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Measures of Frequency and Association

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Broken Hill UDRH
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Key Questions

- How frequent is the event?
- How strongly associated with suspected cause?
- Likely to be real or due to chance?

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How frequent?

- Main measures of frequency
  - Number of existing cases (prevalence)
  - Number of new cases (incidence)

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Prevalence

The proportion of a defined population with an attribute of interest (eg disease).

$$= \frac{\text{Persons with an attribute at a given time}}{\text{Total population at a given time}}$$

Eg $\frac{\text{Number of adults with arthritis}}{\text{Number of adults resident in Broken Hill}}$

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Incidence

The number of new cases of disease in a population, over a given period of time.

$$\text{Cumulative Incidence} = \frac{\text{New cases over specified time period}}{\text{Number } \textbf{susceptible} \text{ individuals at the beginning of time period}}$$

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Calculating incidence

INTERVENTION	HEART DISEASE		TOTAL
	Present	**Absent**	
Yes	20	1,980	2,000
No	32	1,968	2,000
TOTAL	52	3,948	4,000

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Did the treatment work?

INTERVENTION	HEART DISEASE		TOTAL
	Present	Absent	
Yes	20	1,980	2,000
No	32	1,968	2,000
TOTAL	52	3,948	4,000

Incidence yes = 20 / 2,000 = 10/1,000
Incidence no = 32 / 2,000 = 16/1,000

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How strong?

Relative risk

- Derived from estimates of incidence so can only be directly estimated from RCT & cohort studies.
- RR = $\frac{\text{Incidence in exposed group}}{\text{Incidence in unexposed group}}$

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How strong?

Relative risk

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- RR = $\frac{\text{Incidence in exposed group}}{\text{Incidence in unexposed group}}$

Incidence yes = 10/1,000
Incidence no = 16/1,000

RR = $\frac{10/1,000}{16/1,000}$ = 0.625

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Interpreting the strength

RR > 1 Incidence higher in treatment group

RR = 1 No difference

RR < 1 Incidence lower in treatment group

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Interpreting the strength

- Relative Risk Reduction (RRR)
  - In trials of therapy or prevention, the relative risk for a successful intervention is below 1. This is often described using the Relative Risk Reduction.
  - Relative Risk Reduction = 1 – Relative Risk
  - **Relative Risk = 0.625**

RRR = 1 – 0.625 = 0.375

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Interpreting the strength

- Risk Difference (RD)
  - Measures the difference in incidence between the treatment and control groups in a clinical trial.
  - RD = Incidence control – incidence treatment
  - Incidence in the control group = 16 / 1,000
  - Incidence in intervention group = 10 / 1,000
  - RD = 16 / 1,000 – 10 1,000 = 0.006

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Interpreting the strength

- **Number needed to treat (NNT)**
  - This concept has arisen from the literature to describe the outcome of randomised trials.
  - NNT = 1 / Risk Difference
  - Risk Difference = 6 / 1,000 = 0.006
  - NNT = 1 / 0.006 = 167

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Case-control studies

INTERVENTION	HEART DISEASE		TOTAL
	Present	Absent	
Yes	20	1,980	2,000
No	32	1,968	2,000
TOTAL	52	3,948	4,000

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Case-control studies

INTERVENTION	HEART DISEASE		TOTAL
	Present	Absent	
Yes	20	104	124
No	32	104	134
TOTAL	52	208	258

4 x the cases

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Case-control studies

INTERVENTION	HEART DISEASE		TOTAL
	Present	Absent	
Yes	20	104	124
No	32	104	134
TOTAL	52	208	258

Incidence yes = 20 / 124 = 1 / 6 (not 10 / 1,000)
Incidence no = 32 / 104 = 1 / 3 (not 16 / 1,000)

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Case-control studies

- **Odds Ratio (OR)**
  - Based on the ratio of the odds of exposure in the diseased, divided by the odds of exposure in the non-diseased.
  - OR = $\frac{\text{Odds of exposure in diseased}}{\text{Odds of exposure in non-diseased}}$

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Case-control studies

- **Odds Ratio (OR)**
  - Based on the ratio of the odds of exposure in the diseased, divided by the odds of exposure in the non-diseased.
  - OR = $\frac{\text{Odds of exposure in diseased}}{\text{Odds of exposure in non-diseased}}$

$$OR = \frac{20 / 32}{104 / 104} = 0.625$$

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Interpreting the strength

OR > 1 Exposure higher among cases

OR = 1 No difference

OR < 1 Exposure lower among cases

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Likelihood it's real?

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From population to sample

Population

Representative sample

Study results

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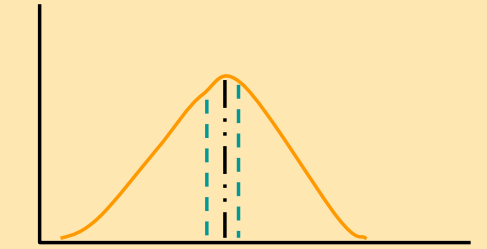
From population to sample



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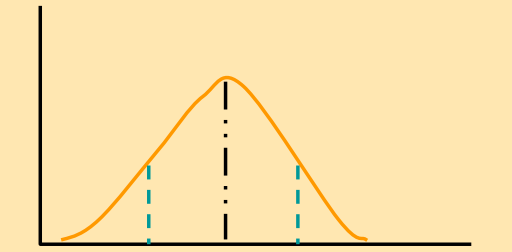
From population to sample



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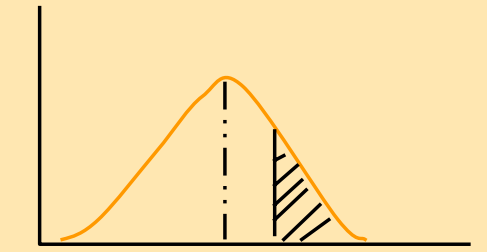
From population to sample



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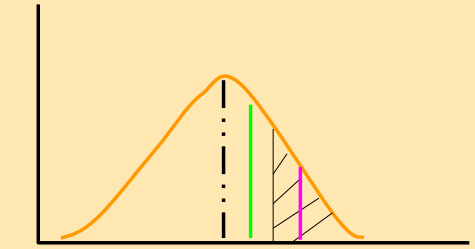
From population to sample



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From population to sample

How do we decide whether the difference reflects a real difference between the treatments, or just the usual variation we would expect between samples drawn from the same population?

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We can never know for certain..

But we can infer, based on three pieces of information:

1. The likelihood the two groups are really different.
2. The size of the difference.
3. The precision with which the size of the difference is known.

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Likely to be a real difference?

P values

1.0	little or no evidence
0.1	weak evidence
0.05	← Statistically significant evidence
0.01	strong evidence
0.001	very strong evidence
0.0	

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You can never know for certain…….

P = 0.001

999 times in 1,000 we will correctly conclude there is a difference between the groups

BUT

1 time in 1,000 we will think there is a difference when there really isn't

And we can never know which is the 1 time!

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How large is the difference?

- Statistical significance does not necessarily mean practical importance
  - How large is the difference?
  - Is it large enough to be of practical or clinical importance? This is not a question that can be answered by statistics!

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Might we have missed an important difference?

- If no evidence of difference was found, was the sample size large enough to detect a clinically important difference if one was present?
  - Was there truly no difference?
  - Were the results inconclusive?

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How precisely is the size of the difference known?

- Confidence Intervals (CI)
  - Indicate how precisely the size of the difference between groups is known
  - Provide an estimate of the range of values with which the data are consistent
  - Based on sample size and degree of variability within sample

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How precisely is the size of the difference known?

Eg, reduction in blood pressure on new treatment:
15 mm Hg +/- 5

95% likely that true value is in range 10-20 mm Hg reduction

Eg, RR of experiencing clinically significant reduction in blood pressure on new treatment:
RR 1.6, +/- 0.2

95% likelihood that true benefit is within range of 1.4 – 1.8

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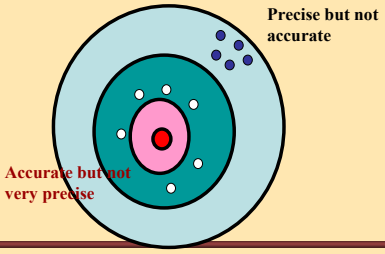
Accuracy vs precision



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