

A Fishbowl Activity – Demonstrating Relative Risk

By W. Conway Link
Department of Mathematics
Louisiana State University - Shreveport
One University Place
Shreveport, LA 71115
PH: 318.797.5309
Email: clink@pilot.lsus.edu

Abstract

The term “relative risk”, a concept often used by epidemiologists and biostatisticians, is not one with which the general public is familiar. Yet, the term is seen from time to time in the popular press. This paper reports the results of an informal survey given to mathematics students at LSU-Shreveport on their knowledge of the definition of the term, and describes a simple classroom activity/demonstration to illustrate the concept of relative risk.

The general public has only a minimal understanding of basic concepts of statistics and probability. At best, knowledge seems to be limited to the idea of “average”, although in the experience of the investigator, those who have had no coursework in statistics would find it difficult to explain the differences among the most commonly used averages --“arithmetic mean”, “median”, and “mode.” Media reports of journal findings typically will include averages, but often fail to mention variability or p-values, and with good reason.

Nevertheless, relative risk, a measure of the strength of the exposure effect, and a concept somewhat more obscure than that of variability and p-values, has been mentioned in diverse places over the last several years: (1) *Newsweek's* August 11, 1997 story “Mother’s pelvic size, fetal growth, and death from stroke and coronary heart disease in men in the UK” as reported in the November 9, 1996 issue of *The Lancet*; (2) The article “Using Relative-Risk Pedigree Analysis in Breeding” as reported in *Today's Breeder*, a publication of Nestle Purina; (3) *The (Shreveport) Times* story “Study links cigarette smoke, feline lymphoma” of January 20, 2003 referencing the article “Environmental Tobacco Smoke and Risk of Malignant Lymphoma in Pet Cats” published in Volume 156 of the *American Journal of Epidemiology* in August 2002, and (4) “CRP -- Another Piece of the Heart-Disease Puzzle?” published in *Nutrition Action Health Letter*, March 2003.

The possibility that relative risk may not be universally understood, even among health care professionals, is illustrated by an editorial – “The Interpretation of Epidemiologic Studies” published in Volume 323, Number 12 of *The New England Journal of Medicine*. In an effort to gauge how well college students understand the

concept, an informal survey of three mathematics classes at LSU-Shreveport was taken, during which students were read the following excerpt from *The (Shreveport) Times* and asked to provide a definition of relative risk: “Adjusting for age and other factors, the study showed that the relative risk for lymphoma in cats was 2 ½ times that of cats that were in non smoking households.”

Twelve of the 75 students (16%) responded with “I don’t know, or I don’t have a clue.” Some responses such as “Means that if a person does something to harm another living thing other than himself or herself,” “A small problem that could get bigger,” and “Relative risk is the amount of risk a person is willing to take to gain the maximum amount of pleasure” indicated a clear non-understanding of the concept. Only a few students seemed to have a grasp as indicated by the following responses: “In context of the article: the risk of cats getting cancer in a smoking home as compared to cats in a non-smoking home,” “In math – a ratio,” and “The risk of ‘X’ in comparison to what is normally observed without agent ‘Y’, in this case, the presence of smoking.”

For those teaching probability and statistics classes, relative risk can be a very worthwhile application of conditional probability, requiring little background information to understand. A simple fishbowl and paddle demonstration can be used to illustrate not only relative risk, but also the variation in the relative risk estimates as more and more samples are taken. In conducting the relative risk demonstration/activity, the investigator used a fishbowl, a paddle with thirty holes, and two sets of beads with the following composition -- one set of 800 beads containing 600 blue beads and 200 orange ones and a second set containing 1000 beads, 900 of which were blue.

Once the concept of relative risk as a measure of the strength of the exposure effect was covered, the set of 800 beads was said to represent the population of those exposed, with the 200 orange beads in this set representing the 200 of the 800 exposed who were determined to be diseased at the end of the study. Here, $P(D/E) = 0.25$. The 1000 beads in the second set were said to represent those who were not exposed. Here, the 100 orange beads represent those who were determined to have the disease, so $P(D/\sim E) = 0.10$, with the true relative risk being $p = 2.5$.

Students sampled from the population of those exposed ($n_1 = 800$), with each getting an individual estimate of $P(D/E)$, which was recorded on the board. Then each sampled from the population of those not exposed ($n_2 = 1000$), obtaining an estimate of $P(D/\sim E)$. Next, each student found the quotient of their two estimates which yielded an estimate of the true relative risk.

Depending on the time factor, the instructor might consider the following modifications to the demonstration: (1) Instead of using only the risk estimates as ordered pairs and obtaining one relative risk estimate from each student, it may be of interest to pair each $P(D/E)$ with each $P(D/\sim E)$ and examine the distribution of the quotients, resulting in n^2 relative risk estimates rather than n estimates (assuming n students). Using this approach, even a small class can generate a reasonable number of relative risk estimates; (2) If two sets of beads are not available or practical, one might consider letting the one set which is available represent one of either $P(D/E)$ or $P(D/\sim E)$. The other value could be stated by the instructor with the relative risk estimates being found in the appropriate manner. This would give the instructor the option of varying one risk and showing the resulting variation in the relative risk estimates.