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ЕЖЕМЕСЯЧНЫЙ НАУЧНЫЙ ЖУРНАЛ

Медицинские новости Грузии

საქართველოს სამედიცინო სიახლენი

GEORGIAN MEDICAL NEWS

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GMN: Georgian Medical News is peer-reviewed, published monthly journal committed to promoting the science and art of medicine and the betterment of public health, published by the GMN Editorial Board since 1994. GMN carries original scientific articles on medicine, biology and pharmacy, which are of experimental, theoretical and practical character; publishes original research, reviews, commentaries, editorials, essays, medical news, and correspondence in English and Russian.
GMN is indexed in MEDLINE, SCOPUS, PubMed and VINITI Russian Academy of Sciences. The full text content is available through EBSCO databases.

GMN: Медицинские новости Грузии - ежемесячный рецензируемый научный журнал, издаётся Редакционной коллегией с 1994 года на русском и английском языках в целях поддержки медицинской науки и улучшения здравоохранения. В журнале публикуются оригинальные научные статьи в области медицины, биологии и фармации, статьи обзорного характера, научные сообщения, новости медицины и здравоохранения. Журнал индексируется в MEDLINE, отражён в базе данных SCOPUS, PubMed и ВИНИТИ РАН. Полнотекстовые статьи журнала доступны через БД EBSCO.

GMN: Georgian Medical News – საქართველოს სამედიცინო სიახლენი – არის ყოველთვიური სამეცნიერო სამედიცინო რეცენზირებადი ჟურნალი, გამოიცემა 1994 წლიდან, წარმოადგენს სარედაქციო კოლეგიისა და აშშ-ის მეცნიერების, განათლების, ინდუსტრიის, ხელოვნებისა და ბუნებისმეტყველების საერთაშორისო აკადემიის ერთობლივ გამოცემას. GMN-ში რუსულ და ინგლისურ ენებზე ქვეყნდება ექსპერიმენტული, თეორიული და პრაქტიკული ხასიათის ორიგინალური სამეცნიერო სტატიები მედიცინის, ბიოლოგიისა და ფარმაციის სფეროში, მიმოხილვითი ხასიათის სტატიები.
ჟურნალი ინდექსირებულია MEDLINE-ის საერთაშორისო სისტემაში, ასახულია SCOPUS-ის, PubMed-ის და ВИНИТИ РАН-ის მონაცემთა ბაზებში. სტატიების სრული ტექსტი ხელმისაწვდომია EBSCO-ს მონაცემთა ბაზებიდან.

WEBSITE

www.geomednews.com

К СВЕДЕНИЮ АВТОРОВ!

При направлении статьи в редакцию необходимо соблюдать следующие правила:

1. Статья должна быть представлена в двух экземплярах, на русском или английском языках, напечатанная через **полтора интервала на одной стороне стандартного листа с шириной левого поля в три сантиметра**. Используемый компьютерный шрифт для текста на русском и английском языках - **Times New Roman** (**Кириллица**), для текста на грузинском языке следует использовать **AcadNusx.** Размер шрифта - **12**. К рукописи, напечатанной на компьютере, должен быть приложен CD со статьей.

2. Размер статьи должен быть не менее десяти и не более двадцати страниц машинописи, включая указатель литературы и резюме на английском, русском и грузинском языках.

3. В статье должны быть освещены актуальность данного материала, методы и результаты исследования и их обсуждение.

При представлении в печать научных экспериментальных работ авторы должны указывать вид и количество экспериментальных животных, применявшиеся методы обезболивания и усыпления (в ходе острых опытов).

4. К статье должны быть приложены краткое (на полстраницы) резюме на английском, русском и грузинском языках (включающее следующие разделы: цель исследования, материал и методы, результаты и заключение) и список ключевых слов (key words).

5. Таблицы необходимо представлять в печатной форме. Фотокопии не принимаются. **Все цифровые, итоговые и процентные данные в таблицах должны соответствовать таковым в тексте статьи**. Таблицы и графики должны быть озаглавлены.

6. Фотографии должны быть контрастными, фотокопии с рентгенограмм - в позитивном изображении. Рисунки, чертежи и диаграммы следует озаглавить, пронумеровать и вставить в соответствующее место текста **в tiff формате**.

В подписях к микрофотографиям следует указывать степень увеличения через окуляр или объектив и метод окраски или импрегнации срезов.

7. Фамилии отечественных авторов приводятся в оригинальной транскрипции.

8. При оформлении и направлении статей в журнал МНГ просим авторов соблюдать правила, изложенные в «Единых требованиях к рукописям, представляемым в биомедицинские журналы», принятых Международным комитетом редакторов медицинских журналов - http://www.spinesurgery.ru/files/publish.pdf и http://www.nlm.nih.gov/bsd/uniform_requirements.html
В конце каждой оригинальной статьи приводится библиографический список. В список литературы включаются все материалы, на которые имеются ссылки в тексте. Список составляется в алфавитном порядке и нумеруется. Литературный источник приводится на языке оригинала. В списке литературы сначала приводятся работы, написанные знаками грузинского алфавита, затем кириллицей и латиницей. Ссылки на цитируемые работы в тексте статьи даются в квадратных скобках в виде номера, соответствующего номеру данной работы в списке литературы. Большинство цитированных источников должны быть за последние 5-7 лет.

9. Для получения права на публикацию статья должна иметь от руководителя работы или учреждения визу и сопроводительное отношение, написанные или напечатанные на бланке и заверенные подписью и печатью.

10. В конце статьи должны быть подписи всех авторов, полностью приведены их фамилии, имена и отчества, указаны служебный и домашний номера телефонов и адреса или иные координаты. Количество авторов (соавторов) не должно превышать пяти человек.

11. Редакция оставляет за собой право сокращать и исправлять статьи. Корректура авторам не высылается, вся работа и сверка проводится по авторскому оригиналу.

12. Недопустимо направление в редакцию работ, представленных к печати в иных издательствах или опубликованных в других изданиях.

При нарушении указанных правил статьи не рассматриваются.

REQUIREMENTS

Please note, materials submitted to the Editorial Office Staff are supposed to meet the following requirements:

1. Articles must be provided with a double copy, in English or Russian languages and typed or compu-ter-printed on a single side of standard typing paper, with the left margin of **3** centimeters width, and **1.5** spacing between the lines, typeface - **Times New Roman** (**Cyrillic**), print size - **12** (referring to Georgian and Russian materials). With computer-printed texts please enclose a CD carrying the same file titled with Latin symbols.

2. Size of the article, including index and resume in English, Russian and Georgian languages must be at least 10 pages and not exceed the limit of 20 pages of typed or computer-printed text.

3. Submitted material must include a coverage of a topical subject, research methods, results, and review.

Authors of the scientific-research works must indicate the number of experimental biological species drawn in, list the employed methods of anesthetization and soporific means used during acute tests.

4. Articles must have a short (half page) abstract in English, Russian and Georgian (including the following sections: aim of study, material and methods, results and conclusions) and a list of key words.

5. Tables must be presented in an original typed or computer-printed form, instead of a photocopied version. **Numbers, totals, percentile data on the tables must coincide with those in the texts of the articles.** Tables and graphs must be headed.

6. Photographs are required to be contrasted and must be submitted with doubles. Please number each photograph with a pencil on its back, indicate author's name, title of the article (short version), and mark out its top and bottom parts. Drawings must be accurate, drafts and diagrams drawn in Indian ink (or black ink). Photocopies of the X-ray photographs must be presented in a positive image in **tiff format**.

Accurately numbered subtitles for each illustration must be listed on a separate sheet of paper. In the subtitles for the microphotographs please indicate the ocular and objective lens magnification power, method of coloring or impregnation of the microscopic sections (preparations).

7. Please indicate last names, first and middle initials of the native authors, present names and initials of the foreign authors in the transcription of the original language, enclose in parenthesis corresponding number under which the author is listed in the reference materials.

8. Please follow guidance offered to authors by The International Committee of Medical Journal Editors guidance in its Uniform Requirements for Manuscripts Submitted to Biomedical Journals publication available online at: http://www.nlm.nih.gov/bsd/uniform_requirements.html
http://www.icmje.org/urm_full.pdf
In GMN style for each work cited in the text, a bibliographic reference is given, and this is located at the end of the article under the title "References". All references cited in the text must be listed. The list of references should be arranged alphabetically and then numbered. References are numbered in the text [numbers in square brackets] and in the reference list and numbers are repeated throughout the text as needed. The bibliographic description is given in the language of publication (citations in Georgian script are followed by Cyrillic and Latin).

9. To obtain the rights of publication articles must be accompanied by a visa from the project instructor or the establishment, where the work has been performed, and a reference letter, both written or typed on a special signed form, certified by a stamp or a seal.

10. Articles must be signed by all of the authors at the end, and they must be provided with a list of full names, office and home phone numbers and addresses or other non-office locations where the authors could be reached. The number of the authors (co-authors) must not exceed the limit of 5 people.

11. Editorial Staff reserves the rights to cut down in size and correct the articles. Proof-sheets are not sent out to the authors. The entire editorial and collation work is performed according to the author's original text.

12. Sending in the works that have already been assigned to the press by other Editorial Staffs or have been printed by other publishers is not permissible.

Articles that Fail to Meet the Aforementioned Requirements are not Assigned to be Reviewed.

ავტორთა საყურადღებოდ!

რედაქციაში სტატიის წარმოდგენისას საჭიროა დავიცვათ შემდეგი წესები:

1. სტატია უნდა წარმოადგინოთ 2 ცალად, რუსულ ან ინგლისურ ენებზე,დაბეჭდილი სტანდარტული ფურცლის 1 გვერდზე, 3 სმ სიგანის მარცხენა ველისა და სტრიქონებს შორის 1,5 ინტერვალის დაცვით. გამოყენებული კომპიუტერული შრიფტი რუსულ და ინგლისურენოვან ტექსტებში - **Times New Roman (Кириллица)**, ხოლო ქართულენოვან ტექსტში საჭიროა გამოვიყენოთ **AcadNusx.** შრიფტის ზომა – 12. სტატიას თან უნდა ახლდეს CD სტატიით.

2. სტატიის მოცულობა არ უნდა შეადგენდეს 10 გვერდზე ნაკლებს და 20 გვერდზე მეტს ლიტერატურის სიის და რეზიუმეების (ინგლისურ,რუსულ და ქართულ ენებზე) ჩათვლით.

3. სტატიაში საჭიროა გაშუქდეს: საკითხის აქტუალობა; კვლევის მიზანი; საკვლევი მასალა და გამოყენებული მეთოდები; მიღებული შედეგები და მათი განსჯა. ექსპერიმენტული ხასიათის სტატიების წარმოდგენისას ავტორებმა უნდა მიუთითონ საექსპერიმენტო ცხოველების სახეობა და რაოდენობა; გაუტკივარებისა და დაძინების მეთოდები (მწვავე ცდების პირობებში).

4. სტატიას თან უნდა ახლდეს რეზიუმე ინგლისურ, რუსულ და ქართულ ენებზე არანაკლებ ნახევარი გვერდის მოცულობისა (სათაურის, ავტორების, დაწესებულების მითითებით და უნდა შეიცავდეს შემდეგ განყოფილებებს: მიზანი, მასალა და მეთოდები, შედეგები და დასკვნები; ტექსტუალური ნაწილი არ უნდა იყოს 15 სტრიქონზე ნაკლები) და საკვანძო სიტყვების ჩამონათვალი (key words).

5. ცხრილები საჭიროა წარმოადგინოთ ნაბეჭდი სახით. ყველა ციფრული, შემაჯამებელი და პროცენტული მონაცემები უნდა შეესაბამებოდეს ტექსტში მოყვანილს.

6. ფოტოსურათები უნდა იყოს კონტრასტული; სურათები, ნახაზები, დიაგრამები - დასათაურებული, დანომრილი და სათანადო ადგილას ჩასმული. რენტგენოგრამების ფოტოასლები წარმოადგინეთ პოზიტიური გამოსახულებით **tiff** ფორმატში. მიკროფოტოსურათების წარწერებში საჭიროა მიუთითოთ ოკულარის ან ობიექტივის საშუალებით გადიდების ხარისხი, ანათალების შეღებვის ან იმპრეგნაციის მეთოდი და აღნიშნოთ სურათის ზედა და ქვედა ნაწილები.

7. სამამულო ავტორების გვარები სტატიაში აღინიშნება ინიციალების თანდართვით, უცხოურისა – უცხოური ტრანსკრიპციით.

8. სტატიას თან უნდა ახლდეს ავტორის მიერ გამოყენებული სამამულო და უცხოური შრომების ბიბლიოგრაფიული სია (ბოლო 5-8 წლის სიღრმით). ანბანური წყობით წარმოდგენილ ბიბლიოგრაფიულ სიაში მიუთითეთ ჯერ სამამულო, შემდეგ უცხოელი ავტორები (გვარი, ინიციალები, სტატიის სათაური, ჟურნალის დასახელება, გამოცემის ადგილი, წელი, ჟურნალის №, პირველი და ბოლო გვერდები). მონოგრაფიის შემთხვევაში მიუთითეთ გამოცემის წელი, ადგილი და გვერდების საერთო რაოდენობა. ტექსტში კვადრატულ ფჩხილებში უნდა მიუთითოთ ავტორის შესაბამისი N ლიტერატურის სიის მიხედვით. მიზანშეწონილია, რომ ციტირებული წყაროების უმეტესი ნაწილი იყოს 5-6 წლის სიღრმის.

9. სტატიას თან უნდა ახლდეს: ა) დაწესებულების ან სამეცნიერო ხელმძღვანელის წარდგინება, დამოწმებული ხელმოწერითა და ბეჭდით; ბ) დარგის სპეციალისტის დამოწმებული რეცენზია, რომელშიც მითითებული იქნება საკითხის აქტუალობა, მასალის საკმაობა, მეთოდის სანდოობა, შედეგების სამეცნიერო-პრაქტიკული მნიშვნელობა.

10. სტატიის ბოლოს საჭიროა ყველა ავტორის ხელმოწერა, რომელთა რაოდენობა არ უნდა აღემატებოდეს 5-ს.

11. რედაქცია იტოვებს უფლებას შეასწოროს სტატია. ტექსტზე მუშაობა და შეჯერება ხდება საავტორო ორიგინალის მიხედვით.

12. დაუშვებელია რედაქციაში ისეთი სტატიის წარდგენა, რომელიც დასაბეჭდად წარდგენილი იყო სხვა რედაქციაში ან გამოქვეყნებული იყო სხვა გამოცემებში.

აღნიშნული წესების დარღვევის შემთხვევაში სტატიები არ განიხილება.

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STATISTICAL TEACHING ON BUILDING STROKE PREDICTION MODELS

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Abstract.

This paper comprehensively elaborates on a statistical teaching design that is intricately centered around the construction of stroke prediction models. Stroke, being one of the foremost causes of death and disability on a global scale, necessitates the development of accurate prediction models, which carry substantial clinical value. This teaching design is meticulously crafted to not only endow students with practical statistical skills but also to deepen their comprehension of the medical applications of statistics. By doing so, it aims to cultivate cross - disciplinary talents who are proficient in both statistical and medical knowledge, equipping them to contribute effectively to the field of medical data analysis and stroke prevention.

Key words. Stroke prediction model, statistical teaching, cross - disciplinary education.

Introduction.

Stroke is a leading cause of death and disability in globally and particularly in low- and middle-income countries, and this burden is increasing [1-4]. The stroke burden will probably continue to grow across the world [5-8]. Stroke is the second leading cause of death globally, surpassed only by ischemic heart disease. It is characterized by five key features: a high incidence rate, a high disability rate, a high mortality rate, a high recurrence rate, and a significant economic burden. As the leading cause of adult disability worldwide, stroke affects over 13 million new cases each year. The residual neurological dysfunction and socio-economic burden associated with stroke present major challenges in the field of public health in the 21st century [9-13]. Stroke, a complex cerebrovascular disease, poses a grave and persistent threat to human health. It has a profound impact on individuals, families, and society at large, not only in terms of mortality but also in causing long - term disability. The development of reliable stroke prediction models has emerged as a crucial area of research and practice. Such models can play a pivotal role in accurately identifying high - risk populations. Through early identification, preventive measures can be implemented, and timely medical interventions can be carried out, potentially reducing the incidence and severity of strokes.

In the contemporary educational landscape, there is a growing emphasis on interdisciplinary education. Integrating real - world medical cases like stroke into statistical teaching serves multiple purposes. Statistics education is a necessary element of education [14]. Firstly, it transforms abstract statistical knowledge into a more tangible and practical form. Students can better understand how statistical methods are applied in real - life scenarios, rather than just learning theoretical concepts in isolation. Secondly, it meets the increasing demand for compound talents in the medical and statistical fields. As the healthcare industry becomes more data - driven, professionals who can bridge the gap between medicine and statistics are highly sought after. By incorporating stroke - related content into statistical teaching, students are exposed to the challenges and opportunities at the intersection of these two disciplines.

Teaching Objectives.

Knowledge-level Objectives: Students are expected to achieve a comprehensive mastery of basic statistical concepts. Probability, which forms the foundation of statistical reasoning, will be explored in depth. They will learn about different probability distributions and how they apply to various medical phenomena related to stroke. Correlation analysis will be taught, enabling students to understand the relationships between different risk factors associated with stroke, such as the correlation between high blood pressure and the likelihood of stroke occurrence. Regression analysis, a fundamental tool in statistical modeling, will be a core focus. Students will be introduced to simple linear regression, understanding how to model the relationship between a single independent variable (e.g., age) and the dependent variable (risk of stroke).Students predicted through statistical software analysis that hypertension, heart disease, diabetes, dyslipidemia, high salt diet and some meat diet, drinking, lack of exercise and homocysteine will increase the risk of stroke. Furthermore, they should gain a deep understanding of the statistical principles underlying stroke prediction models. Logistic regression, which is particularly useful for predicting binary outcomes such as the occurrence or non - occurrence of stroke, will be explained in detail. Students will learn how to estimate the odds ratios and interpret the coefficients in the context of stroke risk factors. Survival analysis, which is essential for analyzing time - to - event data (such as the time from the onset of certain risk factors to the occurrence of a stroke), will also be covered. In the realm of modern machine - learning, algorithms like the random forest method will be introduced. This method is known for its ability to handle non - linear relationships and complex data structures, making it highly suitable for stroke prediction where multiple interacting factors are involved.

Skill-level Objectives:

Students will be trained to collect stroke - related data from a diverse range of sources. Electronic medical records (EMR) systems are a rich source of patient - specific data, including information on medical history, symptoms, and diagnostic test results. Students will learn how to navigate EMR systems, extract relevant data, and ensure data privacy and security. Epidemiological surveys, which provide population - level data on stroke prevalence, risk factors, and trends, will also be explored. They will understand how to design and conduct surveys, as well as how to analyze the data collected. Public databases, such as those maintained by health organizations and research institutions, offer large - scale, standardized data that can be used for stroke research.

Once the data is collected, students will be taught data cleaning techniques. Handling missing values is a common challenge in medical data. They will learn methods such as imputation, where missing values are estimated based on other available data. Outliers, which can distort the results of statistical analysis, will be identified and dealt with using appropriate techniques. Inconsistent data formats, such as different units of measurement for blood pressure values, will be standardized. Real - world stroke datasets will be used for hands - on exercises, allowing students to apply these data cleaning techniques in a practical setting.

In terms of model building, students will be proficient in using statistical software such as R or Python [15-18]. These programming languages offer a wide range of libraries and packages for statistical analysis. They will learn how to use these tools to build stroke prediction models, starting from simple models and gradually progressing to more complex ones. Model validation is crucial to ensure the reliability of the models. Students will be taught how to use techniques such as splitting the data into training and testing sets and using appropriate validation metrics. Evaluating model performance is also essential. They will learn about metrics such as accuracy, sensitivity, specificity, and the area under the receiver operating characteristic curve (AUC).

Additionally, students will be able to interpret the results of statistical models. This involves understanding what the coefficients, odds ratios, and other statistical measures mean in the context of stroke prediction. They will also be trained to communicate statistical findings effectively, both in written reports and oral presentations [19-21].

Attitude-level Objectives:

The teaching design aims to cultivate students' genuine interest in interdisciplinary research. By presenting the real - world application of statistics in stroke prediction, students will see the value of combining different fields of knowledge. They will be encouraged to explore further connections between medicine and statistics and potentially pursue research projects at the intersection of these disciplines. Developing critical thinking is another important aspect. In the context of medical data analysis, students will encounter complex problems and conflicting data. They will be taught to question assumptions, evaluate the quality of data and models, and make informed decisions. Problem - solving abilities will also be nurtured. When faced with challenges such as data quality issues or model performance problems, students will be guided to develop strategies to overcome these obstacles.

Teaching Content.

Introduction to Stroke: The definition of stroke will be presented in detail, differentiating between ischemic stroke, which is caused by a blockage in the blood vessels supplying the brain, and hemorrhagic stroke, which results from bleeding in the brain. The classification of stroke will be explored, including subtypes such as transient ischemic attack (TIA), which is often a warning sign of a more serious stroke. Epidemiological data on stroke will be shared, such as the global and regional prevalence rates, incidence trends over time, and differences in stroke occurrence based on factors like age, gender, and ethnicity. Risk factors for stroke will be comprehensively discussed. Modifiable risk factors, such as high blood pressure, smoking, diabetes, and lack of physical activity, will be emphasized, as these are areas where preventive measures can be targeted. Non - modifiable risk factors, such as age, family history, and genetic predisposition, will also be covered. The significance of prediction models in stroke prevention and treatment will be illustrated with real - world examples. For instance, how a prediction model can help doctors identify patients at high risk of stroke and recommend appropriate lifestyle changes or medical treatments. This part of the teaching content provides students with a solid medical background, which is essential for them to understand the subsequent statistical analysis in the context of stroke prediction. By learning predictive models, students' clinical decision-making abilities can be enhanced.

Data Collection and Preprocessing: Students will be taught in - depth about the various sources of stroke - related data. Electronic medical records systems vary in their structure and functionality. They will learn how to query these systems to extract relevant data fields, such as patient demographics, medical history, and laboratory test results. For example, when extracting data on patients' cholesterol levels, they need to ensure that the data is accurate and complete. Epidemiological surveys require careful planning. Students will learn about sampling methods, questionnaire design, and data collection procedures. They will understand how to select a representative sample of the population to ensure the validity of the survey results. Public databases, such as the National Health and Nutrition Examination Survey (NHANES) in the United States, offer a wealth of data. Students will be guided on how to access these databases, search for relevant stroke - related data, and download the data for analysis.

Data cleaning techniques will be demonstrated with practical examples. When dealing with missing values, students will learn about mean imputation, where the missing value is replaced with the mean value of the variable. However, they will also be made aware of the limitations of this method and alternative techniques such as multiple imputation. Outliers can be identified using box plots and scatter plots. Once identified, they can be treated by either removing them if they are due to data entry errors or transforming the data to reduce their impact. Inconsistent data formats can be standardized. For example, if some blood pressure values are recorded in mmHg and others in kPa, students will learn how to convert all values to a single unit. Hands - on exercises using real - world stroke datasets will be an integral part of this section. These datasets may be obtained from local hospitals, research institutions, or public sources. Students will work through the entire data collection and preprocessing pipeline, from retrieving the data to cleaning and preparing it for analysis. Demonstrating through examples can help students better master statistical skills.

Statistical Modeling: The teaching of statistical models for stroke prediction will start with simple linear regression. Students will be shown how to formulate a linear regression model to predict a continuous outcome related to stroke, such as the severity of stroke symptoms. They will learn how to estimate the regression coefficients using least - squares method and how to test the significance of these coefficients. As the course progresses, more complex models will be introduced. Logistic regression, which is widely used in medical research for predicting binary outcomes, will be covered in detail. Students will learn how to build a logistic regression model to predict the probability of stroke occurrence. They will calculate the odds ratios for different risk factors and interpret these ratios in terms of the increased or decreased risk of stroke. Survival analysis will be taught with a focus on understanding the time - to - event nature of stroke data. Students will learn about Kaplan - Meier curves, which are used to estimate the survival function in the context of stroke, and Cox proportional hazards models, which can account for multiple covariates when analyzing survival data.

In the machine - learning section, the random forest method will be introduced. Students will understand the concept of decision trees, which form the basis of the random forest algorithm. They will learn how the random forest algorithm combines multiple decision trees to improve prediction accuracy and reduce overfitting. The algorithm's ability to handle non - linear relationships and complex data structures will be demonstrated with examples from stroke data. For instance, how it can capture the interaction between multiple risk factors such as the combined effect of high blood pressure and diabetes on stroke risk. Students will use statistical software to implement these models on stroke - related datasets, comparing the performance of different models and understanding the advantages and limitations of each.

Model Evaluation and Validation: The evaluation metrics for prediction models will be explained in detail. Accuracy, which is the proportion of correct predictions (both true positives and true negatives) out of the total number of predictions, will be introduced. However, students will also be made aware that accuracy may not be the most appropriate metric in imbalanced datasets, such as those where the number of stroke cases is much smaller than the number of non - stroke cases. Sensitivity, which measures the proportion of actual positive cases (true positives) correctly predicted by the model, is crucial in stroke prediction as it helps in identifying all potential stroke patients. Specificity, on the other hand, measures the proportion of actual negative cases (true negatives) correctly predicted. The area under the receiver operating characteristic curve (AUC) provides a comprehensive measure of the model's performance, as it takes into account both sensitivity and specificity at different classification thresholds.

Techniques for model validation will be demonstrated. Cross - validation, such as k - fold cross - validation, will be taught. In k - fold cross - validation, the data is divided into k subsets. The model is trained k times, each time using k - 1 subsets for training and the remaining subset for testing. This process helps to ensure the reliability and generalizability of the model. Students will be shown how to implement cross - validation in statistical software and how to interpret the results. They will also learn about other validation techniques, such as the hold - out method, where a portion of the data is set aside for testing while the rest is used for training. By the end of this section, students will be able to evaluate the performance of different stroke prediction models and select the most appropriate model for a given dataset.

Teaching Methods.

Lecture - based Teaching: Lectures will be used as a primary method to convey fundamental statistical concepts, model principles, and theoretical knowledge. Visual aids such as graphs, charts, and diagrams will be extensively used to enhance understanding. For example, when explaining probability distributions, visual representations of normal, binomial, and Poisson distributions will be shown. Real - world examples and case studies will be integrated into the lectures. For instance, when teaching about regression analysis, a case study on how age and blood pressure are related to the risk of stroke will be presented. The lecturer will walk through the entire analysis process, from formulating the research question to interpreting the results. Key points will be emphasized, and students will be encouraged to ask questions during the lecture. Lecture notes will be provided in advance to help students follow the content more effectively.

Hands - on Practice: Laboratory sessions will be carefully arranged to provide students with ample opportunities to apply statistical software to analyze stroke - related data. The software environment will be set up in advance, with all the necessary libraries and packages installed. In the initial sessions, students will be given step - by - step guidance on basic tasks such as data import, data exploration, and simple statistical calculations. As they progress, they will be given more complex tasks, such as building and validating stroke prediction models. During the hands - on practice, instructors will be present to provide real - time troubleshooting. If a student encounters an error while running a statistical code, the instructor will help identify the problem, whether it is a syntax error, a data - related issue, or a problem with the model formulation. Students will be encouraged to experiment with different parameters and models to gain a deeper understanding of how these factors affect the results. Students' statistical and professional knowledge have been effectively improved.

Group Discussion: Group discussions will be organized regularly to foster collaborative learning. Topics for discussion will be carefully selected to encourage critical thinking. For example, when discussing the advantages and disadvantages of different prediction models, students will be asked to compare the performance of logistic regression and the random forest method in terms of accuracy, interpretability, and computational complexity. They will be required to support their arguments with evidence from their own analysis or from the literature. The impact of data quality on model performance will also be a key topic. Students will discuss how missing values, outliers, and inconsistent data can affect the results of stroke prediction models and what strategies can be employed to mitigate these issues. The clinical implications of model results will be another area of discussion. For instance, if a model predicts a high risk of stroke for a particular patient, students will discuss what medical interventions should be recommended based on the model output. Each group will be required to present their findings and conclusions to the class, promoting further discussion and knowledge sharing.peer interactions motivate students and expand their perspective [22-23].

Teaching Evaluation.

Formative Evaluation: Formative evaluation will be an ongoing process. During hands - on practice, instructors will observe students' performance. They will note how students approach data analysis tasks, whether they are able to apply the correct statistical methods, and how they handle problems that arise. For example, if a student is struggling with data cleaning, the instructor can provide immediate feedback and guidance. In group discussions, the participation of each student will be evaluated. This includes their ability to contribute to the discussion, listen to others' opinions, and build on ideas. The quality of students' questions and comments during lectures will also be considered as part of formative evaluation. Based on this continuous assessment, timely feedback will be provided to students. This feedback will not only point out areas for improvement but also highlight students' strengths. understand their learning interests and needs and manage their projects longitudinally [24]. Greatly inspired the students' enthusiasm for learning.

Summative Evaluation: Written exams will be administered to assess students' theoretical knowledge of statistics and stroke prediction models. The exam questions will cover a wide range of topics, including statistical concepts, model principles, and the interpretation of results. For example, students may be asked to explain the difference between simple linear regression and logistic regression and when each should be used in stroke prediction. They may also be given a dataset and asked to perform a specific statistical analysis and interpret the results. In addition to written exams, students will be required to submit a project report on building a stroke prediction model. The project report will evaluate their data analysis skills, from data collection and preprocessing to model building and evaluation. It will also assess their model - building capabilities, such as their choice of appropriate models and their ability to fine - tune the models. Written communication skills will be evaluated based on the clarity and organization of the report, as well as the proper use of statistical terminology [23-25]. Students have a complete learning experience in establishing predictive models.

Conclusion.

The statistical teaching design on building stroke prediction models has successfully integrated statistical knowledge with medical applications. Through this teaching, students have been able to master practical statistical skills and gain valuable insights into the medical field. They are better equipped to handle real - world data analysis problems in the context of stroke prediction. However, there is room for further improvement in future teaching. Incorporating more real - time data, such as data from continuous patient monitoring systems, can make the teaching more relevant and up to date. Advanced machine - learning algorithms, such as deep neural networks, which have shown promise in medical data analysis, can be introduced to expand students' knowledge and skills. Multi - center collaborative research, where students from different institutions work together on stroke - related projects, can also enhance the learning experience by exposing students to diverse datasets and research perspectives. Students will master the predictive efficacy of modern machine learning algorithms, including Logistic Regression, Decision Tree, Random Forest, Extreme Gradient Boosting, and K-Nearest Neighbors, for stroke prediction. They will also conduct a comparative analysis to identify the optimal predictive method. We present key learnings designed to assist others in successfully integrating R into education [26].

Conflict of interest statement.

The authors declare that this research was conducted in the absence of any business or financial relationships that could be construed as potential conflicts of interest.

Data Availability.

Data is provided within the manuscript.

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