BIOSTATISTICS

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Unit One

INTRODUCTION

Biostatistics

- **It** can be defined as the application of the mathematical tools used in statistics to the fields of biological sciences and medicine.
- It is a growing field with applications in many areas of biology including epidemiology, medical sciences, health sciences, educational research and environmental sciences.

Concerns of Biostatistics

- Biostatistics is concerned with collection, organization, summarization, and analysis of data.
- We seek to draw inferences about a body of data when only a part of the data is observed.

Purposes of Statistics

- To describe and summarize information thereby reducing it to smaller, more meaningful sets of data.
- To make predictions or to generalize about occurrences based on observations.
- To identify associations, relationships or differences between the sets of observations.

Data

- Data are numbers which can be measurements or can be obtained by counting.
- Biostatistics is concerned with the interpretation of the data and the communication of information about the data.

Populations and Samples

1. A population is the collection or set of all of the values that a variable may have. The entire category under consideration.
2. A sample is a part of a population. The portion of the population that is available, or to be made available, for analysis.

Population and Sampling

- Sampling: the process of selecting portion of the population.
- Representativeness: the key characteristic of the sample is close to the population.
- Sampling bias: excluding any subject without any scientific rational. Or not based on the major inclusion and exclusion criteria.

Example

- Studying the self esteem and academic achievement among college students.
- Population: all student who are enrolled in any college level.
- Sample: students' college at the University of Jordan.

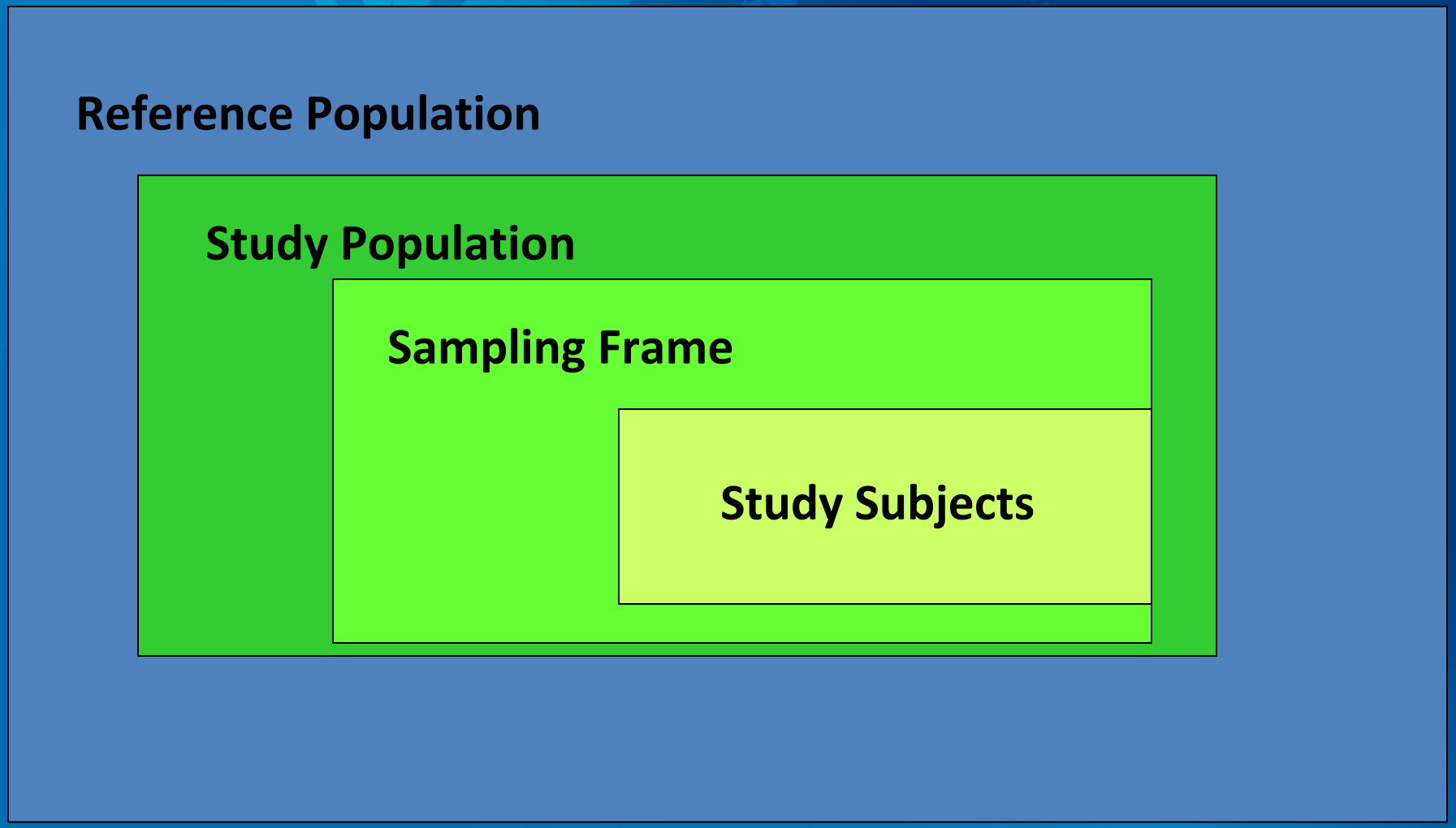
What is sampling?

- Sampling is the selection of a number of study units/ subjects from a defined population.

Questions to Consider

- Reference population – to whom are the results going to be applied?
- What is the group of people from which we want to draw a sample (study population)?
- How many people do we need in our sample (Sample Size) ?
- How will these people be selected(Sampling Method)?

Sampling - Populations



Sampling

- Element: The single member of the population (population element or population member are used interchangeably)
- Sampling frame is the listing of all elements of a population, i.e., a list of all medical students at the university of Jordan, 2014-2016.

Sampling Methods

- Sampling depends on the sampling frame.
- Sampling frame: is a listing of all the units that compose the study population.

Types of Sampling Methods

- Probability Sampling Methods. Involves the use of random selection process to select a sample from members or elements of a populations.
  - Simple Random Sampling
  - Systematic sampling.
  - Stratified sampling.
  - Cluster sampling.
  - Multistage sampling.

Probability Sampling Methods

- Involves random selection procedures to ensure that each unit of the sample is chosen on the basis of chance
- All units of the study population should have an equal or at least a known chance of being included in the sample
- Requires a sampling frame
  - Listing of all study units

Simple Random Sampling

- This is the simplest of probability sampling
  - Make a numbered list of all units in the population
  - Decide on the sample size
  - Select the required number of sampling units using the lottery method or a random number table

TABLE 10–2. Random Numbers

21	71	89	96	97
82	59	22	78	12
76	93	64	79	28
20	60	70	34	51
93	58	36	93	90
68	63	19	21	91
18	32	36	27	71
58	80	(58)	67	50
66	25	(20)	31	62
17	25	(07)	94	18
02	29	(30)	15	92
55	06	(25)	09	26
38	11	(01)	47	93
42	47	(73)	25	84
82	04	(23)	08	88
37	24	(51)	98	05
94	58	85	86	71
37	92	(27)	20	58
29	64	(13)	05	24
85	48	(37)	37	21
20	56	91	53	66
33	23	13	82	54
62	11	(29)	17	37
01	57	73	53	97
34	19	(75)	62	16
81	10	(55)	36	36
92	50	32	68	82
37	33	43	20	08
10	50	18	85	27

Systematic Sampling

- Individuals are chosen at regular intervals from the sampling frame
- Ideally we randomly select a number to tell us the starting point
  - every 5th household
  - every 10th women attending ANC
- Sampling fraction = $\frac{\text{Sample size}}{\text{Study population}}$
- Interval size= $\frac{\text{study population}}{\text{Sample size}}$

Stratified Sampling

- If we have study units with different characteristics which we want to include in the study then the sampling frame needs to be divided into strata according to these characteristics
- Ensures that proportions of individuals with certain characteristics in the sample will be the same as those in the whole study population
- Random or systematic samples of predetermined sample size will have to be obtained from each stratum based on a sampling fraction for each stratum

Cluster Sampling

- Selection of study units (clusters) instead of the selection of individuals
- All subjects/units in the cluster who meet the criteria will be sampled.
  - Clusters often geographic units
  - e.g. schools, villages etc
- Usually used in interventional studies
  - E.g. assessing immunization coverage
- Advantages
  - sampling frame is not required in this case
  - Sampling study population scattered over a large area

Multistage Sampling

- Involves more than one sampling method
- Is therefore carried out in phases
- Does not require a initial sampling frame of whole population
- NEED TO KNOW SAMPLING FRAME OF CLUSTERS E.G. PROVINCES
- Require sampling frames of final clusters final clusters
- Applicable to community based studies e.g. interviewing people from different villages selected from different areas, selected from different districts, provinces

Nonprobability Sampling Methods

Nonprobability sampling: the sample elements are chosen from the population by nonrandom methods.

More likely to produce a biased sample than the random sampling.

This restricts the generalization of the study findings.

Most frequent reasons for use of nonprobability samples involve convenience and the desire to use available subjects.

Types of Sampling Methods

- Nonprobability Sampling Methods:
  - Convenience sampling.
  - Snowball sampling.
  - Quota sampling.
  - Purposive sampling.

- **Convenience sampling** (Accidental or incidental sampling):
  - People may or may not be typical of the population, no accurate way to determine their representativeness
  - Most frequently used in health research
- Advantages:
  - Saves time and money

- **Snowball sampling**: a method by which the study subjects assist in obtaining other potential subjects (networking)
- Useful in topics of research where the subjects are reluctant to make their identity known, Drug users, Aids patients, etc.

- **Quota sampling**
  - In quota sampling, the sample is selected by convenience (e.g. the first 50% of males and 50% of females)
  - A mean for securing potential subjects from these strata.
  - In a quota sampling variables of interest to the researcher (include subject attributes), such as age, gender, educational background are included in the sample

- **Purposive sampling** (handpicking, judgmental):
  - Subjects are chosen because they are typical or representative of the accessible population, or because they are experts (more knowledgeable) in the field of research topic.
  - Qualitative researchers use Purposive sampling

Variables

1. A variable is an object, characteristic, or property that can have different values.
2. A quantitative variable can be measured in some way.
3. A qualitative variable is characterized by its inability to be measured but it can be sorted into categories.

Types of Variables

- Independent variable—the presumed cause (of a dependent variable)
- Dependent variable—the presumed effect (of an independent variable)
- Example: Smoking (IV) ▫ Lung cancer (DV)

Levels of Measurement

- Nominal
- Ordinal
- Interval
- Ratio

Levels of Measurement

Nominal Level of Measurement

- Categories that are distinct from each other such as gender, religion, marital status.
- They are symbols that have no quantitative value.
- Lowest level of measurement.
- Many characteristics can be measured on a nominal scale: race, marital status, and blood type.
- Dichotomous.
- Appropriate statistics: mode, frequency
- We cannot use an average. It would be meaningless here.

Ordinal Level of Measurement

- The exact differences between the ranks cannot be specified such as it indicates order rather than exact quantity.
- Involves using numbers to designate ordering on an attribute.
- Example: anxiety level: mild, moderate, severe. Statistics used involve frequency distributions and percentages.
- Appropriate statistics: same as those for nominal data, plus the median; but not the mean.

Interval level of Measurement

- They are real numbers and the difference between the ranks can be specified.
- Equal intervals, but no “true” zero.
- Involves assigning numbers that indicate both the ordering on an attribute, and the distance between score values on the attribute
- They are actual numbers on a scale of measurement.
- Example: body temperature on the Celsius thermometer as in 36.2, 37.2 etc. means there is a difference of 1.0 degree in body temperature.
- Appropriate statistics
  - same as for nominal
  - same as for ordinal plus,
  - the mean

Ratio level of Measurement

- Is the highest level of data where data can categorized, ranked, difference between ranks can be specified and a true or natural zero point can be identified.
- A zero point means that there is a total absence of the quantity being measured.
- All scales, whether they measure weight in kilograms or pounds, start at 0. The 0 means something and is not arbitrary (SUBJECTIVE).
- Example: total amount of money.

What Type of Dats To collect?

- The goal of the researcher is to use the highest level of measurement possible.
  - Example: Two ways of asking about Smoking behavior. Which is better, A or B?
    (A) Do you smoke? ▫Yes ▫No
    (B) How many cigarettes did you smoke in the last 3 days (72 hours)?

(A) Is nominal, so the best we can get from this data are frequencies. (B) is ratio, so we can compute: mean, median, mode, frequencies.

Parameter and Statistic

- Parameter is a descriptive measure computed from the data of the population.
  - The population mean, μ, and the population standard deviation, σ, are two examples of population parameters.
  - If you want to determine the population parameters, you have to take a census of the entire population.
  - Taking a census is very costly.
  - Parameters are numerical descriptive measures corresponding to populations.
  - Since the population is not actually observed, the parameters are considered unknown constants.
- Statistic is a descriptive measure computed from the data of the sample.
  - For example, the sample mean, $\bar{x}$, and the standard deviation, s, are statistics.
  - They are used to estimate the population parameters.

Statistics

- It is a branch of applied mathematics that deals with collecting, organizing, & interpreting data using well-defined procedures in order to make decisions.
- The term parameter is used when describing the characteristics of the population. The term statistics is used to describe the characteristics of the sample.
- Types of Statistics:
  - Descriptive Statistics. It involves organizing, summarizing & displaying data to make them more understandable.
  - Inferential Statistics. It reports the degree of confidence of the sample statistic that predicts the value of the population parameter

Descriptive Statistics

- Measures of Location
  - Measures of Central Tendency:
    - Mean
    - Median
    - Mode
  - Measures of noncentral Tendency-Quantiles:
    - Quartiles.
    - Quintiles.
    - Percentiles.
- Measure of Dispersion (Variability):
  - Range
  - Interquartile range
  - Variance
  - Standard Deviation
  - Coefficient of variation
- Measures of Shape:
  - Mean > Median-positive or right Skewness
  - Mean = Median- symmetric or zero Skewness
  - Mean < Median-Negative of left Skewness

Statistical Inference

- Is the procedure used to reach a conclusion about a population based on the information derived from a sample that has been drawn from that population.

Inferential Statistics

- Inferential statistics are used to test hypotheses (prediction) about relationship between variables in the population. A relationship is a bond or association between variables.
- It consists of a set of statistical techniques that provide prediction about population characteristics based on information in a sample from population. An important aspect of statistical inference involves reporting the likely accuracy, or of confidence of the sample statistic that predicts the value of the population parameter.

Inferential Statistics

- Bivariate Parametric Tests:
  - One Sample t test (t)
  - Two Sample t test (t)
  - Analysis of Variance/ANOVA (F).
  - Pearson's Product Moment Correlations (r).
- Nonparametric statistical tests: Nominal Data:
  - Chi-Square Goodness-of-Fit Test
  - Chi-Square Test of Independence
- Nonparametric statistical tests: Ordinal Data:
  - Mann Whitney U Test (U
  - Kruskal Wallis Test (H)

Research Hypothesis

- A tentative prediction or explanation of the relationship between two or more variables
- It's a translation of research question into a precise prediction of the expected outcomes
- In some way it's a proposal for solution/s
- In qualitative research, there is NO hypothesis

Research Hypothesis

- States a prediction
- Must always involve at least two variables
- Must suggest a predicted relationship between the independent variable and the dependent variable
- Must contain terms that indicate a relationship (e.g., more than, different from, associated with)

Hypotheses Criteria

- Written in a declarative form.
- Written in present tense.
- Contain the population
- Contain variables.
- Reflects problem statement or purpose statement.
- Empirically testable.

Hypothesis Testing

- A hypothesis is made about the value of a parameter, but the only facts available to estimate the true parameter are those provided by the sample. If the statistic differs (and of course it will) from the hypothesis stated about the parameter, a decision must be made as to whether or not this difference is *significant*. If it is, the hypothesis is rejected. If not, it cannot be rejected.
- H_0: The null hypothesis. This contains the hypothesized parameter value which will be compared with the sample value.
- H_1: The alternative hypothesis. This will be "accepted" only if H_0 is rejected.

  Technically speaking, we never accept H_0 What we actually say is that we do not have the evidence to reject it.

Two Types of Errors: Alpha and Beta

- Two types of errors may occur: α (alpha) and ß (beta). The α error is often referred to as a Type I error and ß error as a Type II error.
  - You are guilty of an alpha error if you reject H_0 when it really is true.
  - You commit a beta error if you "accept" H_0 when it is false.

		STATE OF NATURE	
		H_0 Is True	H_0 Is False
DECISION	Do Not Reject H_0	GOOD	ß Error (Type II Error)
	Reject H_0	α Error (Type I Error)	GOOD

Types of Errors

If You……	When the Null Hypothesis is…	Then You Have…….
Reject the null hypothesis	True (there really are no difference)	Made a Type I Error
Reject the null hypothesis	False (there really are difference)	☻
Accept the null hypothesis	False (there really are difference)	Made Type II Error

Steps in Hypothesis Testing

1. Formulate H_0 and H_1. H_0 is the null hypothesis, a hypothesis about the value of a parameter, and H_1 is an alternative hypothesis.

   e.g., H_0: μ=12.7 years; H_1: $\mu \neq$12.7 years
2. Specify the level of significance (α) to be used. This level of significance tells you the probability of rejecting H_0 when it is, in fact, true. (Normally, significance level of 0.05 or 0.01 are used)
3. Select the test statistic: e.g., Z, t, F, etc.
4. Establish the critical value or values of the test statistic needed to reject H_0. DRAW A PICTURE!
5. Determine the actual value (computed value) of the test statistic.
6. Make a decision: **Reject H_0** or **Do Not Reject H_0**.