Interpreting Basic Statistics

Beginners' statistics for assessing the effectiveness of an intervention

UH Bristol library service

Basic Medical Statistics

- Statistics which compare risks
- Statistics which test confidence
- Forest Plots
- Statistics which analyse clinical investigations and screening
- Statistics which test differences

Statistics Which Compare Risk

	Spotless	Spots	Total
Spotfix	5	46	51
Control Group	10	40	50

CER & EER

	Spotlessness	Spots	Total
Spotfix	5	46	51
Control Group	10	40	50

Control event rate (CER) = Risk of outcome event in control group

$$= \frac{\text{no in the control group with event}}{\text{total no in the control group}} = ?$$

Risk of spotlessness in the control group is ?%

Experimental event rate (EER) = Risk of outcome event in experimental group

$$= \frac{\text{no in the experimental group with event}}{\text{total no in the experimental group}} = ?$$

Risk of spotlessness in the Spotfix group is ?%

Relative Risk (RR)

- **Compares the risk of having an event *between* two groups of Dalmatians**

- RR=1 the event is equally likely in both groups of Dalmatians
- RR<1 event is less likely to happen than not (i.e. the intervention reduces the chance of having the event)
- RR>1 event is more likely to happen than not (increases the chances of having the event)

- The smallest value an RR can take is 0

Relative Risk

Compares the risk of having an event *between* two groups

RR = EER /CER =

	Spotless	Spots	Total
Spotfix	5	46	51
Control Group	10	40	50

Relative Risk/Odds Ratio

	Type of outcome	
Value of OR/RR	Adverse outcome (e.g. death)	Beneficial outcome (e.g. stopped smoking)
<1	New intervention better	New intervention worse
1	New intervention no better/no worse	New intervention no better/no worse
>1	New intervention worse	New intervention better

Relative Risk Reduction (RRR)

- The reduction in rate of the event in the treatment group *relative* to the control group

- RRR = 1 – RR = ?

- The relative risk was ?% lower for Spotfix than the control group *or* there is a ?% reduction in risk of spotlessness for Dalmatians in the Spotfix group relative to those Dalmatians in the control group.

	Spotless	Spots	Total
Spotfix	5	46	51
Control Group	10	40	50

Absolute Risk Reduction (ARR)

- The difference in absolute risk of a particular event *between* 2 groups. Also know as the risk difference.

- ARR = 0 no difference between the 2 groups

- ARR = CER – EER = ?

- The absolute risk of spotlessness was ?% lower in the Spotfix group than in the control group *or* Spotfix reduces the risk of spotlessness by ?%

	Spotless	Spots	Total
Spotfix	5	46	51
Control Group	10	40	50

Numbers Needed to Treat (NNT)

- The number of people/Dalmatians who need to be treated in order to prevent one additional outcome of interest.

- NNT = 1/ARR = ?

- ? Dalmatians have to be treated with Spotfix in order to avoid one additional victim of spotlessness

- ? patients have to be treated with statin in order to avoid one additional death

RRR vs. ARR

- Consider 2 RCTs of a new drug done on 2 populations at risk of a heart attack over 10 years

- RCT1 (n=200)
  - High risk group: 90/100 of those *not* receiving the drug (control) will have a heart attack. 60/100 of those receiving the drug will have a heart attack.

- RCT 2 (n=200)
  - Low risk group: 3/100 of those *not* receiving the drug (control) will have a heart attack. 2/100 of those receiving the drug will have a heart attack.

HIGH RISK	Heart attack over 10 yrs (event)	No Heart attack (no event)	Total
Treatment group	60	40	100
Control group	90	10	100

- RR = 0.6
- RRR = 0.3 = 30%
  - The relative risk was ?% lower for new drug than the control group for high risk patients

LOW RISK	Heart attack over 10 yrs (event)	No Heart attack (no event)	Total
Treatment group	2	98	100
Control group	3	97	100

- RR = 0.6
- RRR = 0.3 = 30%
  - The relative risk was ?% lower for new drug than the control group for low risk patients

HIGH RISK	Heart attack over 10 yrs (event)	No Heart attack (no event)	Total
Treatment group	60	40	100
Control group	90	10	100

- ARR = 0.3 = 30%
- NNT = 3.3 ≈ 4
- ? patients have to be treated with statin to avoid one additional death

LOW RISK	Heart attack over 10 yrs (event)	No Heart attack (no event)	Total
Treatment group	2	98	100
Control group	3	97	100

- ARR = 0.01 = 1%
- NNT = 100
- ? patients have to be treated with statin to avoid one additional death

Odds Ratio

	Spotless	Spots	Total
Spotfix	5	46	51
Control Group	10	40	50

- Expresses the odds of having an event *compared* with not having an event:

- OR=1 the event is equally likely in both groups (i.e. no difference)
- OR<1 event is less likely to happen than not (i.e. the treatment reduces the chance of having the event)
- OR>1 event is more likely to happen than not (increases the chances of having the event)

- The smallest value an OR can take is 0

Calculate the Odds Ratio:

- OR = (5/46) ÷ (10/40) ≈ ?

- The odds ratio for spotlessness for Dalmatians receiving Spotfix compared to the control is ?

Online Calculator: http://www.hutchon.net/confidor.htm

Statistics Which Test Confidence

P-values

- The probability (ranging from zero to one) that the results observed in a study could have occurred by chance. (Bandolier)
- Convention states we accept p-values of $p<0.05$ to be statistically significant. (Bandolier)
- The P value is computed from the F ratio which is computed from the ANOVA table.

P value	Interpretation
$P<0.05$	The result is unlikely to be due to chance, a statistically significant result.
$P>0.05$	The result is likely to be due to chance, not a statistically significant result.
$P= 0.05$	the result is quite likely to be due to chance, not a statistically significant result.

Significant at Cut Off?

P value	P<0.05	P<0.01
P<0.001		
P=0.049		
P>0.051		

Confidence Intervals

- What is a confidence interval?
  - If the same trial were to be repeated many times over, the 95% CI would define the range of values within which the true population estimate would be found in 95% of occasions
- What can a confidence interval indicate?
  - Whether a result is statistically significant
  - Indication of precision
  - Strength of the evidence

Online calculator@ http://www.hutchon.net/confidor.htm

Interpreting CIs

Measure of effect	Interpretation of CI
Binary outcome, Ratio	If a CI for an RR or OR, includes 1 then we are unable to demonstrate statistically significant difference between the two groups
Continuous outcome, Mean difference	If a CI for a RRR, ARR, includes 0 we are unable to demonstrate a statistically significant difference between the two groups compared

Confidence Intervals

"Trials examined the effect of education programmes on improvement in lung function in asthma sufferers"

Study	Mean difference (95% CI)
Christiansen	0.35 (-0.28-0.99)
Weingarten	1.24 (0.26-2.22)
Toelle	0.47 (0.18-0.75)

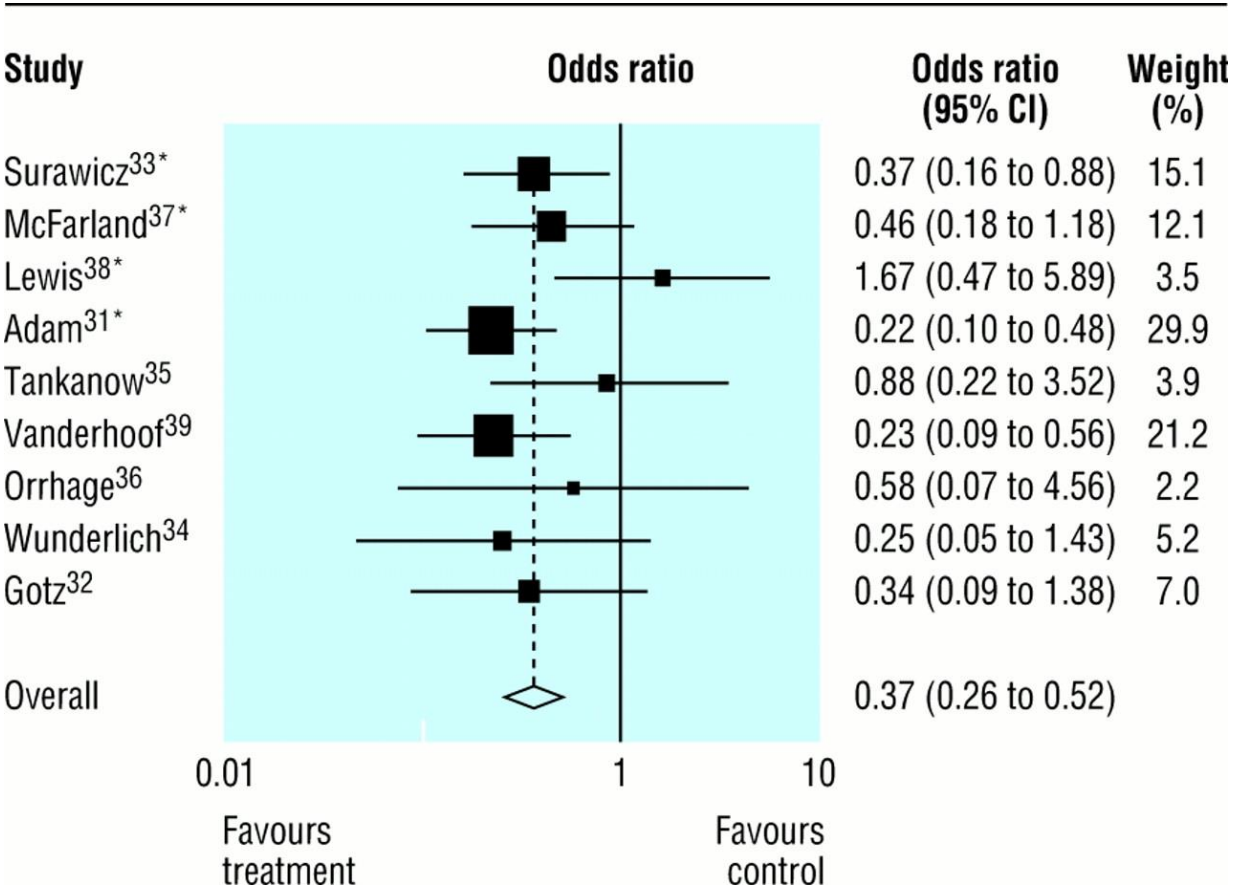
Are educational programmes effective at increasing lung function?
Which study/studies show a significant result?
Which study demonstrated the strongest evidence?

Measure of effect	Interpretation of CI
Binary outcome, Ratio	If a CI for an RR or OR, includes 1 then we are unable to demonstrate statistically significant difference between the two groups
Continuous outcome, Mean difference	If a CI for a RRR, ARR, includes 0 we are unable to demonstrate a statistically significant difference between the two groups compared

Forest Plots

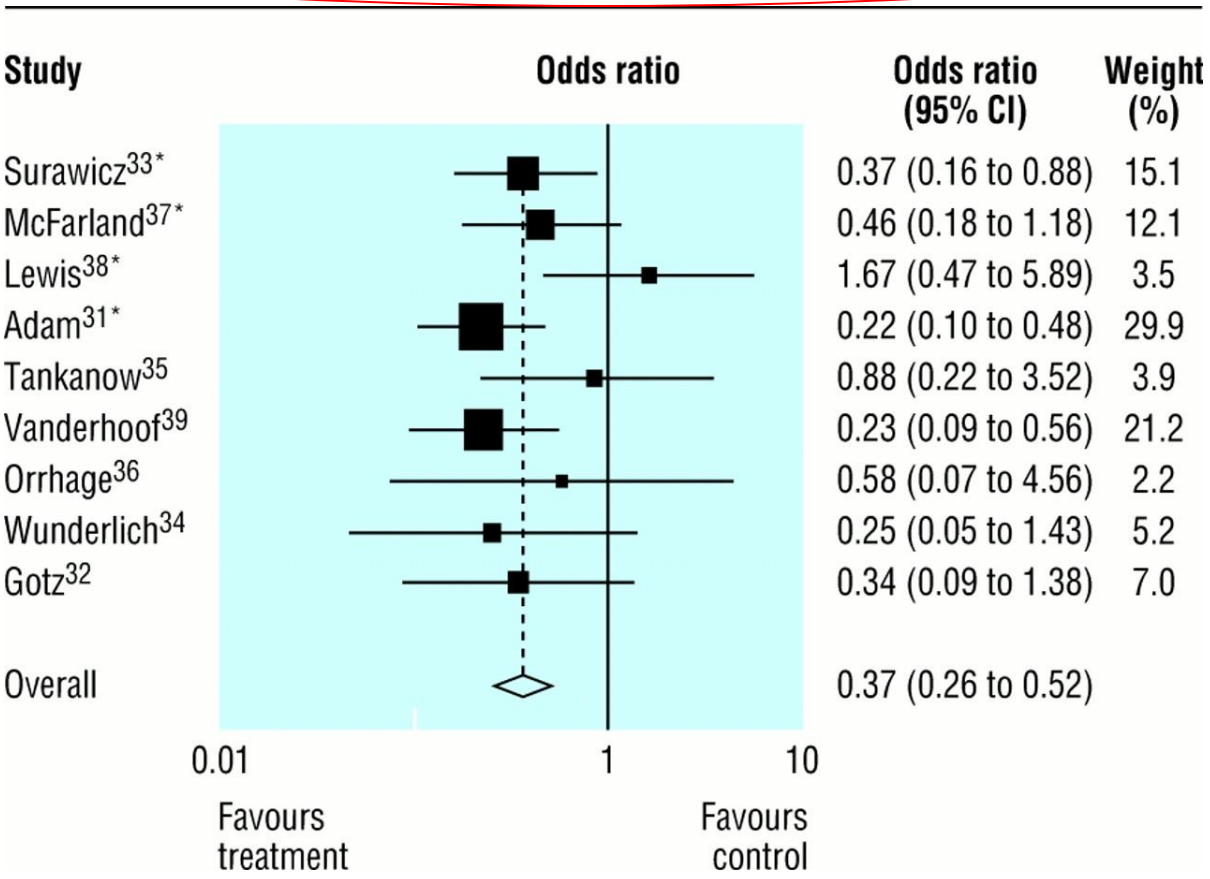
Forest Plots

"Effect of probiotics on the risk of antibiotic associated diarrhoea"



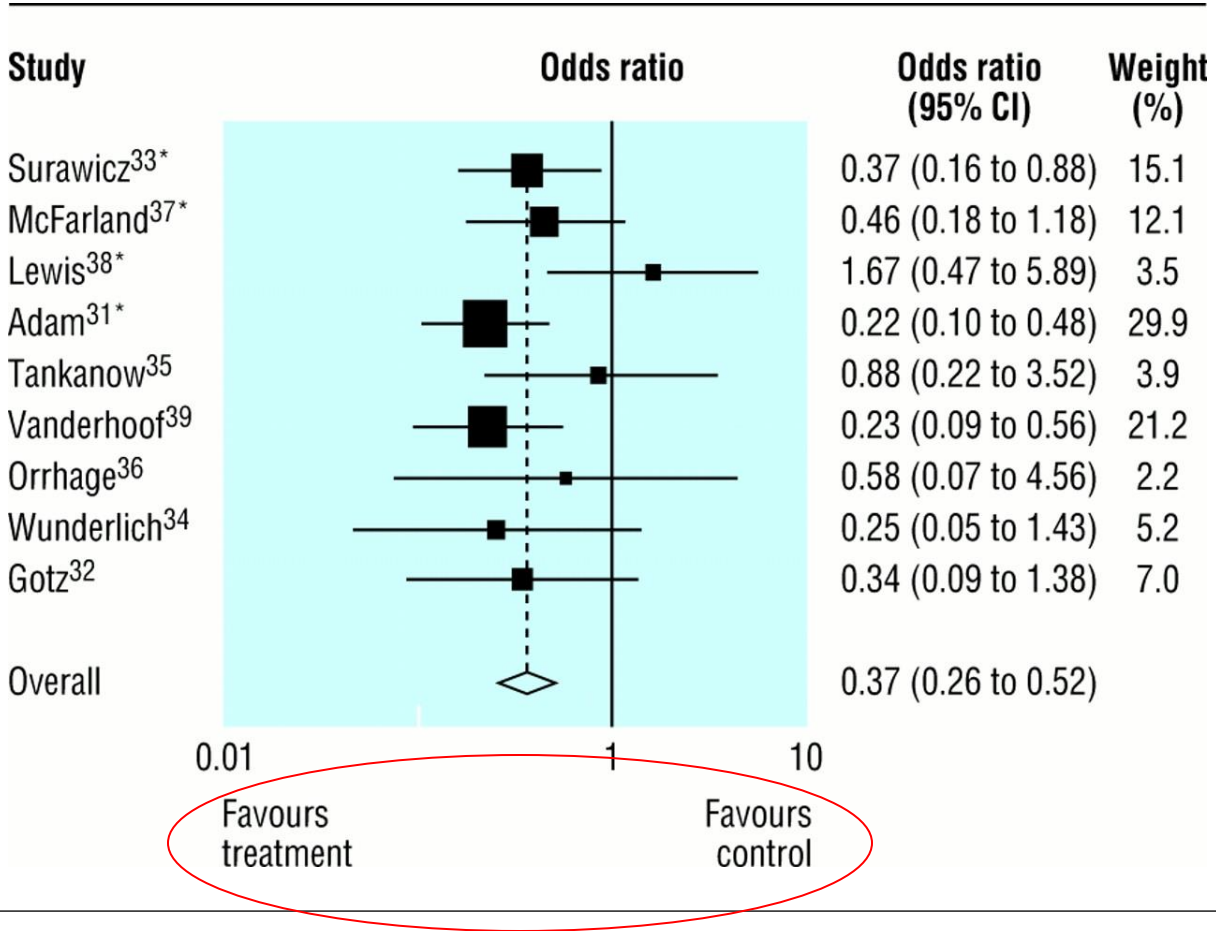
The label tells you what the comparison and outcome of interest are

Effect of probiotics on the risk of antibiotic associated diarrhoea



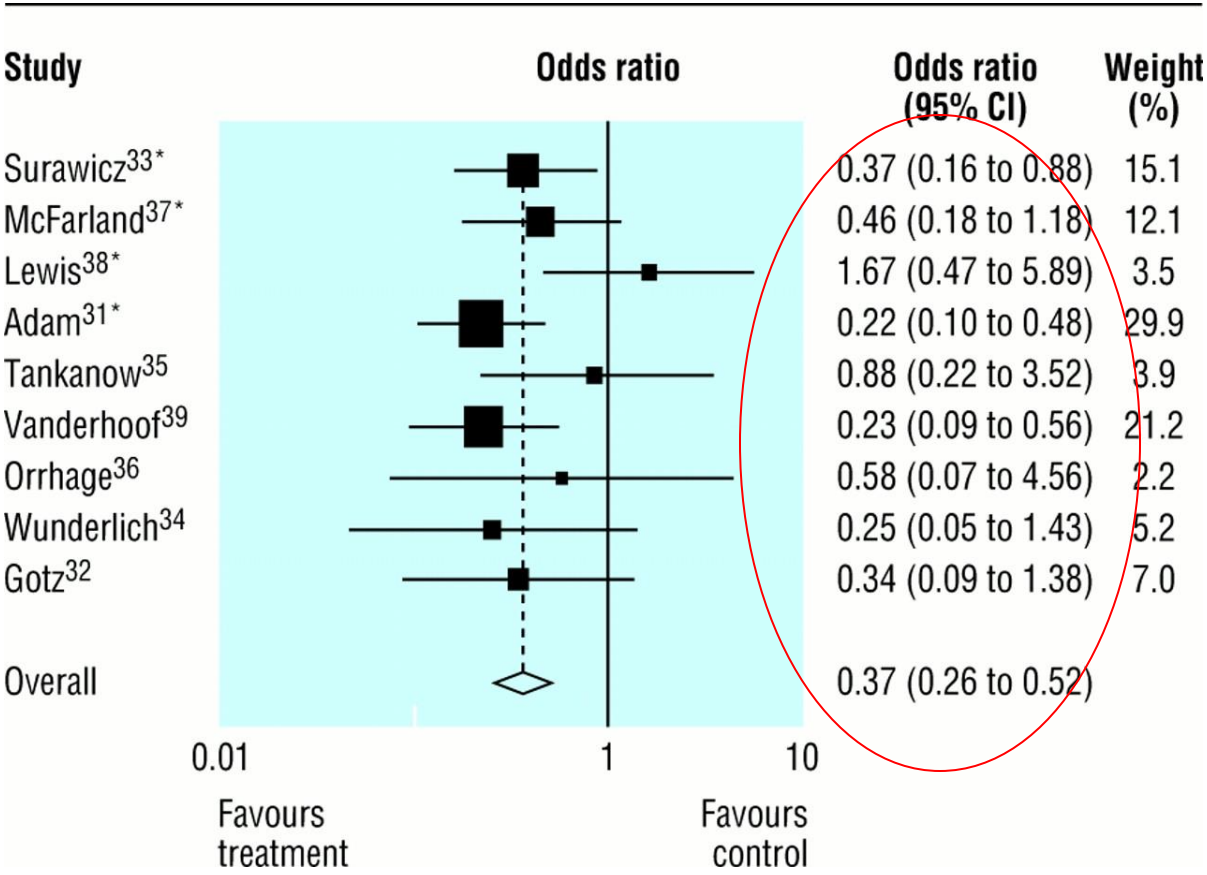
Scale measuring treatment effect. Take care when reading labels!

Effect of probiotics on the risk of antibiotic associated diarrhoea



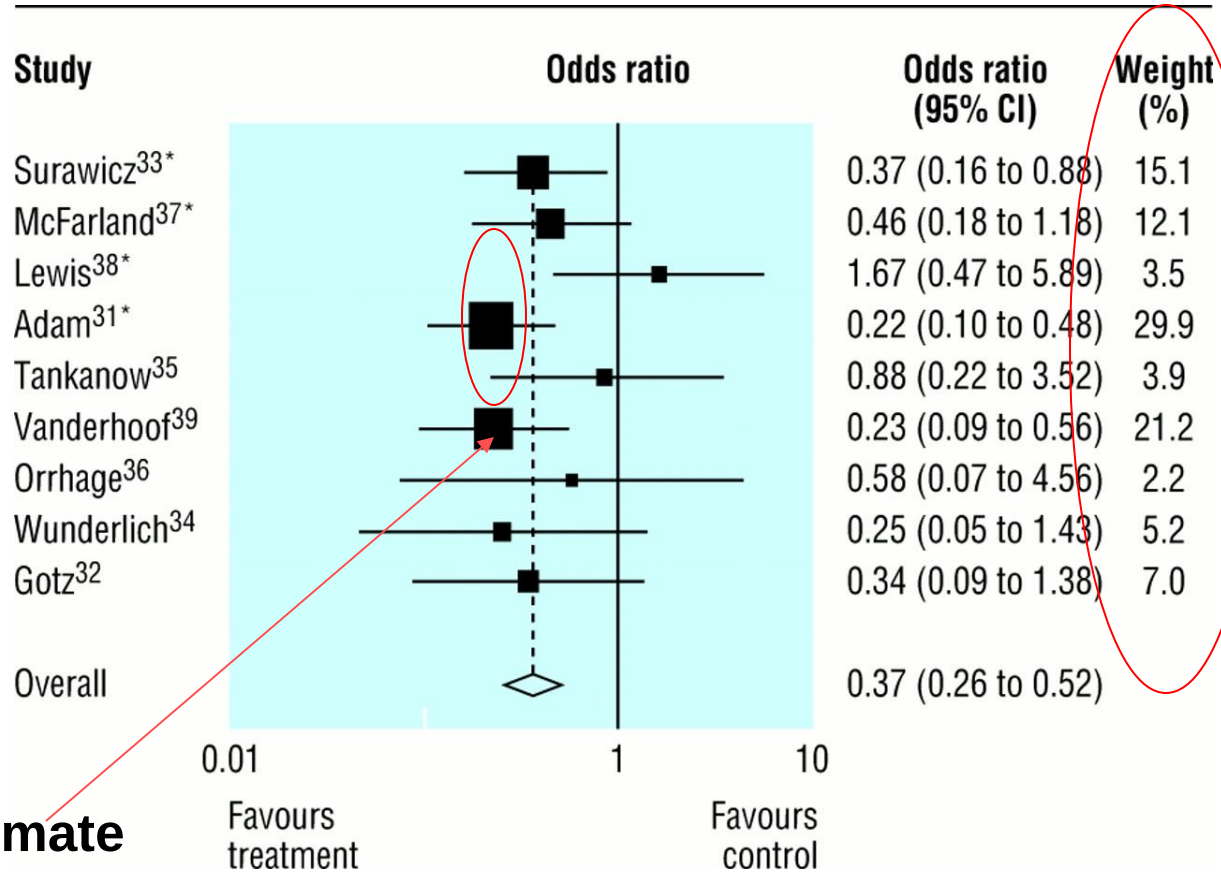
Treatment effect sizes for each study (plus 95% CI)

Effect of probiotics on the risk of antibiotic associated diarrhoea



The % weight given to each study in the pooled analysis

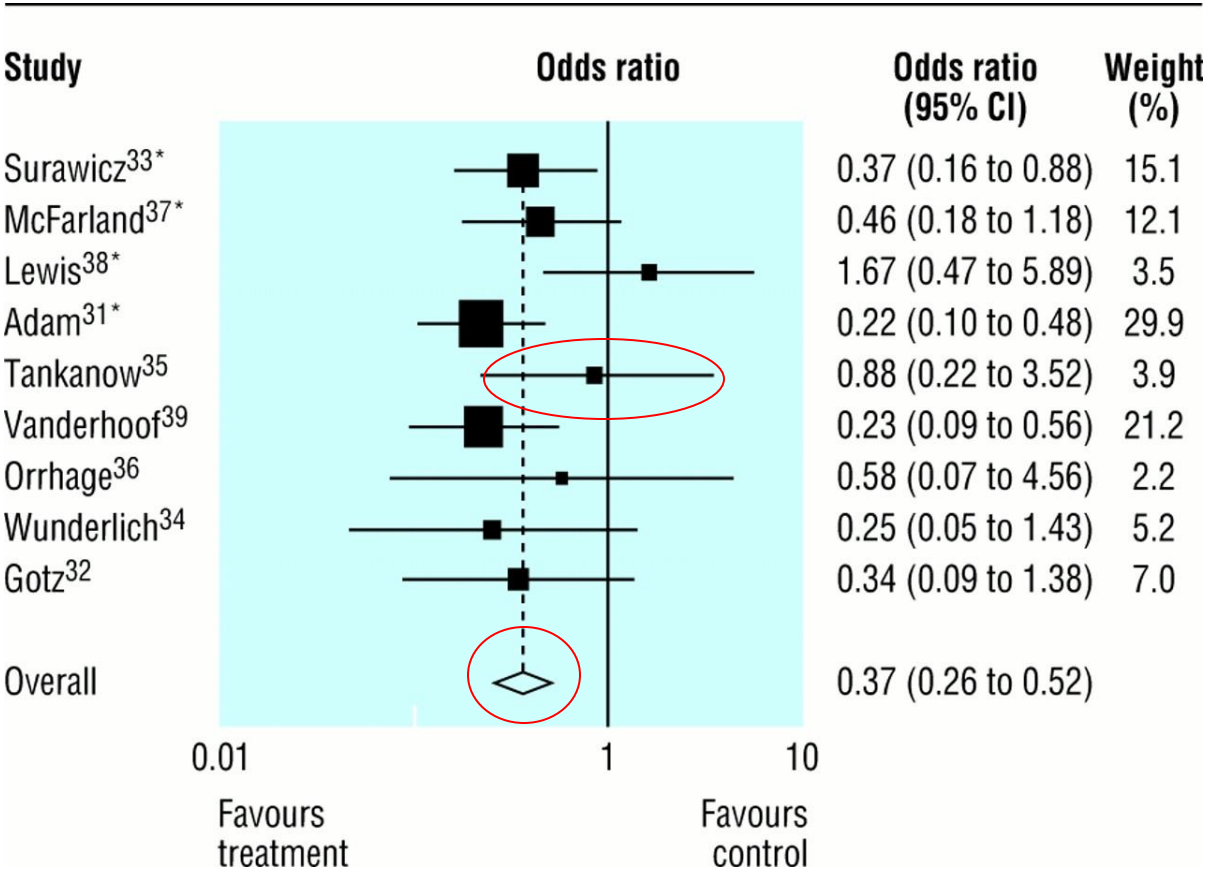
Effect of probiotics on the risk of antibiotic associated diarrhoea



Point estimate

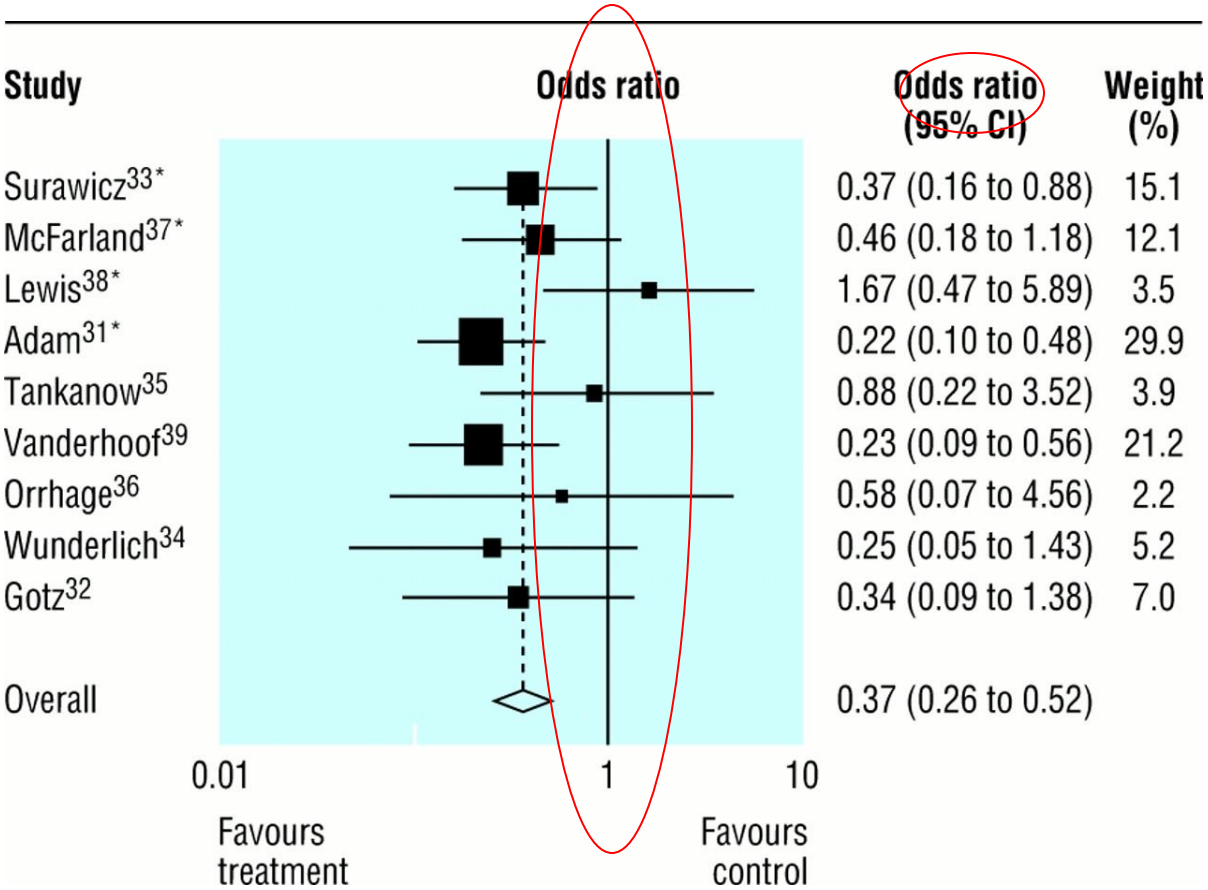
Horizontal lines are confidence intervals
Diamond shape is pooled effect
Horizontal width of diamond is confidence

Effect of probiotics on the risk of antibiotic associated diarrhoea



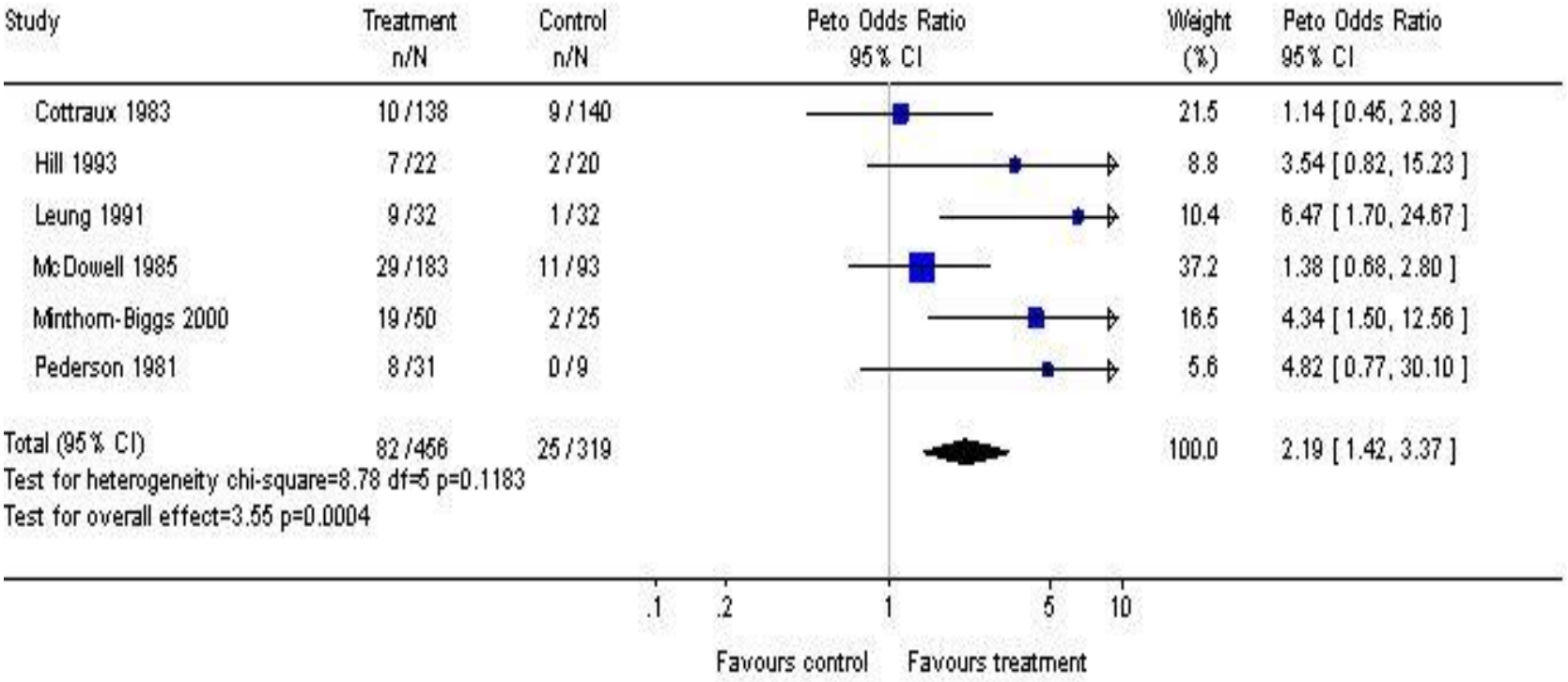
The vertical line in middle is the line of no effect
For ratios this is 1, for means this is 0

Effect of probiotics on the risk of antibiotic associated diarrhoea



Exercise

Review: Group behaviour therapy programmes for smoking cessation
Comparison: 01 Group format behavioural programmes vs Other format
Outcome: 05 Smoking cessation. Group versus 'no intervention' controls



Statistics Which Analyse Clinical Investigations and Screening

Sensitivity Specificity

Sensitivity:

If a person has a disease, how often will the test be positive (true positive rate)?

Put another way, if the test is highly sensitive and the test result is negative you can be nearly certain that they don't have disease.

Specificity:

If a person does not have the disease how often will the test be negative (true negative rate)?

In other terms, if the test result for a highly specific test is positive you can be nearly certain that they actually have the disease.

Sensitivity Specificity

A Sensitive test helps rule out disease (when the result is negative).
Sensitivity rule out or "Snout"

Sensitivity= true positives/(true positive + false negative)

A very specific test rules in disease with a high degree of confidence
Specificity rule in or "Spin".

Specificity=true negatives/(true negative + false positives)

SnNOut & SpPIN!!!!!

A very **specific** test, when positive, helps rule-in disease (SpPIn). For example, if a test was 95% specific but only 70% sensitive, and 10% of patients had the disease, you get the following 2 x 2 table:

	Disease	No Disease
Positive test	14	9
Negative test	6	171

14 out of 25 patients with a positive test have the disease

SnNOut & SpPIN!!!!!

A test that is very sensitive is generally very good at ruling out disease when negative. The acronym is "SnNOut". For example, consider a test which is 95% sensitive, 60% specific, with a pre-test probability of disease of 10%:

	Disease	No Disease
Positive test	19	72
Negative test	1	108

Only 1 of 109 patients with a negative test has the disease in question.

Quick Quiz

A very sensitive test, when negative, helps you:

a: Rule-in disease

b: Rule-out disease

c: Confuse medical students

d: Save money

A test which is highly specific, when positive, helps you:

a: Rule-in disease

b: Rule-out disease

c: Confuse medical students

d: Save money

Two-way table & Calculations

	Disease	No Disease
Positive	A	B (false positive)
Negative	C (false negative)	D

Sensitivity: If the patient has the disease, we need to know how often the test will be positive: This is calculated from $\frac{\mathbf{A}}{\mathbf{A + C}}$

Specificity: If the patient is in fact healthy, we want to know how often the test will be negative: This is given by: $\frac{\mathbf{D}}{\mathbf{D + B}}$

Two-way table & Calculations

	Disease	No Disease
Positive	A	B (false positive)
Negative	C (false negative)	D

Positive Predictive Value: If the test result is positive, what is the likelihood that the patient will have the condition: $\frac{\mathbf{A}}{\mathbf{A + B}}$

Negative Predictive Value: If the test result is negative, what is the likelihood that the patient will be healthy: This is given by: $\frac{\mathbf{D}}{\mathbf{D + C}}$

Exercise

100 patients were tested for haematemesis. The presence or absence of gastric cancers was diagnosed from endoscopic findings and biopsy:

	Present	**Absent**
Positive	20	30
Negative	5	45

Calculate the Sensitivity = If gastric cancer is present, there is ? chance of the test picking it up

Calculate the Specificity = If there is no gastric cancer there is ? chance of the test being negative – but ? will have a false positive result.

Calculate the PPV = There is a ? chance, if the test is positive, that the patient actually has gastric cancer.

Calculate the NPV = There is a ? chance, if the test is negative, that the patient does not have gastric cancer. However, there is still a ? chance of a false negative, i.e. that the patient does have gastric cancer.

Statistics Which Test Differences

Much more difficult statistics!

Parametric Tests

Analysis of Variance (ANOVA)

Compares the means of two or more samples to see if whether they come from the same population. A table is created and then used to calculate **f values** and **P-Values**.

t test

Testing the probability that samples come from a population with the same value. Proves the study has had an effect. It's pretty much impossible to interpret the t-value without knowing the sample sizes in the study. For the overwhelming vast majority of situations, a t-value of 6.67 will be "statistically significant."The further away from 0 the better. **Use P-Values.**

Parametric tests are only used when data follow a 'normal' distribution.

Mann-Whitney U test

- A non-parametric statistic used when data are *not* normally distributed (and thus unsuitable for parametric tests).
- Doesn't state the size of a difference, only the likeliness of difference. For example a study looking at the ages of two groups of triaged patients might use a Mann-Whitney U test to test the hypothesis that there's no difference in the ages between the two groups.
- Very difficult to understand
- Statisticians 'rank' data and compare the ranks
- Go straight to the P-Value for results

Chi-Squared

- Usually written as X^2
- A measure of the difference between actual and expected frequencies. Difficult to interpret by itself, dependent on a number of other factors studied. Gives approximate P-Value and is inappropriate for small samples.
- Use the P-Value to see likelihood there is no difference between the groups.

Some papers will give the "Fisher's exact test" results instead. This is usually stronger as it gives an exact P-Value. Other non-parametric tests include: the Wilcoxon Signed-Rank Test, the Kruskal-Wallis Test, and the Friedman Test

Just use the P- Value

And breathe…

Library outreach service

The library

Level 5, Education Centre

Upper Maudlin St

Tel. ext. 20105

Email. library@uhbristol.nhs.uk