

# Interpreting Results of Case-Control Studies

The odds ratio is the “measure of association” for a case-control study. It quantifies the relationship between an exposure (such as eating a food or attending an event) and a disease in a case-control study. The odds ratio is calculated using the number of case-patients who did or did not have exposure to a factor (such as a particular food) and the number of controls who did or did not have the exposure. The odds ratio tells us how much higher the odds of exposure are among case-patients than among controls.

An odds ratio of

- **1.0 (or close to 1.0)** indicates that the odds of exposure among case-patients are the **same** as, or similar to, the odds of exposure among controls. The exposure is not associated with the disease.
- **Greater than 1.0** indicates that the odds of exposure among case-patients are **greater** than the odds of exposure among controls. The exposure might be a **risk factor** for the disease.
- **Less than 1.0** indicates that the odds of exposure among case-patients are **lower** than the odds of exposure among controls. The exposure might be a **protective factor** against the disease.

The magnitude of the odds ratio is called the “strength of the association.” The further away an odds ratio is from 1.0, the more likely it is that the relationship between the exposure and the disease is causal. For example, an odds ratio of 1.2 is above 1.0, but is not a strong association. An odds ratio of 10 suggests a stronger association.

## Example

In May 2005, the Kent County Health Department in Michigan was notified of an outbreak of vomiting and diarrhea following a company luncheon. Lunch included submarine sandwiches catered by a local restaurant. An estimated 200 persons attended the luncheon; 55 attendees became ill. A case-control study was conducted.

Fifty-three of 54 case-patients and 33 of 40 controls reported eating lettuce in their submarine sandwich. The odds ratio for lettuce was calculated to be 11.2.

**How would you interpret the odds ratio?** An odds ratio of 11.2 means the odds of having eaten lettuce were 11 times higher among case-patients than controls. Because the odds ratio is greater than 1.0, lettuce might be a risk factor for illness after the luncheon. The magnitude of the odds ratio suggests a strong association.

Once the odds ratio is determined, tests of statistical significance must be used to determine the probability of finding an odds ratio as strong as or stronger than the one observed, if the exposure is not truly related to the disease (i.e., due to chance alone). This probability is called the “p-value.” The p-value is calculated using the same numbers that are used to calculate the odds ratio.

The larger the p-value, the higher the probability that you might observe such an association as a result of chance alone and that the exposure is probably not related to the disease. The smaller the p-value, the lower the probability that you might observe such an association as a result of chance alone and the greater the chance that the exposure is related to the disease.

If the p-value is equal to or less than a predetermined cutoff (usually 0.05, or a 5 in 100 probability that the finding is due to chance alone), the association is said to be statistically significant. If it is greater than the predetermined cutoff, the association is said to be not statistically significant.

## Example

**In the Kent County outbreak (described above), the p-value for the association between lettuce and illness is 0.01. If the cutoff for statistical significance is 0.05, is the association between lettuce and illness statistically significant?** A p-value of 0.01 means that there is less than one chance in 100 that an odds ratio of at least 11.2 would result by chance alone, if lettuce is not actually associated with illness. Because 0.01 is less than the cutoff of 0.05, the finding is considered statistically significant.

Source: Centers for Disease Control and Prevention. Multisite outbreak of norovirus associated with a franchise restaurant - Kent County, Michigan, May 2005. *Morbidity and Mortality Weekly Report* 2006;55(14):395-7.

Readers should be aware that **confidence intervals** (i.e., the range of values for the measure of association that are consistent with the study findings) are used by some investigators to evaluate the role of chance in finding an odds ratio as strong or stronger than the one observed in a study. However, confidence intervals will not be discussed in this lesson.

## Give it a try with the following exercise.

### EXERCISE

On October 29, the North Carolina Division of Public Health (NCDPH) received a report of three cases of hemolytic uremic syndrome (HUS) among children caused by *Escherichia coli* O157:H7 infection. All three children visited a petting zoo at the North Carolina State Fair during October 15-24. Case finding efforts by NCDPH identified 105 other persons who had become ill with diarrhea after attending the fair.

A case-control study was undertaken to identify risk factors for infection with *E. coli* O157:H7. Forty-five case-patients and 188 controls who attended the fair and did not get sick were enrolled in the study. A p-value of 0.05 was set as the cutoff for statistical significance.

Thirty-six (80%) of 45 case-patients visited the petting zoo, compared with 64 (36%) of 187 controls (odds ratio = 7.7;  $p < 0.0001$ ). In an analysis of case-patients and controls who were aged <6 years who visited the petting zoo, the following results were found:

Exposure	Odds ratio	p-value
Touching or stepping in manure	6.9	0.001
Falling or sitting on the ground	3.2	0.02
Use of a pacifier or spill-proof cup or sucking on one's thumb while at the zoo	11.0	0.001
Use of alcohol-based hand sanitizer	1.9	0.6
Awareness of risk of disease from contact with livestock*	0.1	0.02

\*among parents who accompanied the children

QUESTION 1: Among children <6 years who had visited the petting zoo, which exposures might be risk factors for infection with *E. coli* O157:H7?

**Answer**  
The odds of touching or stepping in manure were seven times greater among case-patients than among controls. The odds of falling or sitting on the ground were three times greater, and the odds of using a pacifier or spill-proof cup or sucking on one's thumb while at the zoo were 11 times greater among case-patients than among controls. All of these exposures were statistically significantly associated with illness (p-values were less than 0.05) and could be risk factors for infection with *E. coli* O157:H7. (Note: The odds ratio for use of hand sanitizers is greater than 1.0; however, the p-value is greater than 0.05. Therefore, it is not considered a risk factor.)

Note: Use Shift+Ctrl+ Plus to rotate view

QUESTION 2: Among children who visited the petting zoo, which exposures might be protective factors for infection with *E. coli* O157:H7?

**Answer**  
The odds of the child's parent being aware of the risk for disease from contact with livestock were lower among case-patients than among controls. This finding was statistically significant and might indicate that awareness of the risk of disease among parents was a protective factor for infection with *E. coli* O157:H7. Source: Centers for Disease Control and Prevention. Outbreaks of *Escherichia coli* O157:H7 associated with petting zoos --- North Carolina, Florida, and Arizona, 2004 and 2005. Morbidity and Mortality Weekly Report 2005;54:1277-80.

Note: Use Shift+Ctrl+ Plus to rotate view