University of Guelph Numeracy Project

Relative Risk and Odds Ratios: Examples

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► Imagine that the incidence of gun violence is compared in two cities, one with relaxed gun laws (A), the other with strict gun laws (B). In the city with relaxed gun laws, there were 50 shootings in a population of 100,000 and in the other city, 10 shootings in a population of 100,000.

1) What is the relative risk of gun violence in the city with relaxed gun laws (A)?

2) What is the relative risk of gun violence in the city with strict gun laws (B)?

3) What questions need to be asked before concluding that there is an association between shootings and gun laws?

► 1) The relative risk of gun violence in the city with relaxed gun laws (A) is:

$$\frac{\text{incidence in A}}{\text{incidence in B}} = \frac{50/100{,}000}{10/100{,}000} = \frac{50}{10} = 5.00$$

2) The relative risk of gun violence in the city with strict gun laws (B) is:

$$\frac{\text{incidence in B}}{\text{incidence in A}} = \frac{10/100{,}000}{50/100{,}000} = \frac{10}{50} = 0.20$$

► The seemingly obvious conclusion is that the relaxed gun laws in city A cause more gun violence, quintupling the risk. However, before jumping to conclusions, it may be helpful to consider the following questions :

- Is the age distribution and socioeconomic status (SES) of each population similar? Younger people involved in gangs, or individuals of low SES, may be more likely to resort to gun violence. City A may be more prone to such situations.

- Were the risk exposure patterns several decades ago, when the laws were first induced, similar to those in the present?

- Are the judicial systems and records of gun violence different in each city?

Calculating Odds Ratios

Calculating Odds Ratios

► A study looking at breast cancer in women compared cases with non-cases, and found that 75/100 cases did not use calcium supplements compared with 25/100 of the non-cases.

1) Develop a table to display the data.

2) Calculate the odds of exposure in cases and non-cases.

3) Calculate the odds ratio using the cross-product ratio.

4) How does the difference between the two prevalences of breast cancer (75% vs 25%) compare to the odds ratio?

► 1)

Risk factor/exposure	Disease Group	
	Case	Control
No calcium supplement	75 (a)	25 (b)
Calcium supplement	25 (c)	75 (d)

2) The odds of exposure in:

- case group: a/c = 75/25 = 3
- control group: b/d = 25/75 = 1/3

3) The Odds Ratio:

$$\frac{a}{b} \times \frac{d}{c} = \frac{75 \times 75}{25 \times 25} = \frac{5625}{625} = 9.00$$

4) After calculating the odds ratio, we observe a 3-fold difference in the prevalence rate (75% vs. 25%) change to a 9-fold difference in the odds ratio. Clearly, the two methods produce opposing results.

Effect of Changing Incidence on OR

Problem

► Let us consider the relationship between smoking and lung cancer. Suppose exposure to cigarette smoke increases the incidence of lung cancer by 20% (i.e. the relative risk is 1.2). Lung cancer has a baseline incidence of 3% per year (in the non-exposed group). Suppose as well that baseline incidence in obese individuals is 1/3 less (i.e. 1%/yr.), and the relative risk associated with the exposure is also 1.2. You follow up 1000 non-obese and 1000 obese subjects with the exposure, and an equivalent number without the exposure. The study lasts 25 years. Work with 25-year cumulative incidence and a denominator of 1000.

1) Create a table to show the data for obese and non-obese subjects.

2) Calculate the odds ratio of disease in the exposed group in relation to those who are not exposed.

3) Compare the odds ratio with the relative risk of 1.2.

► 1) Data on exposure in those who are and are not obese: annual disease incidence at baseline = 3% and RR = 1.2 (25-year follow up)

	Not Obese		Obese	
	Diseased	Not diseased	Diseased	Not Diseased
Exposed	900	100	300	700
Not Exposed	750	250	250	750

2) Relative Risk and Odds Ratio for the non-obese:

$$\text{Relative Risk} = \frac{900/1000}{750/1000} = 1.20$$

$$\text{Odds Ratio} = \frac{900/100}{750/250} = \frac{900 \times 250}{750 \times 100} = 3.00$$

Relative Risk and Odds Ratio for the obese:

$$\text{Relative Risk} = \frac{300/1000}{250/1000} = 1.20$$

$$\text{Odds Ratio} = \frac{300/700}{250/750} = \frac{300 \times 750}{250 \times 700} = 1.29$$

3) Overall, you can see that decreasing the baseline incidence will decrease the odds ratio (3.00 in those who are non-obese versus 1.29 in those who are obese). Obviously, these results run counter to expected results, putting the onus on the researcher to justify them. Similarly, you should find that increasing the incidence will increase the odds ratio.

► From the data in the previous chart, we can also calculate the relative risk for a lack of disease in non-obese individuals:

$$\text{Relative Risk} = \frac{100/1000}{250/1000} = 0.40$$

- Finally, using the data in the previous chart, we can calculate the odds ratio for a lack of disease in non-obese individuals by use of the cross-product ratio:

$$\text{Odds Ratio} = \frac{100 \text{ x } 750}{250 \text{ x } 900} = 0.33$$

- Consider that the odds ratio for a lack of disease in non-obese individuals (0.333) is equivalent to the reciprocal of the odds ratio for the presence of disease in non-obese individuals (3.00, as calculated in the previous example). This advantageous property holds for all odds ratios.

- Note, both relative risk and the odds ratio are only sensical in well-executed studies which are able to be related to the population from which you wish to draw associations.

Attributable Risk

Calculating Attributable Risk: An Example

- Use the following table to calculate the attributable risk associated with taking a supplement containing folate during pregnancy:

	Annual Death Rates per 100 000	
	Neural Tube Defects	**Premature Births**
No Folate	631	727
Folate	24	563

- Excess risk for no folate supplementation on Neural Tube Defects (NTD):

  631- 24 = 607

  Excess risk for no folate supplementation on Premature births:

  727- 563 = 164

- As we wish to express attributable risk as a percentage, perform the following:

  Attributable risk for no folate supplementation on Neural Tube Defects:

  607/631 x 100% = 96.2%

  Attributable risk for no folate supplementation on Premature births:

  164/727 x 100% = 22.6%

- So, we claim of pregnant women not consuming folate, 96.2% of neural tube defect cases can be attributed to a lack of folate supplementation. Therefore, if the cause were to be removed, the disease could be reduced by up to 96.2% and 607 lives could be saved. Similarly, the attributable risk for premature births is 22.6%.