Chapter 19: Relative risk, odds ratio and number needed to treat

TXCL7565/PHSC7565

What This Lecture Covers

- Relative risk
- Odds ratio
- Number needed to treat
- Comparison of RR and OR
- Confidence Intervals

RELATIVE RISK

Risk

$$Risk = \frac{\text{Number where event occurred}}{\text{Total subjects observed}}$$

	Control design	Test design
Not expelled	1732	1778
Expelled	268	222
Total	2000	2000
Risk	268/2000	222/2000
	0.134	0.111

Relative Risk

$$\text{Relative Risk (RR)} = \frac{\text{Risk in group receiving new or active treatment}}{\text{Risk in group receiving old or control treatment}}$$

- 'Risk' doesn't always mean something negative. For example, it could be risk of cure.
- Traditionally, the 'new' treatment is on top.

Relative Risk - IUD example

$$RR = \frac{\text{Risk of expulsion in group given test IUD design}}{\text{Risk of expulsion in group given control IUD design}}$$
$$= \frac{0.111}{0.134}$$
$$= 0.828$$

The relative risk of expulsion for the test design compared to the control design is 0.83.

Interpreting RR

- **RR = 1** indicates the risk does not differ between groups
- **RR > 1** indicates that the risk is higher in the ‘top’ group compared to the ‘bottom’ group
- **RR < 1** indicates that the risk is lower in the ‘top’ group compared to the ‘bottom’ group

Example RR

	No tablets	Tablets supplied
No diarrhea	312	830
Diarrhea	798	345
Total	1110	1175

When is RR inappropriate?

- Relative risk is only interpretable in the context of an experimental study or a prospective study.
- In a case/control retrospective study, your risk of being a ‘case’ is artificially high because how patients were recruited. You don’t know the ‘risk’ of disease in the entire population.

ODDS RATIO

Odds

$$Odds = \frac{\text{Number where event did occur}}{\text{Number where event did not occur}}$$

What are the odds of a randomly chosen day of the week is Sunday?

Odds

$$Odds = \frac{\text{Number where event did occur}}{\text{Number where event did not occur}}$$

	Control design	Test design
Not expelled	1732	1778
Expelled	268	222
Total	2000	2000
Odds	268/1732	222/1778
	0.1547	0.1249

Odds Ratio

$$\text{Odds Ratio (OR)} = \frac{\text{Odds of event in active group}}{\text{Odds of event in control group}}$$

- Although the interpretation of an OR is not as intuitive as a RR, RR is not applicable for case/control studies and with respect to logistic regression results (next chapter).

Odds Ratio - IUD example

$$OR = \frac{\text{Odds of expulsion in group given test IUD design}}{\text{Odds of expulsion in group given control IUD design}}$$
$$= \frac{0.1249}{0.1549}$$
$$= 0.807$$

The odd ratio of expulsion for the test design compared to the control design is 0.81.

Example OR

	No tablets	Tablets supplied
No diarrhea	312	830
Diarrhea	798	345
Total	1110	1175

NUMBER NEEDED TO TREAT

Purpose of Number Needed to Treat (NNT)

Definition: The number of individuals who would need to be transferred from one treatment to the other to prevent one harmful event or produce one additional beneficial outcome.

Calculation of NNT

1. Calculate the Absolute Risk Difference (ARD)

$$\begin{aligned} ARD &= Risk_{Test} - Risk_{Control} \\ &= 0.134 - 0.111 \\ &= 0.023 \end{aligned}$$

2. Calculate the NNT

$$\begin{aligned} NNT &= 1/ARD \\ &= 1/0.023 \\ &= 43.48 \\ &= 44 \text{ women} \end{aligned}$$

Example NNT

	No tablets	Tablets supplied
No diarrhea	312	830
Diarrhea	798	345
Total	1110	1175

COMPARISON OF RR AND OR

Comparison of Odds and Risk

$$Risk = \frac{\text{Number with the event}}{\text{Number of subjects observed}} \qquad Odds = \frac{\text{Number with the event}}{\text{Number without the event}}$$

- The only difference is the denominator.
- When the event is rare, the number of subjects observed is close to the number without the event.
- When the event is rare, the OR is approximately equal to the RR.

Comparison of OR and RR

	IUD Study	Diarrhea Study
Risk of Event	0.134 and 0.111	0.719 and 0.294
Relative Risk	0.828	0.409
Odds Ratio	0.807	0.163

CONFIDENCE INTERVALS

Confidence intervals for the RR, OR, and NNT for clearly significant results

	Point Estimate	Lower limit	Upper limit
Relative Risk	0.409	0.371	0.450
Odds Ratio	0.163	0.136	0.195
Absolute Risk Difference	0.425	0.387	0.463
Number Needed to Treat	3 (or 2.35)	3 (or 2.16)	3 (or 2.58)

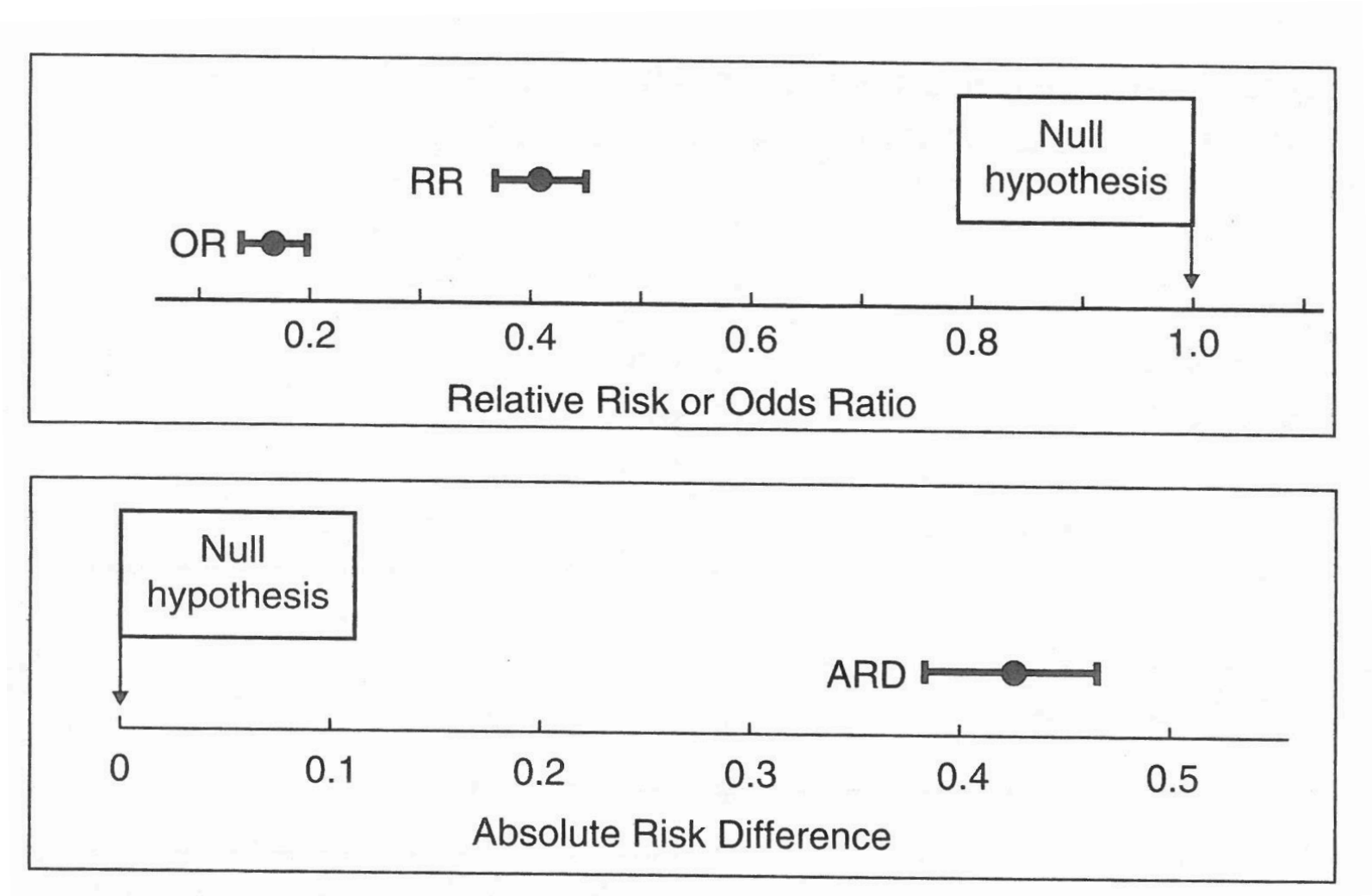


Figure 19.1 95% confidence intervals for the Relative Risk (RR), Odds Ratio OR), and Absolute Risk Difference (ARD) for childhood diarrhea (comparing families with and without access to water sterilizingg tablets) along with their null value.

95% CI vs. statistical significance

- Results will generally agree between 95% CI and p-value from contingency chi-square test.
- In marginally significant cases, the two may disagree.

Confidence intervals for the RR, OR, and NNT for marginally significant or non-significant results

	Point Estimate	Lower limit	Upper limit
Relative Risk	0.828	0.701	0.979
Odds Ratio	0.807	0.667	0.976
Absolute Risk Difference	0.0230	0.0027	0.0433
Number Needed to Treat	44	24	372

CI for NNT

- As the lower limit of the ARD moves to zero, the NNT moves to infinity.
- Small changes in a small ARD result in large changes in the NNT causing the estimate for the upper limit of the CI of NNT to be unstable.
- For non-significant results, the CI for NNT should technically include zero, but a negative number of patients is unrealistic.

RR, OR, ARD, NNT IN GRAPHPAD

1.Choose a ‘Contingency ‘ table format

2.Choose ‘Start with an empty data table‘

3.Click ‘Create‘

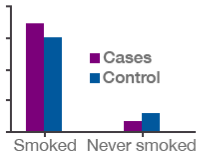
Welcome to GraphPad Prism

New table & graph
XY
Column
Grouped
Contingency
Survival
Parts of Whole

Existing file
Open a File
LabArchives
Clone a Graph
Graph Portfolio

Contingency tables: Each row defines a treatment or exposure, each column defines an outcome, and each value is an exact count of objects or events

Table format Contingency		A	B
		Cases	Control
		Y	Y
1	Smoked		
2	Never smoked		



Learn more

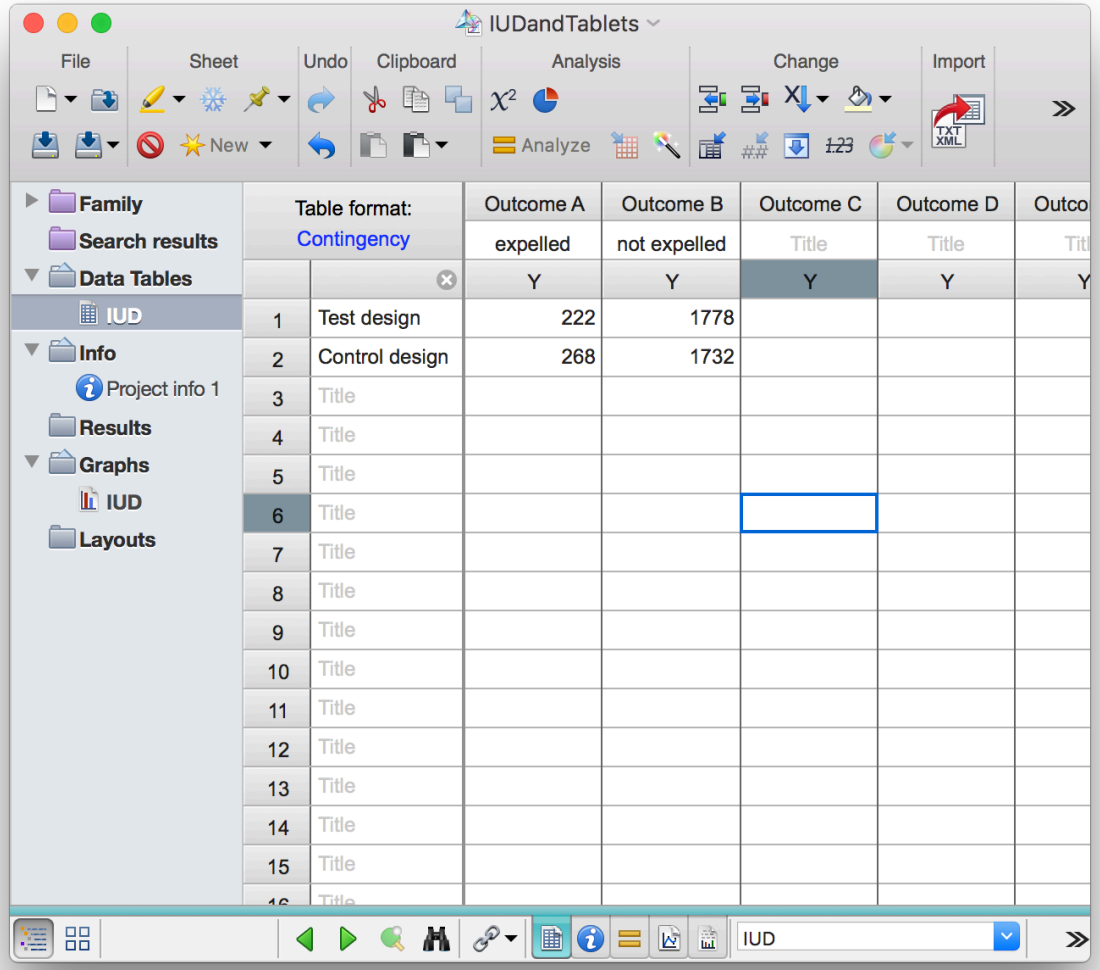
Enter/import data: Start with an empty data table

Use tutorial data:
- Chi-square test of prospective data (aspirin and MI)
- Fishers exact test of retrospective data (smoking and cancer)
- Sensitivity and specificity (HIV)
- Chi-square test for trend

Prism Tips

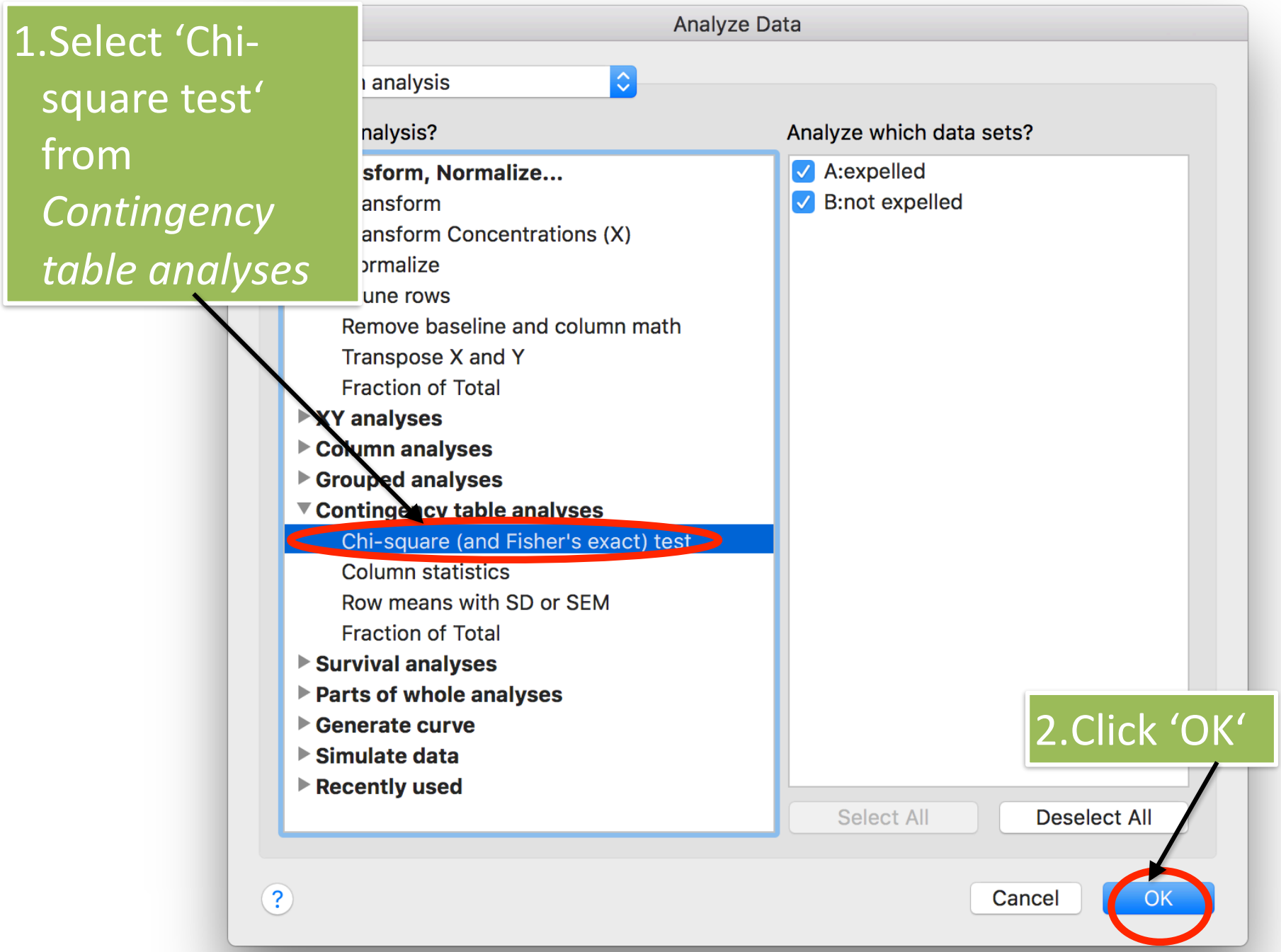
Cancel

Create

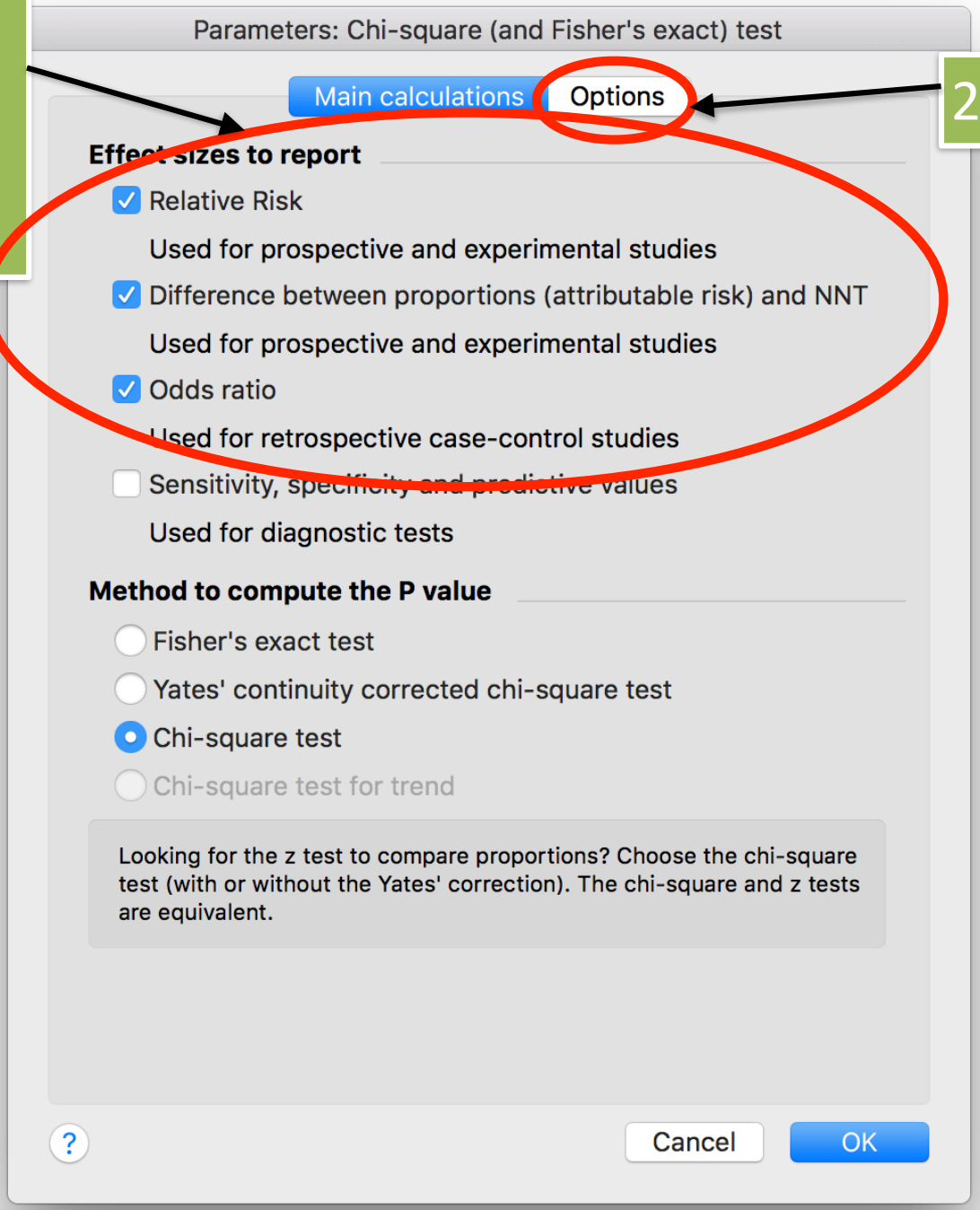


To get relative risk calculated the correct way, you need to follow the template below to get the relative risk of the event in the test group compared to the control group.

	event	no event
test group		
control group		

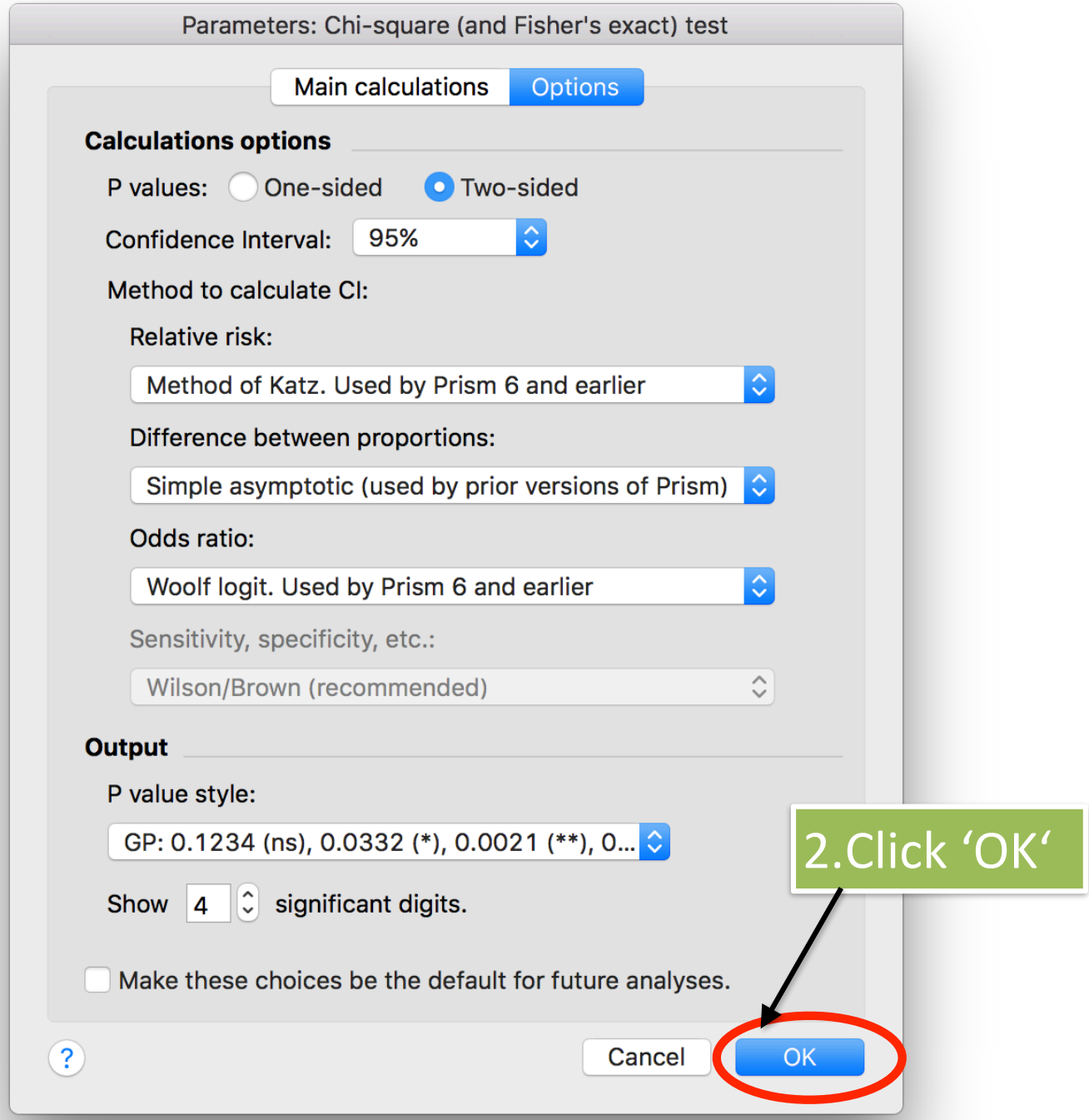

1.Select ‘Chi-square test‘ from *Contingency table analyses*
Analyze Data
analysis
nalysis?
Analyze which data sets?
sform, Normalize...
ansform
ansform Concentrations (X)
ormalize
une rows
Remove baseline and column math
Transpose X and Y
Fraction of Total
XY analyses
Column analyses
Grouped analyses
Contingency table analyses
Chi-square (and Fisher's exact) test
Column statistics
Row means with SD or SEM
Fraction of Total
Survival analyses
Parts of whole analyses
Generate curve
Simulate data
Recently used
A:expelled
B:not expelled
Select All
Deselect All
2.Click ‘OK‘
Cancel
OK

1.Select all the effect sizes that you are interested in.



2.Click ‘Create‘

I switched all the ‘Method to calculate CI:’ options to reflect older versions to get them to match the book. Just pick one and report the method.



Effect size	Value	95% CI
Relative Risk	0.8284	0.7012 to 0.9786
Reciprocal of relative risk	1.207	1.022 to 1.426
Attributable risk (P1 - P2)	0.023	0.002679 to 0.04332
NNT (reciprocal of attrib. risk)	43.48	23.08 to 373.2
Odds ratio	0.8069	0.6674 to 0.9756
Reciprocal of odds ratio	1.239	1.025 to 1.498

What did we learn?

- RR, OR, ARD, and NNT are commonly used to describe the extent of change seen in the proportion of subjects experiencing a particular event.
- RR tends to be the easiest to understand but has its limitations (e.g., case/control studies)
- When the event is rare OR is approximately equal to the RR.
- 95% CI for RR, OR, and ARD are commonly accepted, but a 95% CI for NNT is only used when the results are strongly significant.