Dissertation Module
Research Skills Program

LECTURE 7

STATISTICS WITH CONFIDENCE

LEARNING OBJECTIVES

- Understand the differences between descriptive and inferential statistics.
- Be able to interpret a confidence interval.
- Understand some basic concepts of hypothesis testing.
- Be able to interpret a p-value.

The Probabilistic Nature of Medicine & Public Health

No two people, patients or groups of individuals are ever exactly alike, yet decisions affecting people, patients or the community must be based on experience derived from other people, patients or communities of similar biological and social characteristics.

Because of these inherent differences these decisions cannot be exact; they are always accompanied by some uncertainty.

Random error ("chance")

Generalizibility - Internal Conformity and Consistency

Conformity =	**Absence of Systematic Error (= Bias)**
Consistency =	**Small Random Error**
Generalizibility =	**Conformity & Consistency**

Sound research methods try to avoid systematic error.

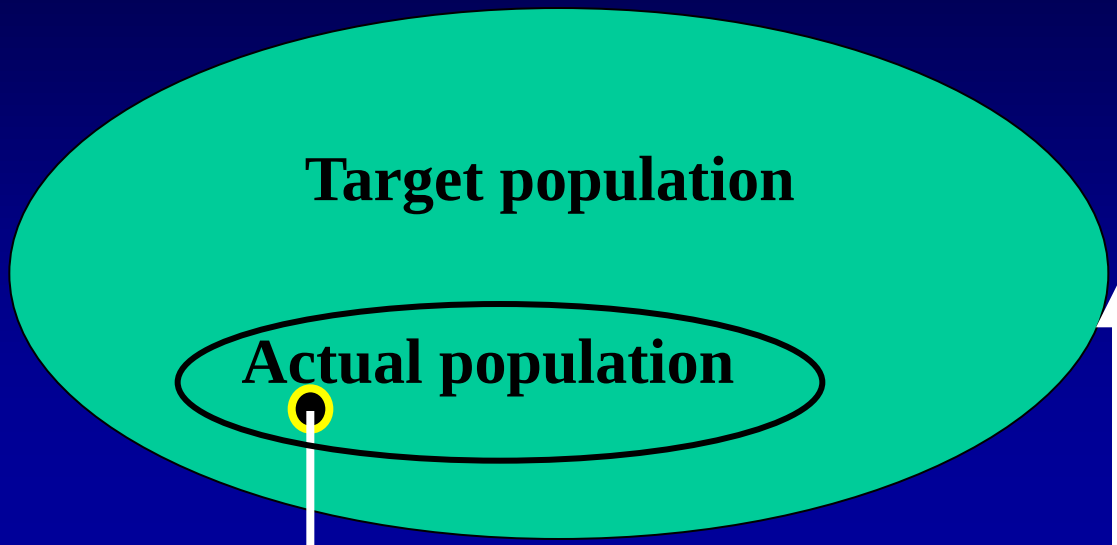
Statistics judge random error.

A study compares the efficacy of a new drug for chronic spinal pain with standard treatment. After six months the proportions of people with reduced pain are compared.

Standard treatment:	**20 people out of 100 with less pain**
New drug:	**40 people out of 100 with less pain**
	Difference 20%

How much will the result differ, if study was repeated with patients sampled from same actual population?

RANDOM ERROR



Sample

Descriptive Statistics:

Percentage, Mean,
Median, Quantiles, etc

Inferential Statistics:

Confidence Intervals
(Parameter Estimation)

Statistical Tests
(Hypothesis Testing)

Confidence Interval of the Population Mean

The interval defined by:

$$\text{sample mean} \pm \text{quantile}(\alpha)\frac{\text{standard deviation}}{\sqrt{\text{sample size}}}$$

is called (1-α)-confidence interval of the population mean.

Interpretation

The (unknown, "true") target population mean lies within the (1-α)-confidence interval with a probability of 1 - α.

A cross-sectional study investigated the alcohol consumption of Australian adolescents in 2001.

The study reported the prevalence of weekly "binge" drinking as 12% (95%-confidence interval = [11%, 13%]).

Explain the finding.

A case-control study interviewed 100 women with breast cancer and 100 control women about their previous use of oral contraceptives.

Cancer cases: **20 long-term users**
95%-CI = [12%, 28%]

Controls: **15 long-term users**
95%-CI = [8%, 22%]

Explain the findings.

What Influences the Width of a Confidence Interval ?

$$\text{sample mean} \pm \text{quantile}(\alpha)\frac{\text{standard deviation}}{\sqrt{\text{sample size}}}$$

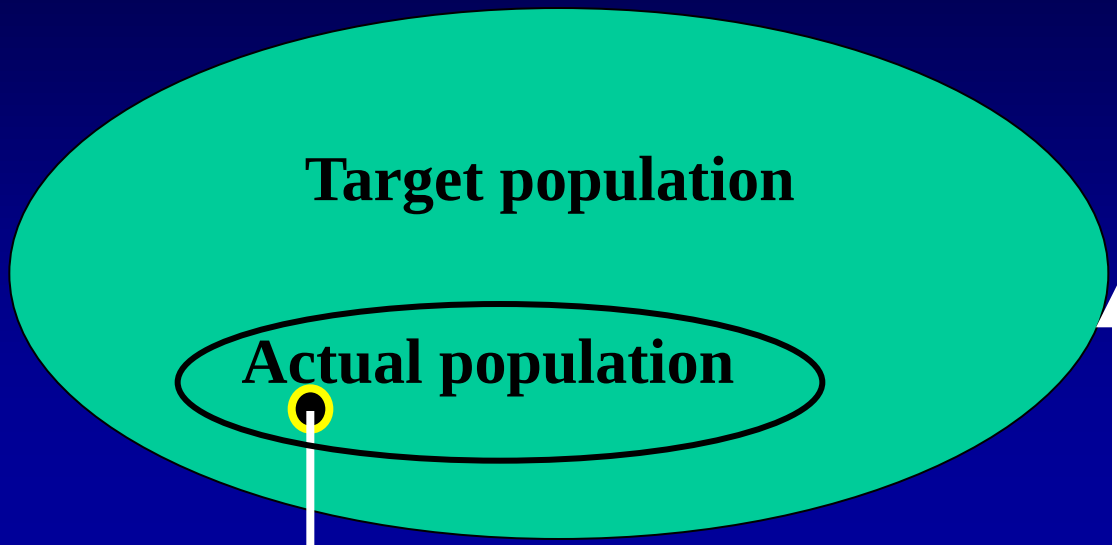
Increased certainty → **Wider interval**

Increased variance → **Wider interval**

Increased sample size → **Narrower interval**

Statistical Hypothesis Testing

A statistical test decides on whether or not an observed difference can be attributed to random error (chance).



Sample

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STATISTICAL HYPOTHESIS TESTING

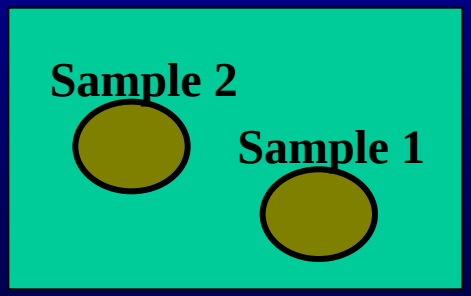
- Decision making tool
- Done to compare groups
- Decides on whether there is a difference between groups beyond chance
- Results in a p-value
- p-value smaller than 0.05 implies “statistically significant”

Statistical Hypothesis Testing

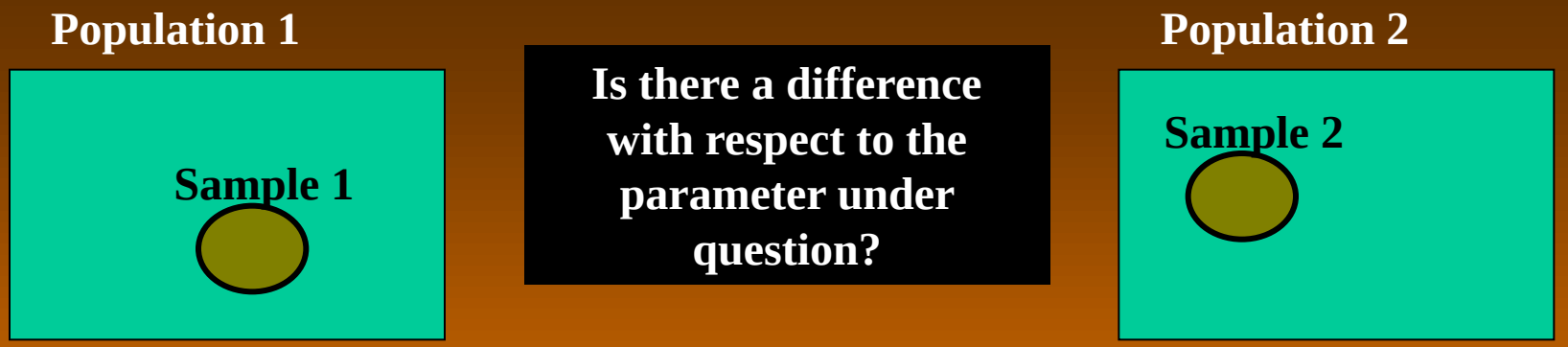
Are

means, medians, survival rates, proportions, relative risks,…….

belonging to the same or to different populations?



Same population



Sample 1

100 women with breast cancer

20% used OC

Sample 2

100 women without breast cancer

15% used OC

Conceptual Research Hypothesis:

The use of OC causes breast cancer.

Statistical Question:

Does the proportion of OC users in women with breast cancer differ from the proportion of OC users in healthy women?

Alpha Error (= Type one Error = Significance Level of a Statistical Test):

Is determined prior to the conduct of a statistical test (usually alpha = 0.05)

The p-value: **Is the result of a statistical test**

If $p < alpha$	test result: significant
If $p \geq alpha$	test result: not significant

“Significant ($p < 0.05$)” means:

The probability that the observed “difference” is attributable to chance alone is less than 5%

Statistical Hypothesis Testing

The p-value gives the probability that the observed difference (or an even larger difference) could have occurred by chance alone, assuming that in reality there is no difference.

A cross-sectional study investigated the alcohol consumption of Australian adolescents in 2001.

The study reported the prevalence of weekly "binge" drinking was 13% in boys and 11.5% in girls ($p = 0.194$).

The study further revealed that the prevalence of drinking alcohol (at least once per month) was approximately 15% in 13 year olds and rose steadily to about 89% in 18 year olds ($p < 0.001$).

Explain the findings.

SUMMARY

- The correct choice of an appropriate statistical method to present and analyse the data is dependent on the type(s) of the variable(s) involved. The main differentiation is between categorical and numerical data.
- Descriptive statistics for categorical variables usually simply describe the frequency of each category in percentages. Numerical variables are summarised using a measure of central tendency together with a measure of dispersion.
- Inferential statistics allow us to assess the random error involved when generalising from a sample to the target population.
- A 95% confidence interval of a parameter, such as a mean or relative risk, implies that we are 95% confident that the true yet unknown parameter in the target population lies within this interval.
- A statistical test is a decision making tool. It is used to confirm or reject a research hypothesis. A statistical test judges how likely it is that an observed difference between groups, or an association between characteristics, is due to random error (chance) alone. A statistical test is based on data from a sample, but delivers inferences about the target population.
- The result of a statistical hypothesis test is called a “p-value”.