Measures of effect

- So far, $\chi 2$ test – testing whether there is an association between two proportions using a 2x2 (or 2xn) table
- We are often interested in the relative difference between two proportions rather than the actual difference
- The effect estimates that we present are then ratios: there are three main measures we will use:
  - Rate ratio
  - Risk ratio
  - Odds ratio

Relative measures of effect (relative risk)

We have 2 groups of individuals:

- An **exposed** group (group with risk factor of interest) and **unexposed** group (without such factor of interest)
- We are interested in comparing the amount of disease (mortality or other health outcome) in the exposed group to that in the unexposed group

Risk/rate

- Measures the strengths of association between the risk factor and disease
- Incidence rate or Risk in exposed (r_1)
- Incidence rate or Risk in unexposed (r_0)

Risk ratio

- we calculate the risk ratio (RR) as:

$$\mathbf{RR = r_1 / r_0}$$

Risk difference

- the absolute difference between two risks (or rates)

$$\mathbf{RD = r_1 - r_0}$$

Example: cohort study of oral contraceptive use and heart attack

	Myocardial infarction		
	Yes	No	Total
OC use			
Yes	25	400	425
No	75	1500	1575
Total	100	1900	2000

Risk (exposed) = 25/425=0.059
Risk (unexposed) = 75/1575=0.048

Relative risk = 0.059/0.048 = 1.23

- We can also have different strata of exposure. We may calculate ratio measures for each strata – we compare measure of frequency in each level with measure of frequency in the baseline (unexposed) level.
- *Example: Death rates from CHD in smokers and non-smokers by age*

Age	Smokers rate	Non-smokers rate	**Rate ratio**
35-44	0.61	0.11	**5.5**
45-54	2.40	1.12	**2.1**
55-64	7.20	4.90	**1.5**
65-74	14.69	10.83	**1.4**
75-84	19.18	21.20	**0.9**
85+	35.93	32.66	**1.1**
ALL AGES	**4.29**	**3.30**	**1.3**

What can you say about this table?

Age	Smokers rate	Non-smokers rate	Rate ratio
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85+	35.93	32.66	**1.1**
ALL AGES	**4.29**	**3.30**	**1.3**

The rate ratio decreases with increasing age. It may suggest that the effect of smoking on the rate of CHD is higher in younger ages.

Odds ratio

- Alternative measure of risk

The odds of disease is the number of cases divided by the number of non-cases

$$\text{Odds} = \frac{\text{Cases}}{\text{Non cases}}$$

Odds ratio (**OR**) is ratio of odds of disease among exposed ($odds_{exp}$) and odds of disease among unexposed ($odds_{unexp}$)

$$\mathbf{OR = odds_{exp} / odds_{unexp}}$$

	Myocardial infarction		
	Yes	No	Total
OC use			
Yes	25	400	425
No	75	1500	1575
Total	100	1900	2000

We can calculate

- Odds (exposed) O_{exp}=25/400
- Odds (unexposed) O_{unexp}=75/1500

- Odds ratio $OR = O_{exp} / O_{unexp}$ = 1.25

Odds ratio as an approximation to the risk ratio

- For a rare disease, odds ratio is approximately equal to the risk ratio (because denumerators are very similar)
- For a common conditions, OR overestimates the true RR

Measures of population impact

- **Population attributable risk (PAR)** is the absolute difference between the risk (or rate) in the whole population and the risk or rate in the unexposed group

$$PAR = r - r_0$$

Population attributable risk fraction (PARF or PAR%)

- It is a measure of the proportion of all cases in the study population (exposed and unexposed) that may be attributed to the exposure, on the assumption of a causal association
- It is also called the aetiologic fraction, the percentage population attributable risk or the attributable fraction

- If r is rate in the total population

$$\mathbf{PAF = PAR/r}$$

$$\mathbf{PAR = r - r_0}$$

$$\mathbf{PAF = (r\text{-}r_0)/r}$$

Risk or rate difference

Measure of the absolute effect

the absolute difference between two risks (or rates)

$$\mathbf{RD = r_1 – r_0}$$

Similar for rates = rate difference = incidence rate in exposed – incidence rate in unexposed

Measure of effect	**Use of the measure**	**How to interpret results**
Risk Difference	Public Health Interested in excess disease burden due to factor (“Attributable risk”)	Close to 0 = little effect Large difference = large effect
Risk Ratio	Epidemiology Causation “This factor doubles the risk of the disease”	Close to 1 = little effect Large ratio = large effect Close to 0 = large effect!
Odds Ratio	As for Risk Ratio “This factor doubles the odds of the disease” Only possibility (case-control study) More advanced statistical methods (logistic regression)	

Exercise

- 50 persons attended a garden party
- 25 of them developed diarrhoea in the next 3 days
- What was the risk of diarrhoea among the participants of the party?

Exercise – cont.

- 30 party visitors had a BBQ (minced meat)
- 24 of them developed diarrhoea

- 20 people did not eat BBQ
- 1 of them developed diarrhoea

- How would you calculate RR related to eating BBQ?

Exercise – cont.

- Risk among unexposed R_0:
- 1/20

- Risk among exposed R_1:
- 24/30

- Relarive risk $RR=R_1/R_0=(24/30)/(1/20)=16$

Summary of this part

1. Construct 2-way table to examine association between two categorical variables
2. Conduct Chi-squared test to assess the association between two categorical variables
3. Calculate measures of the effect for binary data
   - Risk difference
   - Risk ratio (relative risk)
   - Odds ratio