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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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AN INSTRUCTIONAL DESIGN PROCESS FOR TEACHING MEDICAL STUDENTS HOW WILCOXON RANK SUM TEST ARE EXPLAINED

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Abstract.

In medical statistics courses, students encounter numerous challenges when learning to explain the Wilcoxon rank sum test, a widely used nonparametric method for comparing two groups or populations. To address these challenges, we posed the following question: How can an instructor transform their understanding of the Wilcoxon rank sum test to enhance student comprehension? To tackle this question, we first reviewed a model comprising the components utilized by educators to explain the Wilcoxon rank sum test. The MACH model includes the components of Methods (M), Analogies (A), Context (C), and How (H). Subsequently, we developed instructional materials and piloted teaching activities using a MACH model. Students who employed the MACH model to guide their explanations of the Wilcoxon rank sum test demonstrated improvements, alongside some new challenges. Herein, we present an instructional design process aimed at cultivating pedagogical content knowledge for effective understanding of Wilcoxon rank sum test. Our four-stage process can be adapted to enhance instruction using various models in life sciences.

Key words. Instructional design, Wilcoxon rank sum test, medical students.

Introduction.

The Wilcoxon rank sum test, proposed by Frank Wilcoxon in 1945, belongs to the category of non - parametric statistical methods [1]. Non-parametric tests do not rely on the specific form of the overall distribution. They have relatively relaxed requirements for data and are suitable for situations where the pre-conditions of parametric tests (such as the t-test which requires data to follow a normal distribution) are not met.

Understanding the rank-sum test, particularly in a statistical context, poses several challenges for students. Firstly, the conceptual foundation of what a rank-sum test entails can be an obstacle. The rank-sum test, commonly used in non-parametric statistics, compares two independent groups to determine if their population distributions differ without making strong assumptions about the underlying data. This can be a complex concept, especially for students who may not have a solid grasp of how ranks are assigned or how they relate to the original data. Critical challenge is the interpretation of the results produced by the rank-sum test. Unlike mean comparisons in parametric tests, students may find it difficult to understand how to interpret statistics derived from ranks, especially in terms of practical consequences. For example, understanding how differences in ranks can indicate differences in distributions rather than differences in central tendencies requires a shift in thinking that some may struggle with, particularly if they have been predominantly trained in parametric methods that focus on means and standard deviations. Students must not only state null and alternative hypotheses but also comprehend what it means to reject or fail to reject the null hypothesis based on rank data. The cognitive transition required from thinking about the hypotheses in the terms of means to ranks can add an additional layer of complexity, real-world applications of the rank-sum test in research can sometimes seem abstract to students. They may struggle to appreciate when it is appropriate to use this test, particularly if alternative methods exist. Addressing these obstacles often requires a combination of theoretical grounding and practical experience in datasets requiring statistical analysis, which may necessitate additional instructional support and resources. We proposed a teaching plan process aimed at promoting teaching content knowledge in order to achieve an effective understanding of the Wilcoxon rank sum test [2].

Materials and Methods.

Introduction of Knowledge Objectives:

Medical students will be able to accurately define the Wilcoxon rank sum test, including its underlying principles and assumptions.

They will master the key concepts related to the test, such as ranks, median, and non - parametric statistics.

Students will understand the differences between the Wilcoxon rank sum test and parametric tests like the independent samples t - test.

Skill Objectives:

Students will be proficient in determining when the Wilcoxon rank sum test is appropriate to use in medical research, based on data characteristics (e.g., non - normally distributed data, small sample sizes, or ordinal data).

They will be able to correctly calculate the Wilcoxon rank sum statistic by hand, following the step - by - step ranking and summing procedures.

Students will learn to use statistical software (e.g., SPSS, R) to perform the Wilcoxon rank sum test and interpret the resulting output accurately.

Attitude Objectives:

Foster an interest in statistical methods among medical students, reducing their anxiety towards statistical analysis.

Encourage students to think critically about data analysis in medical studies and understand the importance of choosing the right statistical test for valid results.

Introduction to Non - Parametric Tests:

Provide an overview of the classification of statistical tests, highlighting the distinction between parametric and non - parametric tests.

Explain the situations where non - parametric tests are preferred, such as when data do not meet the assumptions of parametric tests (e.g., normality, homogeneity of variance).

Principles of the Wilcoxon Rank Sum Test:

Describe the basic idea behind the Wilcoxon rank sum test, which focuses on comparing the distribution of two independent samples by ranking the combined data from both samples.

Illustrate how ranks are assigned to the data points and how the rank sums for each sample are calculated.

Explain the null hypothesis and alternative hypothesis for the Wilcoxon rank sum test in the context of medical research questions (e.g., comparing the effectiveness of two treatments).

Calculation methods:

Demonstrate the manual calculation process of the Wilcoxon rank sum statistic. Start with a small - scale example data set, showing how to combine the data from two samples, assign ranks, and calculate the rank sums for each sample.

Discuss the correction for tied ranks and its impact on the calculation of the test statistic.

Application in medical research:

Present real - world medical research examples where the Wilcoxon rank sum test has been used. Analyze the research questions, data collection methods, and how the test results contributed to the study conclusions.

Encourage students to identify potential research scenarios in the medical field where the Wilcoxon rank sum test could be applied.

Interpretation of results:

Teach students how to interpret the Wilcoxon rank sum test results, including understanding the significance level (p - value), critical values, and how to draw conclusions based on the comparison between the calculated test statistic and the critical value.

Explain how to report the results of the Wilcoxon rank sum test in a scientific paper, following the appropriate statistical reporting standards.

Analogies (A).

We investigate the total number of combinations for randomly selecting numbers from 1 to 5, where these numbers represent ranks. We calculate the sum of the selected ranks, referred to as the rank sum, and examine the distribution characteristics of the rank sum. The combinations are categorized based on the number of elements extracted, ranging from zero to five. For zero extractions, there is only one combination: the empty set, which results in a sum of zero. When extracting one number, we have five combinations: {1}, {2}, {3}, {4}, and {5}, with corresponding sums of 1, 2, 3, 4, and 5. For two numbers, we calculate the combinations using the formula C(5, 2), yielding ten combinations: {1,2}, {1,3}, {1,4}, {1,5}, {2,3}, {2,4}, {2,5}, {3,4}, {3,5}, and {4,5}, with sums of 3, 4, 5, 6, 5, 6, 7, 7, 8, and 9. When extracting three numbers, the combinations include {1,2,3}, {1,2,4}, {1,2,5}, {1,3,4}, {1,3,5}, {1,4,5}, {2,3,4}, {2,3,5}, {2,4,5}, and {3,4,5}, resulting in sums of 6, 7, 8, 8, 9, 10, 9, 10, 11, and 12.

The combinations of four numbers include: {1,2,3,4}, {1,2,3,5}, {1,2,4,5}, {1,3,4,5}, and {2,3,4,5}, with their corresponding sums being 10, 11, 12, 13, and 14, respectively. Additionally, the combinations of five numbers, {1,2,3,4,5}, has a sum of 15. By summing the combination counts from the various scenarios, the total number of combinations can be calculated as 1 + 5 + 10 + 10 + 5 + 1 = 32. This comprehensive analysis provides insights into the combinatorial nature of data extraction and its implications for further research.

Table 1 and Figure 1 illustrate the distribution of the rank sum for ranks ranging from 1 to 5. As shown in Table 1, the relative frequencies of the rank sum equaling 1 and 15 are both 0.03125. Therefore, the combined relative frequency for these two occurrences is 0.0625, which exceeds the significance level of 0.05.

We further investigate the total number of combinations for randomly selecting numbers from 1 to 8. These numbers, ranging from 1 to 8, represent ranks. We calculate the sum of these selected ranks, referred to as the rank sum, and examine the distribution characteristics of the rank sum. We were surprised to find that the probability of the rank sum being less than or equal to 3 plus the rank sum being greater than or equal to 33 is 0.0390625. The event where the rank sum is less than or equal to 3, in conjunction with the rank sum being greater than or equal to 33, represents a small probability event. Table 2 and Figure 2 illustrate the distribution of the rank sum for ranks ranging from 1 to 8. It can be clearly seen from Figure 2 and Table 2 that when the rank sum is particularly large or particularly small, that is, when the rank sum reaches the extreme value, the probability of its occurrence will decrease.

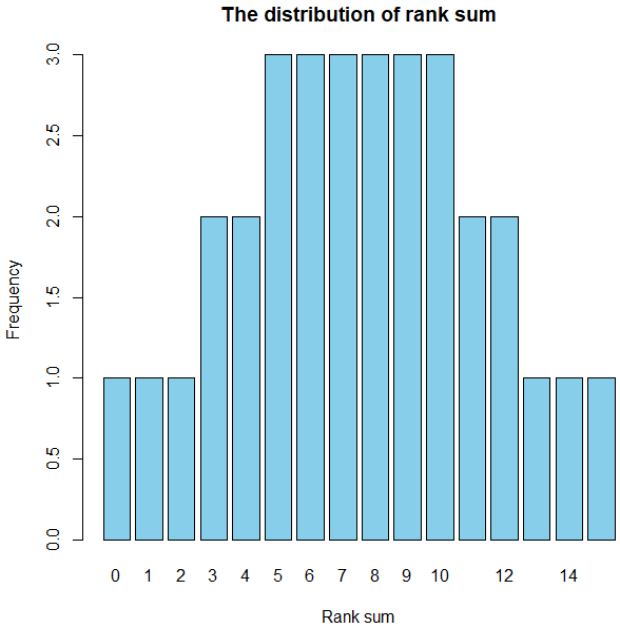

Figure 1. *Bar chart of the distribution of rank sum when the ranks range from 1 to 5.*

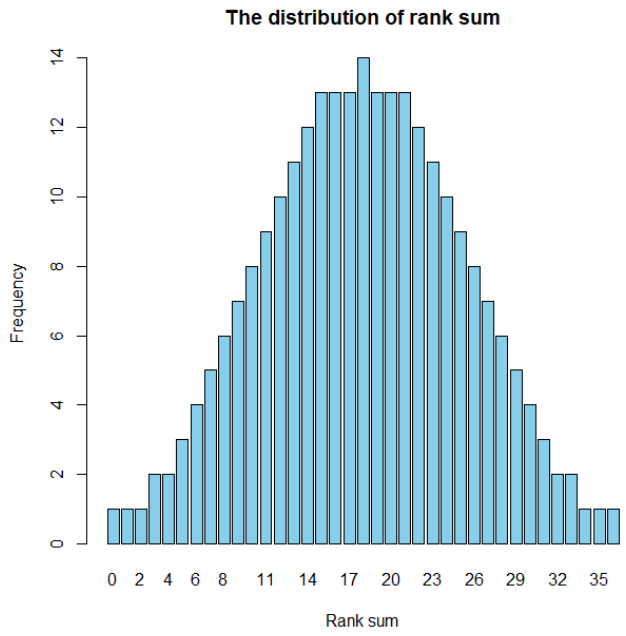

Figure 2. *Bar chart of the distribution of rank sum when the ranks range from 1 to 8.*

Table 1. *The distribution of rank sum when the ranks range from 1 to 5.*

Rank sum	Frequency	Relative Frequency	Cumulative Frequency
0	1	0.03125	0.03125
1	1	0.03125	0.06250
2	1	0.03125	0.09375
3	2	0.06250	0.15625
4	2	0.06250	0.21875
5	3	0.09375	0.31250
6	3	0.09375	0.40625
7	3	0.09375	0.50000
8	3	0.09375	0.59375
9	3	0.09375	0.68750
10	3	0.09375	0.78125
11	2	0.06250	0.84375
12	2	0.06250	0.90625
13	1	0.03125	0.93750
14	1	0.03125	0.96875
15	1	0.03125	1.00000

Table 2. *The distribution of rank sum when the ranks range from 1 to 8.*

Rank sum	Frequency	Relative Frequency	Cumulative Frequency
0	**1**	**0.00390625**	**0.00390625**
1	**1**	**0.00390625**	**0.00781250**
2	**1**	**0.00390625**	**0.01171875**
3	**2**	**0.00781250**	**0.01953125**
4	2	0.00781250	0.02734375
5	3	0.01171875	0.03906250
6	4	0.01562500	0.05468750
7	5	0.01953125	0.07421875
8	6	0.02343750	0.09765625
9	7	0.02734375	0.12500000
10	8	0.03125000	0.15625000
11	9	0.03515625	0.19140625
12	10	0.03906250	0.23046875
13	11	0.04296875	0.27343750
14	12	0.04687500	0.32031250
15	13	0.05078125	0.37109375
16	13	0.05078125	0.42187500
17	13	0.05078125	0.47265625
18	14	0.05468750	0.52734375
19	13	0.05078125	0.57812500
20	13	0.05078125	0.62890625
21	13	0.05078125	0.67968750
22	12	0.04687500	0.72656250
23	11	0.04296875	0.76953125
24	10	0.03906250	0.80859375
25	9	0.03515625	0.84375000
26	8	0.03125000	0.87500000
27	7	0.02734375	0.90234375
28	6	0.02343750	0.92578125
29	5	0.01953125	0.94531250
30	4	0.01562500	0.96093750
31	3	0.01171875	0.97265625
32	2	0.00781250	0.98046875
33	**2**	**0.00781250**	**0.98828125**
34	**1**	**0.00390625**	**0.99218750**
35	**1**	**0.00390625**	**0.99609375**
36	**1**	**0.00390625**	**1.00000000**

Context (C) and application scenarios.

Data that do not meet parametric test assumptions:

When the data do not follow a normal distribution, or the variances are not homogeneous, traditional parametric tests (such as the two - sample t - test) cannot be used. In such cases, the Wilcoxon rank sum test is an excellent alternative. For example, when studying the impact of two different teaching methods on students' academic performance, if the performance data do not meet the normal distribution assumption, the Wilcoxon rank sum test can be considered.

Ordinal data:

If the data are in the form of an ordinal scale, for example, product satisfaction is divided into "very dissatisfied", "dissatisfied", "average", "satisfied", and "very satisfied". In this case, the Wilcoxon rank sum test is also suitable for comparing the differences in satisfaction between two groups.

How (H).

Lecture - based Instruction:

Use PowerPoint presentations with clear visual aids, such as flowcharts, diagrams, and tables, to explain the theoretical concepts of the Wilcoxon rank sum test.

Incorporate real - life medical examples during the lecture to make the content more relatable and easier to understand.

Case - based Learning:

Provide several case studies with different data sets and research questions related to medical studies. Students will work in groups to analyze the data, determine whether the

Wilcoxon rank sum test is applicable, and perform the necessary calculations or software operations.

After each group presents their analysis and results, conduct a class discussion to clarify any misunderstandings and deepen students' understanding of the test.

Hands - on Practice:

In a computer laboratory session, guide students to use statistical software to perform the Wilcoxon rank sum test on sample data sets. Provide step - by - step instructions for using software functions and encourage students to explore different options for data input, analysis, and result output.

Monitor students' progress during the hands - on practice, offer individual feedback, and answer their questions in real - time.

Online learning resources:

Recommend online tutorials, videos, and interactive learning platforms related to the Wilcoxon rank sum test. Students can access these resources for self - study, review, and further exploration of the topic outside of class.

Example of test steps:

Suppose there are two sets of data:

Group 1: 4.79, 4.54,7.98, 6.33,5.14,8.05,7.98,8.33,7.38,7.83

Group 2: 2.93,3.52,3.60,4.54,2.21,4.66,5.13,5.86,6.34,6.55

Establish null hypothesis and alternative hypothesis for the Wilcoxon rank sum test and set the significance level:

H_0: null hypothesis (the two groups of data come from the same distribution).

H_1: alternative hypothesis (the two groups of data come from the different distribution).

α=0.05.

Calculating the P – value:

The following is a program executed in software R^2:

```
group1 <- c(4.79, 4.54, 7.98, 6.33, 5.14, 8.05, 7.98, 8.33, 7.38, 7.83)
group2 <- c(2.93, 3.52, 3.60, 4.54, 2.21, 4.66, 5.13, 5.86, 6.34, 6.55)
result <- wilcox.test (group1, group2).
print(result).
Wilcoxon rank sum test with continuity correction
data: group1 and group2
W = 85.5, p-value = 0.008103
alternative hypothesis: true location shift is not equal to 0.
```

Draw the conclusions:

Under the null hypothesis (that the two groups of data come from the same distribution), the test statistic W follows a specific distribution. The critical value table of the Wilcoxon rank sum test can be consulted, or statistical software can be used to calculate the corresponding P-value. If the P-value is less than the pre-set significance level (such as 0.05), the null hypothesis is rejected, and it is considered that there is a significant difference in the distributions of the two groups of data; otherwise, the null hypothesis is not rejected. In this example,In this example, the obtained P-value (0.008103) is indeed less than 0.05, allowing us to reject the null hypothesis and conclude that there is a significant difference in the distributions of the two groups.

Instructional Evaluation.

Formative Evaluation:

During the lecture, ask students questions to check their understanding of key concepts. For example, randomly call on students to explain the assumptions of the Wilcoxon rank sum test or the meaning of a rank in the context of the test.

After case - based learning activities, collect students' group reports and provide written feedback on their analysis methods, calculation accuracy, and interpretation of results.

In the hands - on practice sessions, observe students' software operations and performance, and give immediate feedback to help them correct mistakes and improve their skills.

Summative Evaluation:

Administer a written exam at the end of the instructional unit. The exam will include multiple - choice questions, short - answer questions, and problem - solving questions. Multiple - choice questions will test students' knowledge of basic concepts, while short - answer questions will require them to explain the principles and application scenarios of the Wilcoxon rank sum test. Problem - solving questions will ask students to analyze given data sets, perform the test (either by hand or using software), and interpret the results.

Assign a project where students need to find a real - medical research article that uses the Wilcoxon rank sum test, summarize the study, reanalyze the data if possible, and write a report on their understanding of the test's application in the article. Evaluate the project based on the quality of the summary, the accuracy of the data analysis, and the depth of the students' insights.

Advantages and disadvantages of Wilcoxon rank sum test.

Advantages:

Wide application range: It has no strict requirements for data distribution.

Effective for non - parametric data: It can provide effective analysis methods for data that do not meet the conditions of parametric tests.

Robust to outliers: When there are extreme values in the data, it is more robust compared to parametric tests, and the results are less affected by extreme values.

Disadvantages:

Lower test efficiency: The test power is relatively lower than that of parametric tests. If the data meet the conditions of parametric tests, using the Wilcoxon rank sum test may increase the probability of making a Type II error (i.e., accepting a null hypothesis that is actually not true).

Complex calculation process: The calculation process is relatively complex, especially when the sample size is large. Manual calculation of rank sums and looking up critical value tables is cumbersome, and statistical software is usually required.

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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Consent for Publication.

All other authors have read the manuscript and have agreed to submit it in its current form for consideration for publication in this journal.

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