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Essential statistics

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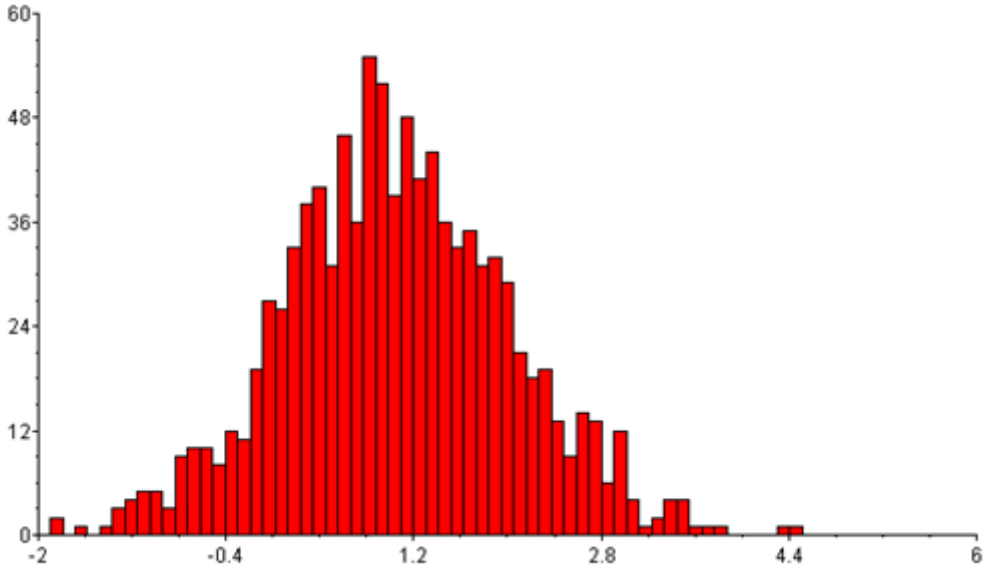
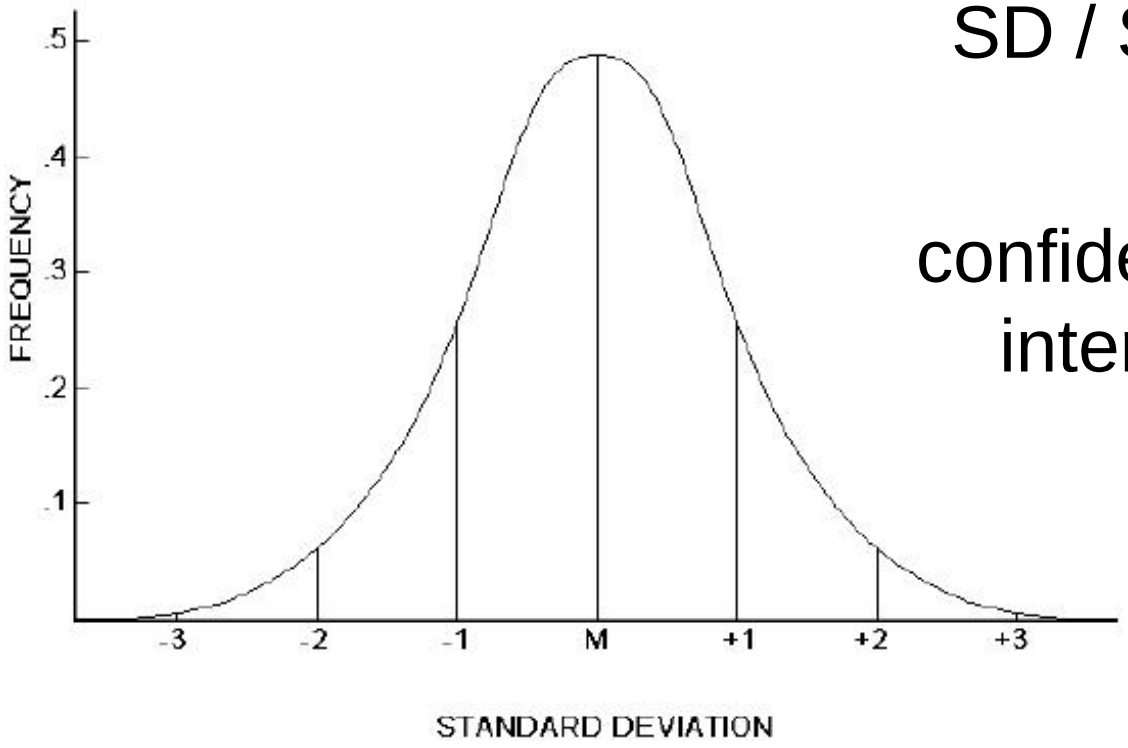
Types of data (variables)

- Categorical - male/female
- Ordered – mild, moderate, severe
- Numerical - age, BP
- Dependent, independent



Are the data normally distributed? parametric analysis

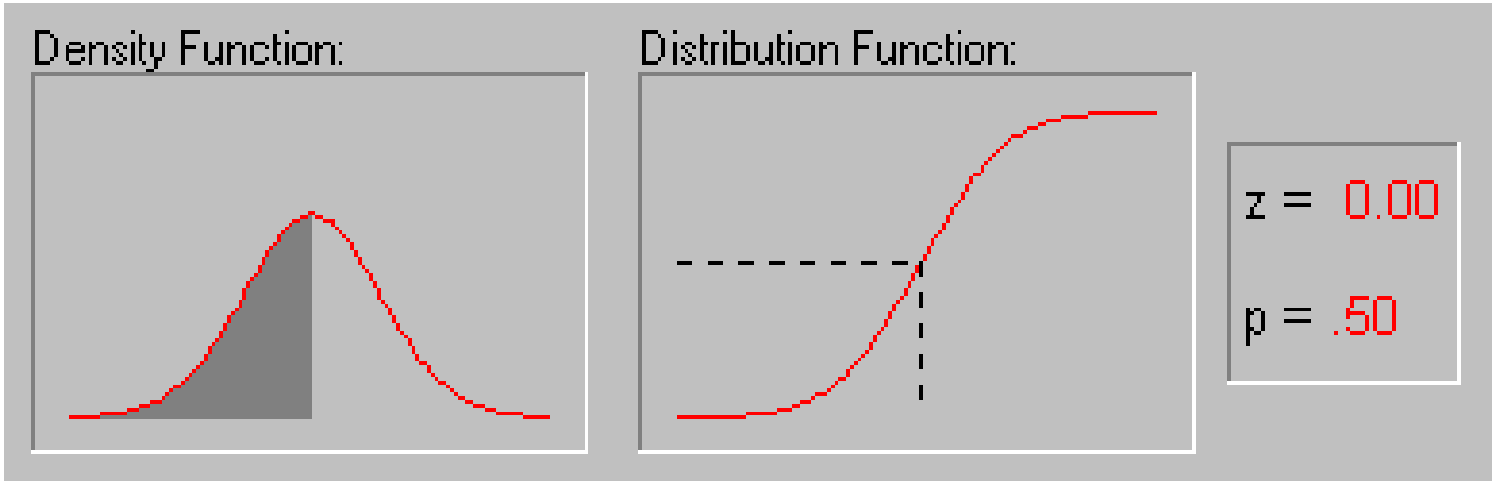


Mean

SD / SEM

95% confidence intervals

normally distributed data



- Tests of normality (Kolmogorov-Smirnov test, or the Shapiro-Wilks' W test)
- Histogram (best)

standard deviation

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \overline{x})^2}$$

- Is the square root of the variance!
- Simply put it is a description of how far an individual observation is away from the mean

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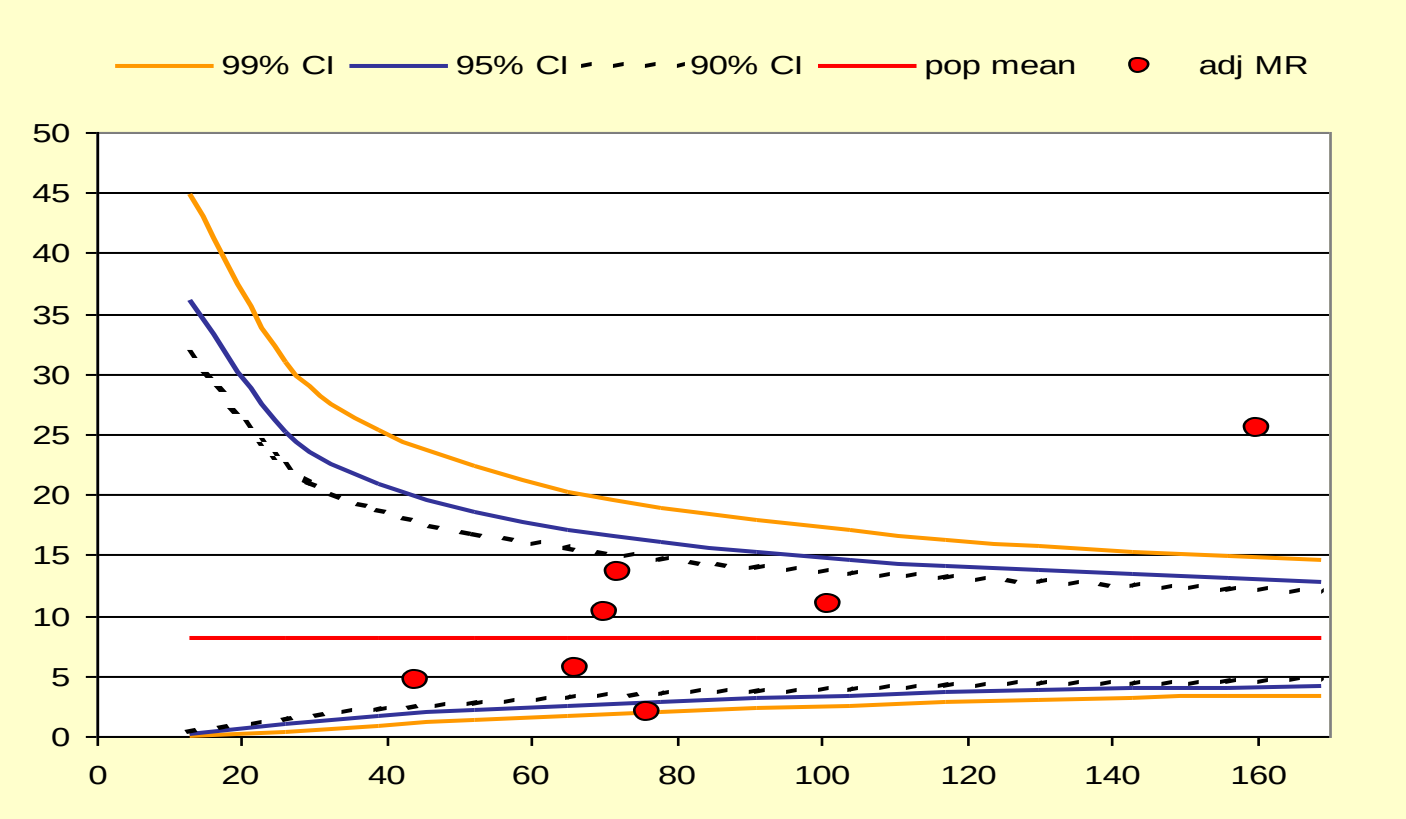
confidence intervals

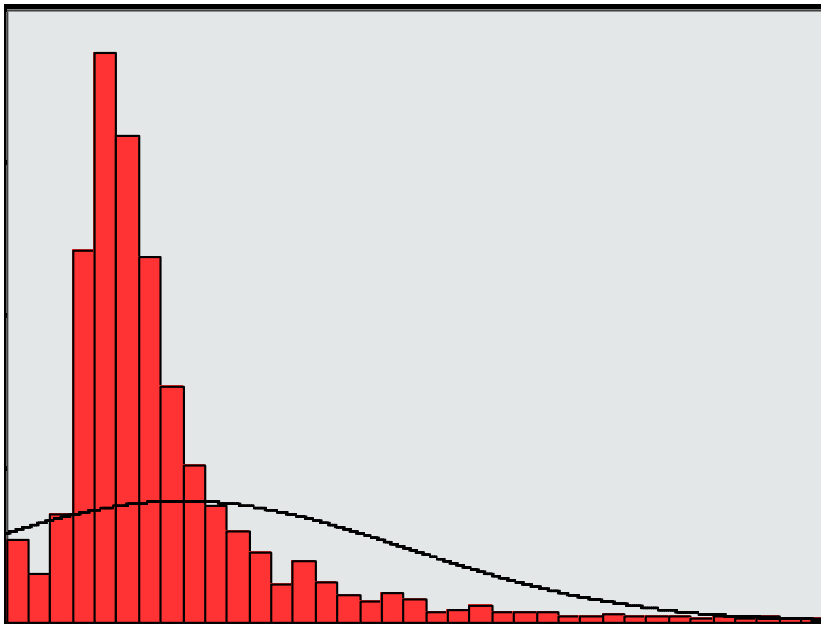


- a range of values where the "true" (population) value of a data point can be expected to be located
- You can specify certainty

Other distributions

- **Binomial –** only 2 possibilities (eg blood grp B and not grp B). As sample size increases, approximates normal
- **Poisson –** number of occurrences of an event, eg daily number of notifications of new cancer to a registry. Again approximates to normal as size increases
- Others include (Bernoulli Distribution Beta Distribution Cauchy Distribution Chi-square Distribution Exponential Distribution Extreme Value Distribution F Distribution Gamma Distribution Geometric Distribution Gompertz Distribution Laplace Distribution Logistic Distribution Log-normal Distribution Pareto Distribution Rayleigh Distribution Rectangular Distribution Student's t Distribution Weibull Distribution)

skewed distribution? non-parametric analysis



- Mode
- Median
- Geometric mean?

geometric mean

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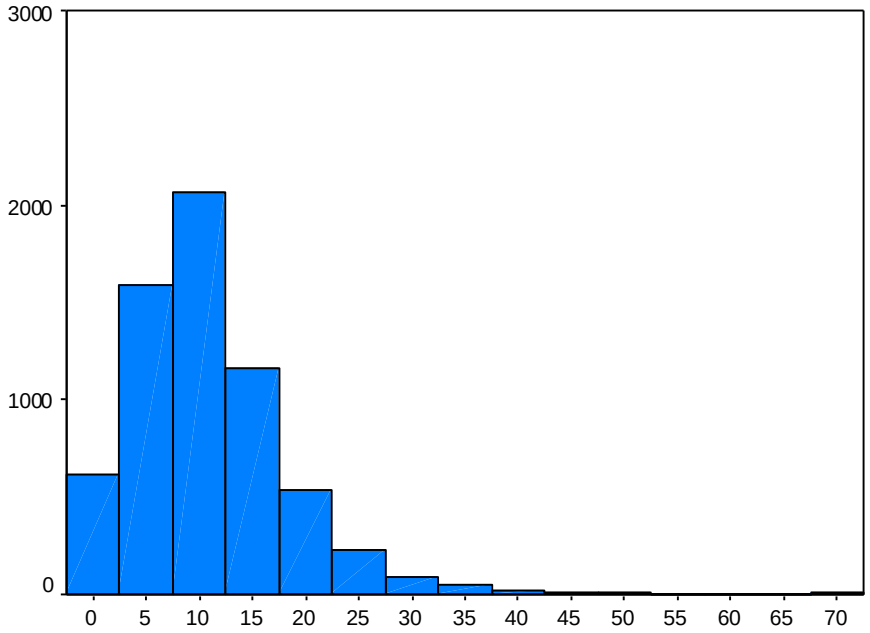
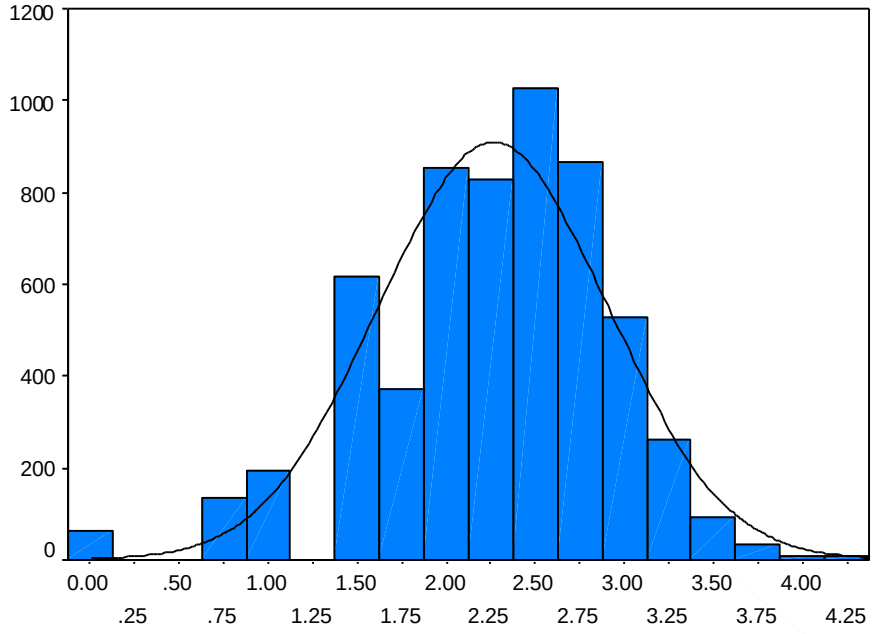
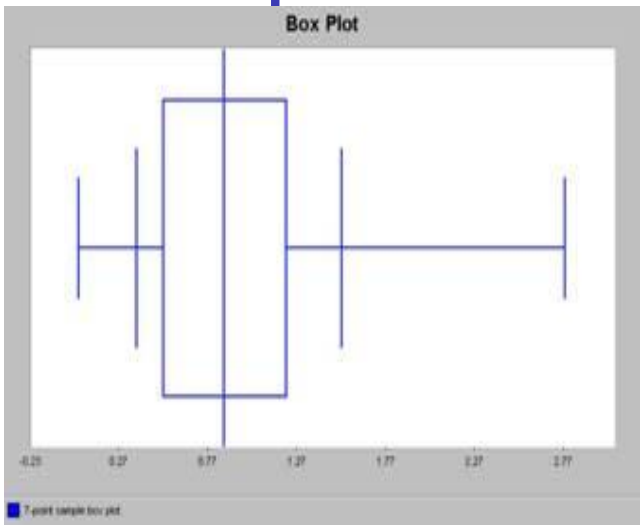


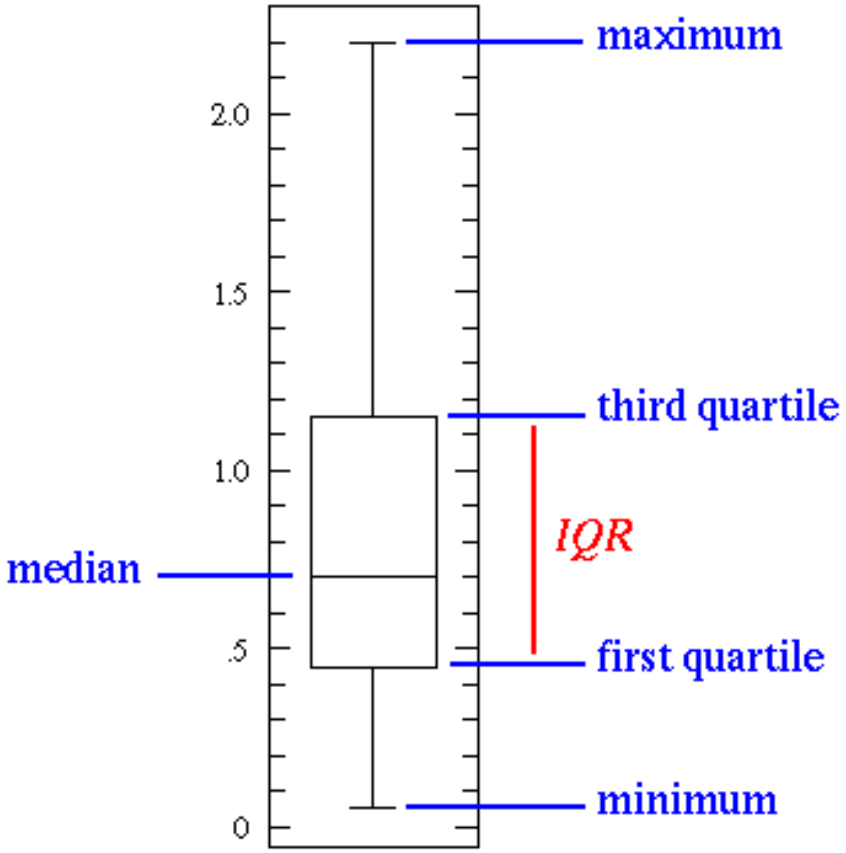
No of lymph nodes harvested



log (base e) number nodes harvested

non-parametric analysis: box-plots





- Median
- Inter-quartile range
- Range

Operation A has a lower 30-day mortality than operation B

P<0.05

what is significance?

the probability that an observed outcome of an experiment or trial is due to chance alone

- What are P values
- Setting acceptable levels (2SD)
- What does P<0.05 mean?
- Arbitrary assignment

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sample size

- Few observations = few combinations = high chance of occurring by chance
- Magnitude of difference
- Power analysis - how large a sample is needed to enable statistical judgments that are accurate and reliable

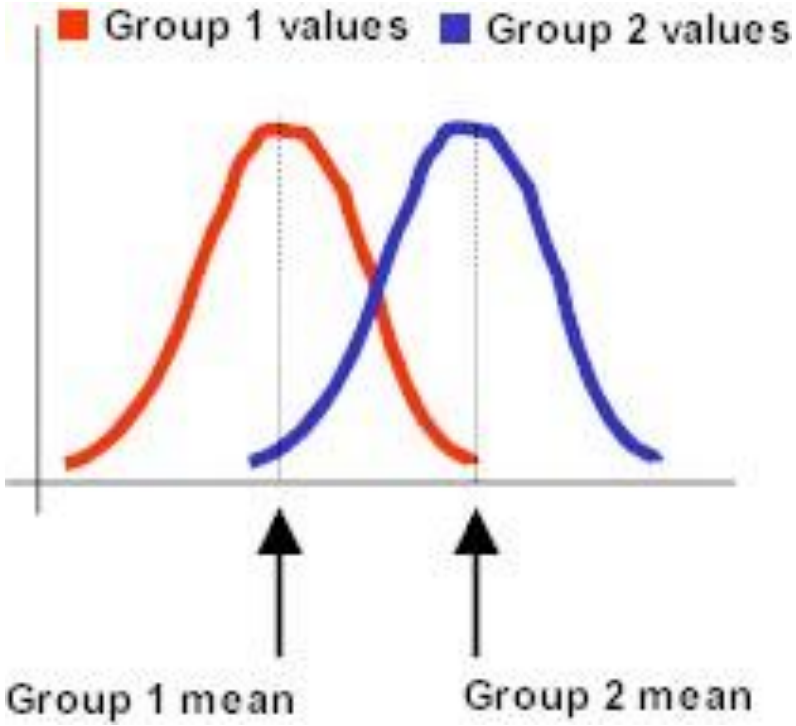
hypothesis testing

- Research hypothesis: Do diabetic patients have a high blood pressure?
- Null hypothesis: the mean blood pressure of diabetic and non-diabetic patients is the same
- Alternative hypothesis?

Comparing two samples

- Compare the average and spread
- Assume that both samples are taken from the same population (null hypothesis)
- Tests the likelihood that they are from the same population
- Arbitrary likelihood (p) less than 5% ($p<0.05$) taken as statistically significant (>2SD)

Parametric two-sample tests

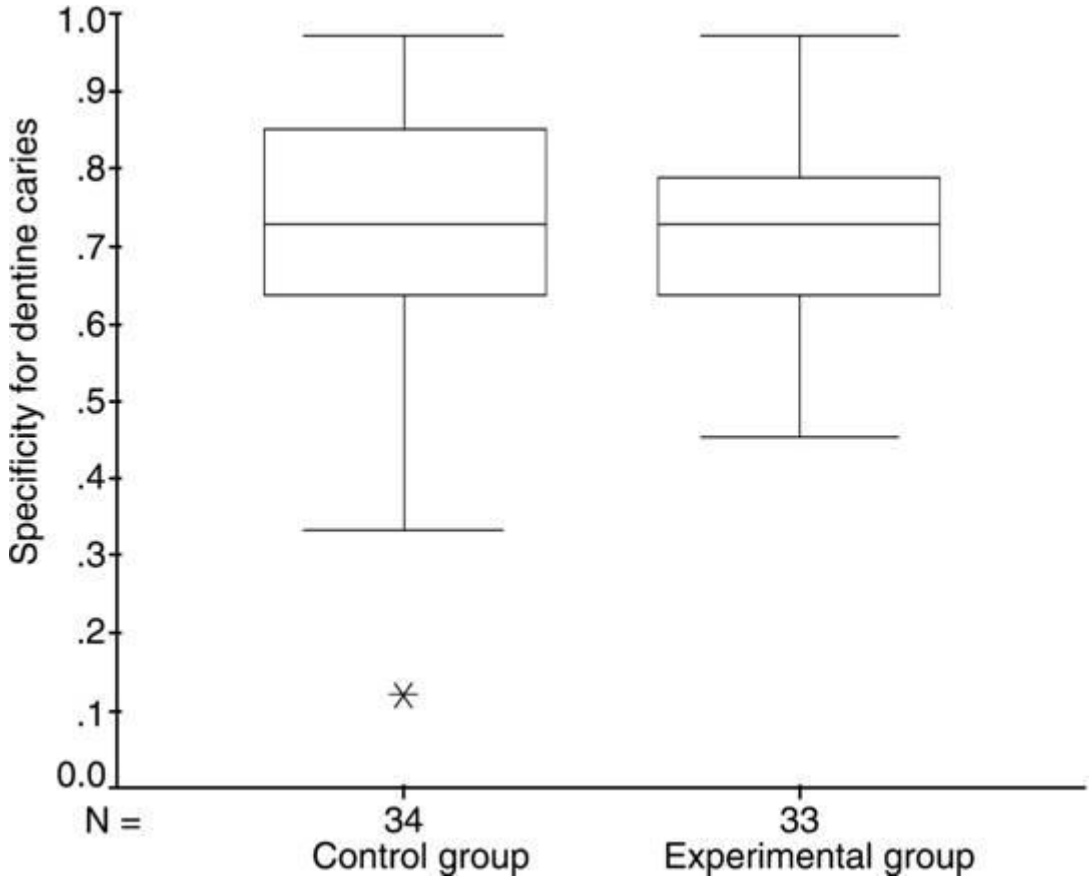


Null-hypothesis

Related samples (before and after) Paired t-test

non-related samples (male vs female) two-sample t-test

Non-parametric – two-box plots



Two sample comparisons

	Parametric	Non-parametric
Two related samples	Paired t-test	Wilcox rank sum test
Two independent	Two-sample t-test	Mann-Whitney U test

Statistical Errors

- Type II
  - A difference is present between the samples but your methods failed to show it (small sample size)
- Type I
  - There are no differences between the samples but the your methods was such that you showed a difference (repeated testing)

Comparative tests – categorical variables

- 2 x2

Is the data large enough*?

Yes- Chi-squared test

No – Fisher exact test

	Dead	Alive
Rx A	25	5
Rx B	3	23

* USE Yates correction for total <100 or any cell <10

Comparative tests – categorical variables

	Dead	Alive
ASA I	2	98
ASA II	5	55
ASA III	10	30

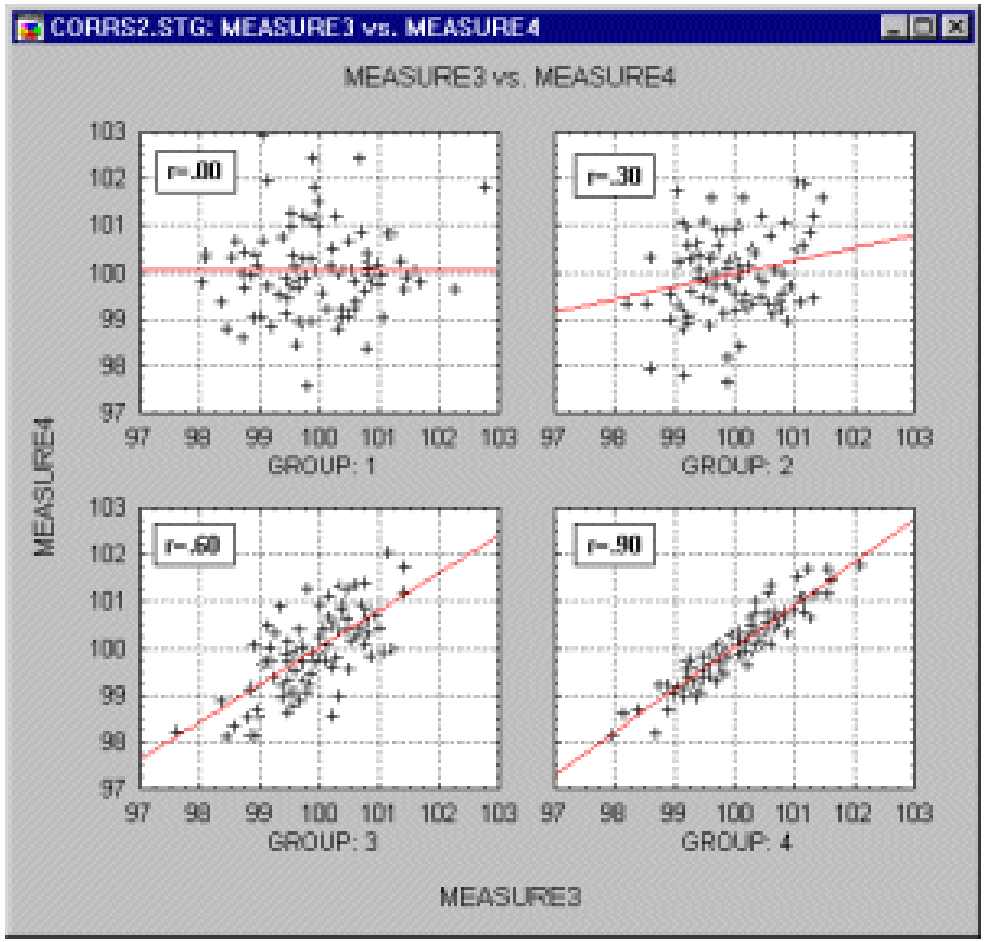
- 3 x2 … 4x2 …5x2

Is there natural ordering

Yes – Chi-squared test for trend

No – r x c Chi-squared test

correlation



- a measure of the relation between two or more variables. Correlation coefficients can range from -1.00 to +1.00
- Regression lines
- Significance depends on sample size

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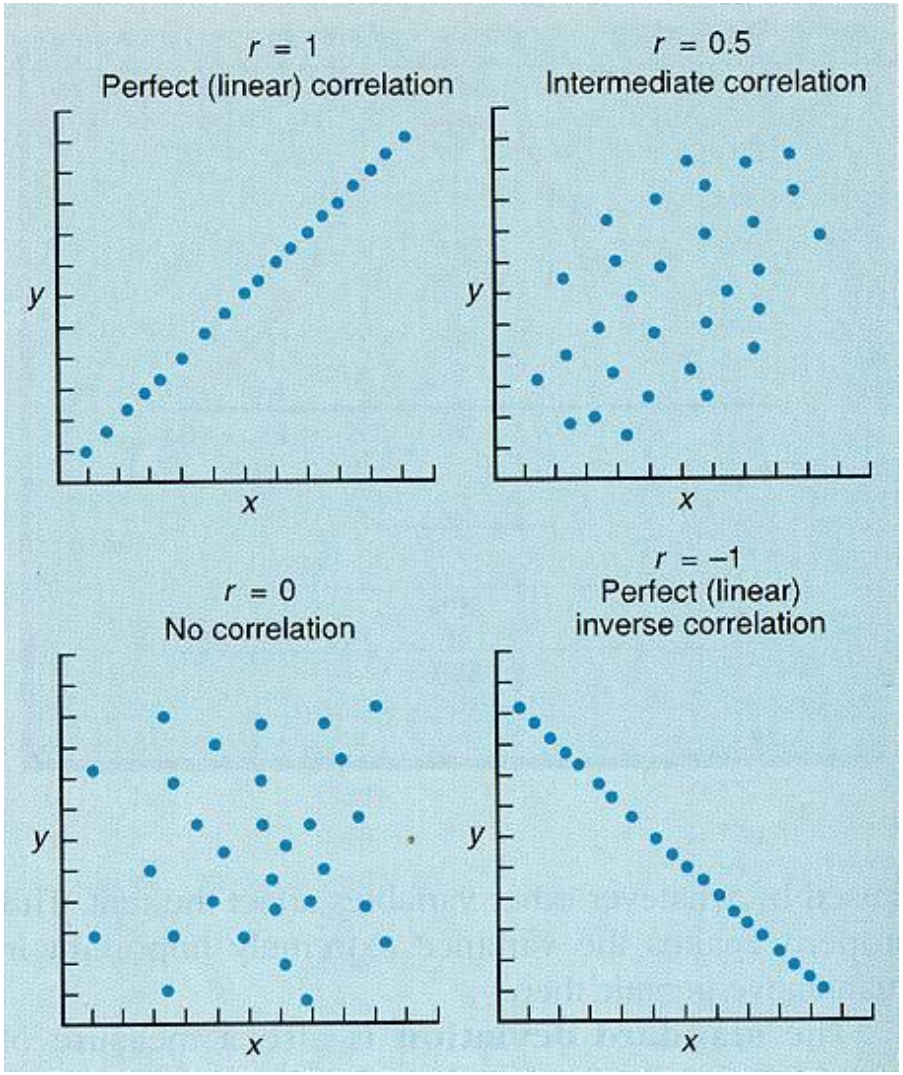


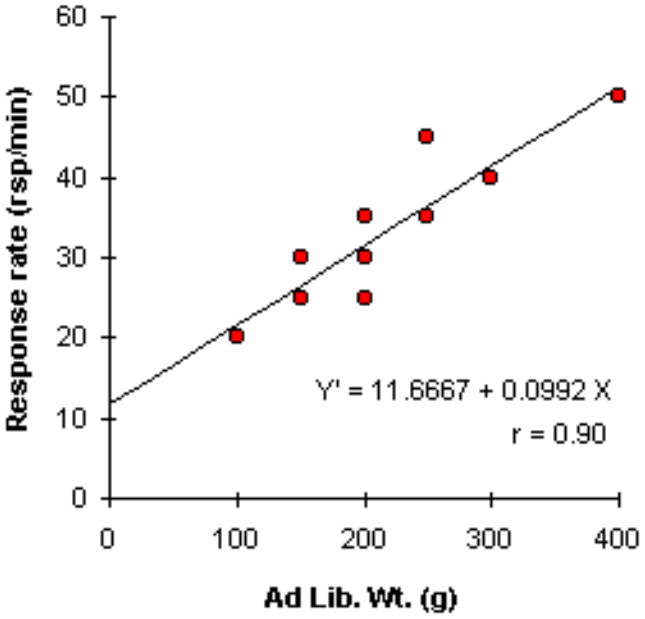
Correlation

Pearsons correlation coefficient– linear

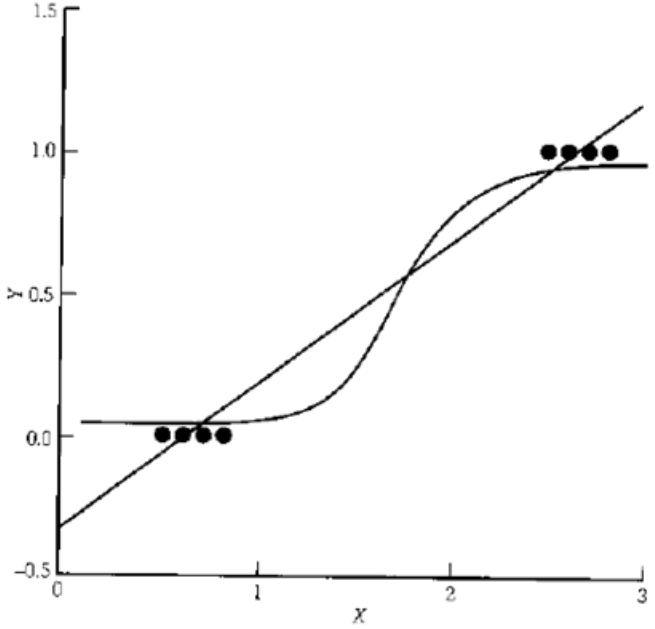
Spearman rank correlation - non-linear

Regression

- Linear: continuous dependent variable



- Logistic – binary dependent variable



Univariate vs multivariate analysis

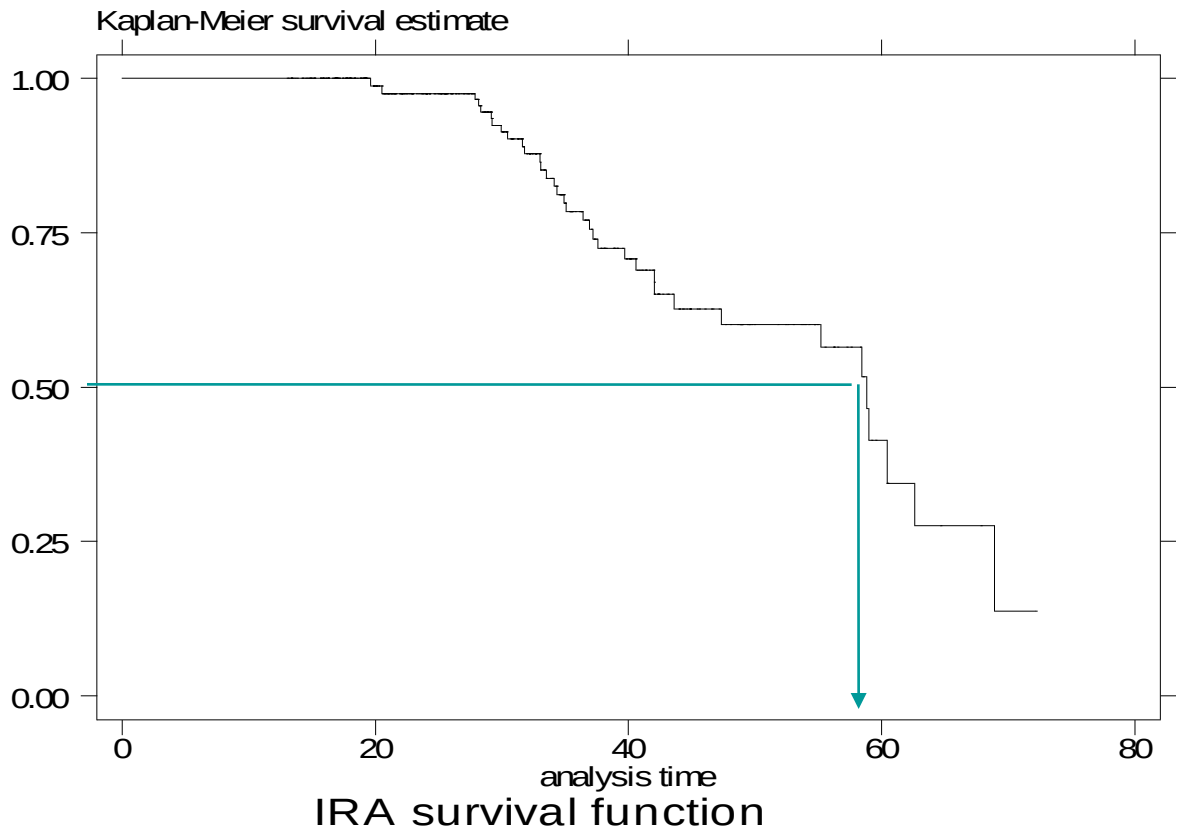
Mortality in colorectal cancer by age

	Coefficient	P-value	Odds ratio	95% CI for OR
Age (10-year^{-1} increase)	0.564	<0.001	1.757	1.600-1.931

Mortality in colorectal cancer by age and mode of surgery

	Coefficient	P-value	Odds ratio	95% CI
Age (10-year^{-1} increase)	0.570	<0.001	1.768	1.606-1.947
Urgent	0.947	<0.001	2.578	2.094-3.173
Emergency	1.446	<0.001	4.246	2.978-6.054

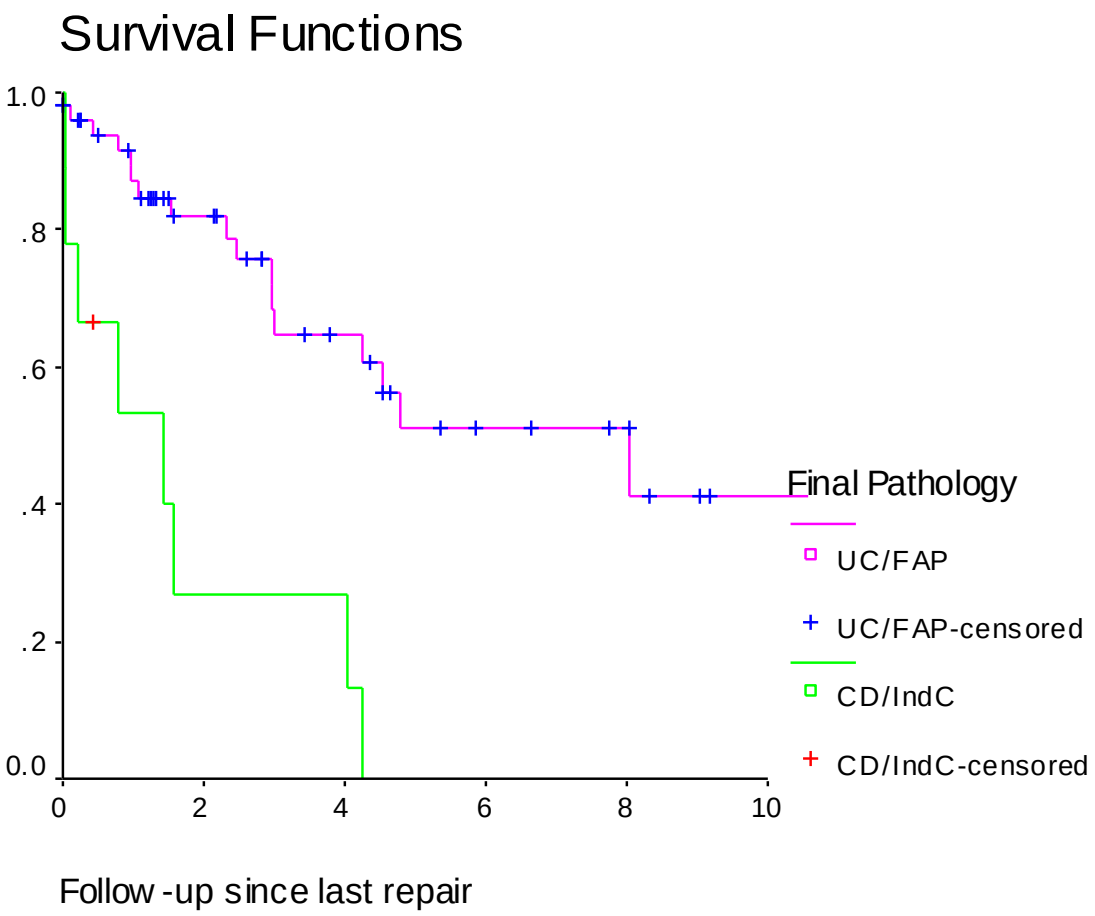
Survival analysis



Censored data: left (late start)
right (lost to follow up, death)

Median survival (95% confidence intervals)

Survival analysis – two sample data



Log-rank test 17.56, 1df, p<0.001

Meta-analysis !

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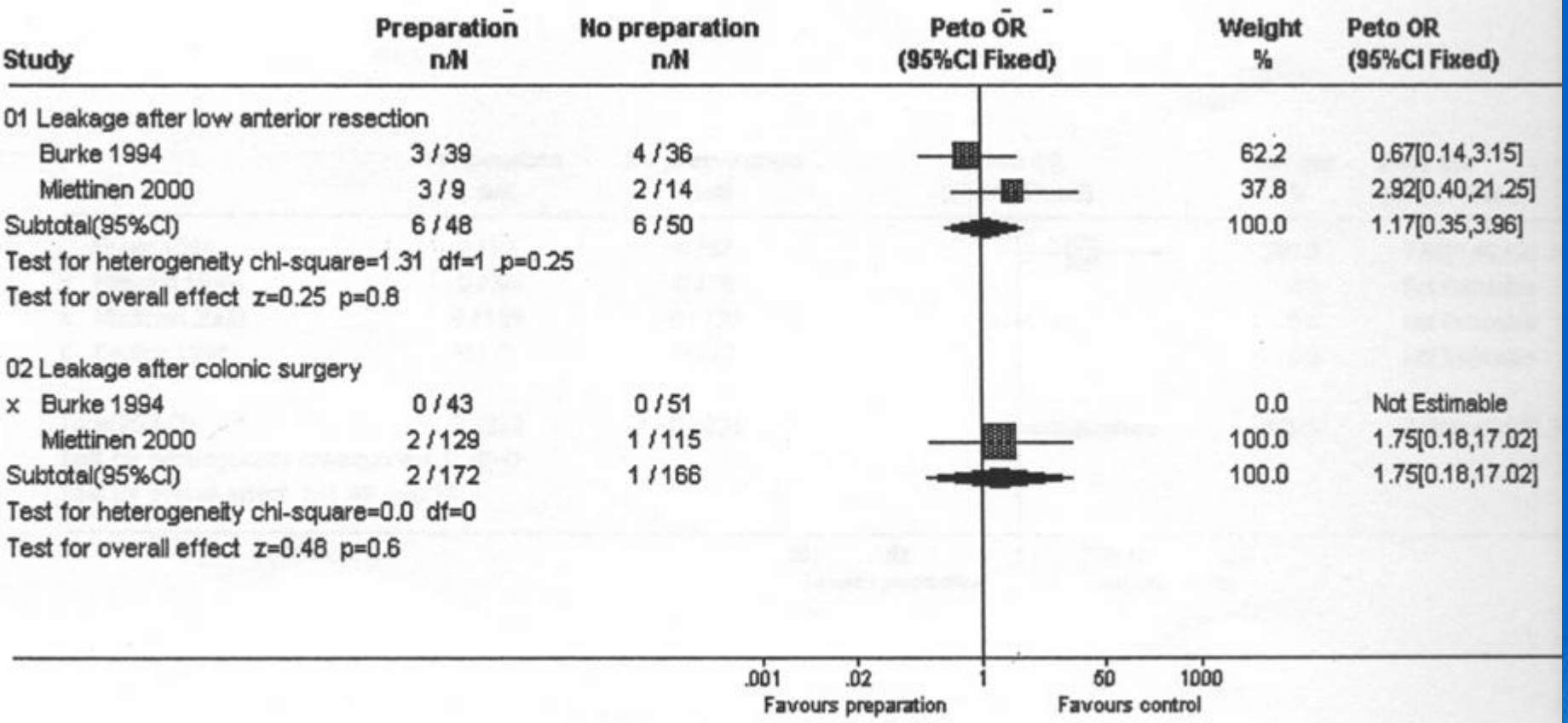

Levels of evidence

- Level 1 – Randomised controlled trials
  - 1a Meta-analysis of RCTs
  - 1b RCT
- Level 2 - Non-randomised trials
  - 2a Control study no randomization
  - 2b Quasi-experimental study
- Level 3 – Descriptive study – case-contol study
- Level 4 – Reports, individual opinion