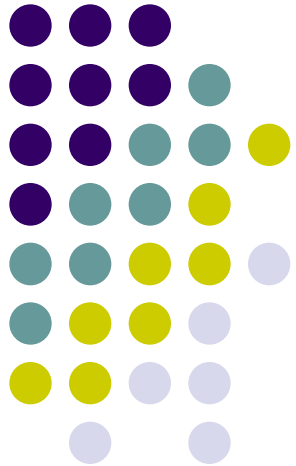
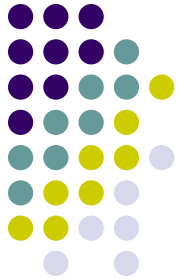
MEASURING ASSOCIATIONS IN EPIDEMIOLOGIC STUDIES



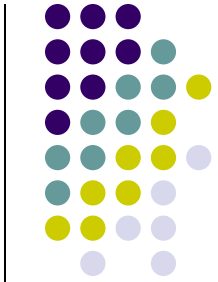
Dr. Ian Gardner – University of California Davis

Measures of association



- “Association” means “relationship”
- Various type of measures of how numerically strong an association is
  - Commonly-used measures
    - Odds ratio
    - Relative risk (synonym: risk ratio)
    - Attributable risk (synonym: risk difference)

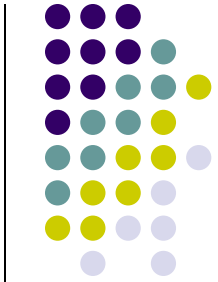
Why measure associations?



- Measures of strength of association are an important consideration when making causal inferences in epidemiologic studies

- In general, the stronger the association the more likely the relationship is “causal”

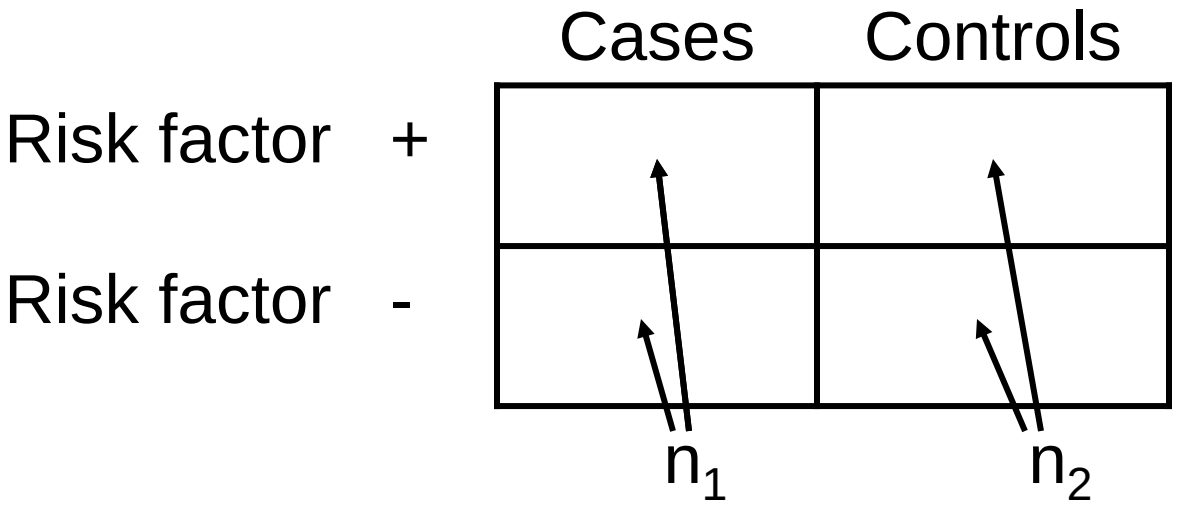
Which measure of association should I use?



- Choice depends on
  - Study design
    - Case-control (Odds ratio)
    - Cross-sectional (Odds ratio)
    - Cohort (Relative risk, attributable risk, odds ratio)
  - Ease of interpretation/explanation
  - Numerical considerations
    - Some can’t be calculated in some situations

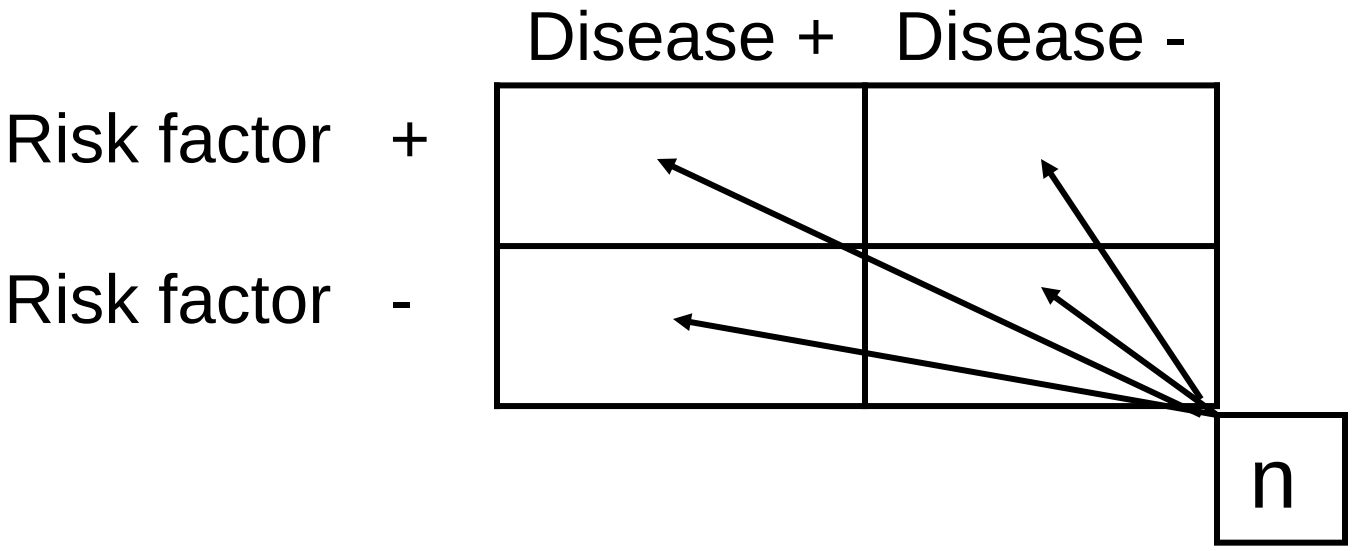
Case-control design

- Find cases and controls (subject to defined criteria), conduct interviews and find out about previous exposure to “risk factors”



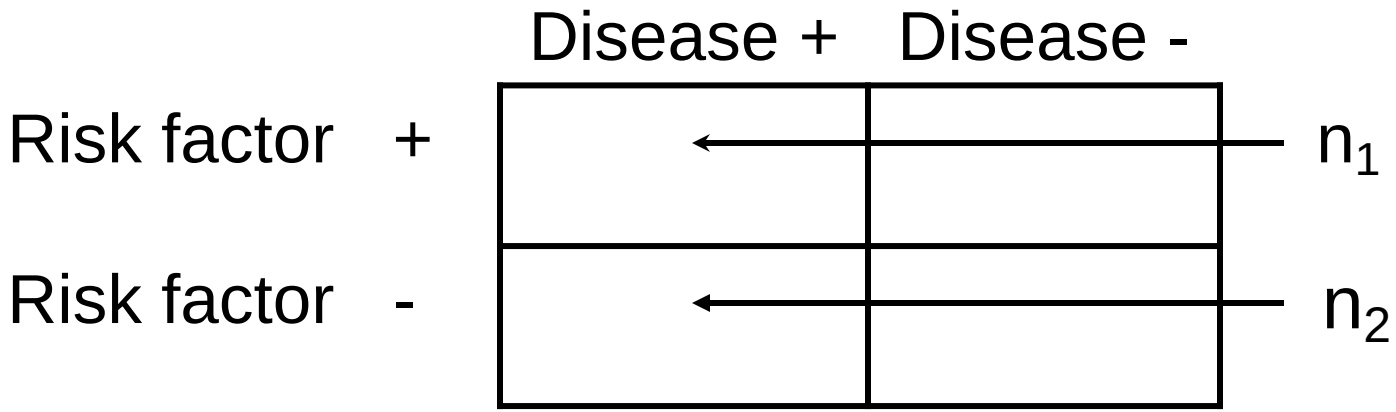
Cross-sectional design

- Find a population of subjects and classify them according to disease status and risk factor status (usually simultaneously)



Cohort design

- Find a group of risk factor positive subjects and a group of risk factor negative subjects and follow groups over time for disease (or other outcome)



Note: this design allows calculation of incidence (risk) – which is not possible in other 2 designs

Odds ratio

- Can be used in all epidemiologic studies (*case-control, cross-sectional, cohort)*

- Ratio of the odds of exposure:non-exposure in disease-specific groups

  or

  Ratio of the odds of disease:no disease in exposure-specific groups

Example: Odds ratio calculation

	AI+ (Cases)	AI – (Controls)
Poor biosecurity	12 (a)	61 (b)
Good biosecurity	1 (c)	73 (d)
	13	134

Odds of disease in exposed (poor biosecurity) group = 12/61

Odds of disease in non-exp (good biosecurity) group = 1/73

Odds Ratio = ad/bc = 12 x 73 ÷ 1 x 61 = 14.4

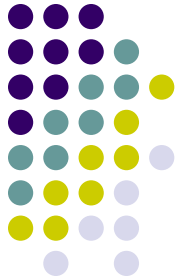
Example: Odds ratio calculation

***Odds Ratio* = 14.4**

Interpretation: Flocks with poor biosecurity were at 14.4 times higher odds of being AI cases than flocks with good biosecurity

Units: Range, 0 to infinity
Null value is 1
(i.e. no increase in odds of disease)

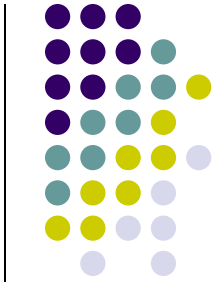
Significance of the Odds ratio



- 95% confidence interval
  - Captures the uncertainty in the magnitude of the odds ratio
  - If it excludes the value 1, then the odds ratio is significantly different at P = 0.05

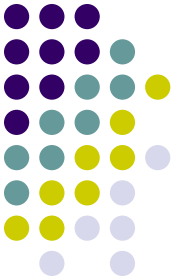
- Statistical test
  - Chi-square test

Computer software



- Various computer software available to assist with calculations
  - Epi Info (www.cdc.gov)
  - Medcalc (www.medcalc.be)
    - Trial version has 25 uses

Confidence intervals for the OR and statistical significance



Command Prompt - epi6

EpiInfo Version 6 — Statcalc — November 1993

Exposure	+ Disease	- Disease	
+	12	61	73
-	1	73	74
	13	134	147

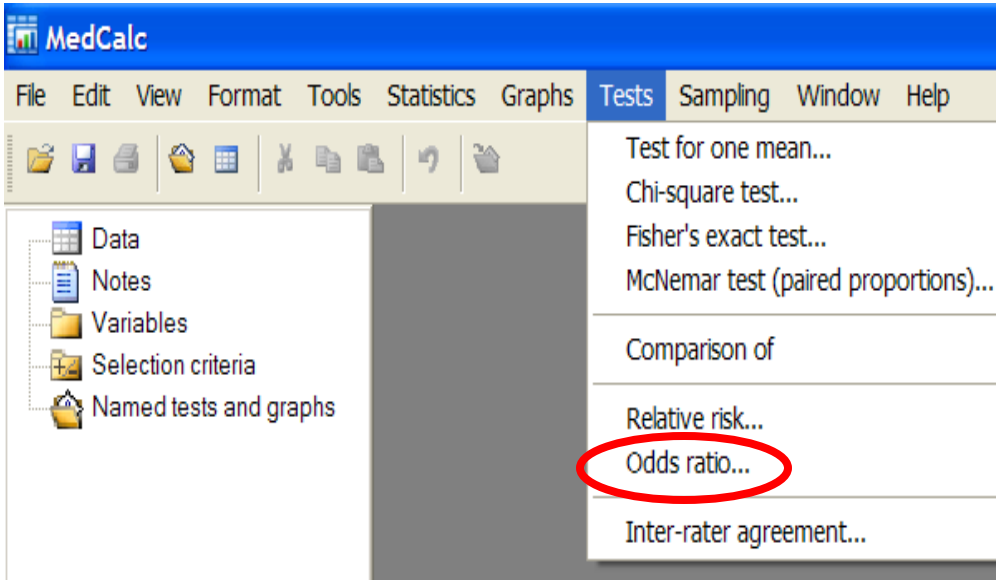
Analysis of Single Table
Odds ratio = 14.36 (1.85 <OR< 303.95*)
Cornfield 95% confidence limits for OR
*Cornfield not accurate. Exact limits preferred.
Relative risk = 12.16 (1.62 <RR< 91.17)
Taylor Series 95% confidence limits for RR
Ignore relative risk if case control study.

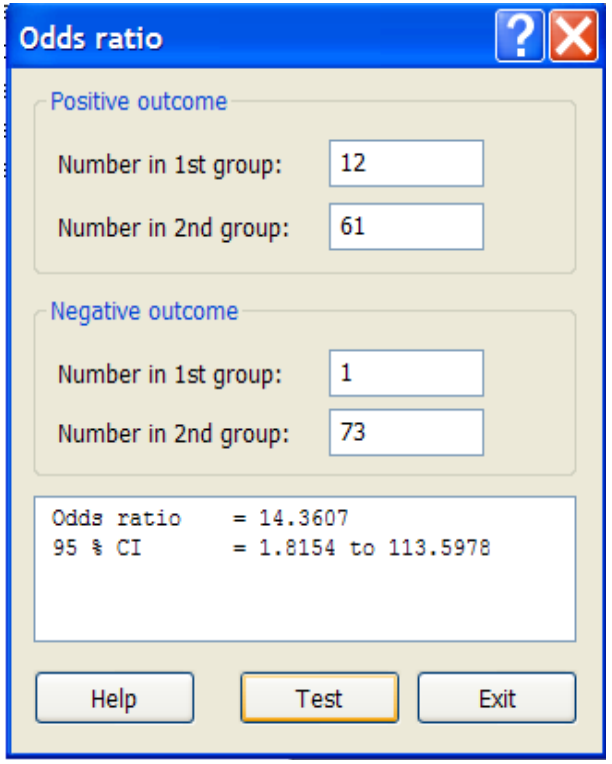
	Chi-Squares	P-values
Uncorrected :	10.38	0.0012766
Mantel-Haenszel:	10.31	0.0013264
Yates corrected:	8.59	0.0033822

F2 More Strata; <Enter> No More Strata; F10 Quit

F1-Help F2-Stratum F5-Print F6-Open File F10-Done

Confidence intervals for the OR using Medcalc





Comment

- Method of calculation of odds ratio in cross-sectional and cohort studies is the same as in a case-control study
- Interpretation and statistical testing are also the same

Cohort design: risk calculations

	AI +	AI -	
Poor biosecurity	12 (a)	61 (b)	73 (a+b)
Good biosecurity	1 (c)	73 (d)	74 (c+d)

Incidence of AI in exposed (poor biosecurity) group = 12/73

Incidence of AI in non-exposed (good biosecurity) group = 1/74

Relative risk = a/(a+b) ÷ c/(c+d) = 12/73 ÷ 1/74 = 12.2

Example: RR calculation

***Relative risk (RR)* = 12.2**

Interpretation: Flocks with poor biosecurity were at 12.2 times higher risk of becoming AI cases than Flocks with good biosecurity

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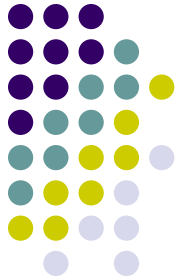
Relative risk (RR):interpretation



- Tells you how many more times likely disease was in the risk-factor positive (exposed) group compared with the risk-factor negative (non-exposed) group
- RR ranges from 0 to ∞; equal risk = 1
- If you get a RR between 0 and 1, the RR is telling you that exposure was protective

Relative risks

- What do these mean?

RR = 1

RR = 2

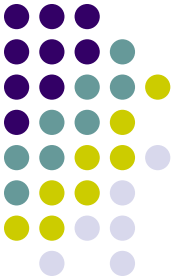
RR = 0.33

Significance of the RR

- 95% confidence interval
  - Captures the uncertainty in the magnitude of the relative risk
  - If it excludes the value 1, then the relative risk is significantly different at P = 0.05

- Statistical test
  - Chi-square test

Confidence intervals for the RR and statistical significance



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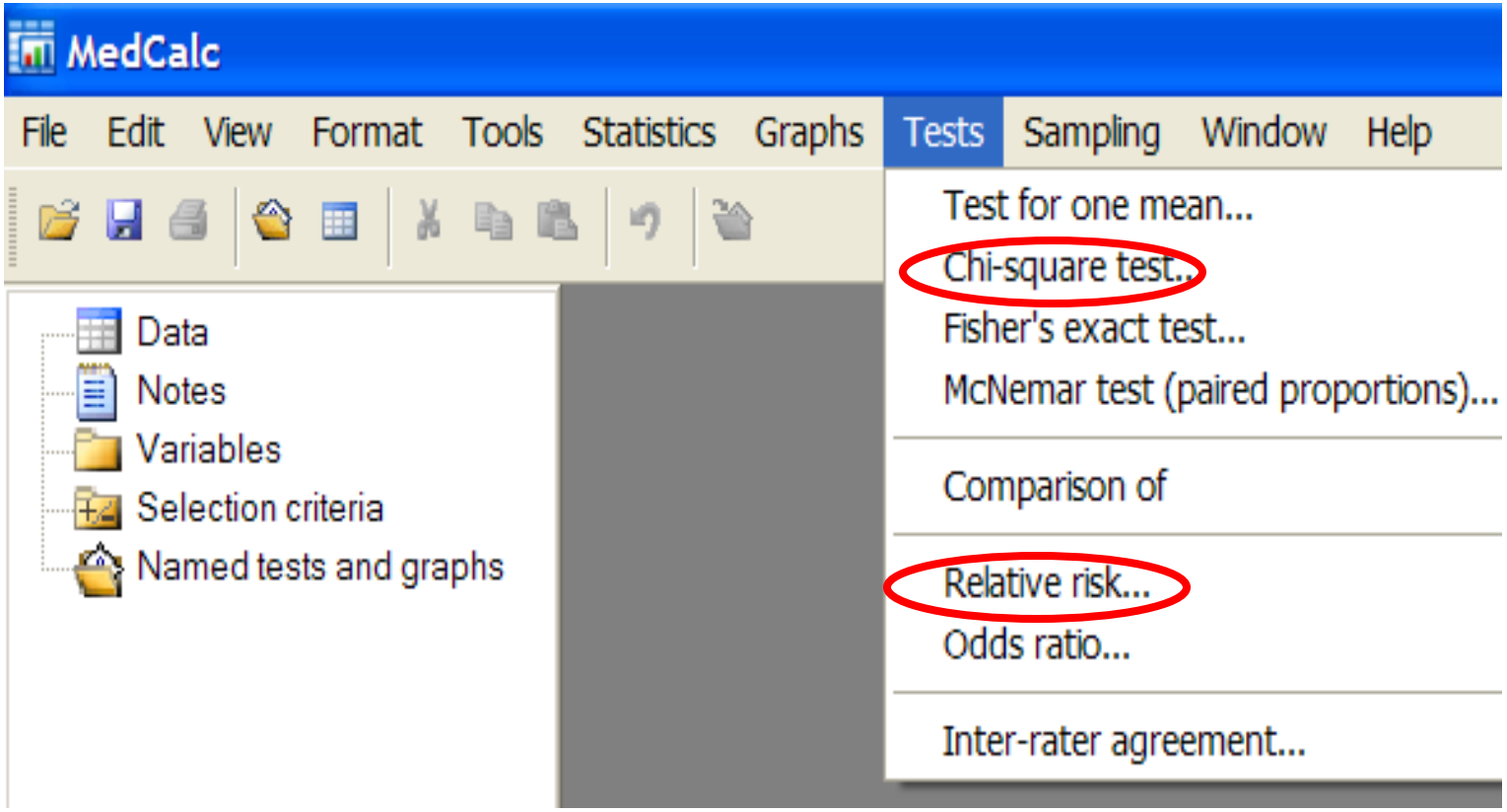
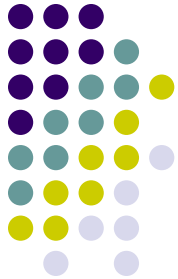
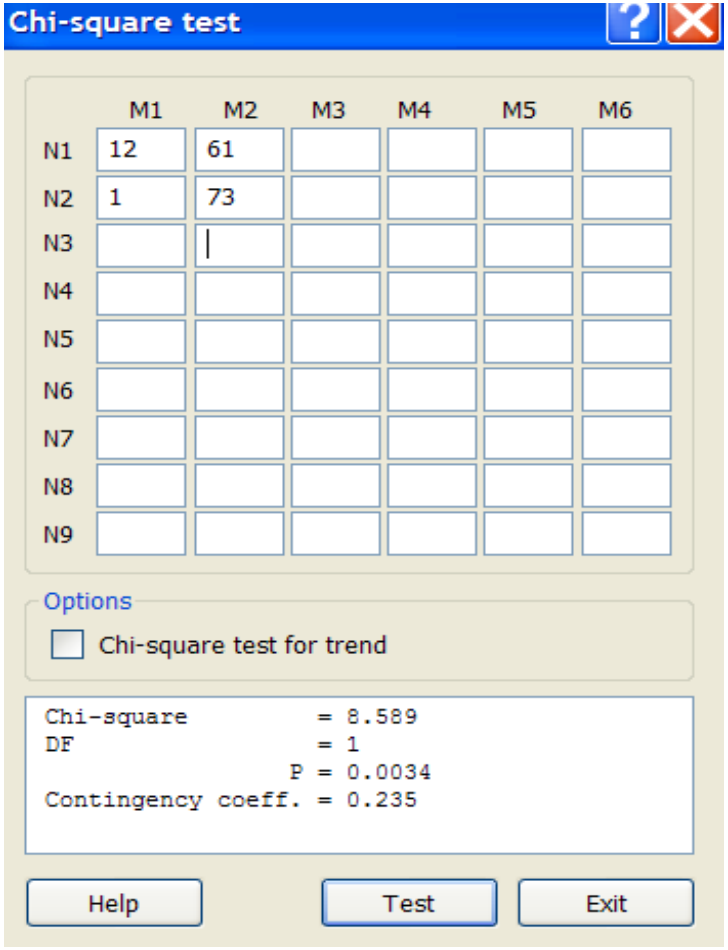
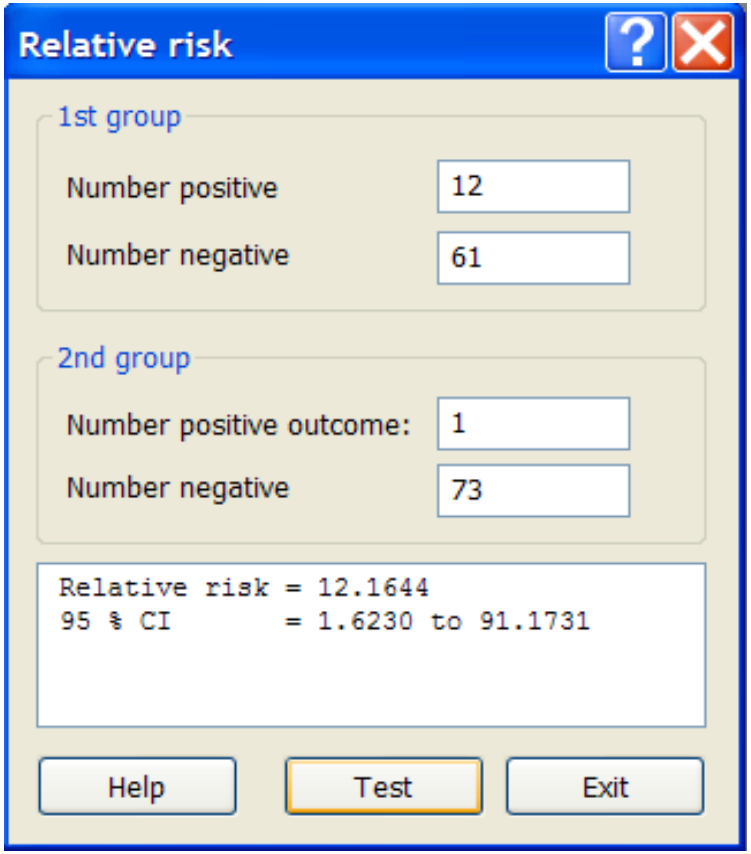
Statistical testing and confidence interval calculation for RR



Statistical testing and confidence interval calculation for Relative Risk







Cohort design: risk calculations

	AI +	AI -	
Poor biosecurity	12 (a)	61 (b)	73 (a+b)
Good biosecurity	1 (c)	73 (d)	74 (c+d)

Incidence of AI in exposed (poor biosecurity) group = 12/73
Incidence of AI in non-expos (good biosecurity) group = 1/74
Attributable Risk = a/(a+b) - c/(c+d) = 12/73 - 1/74 = 0.15

Example: AR calculation

***Attributable risk (RR)* = 0.15 (15%)**

Interpretation: Flocks with poor biosecurity had a higher incidence (by 0.15) of AI than flocks with good biosecurity

Units: Range, -1 to +1
Null value is 0
(i.e. no increase in risk of disease)

Attributable risk

- Incidence of disease that is attributable to the exposure - in theory, it is the incidence of disease that could be removed/prevented if the exposure was removed completely from the exposed (risk factor +) group

- Note that if you get a negative AR, the AR is telling you the rate of disease that was prevented by the exposure

Interpretation of an AR value

- There are several variations on the "pure" attributable risk .. be careful when reading the literature.
- One is the etiologic fraction among the exposed (ARexp%) (also known as attributable fraction) which expresses the AR as a fraction of the incidence among the exposed.
- In theory, this measure indicates the proportion of disease in the exposed that could have been prevented had exposure not occurred.

Summary

- Relative risk and attributable risk should only be calculated in cohort studies where incidence data are collected
- Odds ratios can be calculated in all study types: *case-control*, *cohort* and *cross-sectional* and be used to compare findings across different study types