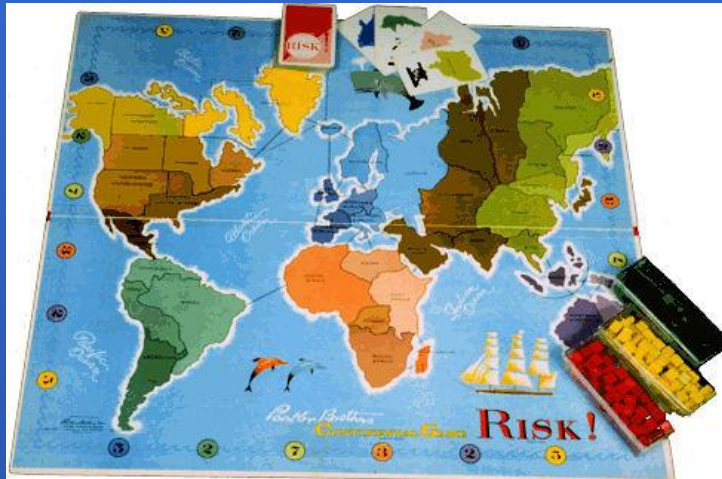# Measures of Association

Association

Statistical dependence between two or more events, characteristics, or variables

An association is present when the probability of occurrence of an event or characteristic, or the quantity of a variable, depends upon the occurrence of one or more other characteristics, or the quantity of one or more variables

What is RISK?

What is RISK?

probability of developing a condition over a defined period of time

# of people developing disease in time period
———————————————————————————
# of disease-free people at start of period

# of people developing TB in 5 years
———————————————————————————
# of people free of TB at start of 5 yr period

10/19/2018

1-year follow-up for the development of CHD

		CHD		
		+	**-**	**Total**
Smoking	**+**	84	2916	3000
	-	87	4913	5000

Incidence in exposed$^+$ = 84/3000 = 28.0/1000
Incidence in exposed$^-$ = 87/5000 = 17.4/1000

		CHD		
		+	**-**	**Total**
Smoking	**+**	84	2916	3000
	-	87	4913	5000

Risk Difference/Attributable Risk

Incidence in exposed$^+$ = 84/3000 = 28.0/1000
Incidence in exposed$^-$ = 87/5000 = 17.4/1000

RD = 28.0-17.4 = 10.6/1000

Among every 1000 smokers, 10.6 more cases of CHD develop than among 1000 non-smokers

3

Risk Difference

- RD > 0 = positive association
- RD = 0 = no association
- RD < 0 = negative association

Relative Risk

Probability of developing disease if risk factor is present

Probability of developing disease if risk factor is absent

Incidence of stroke in hypertensives

Incidence of stroke in normotensives

		CHD		
		+	-	Total
Smoking	+	84	2916	3000
	-	87	4913	5000

Relative Risk or Risk Ratio

Incidence in exposed$^+$ = 84/3000 = 28.0/1000

Incidence in exposed$^-$ = 87/5000 = 17.4/1000

RR = 28.0÷17.4 = 1.61

Risk for CHD among smokers is 1.6 times higher than among non-smokers

Relative Risk

- RR > 1 = positive association
- RR = 1 = no association
- RR < 1 = negative association

RR tells us about the strength of association between exposure and outcome but not about the magnitude of absolute risk (incidence)
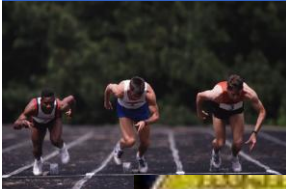
Odds:

- **The ratio of the probability of occurrence of an event to that of**

Odds Ratio (or Relative Odds)

- **The ratio of the probability that something will occur, to the probability that it will not occur (Abramson, MSoD)**

"Odds is understood intuitively only by statisticians and professional gamblers"

Odds Ratio (OR)

outcome

exposure

	a	b
	c	d

Odds Ratio (OR)

outcome

exposure

a	b
c	d

Odds Ratio (OR)

outcome

exposure

a	b
c	d

Prospective study (Disease OR)

Ratio of odds of outcome in exposed (a/b) to the odds of outcome in the unexposed (c/d):

$$\frac{a/b}{c/d} = \frac{ad}{bc}$$

	CHD		
	+	**-**	**Total**
Smoking **+**	84	2916	3000
Smoking **-**	87	4913	5000

Odds Ratio

odds in exposed$^+$ = 84/2916 = 28.8/1000

odds in exposed$^-$ = 87/4913 = 17.7/1000

OR = 28.8÷17.7 = 1.63

ODDS for CHD among smokers is 1.63 times higher than among non-smokers

Odds Ratio

- OR > 1 = positive association
- OR = 1 = no association
- OR < 1 = negative association
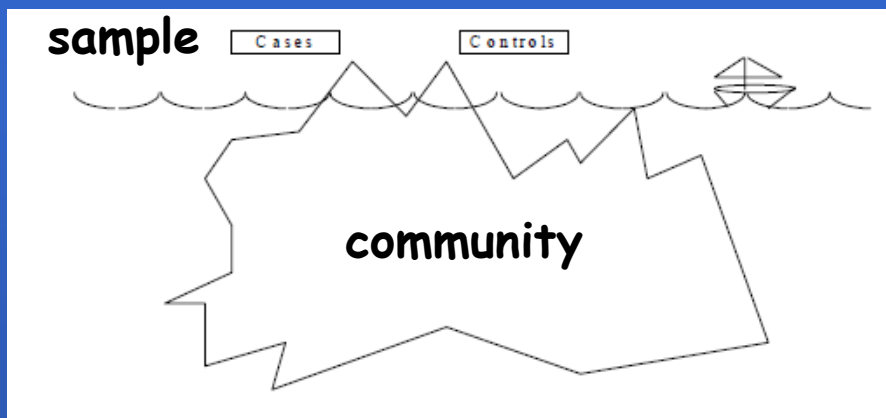
OR $\cong$ RR when…

1. **Outcome is rare because then:**
    $$b \cong (a + b) \text{ and } d \cong (c + d)$$
2. **Cases are representative of all cases in the population re. exposure history**
3. **Controls representative of all non-cases in the population re. exposure history**

exposure	**outcome**		
	a	**b**	**a+b**
	c	**d**	**c+d**

sample   Cases   Controls

community

OR in a retrospective study

outcome

exposure

a	b
c	d

Odds Ratio (OR)

outcome

exposure

a	b
c	d

outcome

a	b
c	d

exposure

Retrospective study (Exposure OR):

Ratio of odds of exposure in cases (a/c) to the odds of exposure in controls (b/d):

$$\frac{a/c}{b/d} = \frac{ad}{bc}$$

RR & OR

- **OR is a useful measure of association in and of itself, in both case-control and prospective studies**
- **In a cohort study, RR can be calculated directly**
- **In a case-control study, RR cannot be calculated directly, so OR is used as an estimate of RR when the risk of disease is low**

Advantages of Odds Ratio

- **Suitable for case-control studies**
- **Identical in both directions**
- **Basis for logistic regression analyses**

Now you try it!

History of sexual abuse	Suicide attempted	
	Yes	No
Yes	14	9
No	49	149

Deykin & Buka (1994) AJPH 84:634-9

History of sexual abuse	Suicide attempted		
	Yes	No	Total
Yes	14	9	23
No	49	149	198

$$R_{exp+} = 14/23 = 60.9\%$$
$$R_{exp-} = 49/198 = 24.7\%$$
$$RR = 60.9/24.7 = 2.46$$

History of sexual abuse	Suicide attempted		
	Yes	No	Total
Yes	14	9	23
No	49	149	198

$$RR = \frac{14/23}{49/198} = 2.46$$

History of sexual abuse	Suicide attempted	
	Yes	No
Yes	14	9
No	49	149

$$OR = \frac{14/9}{49/149} = 4.73$$

Question:
Why do the OR and RR differ?

Answer:

high incidence
(61% in exposed, 25% in unexposed)

therefore b $\neq$ a + b and d $\neq$ c + d