Quantification of Risk **5/21/2001**

Usually, but not always, the statistical evidence for a health risk (or other type of risk) is a two-by-two contingency table. For example, here's data on the risk of high blood pressure.

The "risk factor" is high blood pressure and the "adverse outcome" is death.

Blood Pressure	Died	Survived	Total
Low	21	2655	2676
High	55	3283	3338

Since the totals are not equal, the frequencies have to be converted to percents of the totals:

Blood Pressure	Died	Survived	Total
Low	.785%	99.215%	2676
High	1.648%	98.352%	3338

Rates: Since most risks are small, they are usually expressed as adverse outcomes per 1000 or 10,000 or 100,000, rather than per cent. For example, deaths per 10,000 are 78.5 for men with low blood pressure and 164.8 per 10,000 for men with high blood pressure.

Epidemiological reports generally report risks in one of two ways: relative risks or odds ratios.

Relative risk: is easy to understand. It is just the ratio of the rates:

$$\text{relative risk} = \frac{\text{death rate in exposed group}}{\text{death rate in unexposed group}}$$

I used the word "death" to stand for "the adverse outcome"; however, the adverse outcome might be something else, such as quadraplegia, or an asthma attack.

In this example the relative risk is 1.648/.785 = 2.10 . It doesn't matter if the rates are per cents or per 1000 or per 10,000 or per 100,000. You'll get the same answer. But you have to use rates not actual numbers of deaths.

A relative risk of 2.10 means that men with high blood pressure die twice as fast as men with low blood pressure.

Odds ratio is a bit harder to understand. The definition is,

$$\text{odds ratio} = \frac{\text{odds on death in exposed group}}{\text{odds on death in unexposed group}}$$

To use this formula you have to know how to calculate odds. The odds of something are the chances that it will happen divided by the chances that it will not happen. Thus the odds on death in the high blood pressure group are 55 / 3283 and the odds on death in the low blood pressure group are 21 / 2655.

(Odds like 55 / 3283 are pronounced "55 to 3283" and are often written with a colon rather than a division symbol, 55:3283.)

The odds ratio is

$$\text{odds ratio} = \frac{55/3283}{21/2655} = \frac{.0167}{.00791} = 2.11,$$

Here the odds ratio is almost the same as the relative risk, but that is not always the case. For example, suppose the risk factor is very potent.

	Exposed	Not Exposed
Died	600 (30%)	100 (2%)
Survived	1400	4,900
n	2000	5,000

Here, the relative risk is 15 (30% / 2%) but the odds ratio is 21 (600/1400)/(100/4900).

You need to be able to: calculate and interpret odds ratios and relative risks and determine if the risk is significant. Here are the basic facts about how to interpret relative risks and odds ratios.

A relative risk or odds ratio bigger than 1.00 means that people exposed to the risk factor experience the adverse outcome more often than people not exposed to the risk factor. The bigger the ratio, the worse the risk.

A relative risk or odds ratio equal to 1.00 means that people exposed to the risk factor experience the adverse outcome at exactly the same rate as people not exposed to the risk factor. A relative risk or odds ratio close to 1.00 means that the risk is comparatively small.

A relative risk or odds ratio between 0.00 and 1.00 means that people exposed to the risk factor experience the adverse outcome less often than people not exposed to the risk factor

To summarize,

When Relative Risk or Odds Ratio is:	**The risk factor is**
Bigger than 1.00	bad for you
Equal to 1.00	neither good nor bad
Smaller than 1.00	beneficial

Warning: The relative risk or odds ratio may be biased by confounding factors. Therefore, when you are reading an epidemiological report, you need to read carefully to determine if the relative risk or odds ratio was statistically adjusted for confounding variables. Later on, I'll explain how this type of adjustment is done, but for now, be alert

to this problem and look for some mention of adjustment for confounding variables.

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Margin of Error (Replaces Section 12.2)

There is a statistically significant increased risk if the odds ratio is bigger than 1.0 and the margin of error rules out 1.0 .

Margin of error (AKA, the 95% confidence interval) is expressed as the Lower Confidence Limit (LCL) and the Upper Confidence Limit (UCL). Here is how to do the computation for the odds ratio.

		Outcome	
		Favorable	Adverse
Risk Factor	Unexposed	A	B
	Exposed	C	D

$$OR = \frac{D/C}{B/A} \quad SE_{LOR} = \sqrt{\frac{1}{D}+\frac{1}{C}+\frac{1}{B}+\frac{1}{A}}$$

$$LCL = \frac{OR}{\exp(2 \bullet SE_{LOR})} \quad UCL = OR \bullet \exp(2 \bullet SE_{LOR})$$

Example:

	Alcohol Intake	
	None	Some
Breast Cancer	19	52
No Breast Cancer	6437	13722

$$OR = \frac{52/13722}{19/6437} = 1.28$$

$$SE_{LOR} = \sqrt{\frac{1}{52}+\frac{1}{13722}+\frac{1}{19}+\frac{1}{6437}} = .268$$

$$LCL = \frac{1.28}{\exp(.536)} = 0.75 \quad UCL = 1.28 \bullet \exp(.536) = 2.2$$

Thus the observed odds ratio is 1.28, but the 95% confidence interval (the margin of error) runs from 0.75 to 2.2; therefore we cannot be confident that there is an increased risk. *Jargon: the increased risk is not "statistically significant".*

Assignment

1. Compute the 95% confidence interval for the odds ratio in table 12.4 on page 199. The risk factor is smoking and the adverse outcome is "two or more cycles". Using a different method the textbook concluded that there is a significant increased risk. Do you agree?

Brief Table of exp(x)

x			exp(x)
0.000	to	0.049	1.0
0.049	to	0.140	1.1
0.140	to	0.223	1.2
0.223	to	0.300	1.3
0.300	to	0.372	1.4
0.372	to	0.438	1.5
0.438	to	0.501	1.6
0.501	to	0.560	1.7
0.560	to	0.615	1.8
0.615	to	0.668	1.9
0.668	to	0.718	2.0
0.718	to	0.765	2.1
0.765	to	0.811	2.2
0.811	to	0.854	2.3
0.854	to	0.896	2.4
0.896	to	0.936	2.5
0.936	to	0.975	2.6
0.975	to	1.012	2.7
1.012	to	1.047	2.8
1.047	to	1.082	2.9
1.082	to	1.115	3.0
1.115	to	1.147	3.1
1.147	to	1.179	3.2
1.179	to	1.209	3.3
1.209	to	1.238	3.4
1.238	to	1.267	3.5
1.267	to	1.295	3.6
1.295	to	1.322	3.7
1.322	to	1.348	3.8
1.348	to	1.374	3.9
1.374	to	1.399	4.0
1.399	to	1.423	4.1
1.423	to	1.447	4.2
1.447	to	1.470	4.3
1.470	to	1.493	4.4
1.493	to	1.515	4.5
1.515	to	1.537	4.6
1.537	to	1.558	4.7
1.558	to	1.579	4.8
1.579	to	1.599	4.9
1.599	to	1.619	5.0

2. A risk factor may or may not increase the chances of an adverse outcome. Epidemiologists use the relative risk (RR) to describe the size of the risk. Which of the following indicates that the presence of the risk factor is worse than its absence?

a) RR=1 b) RR < 1

c) RR > 1 d) RR > 0 e) RR < 0

3. Dr. G. Pershagen (Assessment of Inhalation Hazards, Springer-Verlag, 1989) reported, "the relative risk for lung cancer in non-smokers living with smokers is 1.5". Which of the following statement(s) is (are) correct?

a) 1.5% of people living with a smoker got cancer.
b) The lung cancer rate for people living with smokers was 1.5 times higher than for people not living with smokers.
c) lung cancer is the risk factor, living with a smoker is the adverse outcome
d) all of the above are correct
e) none of the above is correct

4. An article in the New England Journal of Medicine in June of 1994 reported the results of a study of several years of medical records of 750 women with silicone breast implants and a matching group of 1500 women who did not have breast implants. Rates per 10,000 per year for three diseases which might have a statistical association with breast implants are shown in this table:

	Women with Implants	Women without Implants
Connective Tissue Disease	8.6	8.1
Hashimoto's Thyroiditis	17.1	17.0
Cancer other than breast	22.2	20.2

The relative risk for connective tissue disease is,

a) less than 1
b) between 1 and 1.10
c) between 1.11 and 1.20
d) between 1.21 and 1.30
e) greater than 1.30