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POLISH JOURNAL OF PHYSIOTHERAPY

OFICJALNE PISMO POLSKIEGO TOWARZYSTWA FIZJOTERAPII

THE OFFICIAL JOURNAL OF THE POLISH SOCIETY OF PHYSIOTHERAPY

NR 5/2023 (23) KWARTALNIK ISSN 1642-0136

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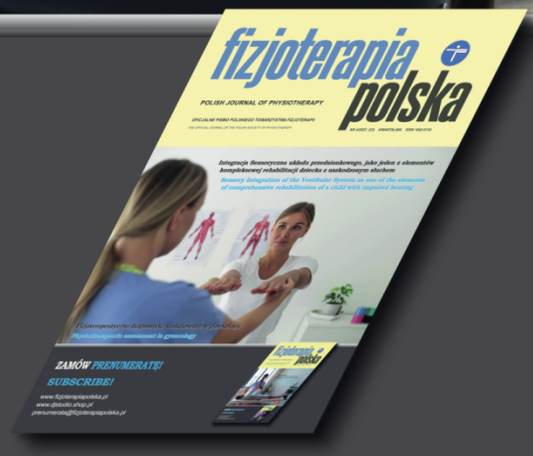

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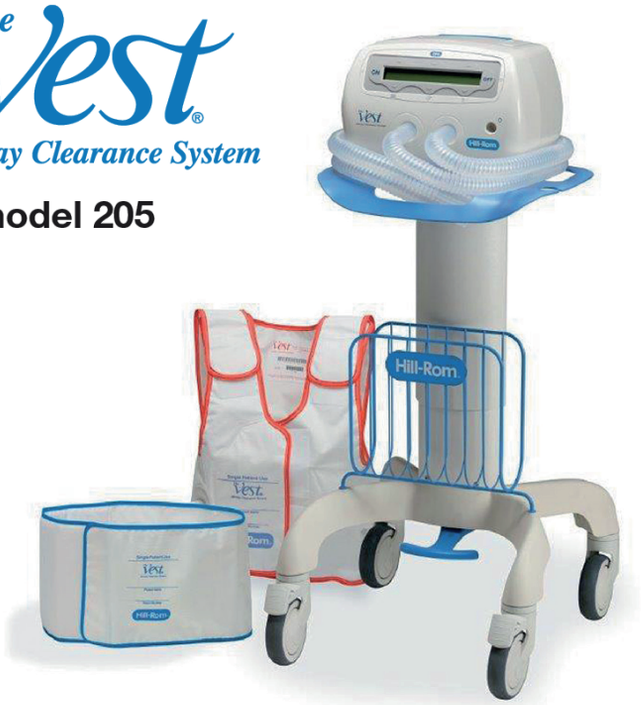

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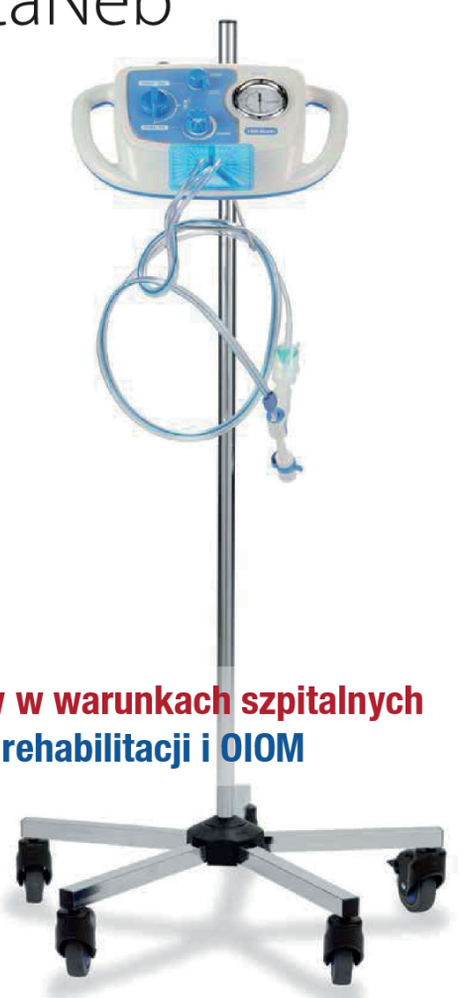

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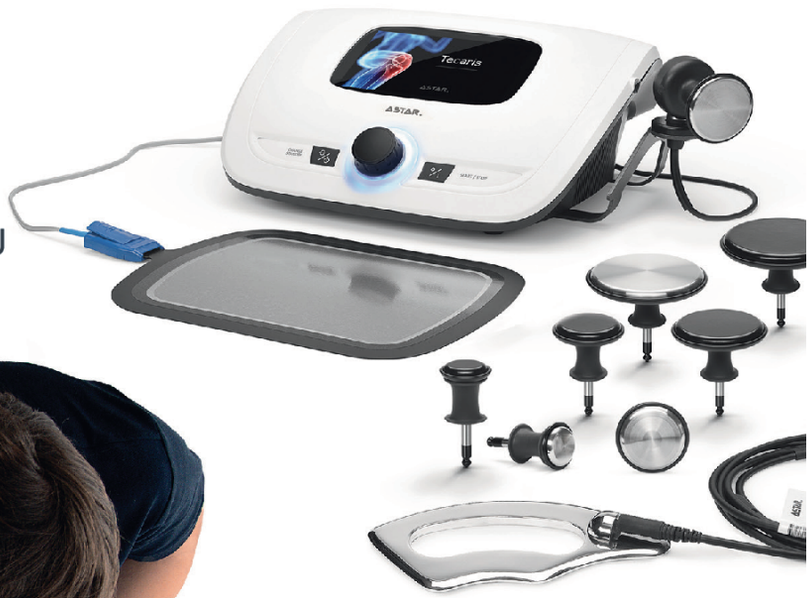

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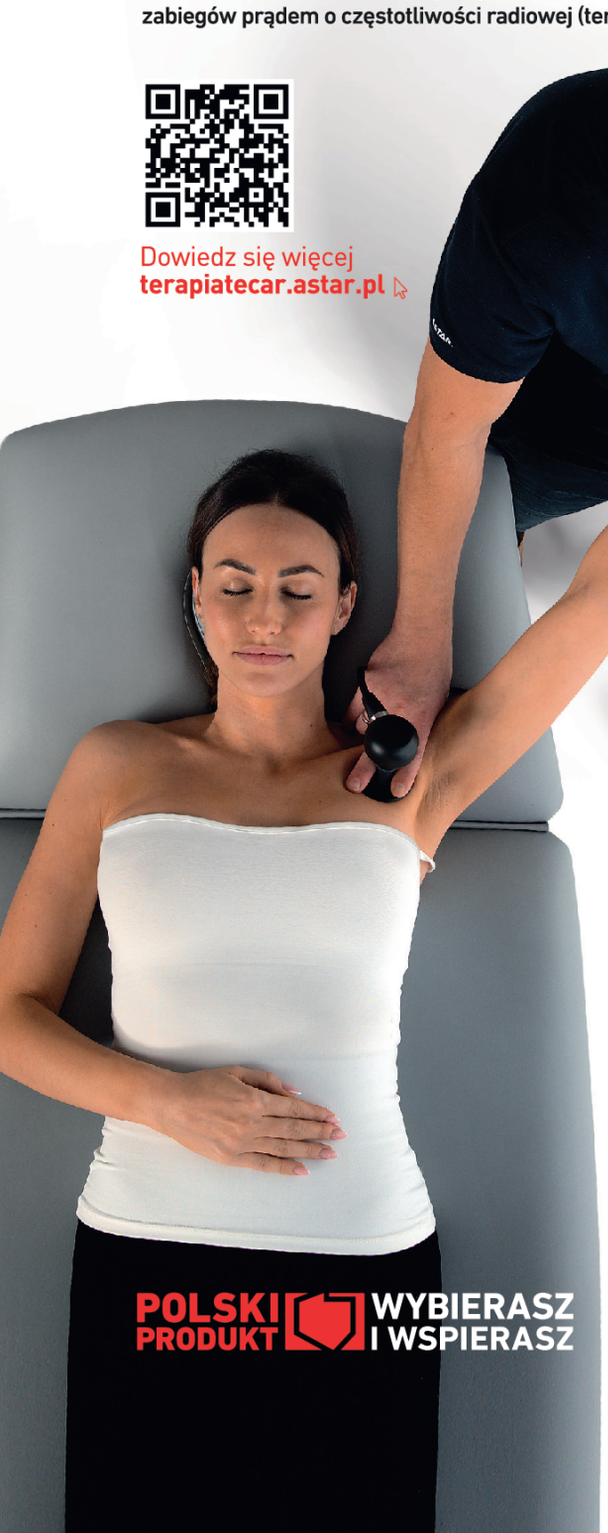

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fizjoterapia polska
nr 5/2023 (23)

Big Data and medical statistics in physiotherapy

Big Data i statystyka medyczna w fizjoterapii

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Abstract

Making decisions is a difficult task in everyone's life. Physiotherapists in the practice of their profession may need access to valuable information that will help them make more accurate decisions and understand the patterns observed in the collected data. Big Data and medical statistics can help here. The purpose of this article is to bring this topic closer.

Key words:

Big Data, medical statistics, decision making

Streszczenie

Podejmowanie decyzji jest trudnym zadaniem w życiu każdej osoby. Fizjoterapeuci podczas wykonywania swojego zawodu mogą potrzebować dostępu do cennych informacji, które pomogą im w trafniejszym podjęciu decyzji oraz w zrozumieniu prawidłowości obserwowanych w zebranych danych. Pomocne w tym może być Big Data oraz statystyka medyczna. Celem niniejszego artykułu jest przybliżenie tej tematyki.

Słowa kluczowe:

Big Data, statystyka medyczna, podejmowanie decyzji

Introduction

With the advancement of technology, there's a growing need for appropriate data processing, analysis, and informed decision-making. In the healthcare system, data volumes are expanding due to the significant amounts of recorded observations and parameters. These large datasets are known as Big Data. Proper utilization of these datasets, including in the field of physiotherapy, enables the identification of areas needing improvement in therapy or innovative methods. Data analysis can also help improve patient care quality, monitor the safety of the treatment process, and counteract patient risks. This paper aims to introduce the concepts of Big Data and medical statistics, which can be useful and interesting for any physiotherapist seeking to improve their healthcare services based on collected data.

doi.org/10.56984/8ZG20BAB4

Big Data

Defining Big Data unambiguously is not straightforward. The concept has evolved over the years and is understood in various ways. It can be seen as a large set of data generated at a significant pace, containing vast amounts of information [1]. The data can come from diverse sources, such as social networks, websites, sensors, and other monitoring devices. Four primary characteristics distinguish Big Data sets:

- volume: significant amount/volume of data;
- variety: diverse types of data;
- velocity: high variability and speed at which new observations arrive;
- value: benefits from the possibility of data analysis.

In the healthcare sector, competition among providers means that proper data analysis on medical activities can be an invaluable advantage and assist in choosing the right way to provide healthcare services. Properly utilized Big Data can even indicate the probability of disease development or the consequences of dangerous patient behaviors [2]. The Big Data processing process can be divided into several stages:

1. Selection: Choosing data based on specific characteristics of the units studied, such as age. Data sources can vary from targeted studies to electronic databases;
2. Preliminary processing: Initial analysis of selected observations, discarding unnecessary data, such as irrelevant eye color information. This stage uses data tables, data warehouses, and the ETL (Extract Transform Load) process;
3. Transformation: Converting selected observations and choosing data ranges according to needs, such as calculating someone's age from their birth date and selecting only individuals aged 18–50. Platforms and tools like Hadoop, HBase, Cassandra, etc., are helpful at this stage;
4. Exploration: Discovering knowledge from a chosen data set, searching for patterns, calculating statistics, and using predictive models to indicate disease frequency and probability. Various statistical software and Business Intelligence tools are used, performing calculations on computers or in the cloud.

Types of data used in medical statistics

In medical statistics, data from various sources are used: research results, observations, or perceptions. They can be divided into quantitative data (also called numerical, e.g., age, height, weight, blood pressure values) and qualitative data (also called descriptive, e.g., gender, education level, skin, hair, or eye color). This distinction is important due to the different analysis methods for quantitative and qualitative data, where only the former allows for mathematical calculations like averages, differences, or maximum and minimum values [3]. Data can be further divided based on the distances between measurement results and the direction of intensity growth of a characteristic. This basis distinguishes data with an interval scale (where the

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distance between points is identical regardless of nominal value, e.g., the age difference between 20 and 25 is the same as between 45 and 50), a nominal scale (where comparing observations provides no information and it's not possible to determine which value is "better" or "worse," e.g., male and female genders, blue, green, or brown eye color), and an ordinal scale (where the obtained data can be divided into categories and determine the direction of intensity growth of a characteristic, e.g., pain severity: mild, moderate, and severe).
Data used in analysis can also be divided based on the number of individuals studied. On this basis, full studies, which include all units belonging to a particular population, and partial studies, where data come from observing only part of the population, are distinguished [4]. The former usually takes the form of a census or statistical register, while the latter uses representative, monographic, or survey methods to determine units for the sample. Due to the high costs and difficulties in accessing, for example, all citizens of a country, many studies use information from partial studies.

The popular representative method requires applying an appropriate procedure in choosing the sample. In purposive selection, units are chosen based on their characteristics and the researcher's decision. In random selection, units are chosen randomly, but each unit has a certain probability of being in the sample, and the researcher only indicates the method of drawing the sample.

Statistical description of observations

After collecting data, it's possible to conduct their analysis. One of the fundamental elements of the study is the use of descriptive statistics. Several groups of measures are available [5]:

1. Average measures – useful for comparing populations or characteristics:
a. Classical measures – of an abstract nature;
i. Arithmetic mean – the sum of the characteristic values of all units divided by the population size,
ii. Harmonic mean – used when characteristic values are expressed per constant unit of another characteristic,
iii. Geometric mean – indicates the growth rate of a characteristic needed to achieve the highest value;
b. Positional measures – related to the place a given value occupies in the population;
i. Mode – the most frequently occurring characteristic value in the population;
ii. Quantiles – dividing the population into two parts in specified proportions;
2. Dispersion measures – measuring the degree of variability of the characteristic's values:
a. Variance and standard deviation – measuring the arithmetic mean of the squares of deviations of the characteristic's values from the mean for the population;
b. Range of variability and coefficient of variability – indicating the range from which at least half of the units take their value;

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3. Measures of asymmetry and concentration – indicating the shape of the characteristic value distribution in the population.
The mentioned measures used in medical statistics can help better understand the regularities in the collected observations. Some of them are used to create or compare the results of econometric models, which serve for forecasting or better understanding of a phenomenon.

Econometric modeling
To understand how the analyzed characteristics of a given set are interdependent, econometric modeling can be used. Thanks to the development of computer science and increased computational power, even very complex models using significant data volumes can be created. To create a useful and correct econometric model, it's necessary to apply a procedure consisting of specific steps, sometimes performed repeatedly until the best possible model is obtained. The model creation scheme includes the following steps [2]:

1. Defining the research goal – defining what the study should indicate and what kind of observations are expected;
2. Specification of variables and data collection – choosing necessary observations and characteristics, assessing basic statistics, and eliminating variables and observations that do not meet research requirements;
3. Choosing the model class – defining the model's form (linear, nonlinear), number of model functions (single or multi-equation), number and type of explanatory variables (one or many variables of quantitative or qualitative nature), determining the role of time in the model (static or dynamic model);
4. Estimation of structural parameters – the estimation method depends on the model's form, for example, linear models can be estimated using the classic least squares method;
5. Model verification – indicating whether the obtained model meets the assumptions, possible use of both visual assessment of charts based on the model and specific statistical tests;
6. Inference based on the model – depending on the model's form, it's possible to determine forecasts or indicate relationships between the used variables.

Most of the mentioned stages can be performed using free or paid programming languages and software, such as R, Python, SPSS, or SAS. The choice of a specific tool depends on the researcher's preferences and hardware and financial capabilities. Most programming languages used in econometric modeling contain similar sets of ready-made functions and statistical tests for building models.

Summary and conclusions
Tools using Big Data and statistical methods can bring invaluable information to anyone who uses them appropriately. Physiotherapists who would like to better understand the factors affecting their patients' health or more accurately understand how healthcare services can be improved can use

doi.org/10.56984/8ZG20BAB4

these techniques for a better understanding of available data. Proper data analysis can lead to more accurate decisions and a better understanding of what might happen in the future.

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