

SUBJECT:

BIOSTATISTICS

CREDITS:

Total:

9

Theory:

6

Practical:

3

GENERAL OBJECTIVE

To provide students with the basic elements required to know and use descriptive and inferential statistical methods as applied to biomedical sciences.

SPECIFIC OBJECTIVES

- Recognize the measurement scale of the different types of data collected in medical activity.
- Learn how to plan data collection. Tabulate data in rows and columns to facilitate analysis and computerized data management.
- Calculate and interpret measures of central tendency, dispersion and relative position appropriate to the measurement scale. In particular: arithmetic mean, variance and median.
- Tabulate qualitative and quantitative data.
- Use graphical representations to present and examine data.
- Interpret the frequency histogram as an empirical distribution of the values of a variable within a population.
- Use commercial statistical software to describe the variables of a computerized database according to their measurement scale.
- Recognize and describe random experiments. List all the possible outcomes of an experiment (sample space). Evaluate verbal probability expressions.
- Define and calculate the probability of an elementary event associated with a random experiment with no prior information, or one conditioned on another event.
- Calculate the probability of observable compound events through the application of laws of addition and multiplication.
- Interpret medical diagnosis as a process of probabilistic decision. Apply the concept of *conditional probability* to the calculation of sensibility and specificity. Apply Bayes' theorem to the calculation of predictive values.
- Define a random variable using the distribution law. Distinguish between the probability function (or probability density function) and the distribution function.
- Identify the type of random variable associated with biological measures.
- Apply binomial, Poisson and normal distribution models to practical cases. Learn to read probability tables.
- Recognize the importance of random sampling to prevent the appearance of bias in collected data. Identify the sampling technique employed in a given study.
- Define parameter, statistic, estimator and estimation. Use descriptive statistics as estimators of the distribution parameters of a variable.
- Confirm that a sample statistic (proportion, mean or variance) is a random variable by constructing its sampling distribution in a concrete situation. Distinguish between the typical deviation of the studied variable and that of the sample statistic (standard error).
- Obtain point and interval estimates of a proportion, mean and variance. Interpret results expressed in terms of confidence limits.
- Calculate the minimum sample size needed to obtain estimations of population parameters (mean and proportion) with a determined precision and confidence, and interpret the effect on the final inference.
- Identify and formulate the null and alternative hypotheses through hypothesis testing.

- Recognize the type of risk associated with a statistical decision. Define the magnitude of the risk and define its critical region.
- Select the appropriate test statistic for the type of hypothesis and variables in order to reach a statistical decision.
- Understand the degree of significance (P) as a probability conditioned on θ_0 and estimate its value. Know how to make statistical decisions and explain the significance of expressions such as " $P < 0.01$ " or " H_1 is accepted with $\alpha = 0.05$ ".
- Resolve a homogeneity of means using the basic schema of a hypothesis test, using both independent and paired data.
- Resolve homogeneity of variance.
- Carry out and interpret tests of conformity and homogeneity of variables with binomial and multinomial distribution.
- Carry out and interpret homogeneity tests of variables measured on an ordinal scale.
- Understand the statistical concept of *association*. Identify dependent or explained variables and independent or explicative variables.
- Calculate the coefficients that measure the degree of dependence between two variables: a) contingency; b) Pearson correlation; c) Spearman correlation. Interpret coefficients as a measure of intensity of the relationship.
- Interpret the regression line as a model of linear dependence. Use the statistical estimation model as a prediction mechanism.
- Distinguish between the correlation coefficient, regression coefficient (b) and coefficient of determination.
- Use commercial statistical software to carry out a statistical analysis of a computerized database. Identify the elements of a hypothesis test in a computerized list of results (output).

PROGRAMME

Theory

Topic 1. Introduction to biostatistics.

Biological and random variability. Concept of *statistics*: descriptive and inferential. Biomedical data: types and sources.

Topic 2. Descriptive statistics

Descriptive: definition and objectives. Measurement scales. Frequency tables: Measures of central tendency: mean, median and mode. Measures of dispersion: amplitude, variance, typical deviation and coefficient of variation. Measures of shape: asymmetry and kurtosis. Measures of relative position: percentiles. Graphical representation of data.

Topic 3. Probability

Random experiment. Sample space. Event: definition, types and representation. Probability of an event: definition and calculation. Conditional probability. Rules of addition and multiplication. Bayes' theorem. Applications to medical diagnosis.

Topic 4. Probability distributions

Random variable: definition and types. Probability distribution functions: definition, types and properties. Expectation and variance of a random variable: concept and properties. Discrete distribution models: Bernoulli, Binomial and Poisson. Continuous distribution models: Normal, Chi-square, Student-Fisher t and Fisher-Snedecor F . Convergence of distributions: central limit theorem. Bivariate distribution: concept and properties. Covariance.

Topic 5. Estimation of parameters

Population and sample. Sampling techniques. Parameter, estimator and estimation. Sampling distribution of an estimator: properties. Point estimation and interval estimation. Determination of sample size. Estimator of proportion parameter. Estimator of mean parameter. Estimator of variance parameter.

Topic 6. Hypothesis testing

General approach to a hypothesis test. Types of hypothesis test: conformity, homogeneity and independence. Types of hypothesis: null and alternative. Error types (I and II) and associated probabilities (α and β risk). Critical region. Power. One-sided and two-sided hypothesis tests. Level and degree of significance.

Topic 7. Conformity tests

Testing for conformity of a distribution: binomial, multinomial and normal. Testing for conformity of parameters: proportion, mean and variance.

Topic 8. Homogeneity tests

Testing for homogeneity of proportions: independent data and paired data. Testing for homogeneity of variance (independent data). Parametric and nonparametric homogeneity tests of two means (independent and paired data).

Topic 9. Independence tests

Independence tests between qualitative variables. Measures of intensity of the relationship. Independence tests between qualitative variables. parametric and nonparametric. Simple linear regression: coefficient of determination and regression line.

Practical training

(A = autonomous)

- Topic 1. Data and Measures
- Topic 2. Descriptive statistics I
- Topic 3. Descriptive statistics II (A)
- Topic 4. Probability: definition and calculation
- Topic 5. Probability distributions
- Topic 6. Applications of probability
- Topic 7. Sampling and sampling distribution.
- Topic 8. Estimation of parameters
- Topic 9. Hypothesis tests: elements and example
- Topic 10. Homogeneity of means
- Topic 11. Analysis of qualitative data
- Topic 12. Nonparametric tests
- Topic 13. Solving practical cases (A)
- Topic 14. Measures of association between variables
- Topic 15. Linear relationship between quantitative variables

LEARNING REQUIREMENTS

Students should have a pocket calculator available for the duration of the course and be familiar with its functions. Almost all calculators are supplied with an instruction manual that explain the most common functions (preferably data entry for calculating basic statistical functions).