Relating Risk Factors to Health, Simplified Version

Goals: Calculate and understand epidemiologic measures of association and impact

Background

Several well-designed and executed [fictitious] epidemiologic studies have implicated enviroxide as a potential cause of environitis, a newly recognized disorder in a small country called Carolina (pop. 10,000). In addition, a previously unseen form of influenza, influenza J, has also been discovered and is believed to be associated with exposure to birds as household pets. Although they are unrelated, the two disorders have similar clinical pictures, with a two-week acute phase for which the most prominent symptom is a profound feeling "like being back in graduate school." Fortunately symptoms resolve quickly and completely, with apparent immunity to further episodes.

A recent survey indicates that 15% of the population are exposed to high levels (>100ppm) of enviroxide and 40% of the population have a pet bird in the household. There is no association between these two exposures. Separate research teams conduct two-year cohort studies of these disorders.

Study 1. The first study recruits 1,000 persons living in buildings with enviroxide levels>100ppm ("exposed") and 1,000 persons living in buildings with enviroxide levels $\leq$100ppm ("nonexposed"). Seven hundred exposed participants develop environitis. Five-hundred unexposed participants do.

Study 2. In the second study 2,000 bird owners and 2,000 persons who do have any contact with birds are recruited. Four hundred bird-exposed participants contract influenza J. One-hundred and sixty unexposed participants contract influenza J.

Part A. Measures of association

1. Create a 2 x 2 table for each cohort study.

2. **For each study,** calculate the following statistics:
   a. Incidence proportions (risks) in the exposed group and in the nonexposed group.
   b. Relative risk associated with exposure
   c. Odds ratio associated with exposure
   d. Risk difference with exposure

3. Compare the risk ratios and odds ratios in each of the studies. Why do differences exist?

4. For which association do data provide stronger evidence that the association is causal?

5. For which association is there a greater effect in absolute terms?

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Part B. Measures of impact – adverse exposures

In preparation for the next election, the Carolina government is seeking a public health success. Assuming that resources and intervention expertise are available to eliminate either enviroxide or pet birds, but not both, which of these two exposures should be chosen for the prevention program in order to have the most visible results? What epidemiologic measure(s) can assist you in this decision?

First, we need to consult with the government's political advisors regarding what will be most salient to the media and the public, i.e., what determines "visibility." One factor might be the attributable reduction in risk in the population (e.g., "influenza J cut by 40%, claims government health expert"). The statistic is called the attributable fraction in the population (AF_p).

Note that the two cohort studies were designed to have equal numbers of exposed and nonexposed participants to maximize statistical power, but the population prevalences are quite different (15% for high enviroxide, 40% for pet bird ownership). The AF_p depends upon the prevalence of exposure in the population *and* the relative risk according to this formula:

$$AF_p = \frac{p_e(RR-1)}{1+p_e(RR-1)}$$

where RR represents the relative risk and p_e represents the proportion of the population that is exposed to the risk factor.

Determine the attributable fractions in the population for each exposure/disease pair. For which disease will elimination of the risk factor have a larger proportional impact?

Part C. Measures of impact – preventive exposure

Eliminating pet bird ownership will not be popular, so the government launches a crash program to develop a vaccine to prevent the ailment. In the subsequent double-blind, randomized efficacy trial of vaccine effectiveness, among 162 persons receiving the vaccine 9 subsequently develop influenza J; of the 169 receiving placebo, 24 contract influenza J.

1. What is the efficacy of the new vaccine?

(a) Let the vaccinated group's risk represent the risk in the exposed group. What is this risk?

(b) Let the placebo group's risk represent the risk in the nonexposed group (R_0). What is this risk?

(c) The effectiveness of the vaccine can be summarized in terms of its **preventive fraction**. Use this formula to calculate the preventive fraction of the vaccine:

$$PF = \frac{R_0 - R_1}{R_0}$$

2. Focus groups suggest that only 30% of the population will accept the vaccine. Assuming minimal herd immunity effect, the preventive fraction due to lack of vaccination in the population will be only 30% of the preventive fraction in vaccine-exposed individuals. Multiply the preventive fraction in the exposed by 30% to determine the attributable fraction (efficacy) in the population.

3. Given the low effectiveness due to the behavioral aspect of vaccine administration, Carolina public health strategists opt instead for environmental modification to prevent environitis. They propose a crash enviroxide abatement program to completely eliminate enviroxide exposure. What proportion of environitis cases will be prevented in the population with complete elimination of enviroxide elimination? (See prior page for formula for the attributable fraction in the population.)

Part D. Interpretation of odds ratios

Suppose a case-control study examining influenza J and pet bird ownership found an OR=3.0. At the end of the flu season, all reported influenza J cases are interviewed and compared with persons chosen from a sample of all others in the population. Examine the following statements and comment on why the statement correctly or incorrectly reflects the meaning of the above odds ratio.

1. The odds of developing influenza J for a pet bird owner are 3 times higher than those for a person who does not have contact with birds.

2. The risk of developing influenza J in pet bird owners is 3 times that of developing influenza J in nonowners.

3. The odds of bird ownership among persons who contract influenza J are 3 times those for persons who do not contract influenza J.