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USING MATHEMATIC-STATISTICAL METHODS IN MEDICAL RESEARCH FOR RAPID DIAGNOSIS

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Abstract
To identify patterns and relationships between various indicators in medicine, it is necessary to apply specific methods of processing experimental data, as well as to have knowledge of the fundamentals of biometrics and mathematical statistics. Statistics in medicine is one of the key tools for analyzing experimental data and clinical observations, as well as the language through which mathematical results are communicated. The mathematical framework is widely used for diagnostic purposes, solving classification problems, and discovering new patterns, as well as for formulating new scientific hypotheses. The use of statistical software requires knowledge of the fundamental methods and stages of statistical analysis, including their sequence, necessity, and sufficiency.

Keywords: Medical experiment, statistics, database, mathematical data processing, chi-square, modern clinical practice, disease development prediction.

Introduction

With the development of evidence-based medicine and digitalization of healthcare, the need for an objective assessment of the effectiveness of treatment measures is increasing. Traditional subjective approaches are giving way to scientifically based methods based on quantitative analysis. Mathematical statistics provides tools for accurate analysis of clinical data, allowing to identify reliable dependencies and reasonably evaluate the results of therapy.

Statistics in medicine is one of the tools for analyzing experimental data and clinical observations, as well as the language used to communicate the obtained mathematical results. The mathematical apparatus is widely used for diagnostic purposes, solving classification problems and searching for new patterns, for formulating new scientific hypotheses. The use of statistical programs requires knowledge of the basic methods and stages of statistical analysis: their sequence, necessity and sufficiency.

Objective

To evaluate the effectiveness of treatment measures using mathematical statistics methods in order to increase the reliability of conclusions and optimize treatment approaches in clinical practice.

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Methods

The work uses the main methods of mathematical statistics:

• descriptive statistics (mean, standard deviation, median);

• significance criteria (Student's t-test, χ^2-test, ANOVA);

• correlation and regression analysis to identify relationships between variables;

• survival analysis (for example, the Kaplan-Meier method, log-rank test) in the case of long-term observations;

• data visualization (histograms, boxplots, scatter plots).

The methods are applied based on data obtained from clinical observations or controlled studies. Statistical processing of medical research is based on the principle that what is true for a random sample is also true for the general population from which this sample was obtained. Statistical data can be presented as quantitative (numeric continuous or discrete) and qualitative (categorical ordinal or nominal) variables.

It is necessary to clearly indicate the type (kind) of the variable when filling out the database and strictly adhere to the selected data type, since further processing of variables in many currently used statistical programs may depend on this.

Quantitative (numeric) data assume that the variable takes on a certain numerical value. From these, discrete data are distinguished, which can take strictly defined values, while continuous data can be represented by any values.

A unique example of quantitative data is the representation of age in two types: as a continuous variable - the exact age of the patient is indicated, and as a discrete variable - only the number of full years is indicated (50.3 years and 50 years; 50.9 years and 51 years).

Categoricality is the basis for the semantic understanding of qualitative variables. Categorical data are used to describe the state of an object by assigning it a number corresponding to the category to which this object belongs. An important condition for the use of categorical data is the belonging of one research object to only one possible category for one criterion. Qualitative nominal data are used if the categories are not ordered. The numbers in this case are only a designation for the state of the object and do not order this state. For example, by gender: 1 - male, 2 - female.

Qualitative ordinal (rank, ordinary) data - data for which categories can be ordered. For example, from poor health to good: 1 - good, 2 - satisfactory, 3 - poor. In practice, quantitative data are often converted to a qualitative categorical ordered representation, especially when calculating cut-off values for subsequent calculations of risk characteristics or prognostic significance using a contingency table. For example, 1 - total cholesterol concentration is less than or equal to 5.2 mmol / l (risk ratio for the development of coronary heart disease is less than 1, the prognostic value of a positive result is more than 80%), 2 - total cholesterol concentration is more than 5.2 mmol / l (risk ratio for the development of coronary heart disease is more than 1, the prognostic value of a positive result is more than 80%). In the practice of processing the results of the conducted studies, two types of statistical data analysis are used - primary (planned) and secondary (unplanned).

Primary data analysis is used to study and describe patterns, the existence of which is assumed by the researcher, and which are actually the hypothesis of the study. In this case, the features

are analyzed, the study of which is taken into account when planning the study, and pre-formulated hypotheses are tested.

Secondary data analysis is used to form the prospects of the conducted study, search, exploration of potential patterns and hypotheses. In this case, "sifting" of data not planned for a specific work is performed, which is often advisable already at the first stage of familiarization with the data. One of the main components of any data analysis is descriptive statistics (descriptive statistics). Its main task is to provide a condensed and concentrated characteristic of the phenomenon under study in numerical and graphical form.

Descriptive statistics indicators can be divided into several groups: - position indicators describing the position of experimental data on the numerical axis. Examples of such data are the maximum and minimum sample elements, average value, median, mode, etc .; - dispersion indicators describing the degree of dispersion of data relative to the central tendency. These include: sample dispersion, the difference between the minimum and maximum elements (range, sample interval), etc.; - asymmetry indicators: the position of the median relative to the mean, etc.; - graphical representations of the results - histogram, frequency diagram, etc.

These indicators are used for visual presentation and analysis of the results of the entire research sample, experimental and control groups. When using descriptive statistics, it is important to take into account the type of data and distribution parameters, characterized by asymmetry indicators and the distribution histogram.

The most frequently used criteria for testing the hypothesis about the distribution law are the Pearson criterion, the $\chi 2$ criterion and the Kolmogorov-Smirnov criterion: if the distribution of the feature in the studied sample differs from the normal distribution with statistical significance of less than 0.05 ($p<0.05$), the distribution of the feature in the sample is recognized as abnormal, and vice versa.

The main types of feature distributions are: discrete (for discrete features - binomial, Poisson distribution, Bernoulli distribution) and continuous (for continuous features - normal (Gaussian, or Gaussian distribution), lognormal, constant, exponential, chi-square $\chi 2$). In accordance with the type of distribution, two principles of statistical processing are used: 8 parametric and nonparametric. The parametric principle includes all methods of analyzing normally distributed quantitative characteristics. The nonparametric principle is used in all other cases - for analyzing quantitative characteristics regardless of their type of distribution and for analyzing qualitative characteristics.

CONCLUSION

The use of mathematical and statistical methods in the analysis of treatment results allows to ensure the objectivity and scientific validity of clinical conclusions. This contributes to an accurate assessment of the effectiveness of therapy, the identification of significant factors affecting the outcome of treatment, and the formation of a personalized approach to the patient. Thus, statistical analysis becomes an integral part of modern medical research and practice, ensuring high quality of medical care.

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