Presenting Statistical Results

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The four main questions that we want answered include:

- What is the research question?
- Can the results be trusted? (are they likely to be **valid**?)
- What are the results of the trial?
- How can the results/conclusions be applied? (to whom are they **generalizable**?)

Statistics

- Used to summarize data that has been collected for a study and enable analysis
- Misuse of statistics are prevalent
- Imperative to consult biostatisticians during the early stages of study design
- Must be stated in sufficient detail to verify the results

Statistics in the Manuscript

- Materials and Methods section
- Results Section
- Discussion Section

Statistics in the Materials and Methods Section

Section	Requirement
STUDY DESIGN	accurate and detailed enough to be reproduced
POPULATION AND SAMPLE SIZE-	discuss eligibility of experimental subjects, how the sample was selected; method of sample size calculation
DATA COLLECTION	give number of observations; method of dealing with losses of observations such as dropouts

STATISTICAL ANALYSIS	provide clear descriptions of the main features of the statistical analysis – e.g. confidence intervals including degree of confidence; hypothesis tests, including null and alternative hypotheses; level of significance; particular tests and test statistics

Statistics in the Materials and Methods Section

- State the statistical tests that were used, if sophisticated, advanced techniques were used, provide references
- Describe procedures performed to handle missing values and data
- Describe procedures to determine presence of outliers as well as how they were handled

Statistics in the Materials and Methods Section

- When several techniques are used it should be absolutely clear which method was used
- Very common techniques, such as t tests, simple X2 tests, Wilcoxon and Mann-Whitney tests, correlation (r), and linear regression, do not need to be described,
- methods with more than one form, such as t tests (paired or unpaired), analysis of variance, and rank correlation, should be identified unambiguously.
- More complex methods do need some explanation, and if the methods are unusual a precise reference should be given.

Statistics in the Materials and Methods Section

- Describe the model of assumption tests that were performed- test of normality or goodness-of-fit test
- Specify the statistical software used and version used- provide in parenthesis the manufacturer of the software, city and country of origin

Statistics in the Results Section

- Presents results of the main analysis carefully and clearly, explain how the results address the study objectives
- Use appropriate measures of central tendency

  if using notation a $\pm$ b, states if b is standard deviation or standard error

May use tables to report summary stats

Statistics in the Results Section

Reporting Results of Statistical tests

State the test name, followed by a colon, then the test statistic (together with any degree of freedom) and the p-value

Ex.

Chi square test: χ^2= 16.81, p=0.01

Statistics in the Results Section

- Report the effect of variables using measures which are clinically relevant

e.g. Report effects of age in 10 year increments rather than 1 year increments

report effects of weight in 10 kg increments rather than 1 kg increments

Statistics in Results Section

- Avoid non-technical use of technical terms in statistics
- All statistical terms, abbreviations and symbols should be defined

Examples of terms to avoid

	Usual Definition	Statistics
RANDOM	made, or occurring without definite aim, reason, or pattern	of or characterizing a process of selection in which each item of a set has an equal probability of being chosen
NORMAL	usual, typical, or expected.	Collection of probability distributions described by a specific formula
SIGNIFICANT	Sufficiently great or important to be worthy of attention; noteworthy	Outcome of a formal test fell outside a chosen predetermined region
CORRELATION	A mutual relationship or connection between two or more things	statistical measurement of the relationship between two variables. Possible correlations range from +1 to –1

REPORTING OF NUMBERS

Avoid using the words “about” or “approximate”, show exact values

Number of decimal places should reflect the degree of precision of the measurement

Examples

Mean age of adults- report to 1 decimal place only (e.g. 45.2 years not 45.2333)
Mean and standard deviation- report one digit more than was presented in the raw data (e.g. height reported in tenth of a centimeter, may report mean to nearest hundredth of a centimeter
For percentages, nearest whole % usually adequate, some prefer to tenth of a percent
For test statistics (chi square, t test, ANOVA) report to 2 decimal places for accuracy

P-values and confidence intervals

- Report exact values
- e.g. p= 0.95
- Do not use the terms “N.S.” or “not significant”
- If a p-value is stated in a table or graph, do not repeat it in the text

P values and Confidence intervals

Reporting *t-test results:*

- The difference between the sample mean systolic blood pressure in diabetic patients and non-diabetic patients was 6.0 mmHg, with a 95% confidence interval from 1.1 to 10.9 mmHg; the *t-test statistic was 2.4, with 198 degrees of freedom and an associated p-value of 0.02.*

Statistics in the Discussion section

- A significant result does not necessarily indicate a real effect. There is always some risk of a false positive finding
- A statistically significant association (obtained from correlation or X2 analysis) does not in itself provide direct evidence of a causal relationship between the variables concerned- esp in observational studies

Statistical vs. Clinical Significance

- **Statistical significance-** an interpretation of statistical data that indicates that an occurrence was probably the result of a causative factor and not simply a chance result
- **Clinical significance -** The clinical importance of data generated in a study, irrespective of statistical results. Usually refers to the application of study results in clinical practice. Also can be called clinical meaningfulness.

Statistical vs Clinical Significance

- Suppose two hypotensive agents are compared and the mean arterial BP after treatment with drug A is 2 mm Hg lower than after treatment with drug B. If the study sample sizes are large enough, even such a small difference between the two groups may be statistically significant with a *P*-value of <0.05.
- clinical advantage of an additional 2 mm Hg reduction in mean arterial blood pressure is small and not clinically significant.

Common errors:

- Making the assumption that if $p < 0.05$, the results are worth publishing as they are statistically significant.
- Using statistical significance to prove that there is clinical significance.
- Making the assumption that a non-significant result proves the null hypothesis.

- The purpose of statistical methods is to provide a straightforward factual account of the scientific evidence derived from a piece of research.
- The skills and experience needed to design suitable studies, carry out sensible statistical analyses, and communicate the findings in a clear and objective manner are **not easy to acquire.**

Take home points:

1. Exercise statistical judgment at all times.
2. Seek the advice of a biostatistician before beginning the research, instead of waiting until the results have been obtained.

THANK YOU!