.

Important!

Even when a study reports a fairly large odds ratio or relative risk, and seems to convincingly identify a risk factor for the outcome in question, this is very rarely the last word. There are any number of choices that are made in designing a study and in analysing the data, and it is extremely difficult to assess how these affect the study results. There is always the possibility of unobserved variables that could have an important relation to the conditions or the outcomes studied, and the possibility that unsuspected biases have affected the the study results as well.

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[2] The precise definition is slightly more technical and is omitted here.

[3] "Should pregnant women move? Linking risks for birth defects 'with proximity to toxic waste sites." S.A. Geschwind, *Chance* **5**(3-4), 40–46 (1992)