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The Journal aims to;

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- Radiology and Radiodiagnostics
- Anesthesia and Intensive Care Medicine

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- Adolescent Diseases
- Childhood Diseases
- Multisystem Diseases
- Physical Medicine and Rehabilitation
- Forensic Medicine
- Mental Health and Diseases
- Cardiovascular System Diseases
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Expressions such as ... "Our study, in our study, we, we did, we found, we aimed, I did, I found, I think ... etc." should be revised as follows;

- In this study, … it was found/determined/… or
- In this study … it was aimed to …

Names made up of single word should not be abbreviated.

Instead of,

- Hypertension (HT) is one of the most …

Throughout the manuscript, you should use;

- Hypertension is one of the most …

Instead of,

- Rituximab (RTX) is an IgG1 kappa chimeric monoclonal

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Throughout the manuscript, you should use;

• Rituximab is an …

Numbers should always be used to indicate statistics, age and measurements (including time as in the 3 weeks example). In specifying the others, only the numbers one to nine should be written in letters. (Numbers between 1-10 should be written with letters, except for the date and number of cases)

For example;

• In 2 studies, …

Should be replaced with;

• In two studies …

For example;

• … perivascular lymphotic infiltration in only 10 percent and fibrosis in 7 percent of the patients,

Should be replaced with;

• … perivascular lymphotic infiltration in only 10% of patients … in 7% of patients …

Prejudiced expressions should be avoided in expressions other than classical textbook knowledge, which has been verified by dozens of studies and has become the industry standard in the literature.

• determined to be high

Should be replaced with;

• … was found to be high.

Or throughout the entire manuscript;

• found to be significantly higher …

If diametrically opposite findings are mentioned among the studies mentioned in the Discussion section, it should be stated as "… a significant relationship was found / observed / reported", rather than "a significant relationship was determined" etc.

• While no significant relationship was determined between blood pressure and disease severity (26,27), a strong relationship was determined in some studies (28,29).

Should be replaced with;

While no significant relationship was observed between blood pressure and disease severity (26,27), it was reported that a strong relationship was found in some studies (28,29).

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Abstract

Original research, systematic reviews, and meta-analyses require structured abstracts. The abstract should provide the context or background for the study and should state the study's purpose, basic procedures (selection of study participants, settings, measurements, analytical methods), main findings (giving specific effect sizes and their statistical and clinical significance, if possible), and principal conclusions. It should emphasize new and important aspects of the study or observations, note important limitations, and not overinterpret findings. Please, do not cite figures, tables or references in the abstract.

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Examples; carbon monoxide, firearms, sexual abuse, oral mucosa

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The guiding principle of the Methods section should be clarity about how and why a study was done in a particular way. The Methods section should aim to be sufficiently detailed such that others with access to the data would be able to reproduce the results.

The authors should clearly describe the selection of observational or experimental participants (healthy individuals or patients, including controls), autopsied persons, including eligibility and exclusion criteria and a description of the source population.

In general, the section should include only information that was available at the time the plan or protocol for the study was being written; all information obtained during the study belongs in the Results [Findings] section. If an organization was paid or otherwise contracted to help conduct the research (examples include data collection and management), then this should be detailed in the methods.

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Sample for in-text citation:

In a clinical research in healthy individuals, Ellis (25) has studied the sciatic nerve excursion using ultrasound technique.

Wright and Ellis (10) has investigated the excursion of nerves around the elbow joint.

In another and similar cadaveric study by Wright et al (13), the radial nerve median excursion values were 4.1, 8.8, and 0.2, 0.1 mm with motions of shoulder, elbow, wrist and fingers respectively.

Suicide is a major public health problem and globally the second leading cause of death among young adults (1). Studies focusing on how mental health risk factors impact on youth suicidal behaviors suggest that psychopathological symptoms are associated with suicidal behavior (3,4).

Adverse effects of H2S on human health vary from local irritation to immediate death depending on the form, concentration, duration and route of exposure (9, 13-15).

Reference Style

The Vancouver system, also known as Vancouver reference style or the author–number system, is a citation style that uses numbers within the text that refer to numbered entries in the reference list. Vancouver style is used by MEDLINE and PubMed. The names "Vancouver system" or "Vancouver style" have existed since 1978. The latest version of the latter is Citing Medicine, per the References > Style and Format section of the ICMJE Recommendations. In 1978, a committee of editors from various medical journals, the International Committee of Medical Journal Editors (ICMJE), met in Vancouver, BC, Canada to agree to a unified set of requirements for the articles of such journals. This meeting led to the establishment of the Uniform Requirements for Manuscripts Submitted to Biomedical Journals (URMs). Part of the URMs is the reference style, for which the ICMJE selected the long-established author–number principle.

Since the early to mid-2000s, the United States National Library of Medicine (which runs MEDLINE and PubMed) has hosted the ICMJE's "Sample References" pages. Around 2007, the NLM created Citing Medicine,

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its style guide for citation style, as a new home for the style's details. The ICMJE Recommendations now point to Citing Medicine as the home for the formatting details of Vancouver style.

Scientific Reports in Medicine, since the first day of its publication uses the PubMed/NLM reference style. Thus, references should follow the standards summarized in the NLM's International Committee of Medical Journal Editors (ICMJE) Recommendations for the Conduct, Reporting, Editing and Publication of Scholarly Work in Medical Journals: Samples of Formatted References for Authors of Journal Articles web page and detailed in the NLM's Citing Medicine, 2nd edition.

According to the Vancouver rules, you can only refer to the literature you have read yourself. If you find anything interesting in a text where it is referred to another text, you must read and refer to the original.

Reference List

The reference list should be ordered numerically in the order in which the references appear in the text.

The journal's name may be abbreviated, according to the abbreviation rules for journal titles. Records retrieved from a search for the full journal title in the National Library of Medicine's search page include the abbreviated title.

Authors' names should be given as surname followed by initials. There should be a space between surname and initials. A maximum of two initials are allowed for each author, they should be entered without spaces or punctuation. Different authors should be separated by a space and a comma. A period (.) should follow the last author's name. If six or more authors, list the first six authors followed by et al.

Only capital letter of the first word of the title, proper nouns, proper adjectives, acronyms, and initialisms should be capitalized.

The most reliable method for calculating the impact factor of our journal and number of citations of articles published in our journal or calculating the number of times your own article is cited in a healthy way, is to add DOIs to the references section. In order to give the DOIs to the articles published in Scientific Reports in Medicine, the CrossRef membership application has been completed and all the research articles, case reports, and reviews are being assigned DOIs. For this reason, DOIs need to be added to the References section if available for those references. We hope that the Simple Text Query Form will be helpful in referencing articles published in our journal. With the help of the Simple Text Query Form web page, which has a link in the full-text template, DOI records need to be added to the sources.

https://apps.crossref.org/SimpleTextQuery

Note: Please, do not insert Pubmed ID (PMID) or Pubmed Central ID (PMCID) records to the reference list since they are useless in determining the citation counts.

We place great importance to the addition of DOIs to the references.

Sample for Journal Article without DOI

Dokgöz H, Kar H, Bilgin NG, Toros F. Forensic Approach to Teenage Mothers Concept: 3 Case Reports. Turkiye Klinikleri J Foren Med 2008;5(2):80-4

Kaufman DM, Mann KV, Miujtjens AM, Van der Vleuten CP. A comparison of standard setting procedures for an OSCE in undergraduate medical education. Academic Medicine 2000;75:267–71.

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Sample for Journal Article with DOI

Koçak U, Alpaslan AH, Yağan M, Özer E. Suicide by Homemade Hydrogen Sulfide in Turkey a Case Report. Bull Leg Med. 2016;21(3):189-192. https://doi.org/10.17986/blm.2016323754

Article not in English

Kar H, Dokgöz H, Gamsız Bilgin N, Albayrak B, Kaya Tİ. Lazer Epilasyona Bağlı Cilt Lezyonlarının Malpraktis Açısından Değerlendirilmesi. Bull Leg Med. 2016;21(3):153-158. https://doi.org/10.17986/blm.2016323748

Books and Other Monographs

Personal author(s)

Murray PR, Rosenthal KS, Kobayashi GS, Pfaller MA. Medical microbiology. 4th ed. St. Louis: Mosby; 2002.

Editor(s), compiler(s) as author

Gilstrap LC 3rd, Cunningham FG, VanDorsten JP, editors. Operative obstetrics. 2nd ed. New York: McGraw-Hill; 2002.

Author(s) and editor(s)

Breedlove GK, Schorfheide AM. Adolescent pregnancy. 2nd ed. Wieczorek RR, editor. White Plains (NY): March of Dimes Education Services; 2001.

Chapter in a book

Meltzer PS, Kallioniemi A, Trent JM. Chromosome alterations in human solid tumors. In: Vogelstein B, Kinzler KW, editors. The genetic basis of human cancer. New York: McGraw-Hill; 2002. p. 93-113

Emmerson BT. Gout and renal disease. In: Massry SG, Glassock RJ (Editors). Textbook of Nephrology 1. Baskı, Baltimore: Williams and Wilkins; 1989. p. 756–760.

Conference proceedings

Harnden P, Joffe JK, Jones WG, editors. Germ cell tumours V. Proceedings of the 5th Germ Cell Tumour Conference; 2001 Sep 13-15; Leeds, UK. New York: Springer; 2002.

Article published on the Internet ahead of the print version:

Yu WM, Hawley TS, Hawley RG, Qu CK. Immortalization of yolk sac-derived precursor cells. Blood. 2002 Nov 15;100(10):3828-31. Epub 2002 Jul 5.

Part of a homepage/Web site [Edited 28 Dec 2016]

American Medical Association [Internet]. Chicago: The Association; c1995-2016 [cited 2016 Dec 27]. Office of International Medicine; [about 2 screens]. Available from: https://www.ama-assn.org/about/office-international-medicine

Thesis

Skrtic L. Hydrogen sulfide, oil and gas, and people's health [Master's of Science Thesis]. Berkeley, CA: University of California; 2006.

Weisbaum LD. Human sexuality of children and adolescents: a comprehensive training guide for social work professionals [master's thesis]. Long Beach (CA): California State University; 2005. 200 p.

For the reference types not listed here, please visit Samples of Formatted References for Authors of Journal Articles available at Medline Web site (https://www.nlm.nih.gov/bsd/uniform_requirements.html).

Tables

Tables capture information concisely and display it efficiently; they also provide information at any desired level of detail and precision. Including data in tables rather than text frequently makes it possible to reduce the length of the text.

It would be appropriate to place the tables at the end of the main text. Number tables consecutively in the order of their first citation in the text and supply a title for each. Titles in tables should be short but self-explanatory, containing information that allows readers to understand the table's content without having to go back to the text. Be sure that each table is cited in the text. Give each column a short or an abbreviated heading. In the tables, case counts (n) and percentages (%) should be specified in separate columns, not in the same cell.

Authors should place explanatory matter in footnotes, not in the heading. Explain all nonstandard abbreviations in footnotes and use symbols to explain information if needed. Symbols may be as alphabet letters or such symbols as *, p t> T §). Please, identify statistical measures of variations, such as standard deviation and standard error of the mean.

Illustrations (Figures)

The lexical meaning of figure constitutes a number symbol (numeral, digit), a written or printed character, a diagram or pictorial illustration of textual matter, arithmetical calculation or digits representing an amount when plural.

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While definition of picture includes a design or representation made by various means (as painting, drawing, or photography), illustration means a picture or diagram that helps make something clear or attractive. Although these terms bear distinctive meanings, they are too often used interchangeably. Thus, we meant them in the same way without distinction.

Digital images

The 300 DPI Story

In the ancient times when digital cameras have not been invented, the photos taken by analogue cameras were used to be printed on photo papers. In order to transfer these photos to the digital environment, they had to be scanned by optical devices called scanners. On the same dates, desktop publishing and printing technology was far beyond the digital photography, and many years had passed since the invention of laser printing technology. Here, several technical terms should be explained to make the concept clearer. DPI is used to describe the resolution number of dots per inch in a digital print and the printing resolution of a hard copy print dot gain, which is the increase in the size of the halftone dots during printing. A dot matrix printer, for example, applies ink via tiny rods striking an ink ribbon, and has a relatively low resolution, typically in the range of 60 to 90 DPI (420 to 280 μm). An inkjet printer sprays ink through tiny nozzles and is typically capable of 300–720 DPI. A laser printer applies toner through a controlled electrostatic charge and may be in the range of 600 to 2,400 DPI. Along with the cheaper memory chips, 1200 dpi printers have been widely available in the consumer market since 2008. Monitors do not have dots but do have pixels. The closely related concept for monitors and images is pixels per inch or PPI. Old CRT type video displays were almost universally rated in dot pitch, which refers to the spacing between the subpixel red, green and blue dots which made up the pixels themselves. The DP measurement of a printer often needs to be considerably higher than the pixels per inch (PPI) measurement of a video display in order to produce similar-quality output. This dithered printing process could require a region of four to six dots (measured across each side) in order to faithfully reproduce the color in a single pixel. An image that is 100 pixels wide may need to be 400 to 600 dots in width in the printed output; if a 100×100-pixel image is to be printed in a one-inch square; the printer must be capable of 400 to 600 dots per inch to reproduce the image. The dpi of early model laser printers was 300 to 360, thus scanning images at 300 DPI was a common practice at that time.

In printing, DPI (dots per inch) refers to the output resolution of a printer or imagesetter, and PPI (pixels per inch) refers to the input resolution of a photograph or image. DPI refers to the physical dot density of an image when it is reproduced as a real physical entity, for example printed onto paper. A digitally stored image has no inherent physical dimensions, measured in inches or centimeters. Some digital file formats record a DPI value, or more commonly a PPI (pixels per inch) value, which is

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to be used when printing the image. This number lets the printer or software know the intended size of the image, or in the case of scanned images, the size of the original scanned object. For example, a bitmap image may measure 1,000 × 1,000 pixels, a resolution of 1 megapixel. If it is labeled as 250 PPI, that is an instruction to the printer to print it at a size of 4 × 4 inches. Changing the PPI to 100 in an image editing program would tell the printer to print it at a size of 10×10 inches. However, changing the PPI value would not change the size of the image in pixels which would still be 1,000 × 1,000. An image may also be resampled to change the number of pixels and therefore the size or resolution of the image, but this is quite different from simply setting a new PPI for the file.

Therefore, an image that is 2048 pixels in width and 1536 pixels in height has a total of 2048×1536 = 3,145,728 pixels or 3.1 megapixels. One could refer to it as 2048 by 1536 or a 3.1-megapixel image. Or, you can think of it as a very low-quality image (72 ppi) if printed at about 28.5 inches wide, or a very good quality (300 ppi) image if printed at about 7 inches wide.

Since the 1980s, the Microsoft Windows operating system has set the default display "DPI" to 96 PPI, while Apple/Macintosh computers have used a default of 72 PPI. The choice of 72 PPI by Macintosh for their displays arose from the convenient fact that the official 72 points per inch mirrored the 72 pixels per inch that appeared on their display screens. (Points are a physical unit of measure in typography, dating from the days of printing presses, where 1 point by the modern definition is 1/72 of the international inch (25.4 mm), which therefore makes 1 point approximately 0.0139 in or 352.8 μm). Thus, the 72 pixels per inch seen on the display had exactly the same physical dimensions as the 72 points per inch later seen on a printout, with 1 pt in printed text equal to 1 px on the display screen. As it is, the Macintosh 128K featured a screen measuring 512 pixels in width by 342 pixels in height, and this corresponded to the width of standard office paper (512 px ÷ 72 px/in ≈ 7.1 in, with a 0.7 in margin down each side when assuming 8.5 in × 11 in North American paper size (in Europe, it's 21 cm x 30 cm - called "A4")).

In computing, an image scanner—often abbreviated to just scanner, is a device that optically scans images, printed text, handwriting or an object and converts it to a digital image. Although the history of digital cameras dates back to the 1970s, they have become widely used in the 2000s. While the resolution of the first digital camera invented by Kodak was as low as 100 by 100 pixels (0.01 megapixels), the first commercially available digital camera, Fujix DS-1P had a resolution of 0.4 megapixels. On the other hand, modern scanners are considered the successors of early telephotography and fax input devices. The pantelegraph was an early form of facsimile machine transmitting over normal telegraph lines developed by Giovanni Caselli, used commercially in the 1860s, that was the first such device to enter practical service. The history of the first image scanner developed for use with a computer goes back to 1957. Color scanners typically read RGB (red-green-blue color) data from the array. This data is then processed with some proprietary algorithm to correct for different exposure conditions and sent to the computer via the device's input/output interface. Color depth varies depending on the scanning array characteristics but is usually at least 24 bits. High quality models have 36-48 bits of color depth. Another qualifying parameter for a scanner is its optical resolution, measured in pixels per inch (ppi), sometimes more accurately referred to as samples per inch (spi).

Images in web pages, video, and slide shows can be as low as 72 PPI for a static image or 150 PPI if we are going to focus in on the image. For printing, the DPI needs to be larger, with images scanned in at least 300 DPI. The DPI standard for and images to be printed within journals and books is 300 DPI and for museum exhibits, it's 600 DPI.

The most important factors determining image quality of digital images can be considered as pixel dimensions and color depth. Increasing the dpi value of an image by resampling in Photo Editors (e.g., Adobe Photoshop) has no improving effect on its quality, but it lets us to determine target printing size.

For vector images, there is no equivalent of resampling an image when it is resized, and there is no PPI in the file because it is resolution independent (prints equally well at all sizes). However, there is still a target printing

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size. Some image formats, such as Photoshop format, can contain both bitmap and vector data in the same file. Adjusting the PPI in a Photoshop file will change the intended printing size of the bitmap portion of the data and also change the intended printing size of the vector data to match. This way the vector and bitmap data maintain a consistent size relationship when the target printing size is changed. Text stored as outline fonts in bitmap image formats is handled in the same way. Other formats, such as PDF, are primarily vector formats which can contain images, potentially at a mixture of resolutions. In these formats the target PPI of the bitmaps is adjusted to match when the target print size of the file is changed. This is the converse of how it works in a primarily bitmap format like Photoshop but has exactly the same result of maintaining the relationship between the vector and bitmap portions of the data.

Long story short, it is not technically possible to talk about DPI value for images that were taken by digital cameras or any type of digital images that were transferred to the computer's storage media. The DPI value stored within exif information of images is just a virtual value just to guide the photo editing software and the graphic artist to determine the target printing size of that image.

Requirements for Digital Media

Figures and Figure Legends

Dear author, since the Journal has decision of publishing online, there is no need to upload the photos, pictures, drawings or shapes in the article as a separate file. However, to avoid blurring of images in the pdf of the article, you should add the photos or other images (X-ray, BT, MR etc.) in your Microsoft Word program as follows.

Insert menu - Pictures - Related image file in your computer

You must add the related image file on your computer and set the picture width to 16 cm on Word document. Since the need to upload each image (photo, X-ray, BT, MR or other images) is eliminated, please do not upload it to the system during submission. Place only at the end of full text and blind text.

Due to the reasons explained above, images should be taken by a digital camera of 5 megapixels or more in JPEG, RAW, or TIFF format, and should be inserted in their original form as JPEG or TIFF files.

Paper-printed images or documents should be scanned at 300 DPI resolution and should be inserted as TIFF or JPEG files.

Each vector graphic software has its own built-in settings and may have been preset at 72 dpi. So, the document should be created enough big to obtain the image in the desired dimensions. The vector graphics should be exported to a rasterized image format and inserted such as JPEG or TIFF files.

For X-ray films, CT scans, and other diagnostic images, as well as pictures of pathology specimens or photomicrographs, you should insert high-resolution photographic image files. Since blots are used as primary evidence in many scientific articles, we may require deposition of the original photographs of blots on the journal website.

Letters, numbers, and symbols on figures should therefore be clear and consistent throughout, and large enough to remain legible when the figure is reduced for publication. Figures should be made as self-explanatory as possible. Titles and detailed explanations belong in the legends—not on the illustrations themselves.

Figures should be numbered consecutively according to the order in which they have been cited in the text.

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In the manuscript, legends for illustrations should be in Arabic numerals corresponding to the illustrations. Roman numerals should be avoided. When symbols, arrows, numbers, or letters are used to identify parts of the illustrations, you should identify and explain each one clearly in the legend.

Units of Measurement

Measurements of length, height, weight, and volume should be reported in metric units (meter, kilogram, or liter) or their decimal multiples.

Temperatures should be in degrees Celsius. Blood pressures should be in millimeters of mercury, unless other units are specifically required by the journal.

Authors must consult the International System of Units (SI).

Authors should add alternative or non-SI units, when SI units are not available for that particular measurement. Drug concentrations may be reported in either SI or mass units, but the alternative should be provided in parentheses where appropriate.

Abbreviations and Symbols

Use only standard abbreviations; use of nonstandard abbreviations can be confusing to readers. Avoid abbreviations in the title of the manuscript. The spelled-out abbreviation followed by the abbreviation in parenthesis should be used on first mention unless the abbreviation is a standard unit of measurement.

Types of paper

Scientific Reports in Medicine publishes the following types of articles.

1. Original Articles: Original prospective or retrospective studies clinical and experimental research in areas relevant to human medicine.

The manuscript should contain English abstract, a maximum of 250 words, and the structured abstract should contain the following sections: objective, methods, results [findings], and conclusion. Three to six words or determinative groups of words should be written as keywords below the abstract.

The text of articles reporting original research might contain up to 5000 words (excluding Abstract, references and Tables) and should be divided into Introduction, Methods, Results [Findings], and Discussion sections. References should also be included so that their number does not exceed 50. This so-called "IMRAD" structure is not an arbitrary publication format but a reflection of the process of scientific discovery. Articles need subheadings within these sections to further organize their content. Care should be taken to ensure that the number of figures or tables does not exceed 5-6 each.

2. Review Articles: The authors may be invited to write or should be expert in that subject of review article.

The manuscript should contain both English abstract, a maximum of 250 words, but a structured abstract is not required. The main text should include titles or related topics to further organize the content. The text of review articles might contain up to 5000 words (excluding Abstract, references and Tables). Number of references should not exceed 90. Care should be taken to ensure that the number of figures or tables does not exceed 5-6 each.

3. Case Reports: Brief descriptions of a previously undocumented disease process, a unique unreported manifestation or treatment of a known disease process, or unique unreported complications of treatment regimens.

The manuscript should contain English abstract, a maximum of 150 words, but a structured abstract is not required. The main text should include titles or related topics to further organize the content. The manuscript could be of up to 2000 words (excluding references and abstract) and could be supported with up to 25 references. Care should be taken to ensure that the number of figures or tables does not exceed 5-6 each.

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This journal follows a double-blind reviewing procedure. Authors are therefore requested to submit; a blinded manuscript, and a separate full manuscript file.

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Some authors claim, the influence of the pharmaceutical industry on medical research has been a major cause for concern. In contrast to this viewpoint, some authors emphasize the importance of pharmaceutical industry-physician interactions for the development of novel treatments and argued that moral outrage over industry malfeasance had unjustifiably led many to overemphasize the problems created by financial conflicts of interest.

Thus, full disclosure is required when you submit your paper to the Journal. The journal editor will use this information to inform his or her editorial decisions and may publish such disclosures to assist readers in evaluating the article. The editor may decide not to publish your article based on any declared conflict. The conflict of interest should be declared on your full manuscript file or on the manuscript submission form in the journal's online peer-review system.

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The Acknowledgements section immediately precedes the Reference list. All contributors who do not meet the criteria for authorship should be listed in an 'Acknowledgements' section. Additionally, if the article has been submitted on behalf of a consortium, all author names and affiliations should be listed at the end of the article in the Acknowledgements section. Authors should also disclose whether they had any writing assistance.

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The submitted file must be in Microsoft Word Document format.

The page size must be 210 mm × 297 mm (A4 size). All margins must be set to 2.5 cm. If you are using Microsoft Word 2007 or later, you can easily set the margin by choosing "Normal" setting from Margins menu within Layout tab. The text layout should consist of single column.

Do not capitalize diseases or syndromes unless they include a name or proper noun. Note that the words

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"syndrome" and "disease" are never capitalized; for example, Down syndrome, Hodgkin disease.

The authors should turn off automatic hyphenation. Do not use hyphens with common prefixes unless the word looks confusing when closed up or unless the prefix precedes a proper noun, some other capitalized word, or an abbreviation. Common prefixes that should be "closed up" include ante, anti, hi, co, contra, counter, de, extra, infra, inter, intra, micro, mid, neo, non, over, post, pre, pro, pseudo, re, semi, sub, super, supra, trans, tri, ultra, un, and under.

Use italics sparingly for emphasis in the text.

Spell out Greek letters or use the "Insert, Symbol" feature in Microsoft Word. Do not create your own symbols.

Do not use italics for common expressions, such asin vivo, in utero, en face, aide-mémoire, or in situ.

Use bold type sparingly in text because it competes with headings for the reader's attention.

Always use numerals for statistics, ages, and measurements (including time, for example, 3 weeks). For other uses, spell out numbers from one to nine only.

Spell out abbreviations at first mention in the manuscript, with the abbreviation following in parentheses (except for units of measure, which are always abbreviated following numerals).

Manuscripts including tables, references and figure legends, must be typewritten with a Unicode font (e.g., Times New Roman, Arial, etc.) that is available both for Windows and Mac Os operating systems. Please avoid using a mixture of fonts or non-Unicode fonts that do not support accented characters. The recommended font size is 12 points, but it may be adjusted for entries in a table. Authors should use true superscripts and subscripts and not "raised/lowered" characters. For symbols, please use the standard "Symbol" fonts on Windows or Macintosh.

Use the TAB key once for paragraph indents, not consecutive spaces. The pages should be numbered consecutively, beginning with the first page of the blinded article file. The pages should include title and abstract in English, the main text, tables, figures or diagrams-if exists- and reference list.

The title of the article should be centered at the top of the main text page, with the abstract below, and followed by Keywords. The capital letter of the first word of title should start with upper case letter. Please avoid capitalizing all letters of the title and conjunctions. The title, abstract, and keywords should be present in English and must be organized respectively. In order to start the Introduction section in a new page, a page break could be inserted at the end of Keywords.

While figure legends should be placed below the figures themselves, table captions should be placed above each table. Characters in figures, photographs, and tables should be uncapitalized in principal.

It would be appropriate to place the figures, tables and photographs at the end of the main text. Please, insert them at the end of main text at appropriate sizes, and order.

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EDITORIAL

As the journal Scientific Reports in Medicine (SRINMED), we are excited to share the thrill of launching our publication journey and we are pleased to share it with you, esteemed science readers. I would like to thank all the authors who contributed to our third issue.

Editor-in-Chief

Assoc. Prof. Dr. Burak METE

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Pre- and Postoperative Urea Levels in Open Heart Surgery: An Inflammatory Biomarker for Predicting Mortality Risk

Urea Levels and Mortality in Open Heart Surgery

Burak Toprak[1], Çise Kanat Toprak[2], Hasan Cihan[3]

DOI: 10.37609/srinmed.24

Abstract: Objective: This study aimed to evaluate the predictive role of both preoperative and postoperative urea levels in estimating mortality risk for patients undergoing open-heart surgery. Although the prognostic value of urea levels remains underutilized in clinical practice, this study emphasizes its potential significance in risk stratification.

Methods: In this retrospective analysis, data from patients who had undergone open-heart surgery were reviewed, focusing on the relationship between their preoperative and postoperative urea levels and mortality outcomes. The data were analyzed statistically, employing multivariate analyses to determine the impact of urea levels on mortality risk.

Results: The analysis demonstrated that each unit increase in postoperative urea level correlated with a 5% increase in mortality risk. These findings reveal a compelling association between elevated urea levels and mortality, supporting the prognostic significance of urea as a biomarker. Additionally, higher preoperative urea levels were associated with lower survival rates, particularly among high-risk patients.

Conclusions: Our findings suggest that both preoperative and postoperative urea levels are critical determinants of mortality risk following open-heart surgery. Routine monitoring of these biomarkers could improve postoperative outcomes, particularly in high-risk patient groups. This study underscores the value of incorporating urea levels into standard perioperative assessment protocols to enhance patient survival rates.

Keywords: Open-heart surgery, Urea levels, Mortality risk, Biomarkers, Prognostic factors, Risk stratification

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Abbreviations and acronyms:

AKI: Acute Kidney Injury

CPB: Cardiopulmonary Bypass

EF: Ejection Fraction

HT: Hypertension

DM: Diabetes Mellitus

OR: Odds Ratio

CI: Confidence Interval

CRP: C-Reactive Protein

INTRODUCTION

Open-heart surgery remains a primary approach in managing severe cardiovascular conditions. Procedures involving cardiac surgery, particularly those utilizing cardiopulmonary bypass (CPB), are associated with substantial systemic inflammation and hemodynamic variability, both of which profoundly affect postoperative outcomes (1). These procedures expose patients to marked metabolic stress and hemodynamic instability, elevating the risk of severe complications (1-3). Specifically, the fluctuations in hemodynamics and inflammatory responses during CPB elevate the risk of acute kidney injury (AKI) in vulnerable patients, correlating with increased mortality rates (4,5). These adverse effects emphasize the importance of early identification of at-risk patients to enable customized perioperative care and reduce complications. Beyond its role as a marker of renal function, urea levels also reflect systemic inflammatory responses, which play a critical role in the pathophysiology of postoperative complications. This dual nature of urea underscores its importance as a biomarker not only for kidney health but also for broader systemic stress indicators. Routine protocols, especially in preoperative risk assessments, have limited utilization of biomarkers. Considering the unique role of urea levels in assessing both renal function and systemic inflammation, it is anticipated to fill this gap. The use of urea monitoring as a potential tool for early identification of high-risk patients can significantly enhance perioperative care. In the literature, the study by Liaño and Pascual reports that high preoperative urea levels increase mortality risk. Similarly, Refaat et al. emphasize that perioperative urea monitoring strongly correlates with organ dysfunction and mortality. These findings align with our study, which underscores the prognostic importance of preoperative and postoperative urea levels.

Inflammatory responses during CPB have been linked to an increased risk of AKI and subsequent mortality in patients with impaired renal function (14,16). Such complications are often exacerbated by factors like systemic inflammation and hypoxia, leading to compromised kidney function, with urea levels emerging as a key biomarker in this progression (6-8). Studies indicate that urea levels are not solely indicators of kidney function but are also reflective of systemic inflammation and tissue hypoxia (9). Urea has been established as a significant predictor of mortality, given its association with both renal impairment and the systemic inflammatory response (7,8). Martin et al. noted that elevated urea levels post-cardiovascular surgery are linked with increased mortality, particularly in cases involving renal failure and tissue hypoxia (2). Our findings similarly show that each unit increase in postoperative urea levels corresponds to a 5% rise in mortality risk, affirming the prognostic value of urea within our patient cohort. Elevated urea levels also correlate with cardiovascular complications such as heart failure and cerebrovascular events, in addition to renal dysfunction (10,11). These associations suggest that beyond kidney function, overall inflammatory and immune responses critically influence postoperative mortality risk (12-14).

Preoperative assessment of renal function is crucial for reducing mortality, particularly among high-risk patients. Research indicates that patients with high preoperative urea levels have lower survival rates following surgery (15,16). AKI has been recognized as a factor that heightens postoperative complication risks, with patients with chronic kidney disease facing an even higher likelihood of surgical complications (17,18). Evaluating urea levels in the preoperative period is increasingly regarded as a valuable predictor for enhancing postoperative survival (19-21). Additionally, the long-term impact

of AKI may raise the likelihood of end-stage renal disease (ESRD) postoperatively, potentially resulting in sustained kidney dysfunction (22-23) Early identification and intervention for high-risk patients could significantly reduce postoperative mortality, highlighting the importance of robust predictive markers.

METHODS

This retrospective, observational cohort study was carried out at the Mersin University Medical Faculty Training and Research Hospital, a tertiary academic center with specialization in cardiovascular surgery. The study population included consecutive patients who underwent coronary artery bypass grafting (CABG) from January 1, 2022, to August 1, 2023.

Data Collection

Study Design: A nested case-control design within the cohort was utilized to enhance statistical power. Assuming an odds ratio (OR) of 1.5 for elevated urea levels and other mortality-associated factors, and with a confidence interval width set at 25%, the sample size required was determined to be 445 patients. Among these, deceased patients were matched at a 1:4 ratio with surviving patients.

Data Collection: Patient demographic data, laboratory test results, operative duration, left ventricular ejection fraction (EF), and multi-vessel disease presence were collected. Venous blood samples were taken upon admission and postoperatively on a daily basis in EDTA-containing vacuum tubes. Complete blood counts (CBC) were recorded at multiple time points, with specific focus on urea levels, white blood cell (WBC) count, hemoglobin level, and platelet count, all analyzed via an automated blood cell analyzer.

Data Analysis

-Variable Adjustments: To strengthen mortality prediction accuracy, adjustments were made for key demographic variables, including age, gender, and the presence of comorbidities.

Statistical Analysis: Multivariate analysis was employed to control for confounding variables, enhancing the reliability of identified mortality predictors. Continuous data were expressed as means and standard deviations or medians with ranges, while categorical data were presented as frequencies and percentages. For group comparisons, Student's t-test was applied for continuous variables (e.g., age, EF, biochemical measurements), and paired t-tests were used for repeated measures. Chi-square tests assessed relationships between mortality and categorical variables such as gender, diabetes mellitus (DM), and hypertension (HT). Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated for variables associated with mortality, including age, gender, EF, DM, HT, and biochemical markers. Statistical significance was defined as $p<0.05$.

Software: Data analyses were conducted using IBM SPSS 21 and MedCalc statistical software. Parametric tests were used for continuous variables without normality testing, based on the Central Limit Theorem.

Data Availability Statement

Datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Ethical Approval

Ethical approval for the study was obtained from the Mersin University Ethics Committee with the decision numbered 2024/472 and dated 22/05/2024.

Declaration of Helsinki

The study and the writing of the article were prepared in accordance with the Declaration of Helsinki.

İnformed Written Consent

Informed written consent was obtained in the surgical consent form before the subjects were included in the study.

RESULTS

A total of 446 diagnosed patients were included in the study. The basic characteristics and clinical data are presented in Table 1.

Table 1. Distribution of Socio-Demographic Characteristics in Patients Undergoing Open Heart Vascular Surgery (n=446)

Characteristic	**Mean±SD**	**Median(Min-Mak)**
Age (year)*	64.7±9.8	66(26-85)
	Count (n)	**Percentage (%)**
Gender**		
Male	312	70
Female	134	30
DM**		
No	192	43
Yes	254	57
HT**		
No	280	62,8
Yes	166	37,2
Mortality**		
Alive	350	78,5
Exitus	96	21,5
	($\bar{x}$ ±SS)	**Median (Min-Maks.)**
EF*	52.64±7.09	55(29-65)
PREOP		
Creatinine(mg/dL)*	0.96±0.57	0.88(0.44-9.75)
Ure (mg/dL)*	38.91±15.65	35.6(16.85-114.85)
NEU(103mcL)*	5.58±1.34	5.02(1.01-14.95)
LYM(103mcL)*	2.02±0.78	1.94(0.32-5.79)
PLT(103mcL)*	238.03±63.03	233(79-519)
CRP(mg/L)*	23.54±18.78	8.89(0.43-413.27)
Albumin(mg/L)*	37.75±3.94	38.32(24.15-46.4)

*Student's t-test, **Chi-Square test ($p<0.05$ significance), Paired t-test, p-value: Student's t-test was used for continuous variables, paired t-test for repeated measures, and Chi-Square test for categorical variables. (SD: Standard Deviation, EF: Ejection Fraction, DM: Diabetes Mellitus, HT: Hypertension, CRP: C-Reactive Protein, PLT: Platelets, NEU: Neutrophils, LYM: Lymphocytes.)

This study examined the socio-demographic and clinical characteristics of a total of 446 patients undergoing open heart vascular surgery. These data provide a comprehensive foundation for assessing the impact of biochemical factors on patient outcomes and identifying high-risk individuals for targeted interventions.

The age range of the patients varied from 26 to 85 years, with a mean age of 64.7 ± 9.8 years and a median age of 66 years. This indicates that the majority of the study population falls within the middle-aged and older age groups. Regarding gender, 70% of the patients were male, and 30% were female. This suggests that the majority of patients undergoing heart surgery were male.

Diabetes mellitus (DM) was present in 57% of the patients, indicating a significant portion of the population with this condition, which is known to increase the risk of complications. Hypertension (HT) was found in 37.2% of the patients, which is a known risk factor for cardiovascular diseases and can influence surgical outcomes.

Mortality occurred in 21.5% of the patients, underscoring the importance of assessing preoperative risk factors for better surgical planning and management. The mortality rate was adjusted for

the study by matching deceased patients to surviving patients at a 1:4 ratio. This matching approach aimed to enhance the statistical analysis and provide more accurate comparisons between the groups.

The left ventricular ejection fraction (EF) ranged from 29% to 65%, with a mean EF of 52.64 ± 7.09%, suggesting a wide range of cardiac function within the population. Lower EF values may indicate higher surgical risk.

Biochemical measurements were also taken into account. The mean creatinine level was 0.96 ± 0.57 mg/dL, which is within normal limits but can still be indicative of renal function. The mean urea level was 38.91 ± 15.65 mg/dL, with a maximum value of 114.85 mg/dL. Urea levels, which reflect renal function and systemic inflammation, are important biomarkers to consider in assessing postoperative risk. Other biochemical parameters, including neutrophils (NEU), lymphocytes (LYM), platelets (PLT), C-reactive protein (CRP), and albumin levels, were also measured and could provide valuable insights into the inflammatory status and nutritional condition of patients, both of which are important for postoperative recovery and survival.

This study highlights the significant influence of preoperative risk factors on open heart vascular surgery outcomes. Conditions such as diabetes mellitus and hypertension were common among the patients and strongly associated with poorer surgical results. The findings emphasize the critical role of evaluating left ventricular ejection fraction (EF) and urea levels. Lower EF and elevated urea levels, which indicate both renal dysfunction and systemic inflammation, were key indicators of increased surgical risk. These results reinforce the importance of monitoring these biomarkers to better manage high-risk patients and improve postoperative outcomes.

Table 2. Assessment of Differences and Associations in Socio-Demographic and Biochemical Measurements According to Mortality Status (n=446)

		Alive (n=350)	**Exitus (n=96)**	
Features		**Mean±SD**	**Mean±SD**	**p-value*/*** **
Age (year)		63.88±9.52	64.64±12.72	0.52
EF		53.12±6.56	50.26±9.01	**0.01**
Pre-Creatinine(mg/dL)		0.94±0.54	1.1±0.35	0.21
Post-Creatinine(mg/dL)		0.99±0.56	1.35±0.57	**<0.0001**
p value**		**0.002**	**<0.0001**	
Pre-Ure (mg/dL)		38.37±16.96	42.71±13.81	**0.02**
Post-Ure (mg/dL)		36.86±13.71	53.01±23.18	**<0.0001**
p value**		**<0.0001**	**<0.0001**	
Pre-NEU(103mcL)		5.56±2.41	5.66±2.66	0.74
Post- NEU(103mcL)		10.03±3.87	12.76±5.18	**<0.0001**
p value**		**<0.0001**	**<0.0001**	
Pre-LYM(103mcL)		2.03±0.68	2.14±1.21	0.43
Post-LYM(103mcL)		1.13±0.48	1.53±1.02	**0.02**
p value**		**<0.0001**	**<0.0001**	
Pre-PLT(103mcL)		237.11±69.32	232.74±75.95	0.6
Post-PLT(103mcL)		156.68±48.83	138.81±71.83	0.06

Table 2. Assessment of Differences and Associations in Socio-Demographic and Biochemical Measurements According to Mortality Status (n=446)

		Alive (n=350)	**Exitus (n=96)**	
p value**		**<0.0001**	**<0.0001**	
Pre-CRP(mg/L)		19.06±17.11	26.99±22.39	0.36
Post-CRP(mg/L)		149.32±57.51	134.71±53.34	0.24
p value**		**<0.0001**	**<0.0001**	
Pre-Albumin(mg/L)		38.17±3.47	35.36±5.59	**0.003**
Post-Albumin(mg/L)		28.65±12.55	23.84±4.32	**0.02**
p value**		**<0.0001**	**<0.0001**	
		n(%)	**n(%)**	
Gender	Male	254(72.6)	58(60.4)	**0.02*****
	Female	96(27.4)	38(39.6)	
DM+		218(62.3)	36(37.5)	**<0.0001*****
HT+		136(38.9)	30(31.3)	0.17***

*Student's t-test, **Paired t-test, ***Chi-Square test (p<0.05 significance), p-value: Student's t-test was used for continuous variables, paired t-test for repeated measures, and Chi-Square test for categorical variables. Statistical significance was considered at $p < 0.05$. The values marked in bold in the table indicate statistically significant results. (EF: Ejection Fraction, DM: Diabetes Mellitus, HT: Hypertension, CRP: C-Reactive Protein, PLT: Platelets, NEU: Neutrophils, LYM: Lymphocytes)

In this study, the relationships between mortality and various socio-demographic and biochemical factors were assessed. Age did not show a significant difference between survivors and deceased patients, with no statistical significance observed (p>0.05). This suggests that age alone may not be a reliable predictor of mortality in this population. However, ejection fraction (EF) was significantly lower in deceased patients, with a mean EF of 50.26 ± 9.01 compared to 53.12 ± 6.56 in survivors (p<0.05), highlighting the importance of cardiac function in determining surgical outcomes.

Preoperative and postoperative creatinine levels did not exhibit a strong association with mortality. While the preoperative creatinine difference was not significant (p>0.05), the postoperative creatinine levels were significantly higher in deceased patients (p<0.0001), suggesting that renal dysfunction after surgery is a key factor in mortality risk.

Urea levels, both preoperative and postoperative, showed significant differences between the two groups. Preoperative urea levels were higher in deceased patients, and postoperative urea levels were significantly elevated in the deceased group (p<0.0001). This indicates that urea, a marker of renal function and systemic inflammation, is a strong predictor of postoperative complications and mortality.

Neutrophil and lymphocyte counts were also significantly different between survivors and deceased patients. Postoperative neutrophil and lymphocyte levels were significantly higher in those who did not survive, further supporting the role of inflammation in influencing surgical outcomes.

No significant difference was found in platelet count between the groups, and postoperative C-reactive protein (CRP) levels were not significantly associated with mortality, suggesting that while these markers may reflect inflammation, they are not as strong indicators of mortality risk as other biomarkers like urea, neutrophils, and lymphocytes. Lastly, albumin levels showed a significant difference, with lower postoperative albumin levels observed in deceased patients, indicating its potential role as a

marker for nutritional status and overall health. These findings emphasize the importance of monitoring multiple biochemical parameters to assess the risk of postoperative complications and mortality.

The analysis of socio-demographic and biochemical parameters reveals significant associations between mortality and select clinical indicators. While age and hypertension showed no significant correlation with mortality, factors such as lower ejection fraction (EF), male gender, and absence of diabetes mellitus (DM) were significantly linked to higher mortality rates. Furthermore, postoperative assessments indicated pronounced differences in key biochemical markers, with elevated creatinine, urea, neutrophil, and lymphocyte levels, alongside reduced albumin, being notably higher in patients who did not survive. These findings suggest that postoperative renal function and inflammatory responses are critical in predicting mortality outcomes. Interestingly, the absence of significant variation in postoperative CRP and platelet levels underscores the value of focusing on specific biomarkers to optimize postoperative monitoring and risk stratification.

Logistic regression analysis was performed to evaluate the effects on mortality. Statistical significance was considered at $p < 0.05$. The values marked in bold in the table indicate statistically significant results. (CI: Confidance Interval, EF: Ejection Fraction, DM: Diabetes Mellitus, HT: Hypertension)

Table 3: Assessment of the Association Between Mortality and Age, Gender, and Chronic Disease Status(n=446)

Variables	Odds ratio	95% CI	p-value
Age	1.1	0.98-1.03	0.52
Ejection Fraction (EF)	0.95	0.92-0.98	**0.003**
Gender (Risk: Male)	1.73	1.08-2.78	**0.02**
Diabetes Mellitus (DM) (Risk: Present)	2.75	1.73-4.39	**<0.0001**
Hypertension (HT) (Risk: Present)	1.39	0.86-2.26	0.17

In this study, several factors were evaluated for their association with mortality following open heart surgery. Age did not show a significant relationship with mortality, as the odds ratio of 1.1 (95% CI: 0.98-1.03) and the p-value of 0.52 indicate that age alone does not significantly affect the risk of death. However, ejection fraction (EF) was significantly associated with mortality. Each 1-unit increase in EF reduced the risk of death by 0.95 times (95% CI: 0.92-0.98, $p<0.05$), emphasizing the role of cardiac function in predicting postoperative outcomes. Gender was another significant factor, with male patients showing a 1.73 times higher risk of mortality compared to females (95% CI: 1.08-2.78, $p<0.05$). This suggests that male gender is linked to a higher likelihood of adverse outcomes. Diabetes mellitus (DM) had a strong impact on mortality risk, with diabetic patients having a 2.75 times higher risk of death (95% CI: 1.73-4.39, $p<0.05$). This reinforces the known association between diabetes and increased postoperative complications. On the other hand, hypertension (HT) did not show a significant association with mortality, as its odds ratio of 1.39 (95% CI: 0.86-2.26) and p-value of 0.17 indicate no meaningful impact on mortality risk in this patient cohort.

Logistic regression analysis identified significant associations between mortality and key factors, with ejection fraction (EF), gender, and the presence of diabetes mellitus (DM) emerging as influential predictors. Specifically, each one-unit increase in

EF was associated with a 0.95-fold reduction in mortality risk, highlighting the protective effect of higher EF values. Male patients demonstrated a 1.73-fold higher risk of mortality compared to females, while the presence of DM was associated with a 2.75-fold increase in mortality risk. Notably, age and hypertension did not show significant associations with mortality, underscoring EF, gender, and DM status as primary predictors of postoperative survival.

Table 4: Assessment of the Association Between Preoperative Biochemical Parameters and Mortality(n=446)

Variables	Odds ratio	95% CI	p-value
Pre-Creatinine(mg/dL)	1.13	0.85-1.51	0.41
Pre-Ure (mg/dL)	**1.02**	**1.001-1.03**	**0.03**
Pre-NEU(103mcL)	1.02	0.93-1.11	0.74
Pre-LYM(103mcL)	1.16	0.89-1.52	0.28
Pre-PLT(103mcL)	0.99	0.98-1.01	0.6
Pre-CRP(mg/L)	1.01	0.99-1.001	0.19
Pre-Albumin(mg/L)	-0.84	0.78-0.92	**<0.0001**

Logistic regression analysis was performed to evaluate the effect of preoperative biochemical parameters on mortality. Statistical significance was considered at $p < 0.05$. The values marked in bold in the table indicate statistically significant results. (CI:Confidence Interval, DNI: Delta Neutrophil Index, CRP: C-Reactive Protein, NEU: Neutrophils, LYM: Lymphocytes, PLT: Platelets, EF: Ejection Fraction)

In this study, the association between preoperative biochemical parameters and mortality following open heart surgery was assessed. Preoperative creatinine levels did not show a significant association with mortality ($p>0.05$), suggesting that creatinine alone may not be a strong predictor of surgical outcomes. Similarly, preoperative neutrophil (NEU), lymphocyte (LYM), platelet (PLT), and C-reactive protein (CRP) levels did not demonstrate significant associations with mortality, as their p-values were above the threshold of 0.05 ($p>0.05$). These findings imply that these markers may not be as relevant for predicting mortality in this context.

However, preoperative urea levels showed a significant association with mortality ($p<0.05$). Specifically, each 1-unit increase in preoperative urea levels was found to increase the risk of death by 1.02 times (95% Confidence Interval: 1.001-1.03). This suggests that elevated urea levels, reflecting renal function and systemic stress, could serve as an important predictor of poor postoperative outcomes.

Furthermore, preoperative albumin levels were also significantly associated with mortality ($p<0.05$). A 1-unit increase in albumin was found to reduce the risk of death by 0.84 times (95% Confidence Interval: 0.78-0.92), highlighting albumin's potential as a protective factor. Lower preoperative albumin levels may indicate poor nutritional status and overall health, which are critical for recovery after surgery.

These findings underline the importance of monitoring specific biochemical parameters, such as urea and albumin, before surgery to better assess patient risk and guide management strategies.

The analysis of preoperative biochemical parameters identified urea and albumin levels as significant predictors of mortality. Specifically, each 1 mg/dL increase in preoperative urea was associated with a 1.02-fold increase in mortality risk, underscoring its prognostic importance. In contrast, higher albumin levels demonstrated a protective effect, with each 1 mg/dL increase in

albumin reducing mortality risk by 0.84-fold. Other preoperative factors, including creatinine, neutrophils, lymphocytes, platelets, and CRP, did not exhibit significant associations with mortality. These findings highlight the value of evaluating urea and albumin levels preoperatively to improve mortality risk stratification.

Table 5: Assessment of the Association Between Postoperative Biochemical Parameters and Mortality(n=446)

Variables	Odds ratio	95% CI	p-value
Post-Creatinine(mg/dL)	2.65	1.5-4.55	**<0.0001**
Post-Ure (mg/dL)	**1.05**	**1.03-1.07**	**<0.0001**
Post- NEU(103mcL)	1.14	1.08-1.21	**<0.0001**
Post-LYM(103mcL)	1.85	1.29-2.64	**0.001**
Post-PLT(103mcL)	0.98	0.97-0.99	**0.02**
Post-CRP(mg/L)	0.99	0.98-1.01	0.25
Post-Albumin(mg/L)	-0.67	0.59-0.76	**<0.0001**

Logistic regression analysis was performed to evaluate the effect of postoperative biochemical parameters on mortality. Statistical significance was considered at $p < 0.05$. The values marked in bold in the table indicate statistically significant results. (CI:confidence interval, DNI: Delta Neutrophil Index, CRP: C-Reactive Protein, NEU: Neutrophils, LYM: Lymphocytes, PLT: Platelets, EF: Ejection Fraction)

In this study, the relationship between postoperative biochemical parameters and mortality was assessed, revealing several key findings. Postoperative creatinine levels were strongly associated with mortality. For each 1-unit increase in postoperative creatinine, the risk of death increased by 2.65 times (95% CI: 1.5-4.55, p<0.0001), highlighting the importance of renal function in predicting postoperative survival. Similarly, postoperative urea levels were also significantly associated with mortality, with each 1-unit increase in urea raising the risk of death by 1.05 times (95% CI: 1.03-1.07, p<0.0001). This reinforces the role of urea as a critical marker for both kidney function and systemic inflammation. Postoperative neutrophils (NEU) were another important factor, with a 1-unit increase in neutrophil levels correlating with a 1.14 times higher risk of death (95% CI: 1.08-1.21, p<0.0001). This finding supports the idea that postoperative inflammation, as reflected by neutrophil levels, plays a significant role in mortality risk. Postoperative lymphocytes (LYM) were also associated with mortality, with a 1-unit increase increasing the risk of death by 1.85 times (95% CI: 1.29-2.64, p=0.001), further indicating the importance of the immune response in predicting outcomes.

On the other hand, postoperative platelet levels (PLT) showed an inverse relationship with mortality. For each 1-unit increase in platelet count, the risk of death decreased by 0.98 times (95% CI: 0.97-0.99, p=0.02), suggesting that platelet levels might act as a protective factor in the postoperative period. Postoperative albumin levels were also found to be a significant predictor, with each 1-unit increase in albumin decreasing the risk of death by 0.67 times (95% CI: 0.59-0.76, p<0.0001). This highlights albumin as an important marker for nutritional status and overall health, where lower levels are associated with higher mortality risk.

These findings underscore the critical role of monitoring various postoperative biochemical

markers, particularly creatinine, urea, neutrophils, lymphocytes, platelets, and albumin, in predicting patient outcomes and guiding postoperative care.

Postoperative biochemical parameters revealed strong associations with mortality, with elevated creatinine, urea, neutrophil, and lymphocyte levels significantly increasing mortality risk. Specifically, a 1 mg/dL rise in creatinine correlated with a 2.65-fold increase in mortality risk, highlighting the critical role of renal dysfunction. Elevated urea and neutrophil levels were also strongly associated with mortality, with each 1-unit increase in urea and neutrophil count raising mortality risk by 1.05 and 1.14 times, respectively. In contrast, higher postoperative albumin and platelet counts demonstrated protective effects, with each 1-unit increase in albumin reducing mortality risk by 0.67-fold. These findings underscore the importance of renal, inflammatory, and nutritional markers in postoperative risk stratification.

DISCUSSION

This study corroborates existing literature by affirming the critical role of perioperative urea levels as predictors of mortality in open-heart surgery. Our findings support the argument for integrating urea monitoring into standard protocols to improve postoperative care by facilitating timely, targeted interventions for high-risk patients. Implementing routine urea monitoring can be seamlessly integrated into existing workflows by incorporating regular biochemical assessments during perioperative evaluations. Training healthcare personnel to interpret urea levels in conjunction with other markers can streamline the identification of high-risk patients and ensure timely interventions. Developing standardized guidelines for urea monitoring, including threshold levels for intervention, will further enhance its utility in clinical practice. For example, in intensive care units (ICUs), daily urea level monitoring could be paired with protocols to adjust fluid management and medication dosages based on identified risk thresholds. High urea levels could trigger multidisciplinary discussions to optimize renal function and minimize systemic stress, reducing the likelihood of complications such as acute kidney injury (AKI). This approach not only improves patient outcomes but also ensures efficient use of ICU resources by prioritizing care for high-risk individuals. Incorporating urea levels into routine monitoring protocols not only aids in assessing renal function but also provides a dynamic measure of the inflammatory milieu. Such integration could facilitate targeted anti-inflammatory interventions in patients with elevated perioperative urea levels, thereby mitigating the risk of systemic complications. Postoperative surveillance of renal biomarkers, especially urea and creatinine, provides valuable insight into patient risk stratification and can guide postoperative care aimed at reducing mortality (18,19). Our findings further support the hypothesis that elevated urea levels may serve as a surrogate marker for systemic inflammation. This association highlights the potential for urea to act as an integrative biomarker, capturing both renal dysfunction and inflammatory stress, particularly in the context of perioperative management. Previous studies indicate that each unit increase in postoperative urea levels may raise mortality risk by 5%, underscoring the link between kidney function and tissue hypoxia (2,9). In agreement with these findings, our study observed a significant correlation between elevated postoperative urea levels and increased mortality, further establishing urea as a sensitive marker of renal and systemic stress responses. The literature consistently shows that postoperative urea elevations are associated not only with renal dysfunction but also with systemic inflammation and hypoxia (4,10,12).

Preoperative urea levels have also been documented as effective predictors of mortality (6,13,14). Research by Liaño and Pascual indicates that high preoperative urea levels increase the risk of postoperative mortality (6). A finding our study supports, as lower survival rates were similarly observed in patients with elevated preoperative urea. Elevated urea has been linked to a higher risk of cardiovascular and renal complications, particularly

among elderly patients (16). The long-term complications following acute kidney injury (AKI) can worsen outcomes in high-risk populations, emphasizing the necessity of close monitoring (17,18,21).

Zarbock et al. have underscored the relationship between sepsis-induced AKI and inflammation, highlighting its association with postoperative mortality (22). This link between inflammation and renal function underlines the predictive power of AKI for long-term outcomes and stresses the need for early intervention (22,24). Other studies on AKI prognosis suggest that early diagnosis is crucial to improving postoperative survival (23). Coca et al.'s systematic review further recommends vigilant monitoring for patients at high risk of adverse health outcomes and mortality post-AKI (18,19).

Research by Refaat et al. also points to a connection between high postoperative urea, organ dysfunction, and mortality (7). Our findings reinforce this association, showing a significant link between elevated postoperative urea levels and increased mortality within our study population. Wang et al. have reported that elevated urea levels are tied to systemic stress and trigger an inflammatory response (8). Such systemic stress markers, like increased urea, correlate with poor surgical outcomes, underscoring the importance of urea as a marker in postoperative evaluations (10,16). Collectively, these findings suggest that postoperative urea monitoring may play a crucial role in reducing mortality risk (15,20). This study's emphasis on renal function as a predictor of mortality indicates a potential gap in current clinical practices, advocating for a more integrated approach to patient monitoring. Implementing routine urea monitoring could not only enhance individual outcomes but also support a more personalized approach to perioperative management.

In conclusion, this study's observation that preoperative and postoperative urea levels are strong predictors of mortality aligns with existing literature. Routine monitoring of urea following cardiovascular surgery represents a valuable strategy in reducing mortality risk (13,23,24).

CONCLUSIONS

This study demonstrates that preoperative and postoperative urea levels are strong predictors of mortality following open-heart surgery. Particularly in the postoperative period, elevated urea levels reflect not only compromised renal function but also the metabolic stress associated with increased systemic inflammation and hypoperfusion. Our findings indicate that each unit increase in postoperative urea levels raises mortality risk by 5%, underscoring the influence of urea on cardiovascular stability beyond its role in renal function. This insight could inform the development of guidelines incorporating urea levels into postoperative monitoring, supporting a more personalized approach to patient care.

Additionally, our results, which suggest that preoperative urea levels may serve as a significant prognostic marker for mortality, underscore the importance of enhanced management of high-risk patients during the preoperative phase. These findings highlight the value of monitoring urea levels in strategies aimed at reducing postoperative complications. The dual role of urea as both a renal and inflammatory biomarker reinforces its utility in perioperative care. Future research should further elucidate its inflammatory pathways to optimize its application in predicting and managing postoperative complications. Overall, this study provides valuable insights into the incorporation of urea as a key biomarker in clinical decision-making, with its use emerging as a crucial tool for improving postoperative survival, especially in high-risk patient populations.

Limitations of the Study

Despite the comprehensive nature of this study, its retrospective design and single-center data collection limit the generalizability of the findings. The observational nature also restricts causal inferences and subgroup analyses for specific patient populations, such as those with varying levels of renal impairment or distinct surgical complexities. Future research should focus on large-scale, multicenter studies to validate these findings and

ensure broader applicability across diverse patient populations. Prospective designs incorporating real-time urea monitoring protocols could further refine its prognostic utility and facilitate the development of universally accepted perioperative guidelines.

KEY POİNTS

What is known about the topic?

Urea levels are well-established indicators of kidney function and have been associated with systemic inflammation and hypoxia, especially in patients undergoing cardiac surgery. Elevated urea levels, both preoperatively and postoperatively, have been linked to an increased risk of adverse outcomes, including mortality, particularly in patients with compromised renal function. However, in clinical practice, the use of urea as a routine biomarker for mortality risk assessment in cardiac surgery remains underutilized. Current literature suggests that additional research could further clarify urea's predictive value and support its integration into perioperative management protocols for high-risk populations.

What does this study add?

This study underscores the importance of preoperative and postoperative urea levels as accessible and predictive biomarkers of mortality in open-heart surgery patients. By demonstrating that each unit increase in postoperative urea levels correlates with a 5% increase in mortality risk, the study emphasizes urea's prognostic value beyond kidney function. This research contributes a practical, cost-effective approach to mortality risk stratification, especially for resource-limited settings, and lays the groundwork for incorporating routine urea monitoring into perioperative care protocols. The findings provide a robust foundation for future, larger-scale studies aimed at validating urea levels as a key component of personalized perioperative management strategies, potentially improving outcomes in high-risk cardiac surgery patients.

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CONFLİCT OF INTEREST STATEMENT

We have no conflict of interest.

STATEMENT ON THE USE OF ARTİFİCİAL INTELLİGENCE

No artificial intelligence application was used.

FİNANCİNG

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Evaluation of machine learning methods in medicine: real data application

Running title: machine learning methods in medicine

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Abstract: **Objective:** One of the aims of a health study is to identify risk factors associated with the disease or to obtain predictive models for classification such as healthy / diseased. When the aim of a health study is classification, machine learning methods are widely used. Some of these methods; Logistic Regression, Decision Tree, Random Forest, Support Vector Machine and Naive Bayes. The aim of this study was to evaluate the performance of the machine learning such as Logistic Regression, Decision Tree, Random Forest, Support Vector Machine and Naive Bayes, for different sample size, prevalence and determination coefficient in real data sets.

Method: The data were randomly split into 70% training and 30% test set, and Logistic Regression, Decision Tree, Random Forest, Support Vector Machine and Naive Bayes were applied to the training set. The performance measure (Accuracy, Area Under Curve and Adjusted F Measure) of the methods evaluated on the test set were saved. This procedure was repeated 1000 times.These procedures were performed in the R 3.5 1.

Results: When all variables in the data are categorical, and determination coefficient is low with a moderate sample size, the Naive Bayes method exhibited higher performance. When all variables in the data are continuous, and determination coefficient is moderate with a low sample size, support vector machines method demonstrated superior performance. In cases where the dataset has a high number of categorical variables and a high determination coefficient, the Naive Bayes method outperformed others. The Random Forest method showed higher performance when determination coefficient is high, and the sample size is moderate.

Conclusion: This study provides valuable insights for researchers dealing with classification problems, guiding them to choose the most effective machine learning based on the characteristics of the datasets.

Keywords: Binary Logistic Regression, Random Forest, Support Vector Machine, Naive Bayes, Decision Tree, Real Data Sets

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INTRODUCTION

Classification is a type of problem in machine learning (ML) that is commonly addressed using methods such as Random forest (RF) and Support vector machines (SVM) in areas like marketing, telecommunications, and medicine.[1]

Among the ML models mentioned above, Logistic regression (LR) is one of the fundamental methods in classifying binary (alive/dead, patient/control) groups. Although LR is widely used, the use of other ML models has become widespread recently. Some of these methods are Decision Tree (DT), Artificial Neural Networks, K-nearest neighbor, Ensemble Methods (Bagging, Boosting and RF), Naive Bayes, SVM[2].

As in many other areas, decisions play an important role in medicine, especially in medical diagnostic processes. Since conceptual simple decision-making models that are capable of ML models should be considered for performing such tasks, DT is a very proper candidate.[3] The DT is potent ML model that has been used successfully in many medical studies as it provides easily understandable graphical classification rules.[3] However, in the RF, which is one of the commonly used ensemble learning methods, each tree is built based on recursive partitioning, and the prediction is made on the average of an ensemble of trees rather than of a single tree.[4]

The NB is simple probabilistic ML model based on Bayes' theorem with the assumption of independence between variables.[5]

The SVM is a ML model based on the statistical learning theory developed by Vapnik.[6] SVM and LR use both linear and non-linear data to separate the two groups, but SVM classifies non-linear data better than logistic regression because it uses kernel functions. LR generates the linear decision boundary through logit transformation. SVM finds the linear hyperplane that provides the maximum margin. Therefore, SVM is more optimal than logistic regression as the margin is maximized.

The most commonly used performance criteria for evaluation of ML models in the literature are Accuracy (ACC), Area Under Curve (AUC) and Adjusted F Measure (AGF).

The aim of this study was to evaluate the performance of the ML models such as LR, DT, RF, SVM and NB, for different sample size (n), prevalence (prev) and determination coefficient (R^2) in real data sets.

METHOD

Binary Logistic Regression

Regression methods have become an integral component of any data analysis concerned with describing the relationship between a response variable and one or more explanatory variables. Generally, logistic regression model is the case where the outcome variable is discrete by taking two or more possible values. The difference between an LR model and a linear regression model is that the outcome variable in LR is binary or dichotomous.[7] LR can be used for classification as well as for determining significant risk factors.

2.2. Decision Tree

DT is a non-parametric used for classification.[8] It consists of four parts, which are the decision node, the root node, leaf node, and branches.[9] In this structure, decision nodes represent the splitting measure on explanatory variables, leaf nodes represent a class label, and the root node represents the starting variable of the tree. Branches connect the nodes.

2.3. Random Forest

Breiman (1999) proposed RF, which combines the Random Subspace algorithm with the Bootstrap method.[11] Each DT was constructed from a set obtained from the starting training set using a bootstrap.[12] Ho (1998) has written many papers on "the random subspace" method, which does a random selection of a subset of features to use to grow each tree[13] .

2.4. Naive Bayes

NB is based on the assumption that the variables are conditionally independent[14]. This assumption is called class conditional independence. This assumption is made to simplify the computations involved, hence is called "naive". Despite this unrealistic assumption, the resulting classifier known as naive Bayes is remarkably successful in practice, often competing with much more sophisticated techniques.[15]

2.5. Support Vector Machine

SVM is an ML model based on the statistical learning theory developed by Vapnik (1998). SVM aims to find a maximal margin hyperplane to separate classes. The kernel function is used to map data to a higher dimensional space for learning non-linearly separable functions. The accuracy of the SVM largely depends on the properly chosen kernel and its parameters.[16]

The kernel function can be linear, radial, and polynomial functions. The Radial basis function is affected by the kernel width (γ) and the regularization (C) parameters; therefore, determination of the best pairs of parameters for the study was carried out.[17] The tune parameters for RF and SVM were automatically selected using the Caret package. Analyses were performed using R 3.5.1.

Real Data Study

ML models are tested on data sets from the UCI machine learning repository, including Breast Cancer[18], Breast (Breast Cancer coimbra)[19], Indian diabet pima [20], diabet[21], heart[22], Chronic kidney disease (CKD)[23]. The data were randomly split into 70% training and 30% test set, and the performance criteria of the methods in the test set were recorded. This procedure was repeated 1000 times. These procedures were performed in the R 3.5 1.

Performance Measures

In literature, performance evaluation of ML models is usually based on one performance measure. However, using these criteria, the performance of the methods is evaluated separately. in this evaluation, different evaluations can be made according to each performance criterion. for example, the method with the best performance for accuracy may have the worst performance according to the sensitivity value. In this case, it becomes difficult to determine which method performs better. To overcome this situation, ACC, AUC and AGF are evaluated together in this study.

The standard F measure has some limitations, especially in classification problems with class imbalance or significant differences between classes. The F-measure is defined as the harmonic mean of precision and recall and is often used to evaluate classification models. However, in some cases this metric may not provide sufficiently meaningful results. These tend to over-emphasize the majority class in imbalanced datasets. For example, in a dataset with 95% negative instances and 5% positive instances, a model that correctly classifies only the negative class may still have a high F-measure value, which may misrepresent the performance of the model. Therefore, the adjusted F-measure is used.

This evaluation is the mean performance measures were calculated for each ML model and ordered from largest to smallest and scored from 5 to 1. By summing the scores on each performance measure a final score was obtained. Table 1 shows how the ACC, AUC and AGF performance measures are calculated.

Table 1. Basic 2x2 Count Table			
Disease	**Test results**		
	Positive (*T=1*)	Negative (*T=0*)	Total
Present (D=1)	(True Positive)	(False Negative)	
Absent (D=0)	(False Positive)	(True Negative)	
Total			N

$$\text{Sn(Recall)} = P(T=1|D=1) = s_1 / n_1 \qquad \text{Sp} = P(T=0|D=0) = r_o / n_0$$

$$\text{PPV(Precision)} = P(D=1|T=1) = s_1 / m_1 \qquad \text{NPV} = P(D=1|T=1) = s_1 / m_1$$

$$\text{ACC} = (s_1 + r_0)/N$$

$$F_2 = 5 * \frac{Sn * precision}{(4*Sn) + precision} \qquad \text{Inv } F_{0.5} = \frac{5}{4} * \frac{Sn * Precision}{(0.25*Sn) + Precision} \qquad AGF = \sqrt{F_2 * \text{Inv}F_{0.5}}$$

RESULTS

The performance criteria of the ML models were evaluated using real data sets. The performance scores and properties of the real data sets are given in Table 2.

Table 2 Properties and performance scores of ML models											
	Properties of data sets						**Performance scores**				
Datasets	Prev	R^2	n	NV	#Cat	#Cont	LR	DT	RF	SVM	NB
Breast cancer	0.3	0.3	277	9	9	0	3	8	12	7	**15**
Breast cancer coimbra	0.6	0.4	116	9	0	9	5	6	12	**13**	9
Chronic kidney disease	0.3	0.8	158	24	13	11	3	6	13	9	**15**
Heart	0.3	0.6	299	12	5	7	3	11	**15**	8	8

NV: Number of variables, Cat: Number of Categorical variables, Cont: Number of Continuous variables

In scenarios where Prev=0.3, R2= (0.3, 0.8) and n= (158, 277), NB method has higher performance than other methods. In scenarios where the number of categorical variables in the data is high, the NB method has higher performance.In the scenario where prev=0.3, R2= 0.6 and n=299, RF method has higher performance than other methods, while in the scenario where prev=0.6, R2= 0.4 and n=116, RF and SVM methods have similar and higher performance than other methods. In scenarios where R2 is medium and high and the number of continuous variables in the data is high, RF method has higher performance.

DISCUSSION

Machine learning methods are used to classify diseased and healthy individuals in health studies. Correctly classifying diseased and healthy individuals is of great importance for early diagnosis of diseases and determining treatments for these diagnoses. There are many papers in literature investigating the performance of classification methods, but it is not clear which method performs better under which conditions. Given this situation, our aim in this paper is to evaluate the performance of classification methods on real data sets with n, prev and (R^2). Performance evaluation of ML models is based on one real data set, mostly two- or three-ML models

were compaired based on one or two and rarely three performance criteria. In this study, the performance of five ML models was evaluated based on ACC, AUC and AGF under real data sets. In this context, when all variables in the data were categorical, R^2 was low, and the sample size was moderate, the NB method demonstrated superior performance. When all variables in the data were continuous, and R^2 was moderate, and the sample size was low SVM method exhibited higher performance. When the number of categorical variables in the data was high, and R^2 was high, the NB method outperformed others. The RF method showed higher performance when R^2 was high, and the sample size was moderate to high.

Arasakumar et al. compared LR, DT, and RF on the breast cancer dataset and they observed that RF method shows better performance, which is consistent with our data[24].

Gokiladevi et al. compared SVM, RF, LR and DT on the chronic kidney disease dataset and observed that the performance of RF method shows better performance. This result is compatible with our real data[25].

Yu et al. compared DT, NB, RF and SVM according to the accuracy criteria, on breast cancer dataset and did not observe any significant difference[26].

Limitations of the study

More datasets can be used for comparisons, and different ML models can also be applied.

CONCLUSION

In conclusion, the performances of the data sets differ according to the structure of the data sets (n, r^2 and prev, continuous and categorical). Therefore, evaluating the data sets according to the characteristics of the data sets will enable us to make more accurate comments. We hope that this study helps any researcher confronted with classification problems to select the best performing two- or three-ML models based on the characteristics of the data set.

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Scientific Reports in Medicine

Comparison of Three-Port and Four-Port Laparoscopic Cholecystectomy: A Clinical Intervention Study

Three-Port vs Four-Port Laparoscopic Cholecystectomy

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Abstract: Objective: This study compares the outcomes of 3-port and 4-port laparoscopic cholecystectomy techniques, focusing on pain management, operative time, hospital stay, and recovery, within a clinical intervention framework.

Methods: This clinical intervention study was conducted at Van Başkale State Hospital, where data were retrospectively collected from 120 patients who underwent 3-port (n=60) or 4-port (n=60) laparoscopic cholecystectomy. Group allocation was performed prior to surgery based on clinical decisions, rather than a fully randomized process. Preoperative and postoperative management protocols were standardized. Key variables included gender, surgical priority, pain scores (VAS), operative time, hospital stay duration, and recovery time.

Results: Gender distribution differed significantly between groups (p=0.013), with more females in the 4-port group. No significant differences were observed in pain scores at 12 and 24 hours postoperatively, operative time, or recovery to normal activities. However, the 3-port group demonstrated a shorter hospital stay (p=0.003).

Conclusion: The findings suggest that the 3-port technique may offer advantages in reducing hospital stay duration. This clinical intervention study provides insights into optimizing laparoscopic techniques in resource-limited settings.

Keywords: Laparoscopic cholecystectomy, 3-port technique, 4-port technique, Postoperative recovery, Hospital stay duration

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Introduction

Cholecystectomy, especially laparoscopic cholecystectomy, is a common surgical procedure for treating symptomatic gallbladder diseases, including cholelithiasis and cholecystitis (1). Laparoscopic techniques have significantly reduced surgical morbidity and mortality compared to open cholecystectomy, offering faster recovery times, less postoperative pain, and shorter hospital stays (2). Among laparoscopic techniques, the number of ports used during surgery varies, with three-port and four-port approaches being widely applied. These variations primarily aim to improve patient outcomes by minimizing tissue trauma while maintaining procedural efficacy and safety (3).

The traditional four-port technique includes a standard port placement that allows optimal access to the gallbladder, enhancing visualization and instrument maneuverability (4). However, the three-port technique eliminates one port, theoretically reducing abdominal wall trauma, postoperative pain, and the risk of wound infection (5). Some studies suggest that fewer ports could decrease operative time, hospital stay, and postoperative recovery periods, although the evidence remains mixed and largely dependent on surgeon experience (6). Given the potential advantages of the three-port technique, further studies are needed to determine whether it offers distinct benefits over the four-port method in terms of pain management, recovery time, and overall efficiency (7).

Intraoperative and postoperative management in cholecystectomy patients often involves standard prophylactic antibiotic administration to reduce infection risk, although optimal protocols vary among institutions (8). In this study, all patients received preoperative cefazolin to maintain consistency and prevent infections associated with laparoscopic cholecystectomy. Additionally, postoperative analgesia, typically nonsteroidal anti-inflammatory drugs (NSAIDs), is essential for minimizing discomfort following surgery (9). Diclofenac sodium was selected as the sole analgesic agent for this study, administered twice on the first postoperative day, a protocol aligned with recommendations for effective and minimally invasive pain management in laparoscopic procedures (10).

This study is unique in that it was conducted as a randomized controlled trial by a single surgeon at xxx State Hospital. Data were collected retrospectively to compare the effects of three-port and four-port laparoscopic cholecystectomy on postoperative outcomes, including operative time, hospital stay, pain scores, and recovery duration. Randomization in the initial phase was crucial to minimize selection bias, ensuring comparability between the groups (11). The retrospective data analysis allowed for a comprehensive examination of postoperative outcomes, leveraging real-world data to assess each technique's efficacy in the context of a controlled clinical setting.

Although advanced techniques such as single-incision and robotic cholecystectomy are increasingly popular, they are often not feasible in small, resource-limited hospitals. This study was conducted in xxx Hospital, where limited resources necessitate an evaluation of the efficacy of widely applicable techniques such as 3-port and 4-port laparoscopic cholecystectomy. By focusing on a setting with constrained access to advanced technologies, this study aims to provide relevant insights into the optimization of laparoscopic procedures in such environments.

Material and Methods

This clinical intervention study was conducted at Van Başkale State Hospital to compare the outcomes of 3-port and 4-port laparoscopic cholecystectomy. Group allocation was based on clinical decisions rather than randomization, and data were retrospectively collected from patient records. Patients were included if they met the clinical criteria for laparoscopic cholecystectomy, and exclusions were made for patients with incomplete records or contraindications for surgery.

All patients received a prophylactic dose of 1 gram of cefazolin preoperatively. Postoperative pain management was standardized across groups, with 75 mg diclofenac sodium administered intramuscularly every 12 hours for the first postoperative day only. No additional analgesics or antibiotics were given unless clinically indicated.

The following parameters were collected from medical records: patient age, gender, operative time, hospital stay duration, time to return to normal activities, and pain scores (VAS) at 12 and 24 hours postoperatively. Operative times, duration of hospital stay, and recovery data were carefully documented to assess the effectiveness and patient outcomes associated with each cholecystectomy technique. Statistical analyses were then applied to compare these parameters between the 3-port and 4-port groups.

Results

In this study, we compared the outcomes of 3-port and 4-port cholecystectomy techniques across various patient characteristics and postoperative clinical parameters. In terms of gender distribution, 53% of patients in the 3-port group were female and 47% male, while in the 4-port group, 75% were female and 25% male. This difference in gender distribution was statistically significant (p=0.013), indicating that gender may influence the choice of surgical technique, with a preference for the four-port approach in female patients. However, further investigation is required to determine whether this association is related to gender-independent advantages or specific patient characteristics.

Regarding surgical priority, the proportion of patients requiring emergency surgery was 23% in the 3-port group and 27% in the 4-port group. Elective surgeries were performed on 67% of patients in the 3-port group and 63% in the 4-port group, showing no significant difference (p=0.673). This finding suggests that both techniques are similarly applicable in emergency or elective scenarios, and surgical priority does not significantly impact the choice of technique.

Pain management was assessed using VAS scores at 12 and 24 hours postoperatively. The 12-hour VAS score averaged 4.57 ± 2.13 in the 3-port group and 4.75 ± 2.07 in the 4-port group, with no statistically significant difference (p=0.788). Similarly, 24-hour VAS scores were 1.90 ± 1.08 in the 3-port group and 1.92 ± 1.08 in the 4-port group, with no significant difference (p=0.532). These results indicate that both surgical techniques provide comparable effectiveness in postoperative pain management.

When comparing operation times, the 3-port group had an average surgical duration of 33.90 ± 9.35 minutes, while the 4-port group had an average of 32.53 ± 8.32 minutes, a difference that was not statistically significant (p=0.299). This suggests that both techniques are equally efficient regarding operative time, allowing surgeons flexibility in technique choice without major differences in time requirements.

In terms of hospitalization duration, the average hospital stay was 1.27 ± 0.45 days for the 3-port group and 1.40 ± 0.49 days for the 4-port group, with this difference being statistically significant (p=0.003). The longer hospital stay observed in the 4-port group may imply that this technique could extend postoperative recovery time, indicating a potential advantage for the 3-port technique, especially in settings where shorter hospitalization is prioritized.

Finally, for the time to return to normal activity, patients in the 3-port group resumed daily activities within an average of 3.58 ± 0.77 days, while those in the 4-port group took an average of 3.85 ± 0.92 days, with no statistically significant difference (p=0.279). This finding suggests that neither surgical technique offers a distinct advantage in terms of recovery time to resume normal activities(table-1).

Table 1: Analysis based on laparoscopic port counts				
Variables		3 Port	4 Port	p †
		(n=60)	(n=60)	
Gender	Female	32 (53%)	45 (75%)	0.013
	Male	28 (47%)	15 (25%)	
Surgical Priority	Emergency	14 (23%)	16 (27%)	0.673
	Elective	46 (67%)	44 (63%)	
		Mean ± sd		p ‡
VAS Score 12 Hour		4.57 ± 2.13	4.75 ± 2.07	0.788
VAS Score 24 Hour		1.90 ± 1.08	1.92 ± 1.08	0.532
Surgery Time		33.90 ± 9.35	32.53 ± 8.32	0.299
Hospitalization Time		1.27 ± 0.45	1.40 ± 0.49	0.003
Days to Return Normal Activity		3.58 ± 0.77	3.85 ± 0.92	0.279

Discussion

This study evaluates the outcomes of 3-port versus 4-port laparoscopic cholecystectomy within the context of a clinical intervention study. Unlike fully randomized controlled trials, this study allocated patients based on clinical decisions and retrospectively analyzed their outcomes. While this design may introduce inherent biases, it reflects real-world clinical practices, particularly in resource-limited settings where advanced randomization processes may not be feasible.

The shorter hospital stay observed in the 3-port group highlights its potential for reducing healthcare costs and optimizing resource utilization. These findings are particularly relevant for facilities where efficiency and cost management are priorities. Future research involving prospective, randomized designs may help further validate these results.

Gender distribution was notably different between the two groups, with a higher percentage of female patients undergoing the 4-port technique. This result aligns with some recent studies suggesting that female patients may be more likely to undergo certain surgical techniques due to anatomical or physiological considerations; however, the literature remains divided on whether gender should influence technique choice (12). Some studies have suggested that factors such as the severity of cholecystitis or BMI might also influence technique selection in different patient demographics, potentially impacting recovery and postoperative pain (13). Our data align with findings that suggest female patients may exhibit slightly different responses to laparoscopic interventions, but larger studies are needed to confirm whether such differences hold clinical significance (14).

The postoperative pain scores (VAS) at 12 and 24 hours showed no significant differences between the groups, supporting recent findings that both techniques yield similar pain outcomes when postoperative analgesia is carefully managed (15). Minimally invasive approaches, regardless of the number of ports, have been shown to reduce postoperative pain, a result corroborated by our findings, emphasizing the efficacy of standardized pain management protocols in ensuring patient comfort (16). Given the increased emphasis on early postoperative pain management in laparoscopic procedures, our findings suggest that the choice of port number may not substantially influence pain levels (17). Studies have indicated that other factors, such as intra-abdominal pressure during the procedure, may also contribute to postoperative pain, which could explain the lack of difference between 3-port and 4-port approaches in this study (18).

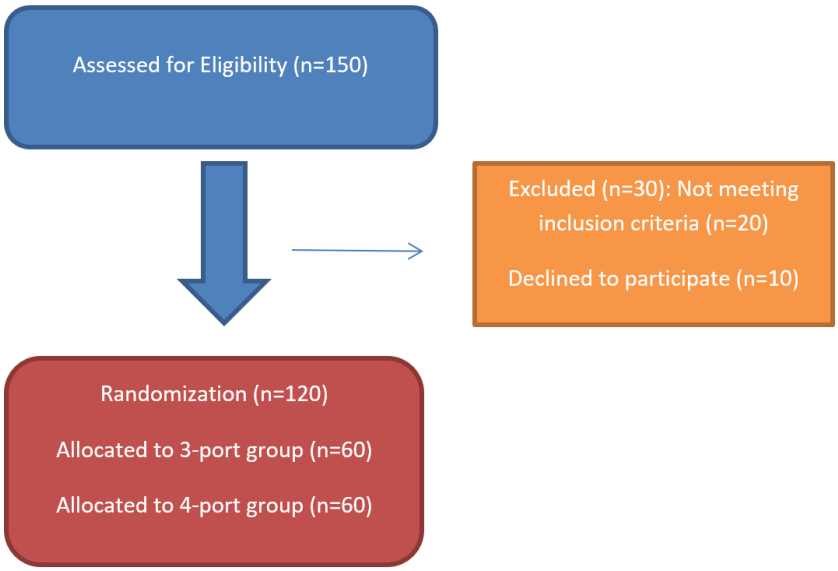

Figure 1: CONSORT Flow Diagram Depicting Patient Enrollment, Randomization, Follow-up, and Analysis

Operative times were also similar between the 3-port and 4-port groups, consistent with recent findings that the number of ports does not significantly impact the duration of laparoscopic procedures (19). This may be due to advances in surgical technique and technology, which have made multi-port and reduced-port approaches equally feasible in terms of operative efficiency (20). Another study highlighted that skill and experience of the surgeon have a greater impact on operative times than the number of ports used (21). The lack of significant difference in operative time in our study implies that surgeons may choose either technique without compromising surgical time, focusing instead on patient-specific factors and surgical expertise (22).

One of the most notable findings was the shorter hospital stay for patients in the 3-port group. Previous studies have suggested that fewer ports may reduce abdominal wall trauma, leading to faster recovery and shorter hospital stays, which is in line with our findings (23). Shorter hospital stays are particularly relevant in modern healthcare systems where reducing healthcare costs and bed occupancy are prioritized (24). Thus, the 3-port technique may offer economic benefits without compromising patient safety or outcomes. However, it is worth considering that this advantage may vary based on institutional protocols, and further research in different healthcare settings is necessary to validate this finding (25). Hospitalization costs and the associated resource allocation remain a critical concern in many healthcare systems, and shorter stays have been shown to contribute positively to resource management (26).

In terms of time to return to normal activities, no statistically significant difference was observed between the groups. This is consistent with studies showing that recovery timelines are often comparable across different laparoscopic techniques as long as postoperative pain and mobility are managed effectively (27). Both 3-port and 4-port techniques provide minimally invasive options that allow for rapid recovery and early resumption of daily activities, aligning with the enhanced recovery protocols commonly employed in laparoscopic surgery (28). However, some reports suggest that even minor differences in recovery time may be significant in patients with active lifestyles or jobs that require early physical activity (29). Our findings suggest that, despite the technical differences, both techniques enable patients to achieve postoperative recovery with similar timelines, which is advantageous in reducing postoperative recovery

periods (30).

Overall, our study suggests that the 3-port technique may offer some advantages in terms of hospital stay while maintaining comparable pain management, operative time, and recovery outcomes with the 4-port approach. Additionally, advancements in laparoscopic tools and the growing experience with reduced-port techniques may further enhance the feasibility and desirability of the 3-port approach, particularly in facilities focused on cost-effective care (31). The findings of this study contribute to the ongoing debate on the optimal laparoscopic approach in cholecystectomy, supporting the notion that fewer ports may confer specific benefits without significant compromises. Nevertheless, the final decision on the choice of technique should always account for patient-specific factors, surgeon experience, and institutional resources (32). This study demonstrates that both 3-port and 4-port laparoscopic cholecystectomy techniques produce comparable results in most postoperative outcomes. The significantly shorter hospital stay in the 3-port group may reflect reduced surgical trauma associated with fewer incisions, supporting findings from previous research that fewer ports can enhance recovery and reduce complications.

This study was conducted in a resource-limited hospital where advanced surgical techniques, such as robotic and single-incision laparoscopic surgery, were not available. Consequently, the findings are specific to conventional laparoscopic methods and may not directly apply to settings with access to advanced technologies.

Future randomized controlled trials with larger sample sizes, multicenter designs, and extended follow-up periods could provide further clarity on the comparative advantages of each technique. Additionally, incorporating quality-of-life metrics and patient satisfaction scores in future studies would provide a more comprehensive evaluation of the true impact of these surgical approaches on patient-centered outcomes (33). By evaluating outcomes from multiple dimensions, future research could enable more individualized surgical planning and further refine laparoscopic cholecystectomy protocols.

These findings may be applicable to other healthcare systems, particularly in low-resource settings. However, further research is needed to confirm their generalizability across diverse patient populations and healthcare contexts.

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Detection of COVID-19 vaccine rejection situation and reasons in people over 18 years of age applying to family health centers in Karabük and its relationship with health literacy level

Detection of COVID-19 vaccine rejection situation

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Abstract: Objective: The aim of this study is to examine the rejection of the COVID-19 vaccine, its reasons and its relationship with health literacy levels.

Material and Method: This study is a cross-sectional analytical study. The sample of the research consisted of 648 people who applied to family health centers in Karabük province between May 1, 2022 and June 30, 2022 and agreed to participate in the research. "Sociodemographic Characteristics", "Questions determining the characteristics of COVID-19 vaccine rejection" and "Health Literacy Scale TSOY-32 scale" were used to collect data. Descriptive characteristics of people are expressed with frequency and percentage in categorical data. Pearson Chi-Square and Fisher's Exact Test were used. A value of $p<0,05$ was considered significant.

Results: It is seen that 31.6% of the participants have an inadequate health literacy level, 36.9% have a problematic-limited health literacy level, 21.9% have an adequate health literacy level and 9.6% have an excellent health literacy level. A significant difference was found between rejection of the COVID-19 vaccine and health literacy ($p = 0.014$).

Conclusion: As a result, by increasing the level of health literacy, positive attitudes towards the COVID-19 vaccine will also increase. It is thought that positive attitudes towards the COVID-19 vaccine will increase by increasing health literacy levels. Therefore, it seems that there is a need for research to increase health literacy

Keywords: COVID-19 vaccines, health literacy, vaccination refusal

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INTRODUCTION

The COVID-19 pandemic first emerged in the news due to pneumonia cases in Wuhan, China. These cases spread from cities to provinces and quickly expanded worldwide (1). While the disease primarily spreads through respiratory droplets, it has also been identified that it can spread when individuals touch droplets released by infected people, thereby contaminating their hands and then touching their mouth, nose, or eyes (2).

After the pandemic was declared, vaccine development efforts were rapidly initiated, and many vaccines were developed in less than a year (3). COVID-19 vaccines, developed using different technological platforms, received emergency use authorization and began to be used starting from the end of 2020 (4). Before the COVID-19 pandemic, the process of developing a vaccine typically took 10-15 years. However, with the emergence of COVID-19, vaccine development was accelerated, and some stages were carried out simultaneously, reducing the timeline to 12-18 months (5).

Vaccine refusal refers to the idea of rejecting vaccines, whereas vaccine hesitancy involves delaying acceptance of the vaccine or rejecting it despite having access to it (6). Among the anti-vaccine statements are claims that the chemicals in vaccines are harmful to human health, that pharmaceutical companies have financial motives, or that it is possible to protect oneself from diseases naturally through diet (7). For this reason, some individuals doubt the safety or effectiveness of vaccines, which can lead to potential risks in vaccine-preventable epidemics (8).

Health literacy refers to the ability to access, understand, and evaluate health-related information in order to make informed decisions in everyday life about disease prevention, healthcare services, and the promotion and improvement of health. It also increases individuals' knowledge, motivation, and competencies in applying this information (9). This concept was first used by Professor Dr. Scott K. Simonds in his 1974 article "Health Education as Social Policy." In this article, health education was considered a policy impacting both the health and education systems, and it was emphasized that health literacy should be one of the fundamental standards at all educational levels (10). The concept of health literacy has continued to evolve to this day through cumulative studies on literacy, adult education, and health promotion (11). Health literacy helps individuals make the most of the healthcare system, while also enabling them to develop critical thinking and decision-making skills. These skills not only affect individual well-being but also have a significant impact on public health (12).

High levels of health literacy encourage individuals to protect themselves and the community from diseases, participate in public health interventions such as vaccination, and increase their awareness (13).

The aim of this study was to determine the attitudes of individuals aged 18 years and over towards COVID-19 vaccination, to evaluate their level of knowledge, and to examine the relationship between these attitudes and health literacy levels

MATERIALS AND METHODS

Type and Purpose of the Study: This is a cross-sectional analytical study. The aim of the research is to determine the state of COVID-19 vaccine refusal, its reasons, and its relationship with health literacy levels among individuals applying to Family Health Centers in Karabük province.

Location and Time of the Study: The study was conducted in all Family Health Centers in Karabük city center between May 1, 2022 and June 30, 2022.

Population and Sample of the Study: The population of the study consists of individuals who applied to Family Health Centers in Karabük province in 2022. The sample size was calculated based on data from a similar study. To achieve a 95% confidence interval and 80% power, the minimum sample size required was determined to be 628 individuals. A total of 648 participants took part in our study.

Data Collection Tools: The questionnaire consists of three sections. The first section gathers sociodemographic characteristics, the second section includes questions identifying the characteristics of COVID-19 vaccine refusal, and the third section comprises the Health Literacy Scale (TSOY-32). We considered refusing the COVID-19 vaccine as not getting the COVID-19 vaccine.

Turkey Health Literacy Scale (TSOY-32): Developed by Okyay and colleagues, this 32-question scale is based on the conceptual framework of the Health Literacy (HLS-EU) study, which has been proven to be effective and reliable. Participants are asked to select the appropriate option based on a 5-point Likert scale (very easy = 1, easy = 2, difficult = 3, very difficult = 4, no opinion = 5). Scoring is reversed: very easy = 4, easy = 3, difficult = 2, very difficult = 1. The lowest health literacy score is 0, and the highest score is 50.

(0-25) points: inadequate health literacy

(>25-33) points: problematic - limited health literacy

(>33-42) points: adequate health literacy

(>42-50) points: excellent health literacy

Data Analysis: Data analysis was conducted using the SPSS 21 software package. Descriptive statistics for categorical variables were expressed as frequencies and percentages. The normality of numerical data was tested using the Kolmogorov-Smirnov test. For normally distributed data, the Independent t-test was used for two or fewer subgroups, and the One-Way ANOVA test was used for more than two groups. For non-normally distributed data, the Mann-Whitney U test was used for two or fewer subgroups, and the Kruskal-Wallis test was used for more than two groups. Chi-square analysis was applied to examine relationships between nominal variables across groups. Fisher's exact test was used when expected values in the cells of 2x2 tables were insufficient, and Pearson's chi-square analysis was performed with Monte Carlo simulation for RxC tables. A significance level of 0.05 was used in interpreting the results.

Ethical Approval: Ethical approval for the study was obtained from the …….. University Non-Interventional Clinical Research Ethics Committee. Other necessary institutional permissions for the study were also obtained. Participation in the study was based on voluntary consent, and a voluntary participation form was used for all participants.

RESULTS

According to Table 1, 92.1% (n=597) of the 648 participants in the study had received the COVID-19 vaccine, while 7.9% (n=51) had not received any COVID-19 vaccine (Table 1).

According to Table 1, 60.0% (n=389) of the participants were female, and 40.0% (n=259) were male. Regarding age distribution, 54.3% (n=352) were aged 18-45, 34.6% (n=224) were aged 46-65, 9.4% (n=61) were aged 66-79, and 1.7% (n=11) were aged 80 and above. Among the participants, 65.4% (n=424) were married, while 34.6% (n=224) were single.

When examining education levels, 24.2% (n=157) of the participants had completed primary school, 43.8% (n=284) had completed secondary school, 29.6% (n=192) had completed associate's/bachelor's degrees, and 2.3% (n=15) had completed graduate studies.

Regarding employment status, 32.4% (n=210) of the participants were actively employed, while 67.6% (n=438) were not working. Among the employed participants, 2.9% (n=19) worked in the primary economic sector, 19.6% (n=127) in the secondary sector, and 12.7% (n=82) in the tertiary sector. Among those not working, 41.0% (n=266) were unemployed, 9.0% (n=58) were students, and 14.8% (n=96) were retirees.

Concerning the place of residence, 95.5% (n=619) of the participants lived in the city, 2.5% (n=16) in the district, and 2.0% (n=13) in the village. Regarding family type, 96% (n=622) lived in nuclear families, while 4.0% (n=26) lived in extended families.

In terms of social security, 89.7% (n=581) had Social Security (SGK), 5.6% (n=36) had a Green

Card, 2.8% (n=18) had private insurance, and 2.0% (n=13) had no insurance.

Regarding chronic illness, 24.1% (n=156) of the participants had a chronic disease, while 75.9% (n=492) did not (Table 1).

Table 1: Sociodemographic Characteristics of Participants in the Study

		n	%
Gender	Female	389	60,0
	Male	259	40,0
Age	18-45 Years	352	54,3
	46-65 Years	224	34,6
	66-79 Years	61	9,4
	80 Years and Above	11	1,7
Marital Status	Married	424	65,4
	Single	224	34,6
Education Level	Primary School	157	24,2
	Secondary School	284	43,8
	Associate's/Bachelor's Degree	192	29,6
	Graduate Studies	15	2,3
Place of Residence	City	619	95,5
	District	16	2,5
	Village	13	2,0
Family Type	Nuclear Family	622	96
	Extended Family	26	4,0
Social Security	SGK	581	89,7
	Green Card	36	5,6
	Private Insurance	13	2,0
	No Insurance	18	2,8
Chronic Illness	Yes	156	24,1
	No	492	75,9
Employment Status	Yes	210	32,4
	No	438	67,6
Occupation	Primary Economic Sector Occupation	19	2,9
	Secondary Economic Sector Occupation	127	19,6
	Tertiary Economic Sector Occupation	82	12,7
	Not Working	266	41,0
	Student	58	9,0
	Retired	96	14,8
COVID-19 Vaccination Status	Vaccinated for COVID-19	597	92,1
	Not Vaccinated for COVID-19	51	7,9

Table 2: Relationship Between COVID-19 Vaccine Refusal and Marital Status					
COVID-19 Vaccine Refusal Status			**Marital Status**		
Married		**Single**	**Total**	**p**	
Vaccinated for COVID-19	**n**	384	213	597	0,042*
	%	59,3	32,8	92,1	
Not Vaccinated for COVID-19	**n**	40	11	51	
	%	6,2	1,7	7,9	
Total	**n**	424	224	648	
	%	65,4	34,6	100	

*Pearson Chi-Square Test

According to Table 2, the number of married individuals who received the COVID-19 vaccine is 384 (59.3%), while the number of single individuals who received the vaccine is 213 (32.8%). Among those who did not receive the COVID-19 vaccine, 40 (6.2%) are married, and 11 (1.7%) are single. Therefore, a statistically significant difference was found between COVID-19 vaccine refusal and marital status (p=0.042) (Table 2).

The number of women who have received the COVID-19 vaccine is 360 (55.6%), while the number of men is 237 (36.6%). There are 29 women (4.5%) who have not received the vaccine, and 22 men (3.4%) who have not received it. It has been found that there is no statistically significant difference between gender and vaccine refusal (p> 0.05).

Table 3: Relationship Between COVID-19 Vaccine Refusal and Health Literacy Scale					
TSOY Group		**Vaccinated for COVID-19**	**Not Vaccinated for COVID-19**	**Total**	**p**
Inadequate	**n**	181	24	205	0,014*
	%	27,9	3,7	31,6	
Problematic	**n**	227	12	239	
	%	35,0	1,9	36,9	
Adequate	**n**	135	7	142	
	%	20,8	1,1	21,9	
Excellent	**n**	54	8	62	
	%	8,3	1,2	9,6	
Total	**n**	597	51	648	
	%	92,1	7,9	100	

*Pearson Chi-Square Test

No statistically significant difference was found between COVID-19 vaccine refusal and employment status, place of residence, chronic illness, or family type (p>0.05).

According to Table 3, among the individuals who received the COVID-19 vaccine, 181 (27.9%) had inadequate, 227 (35%) had problematic, 135 (20.8%) had adequate, and 54 (8.3%) had excellent health literacy levels. Among those who did not receive the COVID-19 vaccine, 24 (3.7%) had inadequate, 12 (1.9%) had problematic, 7 (1.1%) had adequate, and 8 (1.2%) had excellent health literacy levels. Therefore, a significant difference was found between the COVID-19 vaccine refusal status and the TSOY-32 groups (p=0.014) (Table 3).

Table 4: Relationship Between Marital Status and Health Literacy Scale					
TSOY Group		**Marital Status**			
		Married	**Single**	**Total**	**p**
Inadequate	**n**	151	54	205	<0,001*
	%	23,3	8,3	31,6	
Problematic	**n**	160	79	239	
	%	24,7	12,2	36,9	
Adequate	**n**	92	50	142	
	%	14,2	7,7	21,9	
Excellent	**n**	21	41	62	
	%	3,2	6,3	9,6	
Total	**n**	424	224	648	
	%	65,4	34,6	100	

*Pearson Chi-Square Test

According to Table 4, among married individuals, 151 (23.3%) have inadequate, 160 (24.7%) have problematic, 92 (14.2%) have adequate, and 21 (3.2%) have excellent health literacy levels. Among single individuals, 54 (8.3%) have inadequate, 79 (12.2%) have problematic, 50 (7.7%) have adequate, and 41 (6.3%) have excellent health literacy levels. When the relationship between marital status and TSOY-32 groups was statistically analyzed, a significant difference was found (p<0.001) (Table 4).

Table 5: Relationship Between Employment Status and Health Literacy Scale					
TSOY Group		**Employment Status**			
		Yes	**No**	**Total**	**p**
Inadequate	**n**	42	163	205	<0,001*
	%	6,5	25,2	31,6	
Problematic	**n**	92	147	239	
	%	14,2	22,7	36,9	
Adequate	**n**	55	87	142	
	%	8,5	13,4	21,9	
Excellent	**n**	21	41	62	
	%	3,2	6,3	9,6	
Total	**n**	210	43,8	648	
	%	32,4	67,6	100	

*Pearson Chi-Square Test

According to Table 5, when the relationship between employment status and TSOY-32 groups was statistically analyzed, a significant difference was found (p<0.001) (Table 5).

Table 6: Relationship Between Chronic Illness Status and Health Literacy Scale					
TSOY Group		**Is There a Chronic Illness?**			
		Yes	**No**	**Total**	**p**
Inadequate	**n**	88	117	205	<0,001*
	%	13,6	18,1	31,6	
Problematic	**n**	43	196	239	
	%	6,6	30,2	36,9	
Adequate	**n**	20	122	142	
	%	3,1	18,8	21,9	
Excellent	**n**	5	57	62	
	%	0,8	8,8	9,6	
Total	**n**	156	492	648	
	%	24,1	75,9	100	

*Pearson Chi-Square Test

According to Table 6, when the relationship between chronic illness status and TSOY-32 groups was statistically analyzed, a significant difference was found (p<0.001) (Table 6).

117 women (18.1%) have inadequate, 148 women (22.8%) have problematic, 83 women (12.8%) have adequate, and 41 women (6.3%) have excellent health literacy levels. Among men, 88 (13.6%) have inadequate, 91 (14%) have problematic, 59 (9.1%) have adequate, and 21 (3.2%) have excellent health literacy levels. Accordingly, when examining the relationship between gender and the Turkish Health Literacy Scale (TSOY-32), no statistically significant difference was found (p> 0.05).

Similar to gender, no statistically significant differences were observed between the TSOY-32 scale and family type or place of residence.

DISCUSSION

In this study, it was observed that a majority of married individuals had received the COVID-19 vaccine, and there was a statistically significant difference. In a study by Durduran and colleagues, it was found that married individuals had a positive attitude towards the COVID-19 vaccine (14). Similarly, in a study by Walker and colleagues, married individuals were found to have a higher vaccination rate for COVID-19 (15). Likewise, in the study by AlMohaithef and Padhi, it was observed that married individuals were more likely to get vaccinated against COVID-19 (16). The findings of this study align with the mentioned studies. The positive attitude of married individuals towards the COVID-19 vaccine may be due to the sense of responsibility they feel toward each other, and their desire to protect and keep their families healthy from the disease. In the study conducted by Özdinç and colleagues in 2022 on young people, it was found that the vaccination rate was higher among singles (17). The reason for this being different from our study could be that their research was primarily focused on young people.

This study found that single individuals had a significantly higher level of health literacy compared to married individuals. Singles make up 34.6%, while married individuals account for 65.4%. In the study by Değer and Zoroğlu, which examined the relationship between health literacy and cancer knowledge burden in first-level healthcare visitors, singles represented 31.8%, and married individuals made up 65.5% (18). In the study conducted by Türkoğlu, similar to our study, single individuals were found to have a significantly higher level of health literacy compared to married individuals (19). This similarity may stem from the similarity in sample sizes, the balance of single and married

individuals, and the fact that the studies were conducted in urban centers.

This study concluded that health literacy was statistically significantly related to chronic diseases. In the study by İkışık and colleagues, it was found that individuals without chronic diseases had higher levels of sufficient-to-excellent health literacy (20). Based on this difference, it can be concluded that the presence of chronic diseases may have a varying impact on health literacy levels.

In this study, when the relationship between health literacy and employment status was examined, it was found that employed individuals had significantly higher health literacy compared to unemployed individuals. In a study conducted by Temel on individuals over 65 with chronic diseases, a significant difference was also found between employment status and health literacy levels (21). However, in Duman's study on parents in Istanbul Fatih, no change was observed in the health literacy levels according to employment status (22). Looking at these studies, it is evident that there are differences in how employment status affects health literacy levels. These differences may arise from variations in the age range of participants, health status, and the locations where the studies were conducted.

In this study, it was found that 55.6% of those vaccinated for COVID-19 were women, and no statistically significant difference was observed. In a study by Yılmaz and colleagues, it was found that men were more likely to get the COVID-19 vaccine (23). Similarly, in studies by Çağatay and colleagues, and Gencer and colleagues, no statistically significant relationship was found between gender and receiving the COVID-19 vaccine (7, 24). The differences in the number of male and female participants, variations in the sample size, and the fact that some studies were conducted with specific age groups may explain why personal values and responsibilities could differently influence the decision to get vaccinated against COVID-19.

In this study, women were found to have higher levels of health literacy across all levels, but this difference was not statistically significant. In a study conducted by the Ministry of Health, it was found that health literacy was 35% in women and 26.4% in men (25). In Abacıgil and colleagues' study on health literacy, as in our study, it was concluded that there was no significant difference between gender and health literacy (26). In the research conducted by Yılmaz and colleagues, it was noted that women had higher health literacy (27). On the other hand, in the studies by Yakar and colleagues, it was observed that men had higher levels of health literacy (28). As seen in the literature, different results can be obtained regarding the relationship between gender and health literacy. These differences may be due to the different cultures in which the participants were raised, variations in age groups, and differences in educational levels.

Limitations of the Study: The study is limited to the city center of Karabük. The data is limited to the 648 participants who took part in the study. The study is also limited to the responses provided by the participants in the survey and the period during which the research was conducted. The sociodemographic characteristics of the participants, such as education, age, gender, and occupation, show a limitation in that the distribution of people who have received the COVID-19 vaccine and those who have not is not balanced.

CONCLUSION

The study determined that problematic-inadequate health literacy levels were more common. It was observed that individuals who had not received the COVID-19 vaccine had higher levels of inadequate health literacy. Among individuals who received the COVID-19 vaccine, the levels of adequate-excellent health literacy were found to be higher than those who did not receive the vaccine. When examining the relationship between participants' marital status, employment status, chronic illness, and health literacy, it was found that most participants had problematic-inadequate health literacy, with only a few having excellent health literacy. This study demonstrates that there is a relationship

between the refusal of the COVID-19 vaccine and health literacy, and that improving health literacy is essential. To improve health literacy, it is necessary to assess the health literacy levels in the community and place more focus on individuals with lower levels of health literacy. Collaboration with the education system, healthcare system, and media can help promote health literacy. Short, reliable information that is understandable for everyone should be disseminated through mass media. Health education can start from childhood, and efforts can be made to raise awareness about health by including it in school curricula from an early age. Activities to enhance health literacy can be organized, and incorrect and incomplete information should be corrected. To better understand the issues regarding vaccine refusal and health literacy in our country, there is a need to increase the number of studies with larger sample sizes and broader scopes.

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Evaluation of One Health Concept and Climate Change Awareness Among Cukurova University Students

One Health Concept and Climate Change Awareness

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Abstract: Objective: The One Health concept is an approach that evaluates human, animal, and environmental health together, and its importance is increasingly recognized. Climate change is related to the One Health concept and is a significant public health issue. Awareness of these topics, especially among young people, is crucial. This study aims to evaluate Cukurova University students' knowledge of the One Health concept and their awareness of climate change.

Method: The cross-sectional research was conducted in September 2024 at the Department of Public Health, Cukurova University. The study population consisted of students from Cukurova University, with 217 students participating in the research. The data collection form included sociodemographic information, questions related to the One Health concept and global climate change, along with the Global Climate Change Awareness Scale (GCCAS). The Shapiro-Wilk test, Chi-square, Mann-Whitney U, and Kruskal-Wallis tests were utilized for data analysis, followed by post-hoc analysis. A p-value of less than 0.05 was considered statistically significant.

Results: The average age of the students was 23.02±3.94 years. Among the university students included in the study, 53.5% considered themselves uninformed about the One Health concept. There was no significant difference between medical faculty students and those from other faculties in terms of their self-assessed knowledge of the One Health approach and awareness of global climate change. The students' awareness of global climate change was found to be moderate. Their awareness of the sub-dimensions related to natural and human environments and energy consumption was high, while their awareness of global organizations, agreements, and the causes of climate change was moderate

Conclusion: It can be suggested that there are deficiencies in undergraduate education, particularly in medical education, regarding the One Health approach and global climate change. We recommend that more emphasis be placed on the topics of One Health and climate change in undergraduate curricula.

Keywords: One Health, Climate Change, Awareness

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INTRODUCTION

One Health is an integrative approach aimed at improving the health of humans, animals, and the environment (1). According to the CDC's definition, One Health is a collaborative, multi-sectoral, and interdisciplinary approach that works at local, regional, national, and global levels to achieve optimal health outcomes by recognizing the interconnectedness between humans, animals, plants, and their shared environment. A successful One Health approach is made possible through collaborative efforts. Health professionals, including doctors, nurses, public health experts, and epidemiologists, work alongside animal health specialists (veterinarians, agricultural workers), environmental scientists (ecologists, wildlife specialists), and other fields. The concept of One Health is not new; however, it has gained prominence in recent years. One of the primary reasons for this is the increase in human population and its expansion into new geographical areas, resulting in more individuals living in close contact with both wild and domesticated animals (2). Some areas encompassed by One Health include food safety, the control of zoonotic diseases (diseases transmitted from animals to humans), combating antibiotic resistance, climate change, and the impacts of climate on the health of animals, ecosystems, and humans (3).

Climate change refers to any alterations in climate over time; these changes may arise from natural fluctuations or human activities. Climate change is a direct cause of humanitarian emergencies resulting from heatwaves, wildfires, floods, tropical storms, and hurricanes, increasing their scale, frequency, and intensity (4). Intense short-term temperature fluctuations lead to significant health impacts due to extreme heat (hyperthermia) and extreme cold (hypothermia), increasing mortality rates associated with cardiovascular and respiratory diseases. Climate-related illnesses, such as diarrhea, malaria, and malnutrition, contribute to a significant number of deaths worldwide (5).

The One Health approach, which allows for a holistic assessment of human health in relation to animal and environmental health, and the concept of climate change, which has started to affect human health more significantly in recent years, are important societal concepts. Actions to mitigate the effects of climate change are crucial both at the individual and societal levels. The most important point here is to raise awareness regarding climate change. The awareness of young people on this issue is also of particular significance. This study aims to evaluate university students' awareness of the One Health approach and climate change.

METHOD

This cross-sectional study was conducted in September 2024 at the Department of Public Health at Çukurova University. Ethical approval was received from the Çukurova University Faculty of Medicine Research Ethics Committee dated 04.10.2024 and numbered 148. The population of the study consisted of students from Çukurova University. Considering a power of 80%, α error: 0.05, and a two-tailed test, the minimum sample size required was determined to be 199. A total of 217 students were reached using a convenience sampling method. No exclusion criteria were determined, and Cukurova University students who agreed to participate in the study and filled out the online survey were included in the study. The online questionnaire explained the purpose of the research, stating that the information obtained through the research form would be used for scientific purposes, evaluated in accordance with scientific ethical standards, and would not be used for any other purposes. Access to the questionnaire was granted only if the participants accepted these conditions. The data collection form included sociodemographic information, questions related to the One Health approach and climate change, and the Global Climate Change Awareness Scale (GCCAS). The questions regarding the One Health approach and climate change examine participants' knowledge levels on these, sources of information, the scope of the subjects, and their awareness of the effects of climate change on health.

Global Climate Change Awareness Scale (GCCAS)

The GCCAS was developed by Deniz and colleagues in 2020 and consists of 21 items across four sub-dimensions (6). Items 1 to 9 pertain to the dimension of Impacts on Natural and Human Environments, items 10 to 15 relate to the dimension of Awareness of Global Organizations and Agreements, items 16 to 18 address the dimension of Underlying Causes, and items 19 to 21 are concerned with the dimension of Energy Consumption Relationship. There are no negatively coded items in the scale. All dimensions can be summed. The scale yields a maximum score of 105 and a minimum score of 21. Additionally, the total score averages for the scale and its sub-dimensions are interpreted as follows after dividing by the number of items: a score between 1-2.33 indicates low awareness, 2.34-3.66 indicates moderate awareness, and 3.67-5.00 indicates high awareness. The Cronbach alpha coefficient calculated to determine the internal consistency of the scale is 0.826.

Statistical Analysis

The data analysis was conducted using SPSS 21 software. Qualitative data were presented as frequency and percentage, while quantitative data were reported as arithmetic mean, standard deviation, and median. The Shapiro-Wilk test was employed as a normality test. Chi-square, Mann-Whitney U, and Kruskal-Wallis tests were utilized for data analysis, followed by post-hoc analysis. A p-value of less than 0.05 was considered statistically significant.

Table 1. Sociodemographic Characteristics

Characteristics	**mean±SD**	**median(min-max)**
Age	23.02±3.94	23(18-55)
Characteristics	**n**	**%**
Gender		
Male	77	35.5
Female	140	64.5
Marital status		
Married	10	4.6
Single	204	94
Other	3	1.4
Faculty		
Medical	115	53
Non medical	102	47
Mother's education level		
Illiterate	18	8.3
Literate	17	7.8
Primary school	54	24.9
Middle school	12	5.5
High school	42	19.4
University and above	74	34.1
Father's education level		
Illiterate	4	1.8
Literate	7	3.2
Primary school	49	22.6
Middle school	16	7.4

Table 1. Sociodemographic Characteristics		
Characteristics	**mean±SD**	**median(min-max)**
High school	43	19.8
University and above	98	45.2
Income level		
≤17.002	138	63.6
17.003-34.004	51	23.5
≥34.005	28	12.9
Place of longest residence		
City center	150	69.1
District	51	23.5
Village	16	7.4
Presence of healthcare worker in family		
Yes	83	38.2
No	134	61.8
Family member working in animal health		
Yes	12	5.5
No	205	94.5
Family member working in food health		
Yes	15	6.9
No	202	93.1
Family member working in environmental health		
Yes	3	1.4
No	214	98.6

RESULTS

The average age of the 217 university students included in the study is 23.02±3.94 years. Of the participants, 64.5% are female, 94% are single, and 53% are medical school students. Information regarding the sociodemographic characteristics of the participants is presented in Table 1.

Of the university students included in the study, 53.5% believe they are not knowledgeable about the concept of "One Health." Only 15.7% of the participants have gained knowledge as part of their education. When asked "What comes to mind when you hear the term One Health approach?" 85.7% responded with the integration of human, animal, and environmental health. Additionally, 77.9% of participants think they have knowledge about climate change, with 40.1% acquiring information from publications. When asked "What comes to mind when you hear the term climate change?" 58.8% answered "Changes in the average state and/or variability of the climate." Furthermore, 58.1% believe they understand the health impacts of climate change. The diseases most frequently associated with climate change, in order, are water-related diseases (96.3%), respiratory diseases (95.9%), and infections (94.5%) (Table 2).

Table 2. Participants' knowledge about the one health approach and climate change		
CHARACTERISTICS	**n**	**%**
Belief in Knowledge of One Health Approach		
Yes	24	11.1
No	116	53.5
Unsure	77	35.5
Sources of Information on One Health Approach		
From a friend	19	8.8
From social media	18	8.3
From publications (articles,journals,books)	16	7.4
As part of my education	34	15.7
First Association with the One Health Approach		
Evaluation of human, animal and environmental health together	186	85.7
Evaluation of human and environmental health together	22	10.4
Evaluation of human and animal health together	5	2.3
Evaluation of animal and environmental health together	4	1.8
Scope of One Health Approach According to Participants		
Environmental health (water, air pollution, climate change)	213	98.2
Food safety and foodborne diseases	211	97.2
Zoonotic diseases	199	91.7
Antimicrobial resistance	196	90.3
Vector-borne diseases	195	89.9
Laboratory services	166	76.5
Others	45	20.7
Belief in knowledge of Climate Change		
Yes	169	77.9
No	11	5.7
Unsure	37	17.1
Sources of Information on Climate Change		
From a friend	8	3.7
From social media	83	38.2
From publications (articles,journals,books)	87	40.1
As part of my education	24	11.2
First Association with climate change		
Changes in average climate conditions and/or variability	127	58.8
Natural events caused by temperature changes	50	23
Decrease in ozone	15	6.9
Temperature extremes	14	6.5
Heat/cold waves	5	2.3
Air pollution	4	1.8
Changes in air and their effects on living beings	1	0.5
Awareness of Health Effects of Climate Change		
Yes	126	58.1
No	26	12
Unsure	65	30
Health effects of climate change according to participants		
Cardiovascular diseases	189	87.1
Respiratory diseases	208	95.9
Cerebrovascular diseases	178	82
İnfections	205	94.5
Gastrointestinal diseases	184	84.8
Psychiatric disesase	188	86.6
Vector-borne diseases	183	84.3
Water-related diseases	209	96.3
Skin diseases	203	93.5
Eye diseases	183	84.3
Immune system diseases	189	87.1

When comparing the faculties of students included in the study with regard to their belief in knowledge, there was no significant difference between medical faculty students and other students (p: 0.688). However, in the questions regarding the scope of One Health Approach, students who believed that antimicrobial resistance, zoonotic diseases, vector-borne diseases, food safety, foodborne diseases, and environmental health were included in the scope of One Health Approach were found to be significantly higher among medical faculty students (p values: 0.018, 0.006, 0.011, 0.008, 0.047 respectively) (Table 3).

Table 3. Comprasion of students knowledge status regarding one health

Characteristic		Faculty		Total n(%)	p
		Medical faculty n(%)	Other faculties n(%)		
Belief in having knowledge about One health	Yes	11(9.6)	13(12.7)	24(11.1)	0.688
	No	64(55.7)	52(51)	116(53.5)	
	Not sure	40(34.8)	37(36.3)	77(35.5)	
	Total	115(100)	102(100)	217(100)	
Scope of one health					
Antimicrobial resistance	Yes	109(94.8)	87(85.3)	196(90.3)	**0.018**
	No	6(5.2)	15(14.7)	21(9.7)	
Zoonotic diseases	Yes	111(96.5)	88(86.3)	199(91.7)	**0.006**
	No	4(3.5)	14(13.7)	18(8.3)	
Vector-borne diseases	Yes	109(94.8)	86(84.3)	195(89.9)	**0.011**
	No	6(5.2)	16(15.7)	22(10.1)	
Food safety and foodborne diseases	Yes	115(100)	96(94.1)	211(97.2)	**0.008**
	No	0(0)	6(5.9)	6(2.8)	
Environmental health	Yes	115(100)	98(96.1)	213(98.2)	**0.047**
	No	0(0)	4(3.9)	4(1.8)	
Laboratory services	Yes	88(76.5)	78(76.5)	166(76.5)	0.993
	No	27(23.5)	24(23.5)	51(23.5)	
Other	Yes	23(20)	22(21.6)	45(20.7)	0.907
	No	92(80)	80(78.4)	172(79.3)	
	Total	115(100)	102(100)	217(100)	

The information regarding the scores obtained by the participants included in the study from the Global Climate Change Awareness Scale is presented in Table 4. Additionally, when evaluating the average scores obtained by dividing the total scores of the scale and its sub-dimensions by the number of questions, the average total score of the participants for the Global Climate Change Awareness Scale was found to be 3.54±0.89. For the sub-dimension of Natural Human Environments, it was 3.98±1.02; for the sub-dimension of Global Organizations and Agreements, it was 2.93±1.27; for the sub-dimension of Causes of Global Climate Change, it was 3.00±1.26; and for the sub-dimension of Energy Consumption, it was 3.94±1.11. Accordingly, the awareness of the students regarding global climate change is considered to be at a medium level. The awareness in the sub-dimensions of Natural Human

Environments and Energy Consumption was found to be at a high level, while the awareness regarding Global Organizations and Agreements and the Causes of Climate Change was determined to be at a medium level.

Table 4. Scores Obtained by Participants from the GCCAS		
	Average±SD	**Median(min-max)**
Total score of GCCAS	74.35±18.72	73 (21-105)
Dimension of Effects on Natural and Human Environments	35.90±9.22	38(9-45)
Dimension of Awareness of Global organizations and agreements	17.60±7.64	18 (6-30)
Dimension of causes	9±3.79	9 (3-15)
Dimension of enegy consumption relation	11.83±3.33	12 (3-15)

When comparing the scores obtained from the Global Climate Change Awareness Scale based on the participants' gender, faculty, marital status, income status, longest place of residence, having a healthcare professional in the family, or having a family member working in food, animal, or environmental health, no statistically significant difference was found (Table 5). When comparing the scores obtained from the Global Climate Change Scale based on the educational status of the participants' parents, the sub-factors of the scale and the total scores were higher in participants with highly educated parents. (Table 5) Among the participants, those who believed they were knowledgeable about global climate change scored higher in sub-factor 1, sub-factor 4, and total scale scores compared to those who did not believe they were knowledgeable (in order of p:0,001, p:0,005, p:0,033) (Table 5).

Table 5. comparison of participants scale scores based on certain characteristics					
Characteristics	**Factor 1[a] Medyan(IQR)**	**Factor 2[b] Medyan(IQR)**	**Factor 3[c] Medyan(IQR)**	**Factor 4[d] Medyan(IQR)**	**GCCAS total Medyan(IQR)**
Gender					
Male	36(13)	15(14)	9(6)	13(6)	71(23)
Female	39(18)	18(12)	9(6)	12(6)	77.5(24.75)
p	0.170	0.152	0.660	0.594	0.419
Faculty					
Medicine	36(11)	18(12)	9(6)	13(5)	75(22)
Non medicine	38(18)	16.5(14)	9(12)	12(6)	71(29.75)
p	0.835	0.716	0.822	0.282	0.323
Marital status					
Single	38(15.75)	18(12)	9(6)	12.5(6)	74(23.75)
Married/divorced/widowed	37(20.5)	16(9.5)	6(5.5)	9(7.5)	63(36)
p	0.779	0.964	0.052	0.073	0.272
Income level					
≤17.002	37.5(16.25)	18(12)	9(6)	12(6)	73(23)
17.003-34.004	39(12)	17(14)	8(5)	13(6)	76(25)
≥34.005	41(18)	15.5(15.5)	9(10.5)	13.5(6)	72(40)
p	0.762	0.861	0.548	0.874	0.908
Longest lived location					
City center	38(17.25)	17(13)	9(6)	12(6)	72(23)

Table 5. comparison of participants scale scores based on certain characteristics					
Characteristics	**Factor 1[a] Medyan(IQR)**	**Factor 2[b] Medyan(IQR)**	**Factor 3[c] Medyan(IQR)**	**Factor 4[d] Medyan(IQR)**	**GCCAS total Medyan(IQR)**
District	37(13)	18(12)	986)	12(6)	75(23)
Village	42(26)	15(19.75)	7.5(9.75)	14(9)	74(49.25)
p	0.890	0.540	0.796	0.669	0.930
Mother's education level					
Illiterate	30.5(22.5)	12.5(7)	6.5(3.75)	9(7.25)*	63.5(38.5)*
Literate	36(13)	16(9)	7(4.5)	12(6)	70(24.5)
Primary school	39(11)	18(16.5)	9(6)	14(5.25)	78(31.25)
Middle school	42.5(14)	18(15)	8.5(7)	15(5)*	79(30.5)
High school	36(18)	18(12.25)	9(6)	12(6)	73.5(24.75)
University and above	39(13)	17(12.5)	9(7)	13(4.25)*	74(25.25)*
p	0.143	0.107	0.148	**0.005**	**0.045**
Father's education level					
Illiterate	19.5(25,75)	12(3)	6(3.75)	8(7.25)	45(33.25)
Literate	27(19)	12(8)	6(6)	7(4)*	59(23)*
Primary school	39(14)	18(13.5)	9(6)	14(6)*	76(29.5)
Middle school	36(15.75)	18(10.5)	7.5(5.75)	12(6)	74(24)
High school	39(16)	18(12)	9(5)	13(6)	73(22)
University and above	39(12.25)	17.5(13)	9(6.25)	13(4)*	76(24.5)*
p	0.164	0.150	0.319	**0.020**	**0.021**
Presence of a healthcare worker in the family					
Yes	39(18)	18(12)	9(6)	12(6)	73(26)
No	37.5(13.25)	17(12)	9(6)	12(6)	73.5(22)
p	0.332	0.790	0.433	0.756	0.655
Presence of a family member working in animal health					
Yes	39.5(16)	15.5(16,5)	9(8.5)	13.5(5.5)	73.5(26.75)
No	38(16.5)	18(12)	9(6)	12(6)	73(23.5)
p	0.566	0.692	0.621	0.731	0.985
Presence of a family member working in environmental health					
Yes	41	16	9(4)	13	75
No	38(17.25)	18(12)	9(6)	12(6)	74(23)
p	0.940	0.512	0.967	0.875	0.959
Presence of a family member working in food health					
Yes	36(18)	18(19)	9(8)	13(6)	75(41)
No	38(16.25)	18(12)	9(6)	12(6)	733(23)
p	0.971	0.517	0.633	0.647	0.818
Perception of knowledge on the one health approach					

Table 5. comparison of participants scale scores based on certain characteristics					
Characteristics	**Factor 1[a] Medyan(IQR)**	**Factor 2[b] Medyan(IQR)**	**Factor 3[c] Medyan(IQR)**	**Factor 4[d] Medyan(IQR)**	**GCCAS total Medyan(IQR)**
Yes	38(15)	22(13.75)	9(6.5)	12(6.5)	82.5(31.5)
No	37(15.5)	17(14)	9(6.75)	12(6)	72(21.75)
Not sure	39(18)	17(11)	9(6)	13(6)	77(26.5)
p	0.988	0.159	0.436	0.654	0.492
Perception of knowledge on climate change					
Yes	39(12)*	17(13.5)	9(6)	13(5.5)*	75(26.5)*
No	27(9)*	18(3)	9(3)	9(5)*	63(33)
Not sure	36(18)	17(10.5)	9(6.5)	12(7)*	70(26.5)*
p	**0.001**	0.962	0.624	**0.005**	**0.033**

*Post hoc analysis of groups with significant differencesa: Effects on the Natural and Human Environment
b: Awareness of Global Organizations and Agreements
c: Underlying Causes
d: Relationship with Energy Consumption

DISCUSSION

In our study, 53% of the participants are medical faculty students. Of all the students included in the study, 53.5% stated they were not aware of the "One Health" concept, 35.5% were unsure, and 11.1% believed they were knowledgeable. They indicated their sources of information as part of my education (15.7%), friends (8.8%), and social media (8.3%). In a study conducted with senior students from the faculties of medicine, veterinary medicine, and environmental engineering at Uludağ University in Bursa in 2023 (n=518), 73.7% of the students reported not knowing the "One Health" concept (7). In the same study, 69.1% (n=94) of the students who had heard of the "One Health" concept during their undergraduate education acknowledged receiving education on this topic, with 21.3% citing friends and 9.6% citing social media as their sources of information (7). In a study conducted with interns from the Ege University Faculty of Medicine, 40.2% of the 316 participants stated they had not heard of the "One Health" concept before (8). In a study by Gedik and colleagues involving 165 health management students, it was found that 75.8% had not previously heard of the "One Health" concept (9).

In our study, no significant difference was found between the responses of medical faculty students and students from other faculties regarding whether they considered themselves knowledgeable about the "One Health" concept. It might be expected that students from the medical faculty would be more knowledgeable about the "One Health" concept compared to students from other faculties; however, the findings do not support this. This finding could be significant as it suggests insufficient education on this topic in medical faculties. In questions related to the scope of Public Health, medical faculty students were more likely to respond affirmatively. However, this might not necessarily indicate that they received education on Public Health since medical faculty students are generally expected to have more knowledge on these topics compared to students from other faculties due to their medical education.

77.9% of the participants in our study believed they were knowledgeable about global climate change (GCC). They identified their sources of information as publications (40.1%) and social media (38.22%). In a study by Ek et al., 75% of the students stated they had knowledge about GCC, with 78% citing visual media as their source of information (10). In research conducted by Uzun, it was found that 50.9% of the students had no knowledge about GCC (11).

In a study conducted by Yavuz with medical faculty students, all students had heard of the concepts of global warming and climate change before. The most cited sources of information on climate change were the internet/social media at 94.5% (12). The majority of students in the included studies were found to be knowledgeable about GCC, but the internet/social media, visual media, and publications were prominent as sources of information. This is significant as it suggests that GCC is not sufficiently covered in students' education. In our study, students' awareness of global climate change was found to be moderate. Their awareness of the sub-dimensions of impacts on the natural and human environment and energy consumption was high; awareness in other sub-dimensions was moderate. In a study conducted with Giresun University students in 2023 using the same scale, GCC awareness was also found to be moderate, with high awareness in the dimensions of impacts on the natural and human environment and energy consumption, and moderate awareness in other sub-dimensions (13). The findings of this study are similar to ours. Various studies conducted in our country show that students have heard of the concept of global climate change, but their levels of awareness vary. (14-16)

In our study, no significant difference was found between the scores obtained from the Global Climate Change Awareness Scale (GCCAS) between male and female genders. In a study conducted by Yörük et al. on university students, male students were found to have higher scores on the GCCAS (13). In our study, when comparing the GCCAS scores of students based on their parents' education levels, it was found that the dimension related to energy consumption and the total scale scores were higher among those with parents having a higher level of education. In a 2023 study conducted with medical faculty students, it was found that students whose fathers had an education level of high school or above had a higher knowledge of climate change (12). This finding suggests that increasing the level of education, beginning with the family, which is the smallest and most important unit of society, may enhance climate change awareness in communities.

A significant difference was observed in the GCCAS scores among those who believed they had knowledge about global climate change. Those who considered themselves knowledgeable obtained higher scores on the GCCAS. In a study, students who thought they had the necessary knowledge and skills to assess the health impacts of climate change were found to have higher knowledge scores compared to those who did not perceive themselves as having the necessary knowledge and skills (12). Students seeing themselves as competent in this area could be associated with the level of their existing knowledge.

In our study, no significant difference was found between the GCCAS scores of medical faculty students and students from other faculties. This finding might suggest that sufficient information is not provided on global climate change in medical education. In a study conducted in 2023 with students from the faculties of medicine, environmental engineering, and veterinary medicine at Uludağ University in Bursa, it was found that environmental engineering students knew this concept at a higher rate compared to medical and veterinary medicine students (7). The differences among faculties might be related to the emphasis placed on the concept of climate change in undergraduate education.

Limitations of the study

The limitation of our study is that the survey was conducted online rather than face-to-face, and the convenience sampling method was used. To improve the study, a larger sample and a probabilistic sampling method are needed.

CONCLUSION

In our study, only 11.1% of university students consider themselves knowledgeable about the One Health concept. There is no significant difference between medical faculties and other faculties regarding their perception of whether they are informed about the One Health approach.

Additionally, there is no significant difference between medical faculty students and other faculty students concerning the scores obtained from the Global Climate Change Awareness Scale. The students' awareness of global climate change is at a moderate level. Their awareness regarding the subdimensions of natural and human environments and energy consumption is at a high level, while their awareness of global organizations and agreements and the causes of climate change is at a moderate level. It can be stated that there are deficiencies in undergraduate education, especially in medical education, regarding the One Health approach and global climate change. We recommend that more emphasis be placed on the topics of One Health and climate change in the undergraduate curriculum.

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Examining the nutritional habits of individuals with moderate and severe covid-19, evaluation of changing nutritional habits and physical activity behavior after covid-19.

Determination of changing eating habits with COVID-19

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Abstract: **Objective:** This research aimed to examine the eating habits of adult individuals infected with severe and moderate COVID-19 disease and to evaluate the changing eating habits and physical activity behaviors of post-COVID-19 individuals.

Methods: The cross-sectional study included 1340 people over the age of 18 and had a positive PCR test. The data was collected online with the ”Google Form”. The obtained data were analyzed with the statistical package program SPSS 25 (Statistical Package for Social Science). Data Mean±Standard Deviation and percentage distribution and the Chi-square test were used in its analysis. $p<0.05$ significance level was considered statistically significant.

Results: It was found that the food consumption of 66.7% of the participants did not change after infection. It has been concluded that individuals do not pay attention to healthy nutrition after infection.It was found that 71.1% of the individuals didn’t do regular physical activity and this situation didn’t change after COVID-19.

Conclusion: In line with the results obtained from the study, it is necessary to pay attention to the nutritional habits and physical activity status of individuals. Nutrition education should be provided by dietitians, accurate information should be provided by physical therapists to increase physical activity.

Keywords: COVID-19, Pandemic, Nutrition, Nutrition Habits

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INCTRODUCTION

COVID-19 (Coronavirus Disease-2019) is a serious public health problem caused by SARS-CoV-2. Cases of pneumonia have been recorded in the Chinese city of Wuhan, Hubei province in 2019 (1). The first cases in Turkey appeared on March 10, 2020. On the same date, it was declared a pandemic by the World Health Organization (WHO)(2, 3). COVID-19 has appeared asymptomatic or with symptoms such as cough, joint pain, fever and respiratory failure (4). Close contact (direct or indirect by touching the mouth, nose and eyes with the hands after touching the infected surface) and the droplet route (droplets thrown into the air during sneezing, coughing and speech) have been identified as the route of transmission of the disease(5). In order to prevent the transmission and spread of COVID-19, it is recommended to pay attention to hygiene conditions, wear a mask and act in accordance with social distancing rules(6). If infection transmission could not be prevented, treatment was carried out for the symptoms that occurred and it was aimed to prevent complications that may arise in this process. In addition, individuals have been encouraged to adopt a healthy lifestyle in order to strengthen their immune systems(7).

Within the scope of a healthy lifestyle; it has been proposed to implement an order in which an adequate level of sleep is provided, adequate and balanced nutrition is based, and a physically active life is adopted. It has been found that lifestyle changes are a factor that should be taken into account the predisposition to COVID-19 infection and the effect on the healing process(8). In order for individuals to prefer an active life, adults have been recommended at least 150-300 minutes of moderate-intensity or at least 75-150 minutes of intense physical activity per week(9). In addition, it has been stated that the sedentary lifestyle can be changed by simple changes such as providing transportation on foot and using stairs in daily life(10). The changing circadian rhythm and falling sleep quality of individuals have also negatively affected immunity, increasing the risk of COVID-19(11). It has been recommended that an adult should sleep for 7.5-8 hours in order to have an adequate sleep level(12). The nutrition model adopted on the basis of healthy nutrition and nutrient diversity by ensuring an adequate and balanced diet by taking the energy and nutrient elements needed by the body in sufficient quantities and in such a way that they are used appropriately has also become an important basis for a healthy lifestyle(13).

As a healthy nutrition model, the ”Four-Leaf Clover” model and the ”Healthy Eating Plate” model were presented as examples for individuals(13). In addition, for the COVID-19 period, the World Health Organization (WHO) has recommended the consumption of protein-containing foods such as meat-eggs-milk, fruits and vegetables, cereals and legumes, foods that are low in fat, salt and sugar content and a diet rich in unsaturated fatty acids every day. In order to minimize the loss of vitamins, he recommended not cooking fruits and vegetables, limiting the amount of caffeine consumed, and not consuming foods with high fat and sugar content(14). The Turkish Dietitians Association (TDD), has proposed to model the Healthy Eating Plate based on adequate and balanced nutrition. It has been reported that the consumption of vegetables and fruits ,which are quite rich in vitamins and minerals, should be according to the season, should be eating fish on two days of the week, and quality protein sources and legumes should be included in the nutrition stroy every day. During this period, limiting sugar and sugary foods that raise blood sugar rapidly, products and breads prepared with white flour, excessively salty and fatty foods and alcohol consumption were indicate(15). On the other hand, the Food and Agriculture Organization(FAO) drew attention to the consumption of vegetables and fruits with a rich content of vitamins, minerals and fiber. Whole grains and oil seeds, which have a healthy fat content, supported immunity due to the unsaturated fatty acid content. It also recommended that the fat, sugar and salt content of foods be examined, that these nutrients be limited when making choices, that regular water consumption be abundant and

alcohol consumption be moderate. FAO also puts food safety at the forefront in the declaretion it has issued. In order to ensure food safety, clean use of the environment in which food is prepared and cooked, separate cooking and storage of raw and cooked foods, clean water use, cooking and storage of foods at a safe and appropriate temperature were also mentioned(16).

The aim of this study is to evaluate the changing eating habits and physical activity behaviors of adult individuals infected with severe and modarete COVID-19 disease after COVID-19.

METHODS

The study was conducted as a cross-sectional research. This study was conducted with 1340 volunteer participants aged 18 years and older who were exposed to COVID-19 infection living in any province of Turkey. When including participants in the study, having experienced COVID-19 infection at least once was considered sufficient. The study was conducted between May 2022 and February 2023. Consent was obtained from the participants that they were volunteers. For this study, permission was obtained from the …….. University Non-Interventional Clinical Research Ethics Committee dated 01.06.2022 and numbered 2022/964. An online questionnaire prepared by the researcher was sent to the participants who volunteered. The survey which it is concent of questions with sociodemographic characteristics of individuals (age, sex, occupation, etc.), anthropometric measurements (body weight(kg) and height(m)), changing eating habits and physical activity status were questioned. The survey forms were completed online in accordance with the personal statements of the participants. Based on the data from the study assessing the relationship between changing eating habits and physicial activity during the COVID-19 pandemic, the sample size (power analysis) required to achieve a 95% confidence interval and 80% power was calculated to be at least 1252 participants. The study was completed with 1340 volunteer participants.

Statistical analysis

The data obtained as a result of the research were analyzed using the statistical package program SPSS 25 (Statistical Package for Social Science). In the analysis of the study data, percentile, mean, lower value, upper value, standard deviation were used. The Chi-square test was applied in the data analysis. A p-value <0.05 was considered statistically significant.

RESULTS

The demographic characteristics of the individuals who have undergone COVID-19 are given in Table 1. Among the participants, 60.4% are women (n=810) and 39.4% are men (n=530). The average age of the participants is 35.15 ± 11.97 years, with an age range of 18 to 85 years. A statistically significant difference was found between sex and age. (p<0,001) Of the individuals included in the study, 60.9% are married, while 39.1% are single. A statistically significant difference was not found between marital status and sex. (p=0,440) While 17.8% of the participants have graduate postgraduate degree, 59% of them are university graduates. Individuals with a high school education level accounted for 17.8% of the participants, while individuals with an primary-secondary school education accounted for 5.4%.A statistically significant difference was found between educational status and sex. (p<0,001) The study participants include 297 individuals with chronic diseases, while 1,043 individuals do not have any chronic diseases. A statistically significant difference was not found between chronic illness status and sex. (p=0,159)

TABLE 1. Demographic characteristics of the participants								
		Female(n=810)		Male (n=530)		Total(n=1340)		P*
		n	%	n	%	n	%	0,001
Age	18-24	144	17,8	81	15,3	225	16,8	
	25-64	660	81,5	431	81,3	1091	81,4	
	65 and 65+	6	0,7	18	3,4	24	1,8	
Marital status	Married	500	61,7	316	59,6	816	60,9	0,440
	Single	310	38,3	214	40,4	524	39,1	
Educational status	Primary/Secondary School	33	4,1	40	7,5	73	5,4	<0,001
	High School	117	14,4	122	23	239	17,8	
	University	505	62,3	285	53,8	790	59	
	Postgraduate Studies	155	19,1	83	15,7	238	17,8	
Chronic illness status	No chronic illness	190	23,5	107	20,2	297	22,2	0,159
	Has a chronic illness	620	76,5	423	79,8	1043	77,8	

***p<0,05 is considered statistically significant. *Chi-square test was used**

The change in body weight of participants after contracting COVID-19 is shown in Table 2. Among the participants who reported an increase in body weight, 218 (73.6%) were women and 78 (26.4%) were men. Among those who reported a decrease in body weight, 199 (63.2%) were women and 116 (36.8%) were men. Those who reported no change in body weight included 393 (53.9%) women and 336 (46.1%) men. When the data were examined, a statistically significant difference was found between sex and the change in body weight after COVID-19 infection ($p < 0.001$).

TABLE 2. Body weight change of participants after COVID-19 infection								
		Increased		Decreased		Unchanged		p*
		n	%	n	%	n	%	
Sex	Female	218	73,6	199	63,2	393	53,9	<0,001
	Male	78	26,4	116	36,8	336	46,1	

***p<0,05 is considered statistically significant. *Chi-square test was used**

In addition to nutrition habits, the study also investigates the physical activity habits of the participants. The distribution of the obtained data by sex is presented in Table 3. Among the participants, 953 (71.1%) do not engage in regular physical activity or sports and prefer a sedentary lifestyle.

When examining the number of meals consumed daily, the majority of participants (25.6%) followed a routine of 2 main meals and 1 snack. The least common choice, with 2.1%, was eating only one meal a day. A total of 62 participants (4.6%) preferred the Mediterranean diet structure, consisting of 3 main meals and 3 snacks. The majority of female participants (25.9%) preferred 2 main meals and 1 snack, while the majority of male participants (28.3%) preferred 3 main meals. The other most commonly preferred meal patterns were: 2 main meals (21%) and 3 main meals (20.1%). Those who preferred 3 main meals and 2 snacks made up 10.1% of the participants, while those who preferred 2 main meals and 2 snacks accounted for 16.5% of the participants.

TABLE 3. Physical activity and eating habits accord to sex							
		Female(n=810)		Male (n=530)		Total(n=1340)	
		n	%	n	%	n	%
Regular physical activity/ sports participation status	Yes	206	25,4	181	34,2	387	28,9
	No	604	74,6	349	65,,8	953	71,1
The number of daily meals	3 main meals + 3 snacks	45	5,6	17	3,2	62	4,6
	3 main meals + 2 snacks	87	10,7	48	9,1	135	10,1
	3 main meals	120	14,8	150	28,3	270	20,1
	2 main meals + 2 snacks	158	19,5	63	11,9	221	16,5
	2 main meals + 1 snack	210	25,9	133	25,1	343	25,6
	2 main meals	176	21,7	105	19,8	281	21
	1 main meal	14	1,7	14	2,6	28	2,1

The changes in food consumption among participants after contracting COVID-19 are presented in Table 4. Among those whose food consumption increased, 198 (73.6%) were women and 71 (26.4%) were men. Among those whose food consumption decreased, 113 (63.8%) were women and 64 (36.2%) were men. Among those whose food consumption remained unchanged, 499 (55.8%) were women and 395 (44.2%) were men. When examining the data, a statistically significant difference was found between sex and food consumption ($p < 0.001$).

Regarding marital status, among those whose food consumption increased, 147 (54.6%) were married and 122 (45.4%) were single. Among those whose food consumption decreased, 94 (53.1%) were married and 83 (46.9%) were single. Among those whose food consumption remained unchanged, 575 (64.3%) were married and 319 (35.7%) were single. A statistically significant difference was found between marital status and food consumption ($p = 0.001$).

As for education level, among those whose food consumption increased, 10 (3.7%) had completed elementary/secondary school, 37 (13.8%) were high school graduates, 168 (62.5%) had a university degree, and 54 (20.1%) had a postgraduate degree. Among those whose food consumption decreased, 17 (9.6%) had completed elementary/secondary school, 31 (17.5%) were high school graduates, 98 (55.4%) had a university degree, and 31 (17.5%) had a postgraduate degree. Among those whose food consumption remained unchanged, 46 (5.1%) had completed elementary/secondary school, 171 (19.1%) were high school graduates, 524 (58.6%) had a university degree, and 153 (17.1%) had a postgraduate degree. No statistically significant difference was found between education level and food consumption ($p = 0.052$).

Regarding chronic diseases, 65 individuals (24.2%) whose food consumption increased reported having a chronic illness, while 204 (75.8%) did not. Among those whose food consumption decreased, 43 (24.3%) had a chronic illness and 134 (75.7%) did not. Among those whose food consumption remained unchanged, 189 (21.1%) had a chronic illness and 705 (78.9%) did not. No statistically significant difference was found between food consumption and the presence of chronic diseases ($p = 0.436$).

TABLE 4. Changes in food consumption after contracting COVID-19 based on descriptive characteristics								
		Increased		Decreased		Unchanged		p*
		n	%	n	%	n	%	
Sex	Female	198	73,6	113	63,8	499	55,8	<0,001
	Male	71	26,4	64	36,2	395	44,2	
Marital status	Married	147	54,6	94	53,1	575	64,3	0,001
	Single	122	45,4	83	46,9	319	35,7	
Educational status	Primary/Secondary School	10	3,7	17	9,6	46	5,1	0,052
	High School	37	13,8	31	17,5	171	19,1	
	University	168	62,5	98	55,4	524	58,6	
	Postgraduate Studies	54	20,1	31	17,5	153	17,1	
Chronic illness status	No chronic illness	65	24,2	43	24,3	189	21,1	0,436
	Has a chronic illness	204	75,8	134	75,7	705	78,9	

***p<0,05 is considered statistically significant. *Chi-square test was used**

The changes in physical activity/sport status of participants after COVID-19 are presented in Table 5. Among individuals whose physical activity/sport status increased, 51 (60%) were women and 34 (40%) were men. Among those whose physical activity/sport status decreased, 166 (69.5%) were women and 73 (30.5%) were men. Among those whose physical activity/sport status remained unchanged, 593 (58.4%) were women and 423 (41.6%) were men. Upon analysis, no statistically significant difference was found between sex and physical activity/sport status ($p = 0.007$).

Regarding marital status, among those whose physical activity/sport status increased, 37 (43.5%) were married and 48 (56.5%) were single. Among those whose physical activity/sport status decreased, 130 (54.4%) were married and 109 (45.6%) were single. Among those whose physical activity/sport status remained unchanged, 649 (63.9%) were married and 367 (36.1%) were single. A statistically significant difference was found between marital status and physical activity/sport status ($p < 0.001$).

In terms of education level, among those whose physical activity/sport status increased, 4 (4.7%) had completed elementary/secondary school, 10 (11.8%) were high school graduates, 50 (58.8%) had a university degree, and 21 (24.7%) had a postgraduate degree. Among those whose physical activity/sport status decreased, 5 (2.1%) had completed elementary/secondary school, 33 (13.8%) were high school graduates, 150 (62.8%) had a university degree, and 51 (21.3%) had a postgraduate degree. Among those whose physical activity/sport status remained unchanged, 64 (6.3%) had completed elementary or middle school, 196 (19.3%) were high school graduates, 590 (58.1%) had a university degree, and 166 (16.3%) had a postgraduate degree. No statistically significant difference was found between education level and physical activity/sport status ($p = 0.009$).

Regarding chronic diseases, among those whose physical activity/sport status increased, 15 (17.6%) had a chronic illness and 70 (82.4%) did not. Among those whose physical activity/sport status decreased, 72 (30.1%) had a chronic illness and 167 (69.9%) did not. Among those whose physical activity/sport status remained unchanged, 210 (20.7%) had a chronic illness and 806 (79.3%) did not. A statistically significant difference was found between physical activity/sport status and the presence of chronic diseases ($p = 0.005$).

TABLE 5. Changes in physical activity/sport status after contracting COVID-19 based on descriptive characteristics.

		Increased		Decreased		Unchanged		p*
		n	%	n	%	n	%	
Sex	Female	51	60	166	69,5	593	58,4	0,007
	Male	34	40	73	30,5	423	41,6	
Marital status	Married	37	43,5	130	54,4	649	63,9	<0,001
	Single	48	56,5	109	45,6	367	36,1	
Educational status	Primary/Secondary School	4	4,7	5	2,1	64	6,3	0,009
	High School	10	11,8	33	13,8	196	19,3	
	University	50	58,8	150	62,8	590	58,1	
	Postgraduate Studies	21	24,7	51	21,3	166	16,3	
Chronic illness status	No chronic illness	15	17,6	72	30,1	210	20,7	0,005
	Has a chronic illness	70	82,4	167	69,9	806	79,3	

***p<0,05 is considered statistically significant. *Chi-square test was used**

The changes in dietary habits of participants after COVID-19 are presented in Table 6. Among individuals who started eating more healthily, 325 (58.6%) were women and 485 (61.8%) were men. Among those who did not pay attention to healthy eating, 230 (41.4%) were women and 300 (38.2%) were men. The data indicate that there was no statistically significant difference between sex and the preference for healthy eating after COVID-19 (p = 0.234).

Regarding marital status, among those who started eating more healthily, 348 (62.7%) were married and 207 (37.3%) were single. Among those who did not pay attention to healthy eating, 468 (59.6%) were married and 317 (40.4%) were single. The data show that there was no statistically significant difference between marital status and the preference for healthy eating after COVID-19 (p = 0.256).

In terms of education level, among those who started eating more healthily, 38 person (6.8%) had completed elementary/secondary school, 82 person (14.8%) were high school graduates, 320 (57.7%) had a university degree, and 115 (20.7%) had a postgraduate degree. Among those who did not pay attention to healthy eating, 35 (4.5%) had completed elementary or middle school, 157 (20%) were high school graduates, 470 (59.9%) had a university degree, and 123 (15.7%) had a postgraduate degree. A statistically significant difference was found between education level and the preference for healthy eating after COVID-19 (p = 0.003).

Regarding chronic diseases, among those who started eating more healthily, 137 (24.7%) had a chronic illness, and 418 (75.3%) did not. Among those who did not pay attention to healthy eating, 160 (20.4%) had a chronic illness, and 625 (79.6%) did not. The data indicate that there was no statistically significant difference between having a chronic illness and the preference for healthy eating after COVID-19 (p = 0.071).

TABLE 6. Changes in nutritional status after contracting COVID-19 based on descriptive characteristics						
		I started eating more healthily.		I didn't pay attention to healthy eating.		p*
		n	%	n	%	
Sex	Female	325	58,6	230	41,4	0,234
	Male	485	61,8	300	38,2	
Marital status	Married	348	62,7	468	59,6	0,256
	Single	207	37,3	317	40,4	
Educational status	Primary/Secondary School	38	6,8	35	4,5	0,003
	High School	82	14,8	157	20	
	University	320	57,7	470	59,9	
	Postgraduate Studies	115	20,7	123	15,7	
Chronic illness status	No chronic illness	137	24,7	160	20,4	0,071
	Has a chronic illness	418	75,3	625	79,6	

***p<0,05 is considered statistically significant. *Chi-square test was used**

DISCUSSION

COVID-19 is a serious public health problem that surrounds the whole world. Various measures are being taken to prevent the transmission and spread of infection. These measures have led to lifestyle changes among individuals, changes in physical activity behaviors and eating habits have been observed.

Changes in body weight have been observed in individuals based on their altered eating habits after contracting COVID-19. A study conducted by Di Renzo and et al, which included 3,533 participants, found that 48.6% of the participants experienced an increase in body weight(17). A study conducted with 150 participants with type 2 diabetes reported a 19% increase in body weight due to changes in eating habits(18). A comprehensive study conducted in Turkey examining changes in eating habits due to pandemic restrictions found that 38% of participants experienced an increase in body weight(19) As a result of the study, it is believed that there was no change in the participants' body weight, considering that the group involved had a high level of education and a high level of awareness, which is thought to be inconsistent with the literature. A significant relationship was found between body weight change and sex (p<0.001), with a higher proportion of women experiencing an increase in body weight.

Due to the increase in time spent at home, particularly in the kitchen, as part of COVID-19 measures, food consumption has also been affected. In a study by Ersoy and Pınar, which examined food consumption during the quarantine period, it was found that 70.4% of individuals increased their food consumption(20). The level of immunity is important to fight COVID-19 infection. Adequate and balanced nutrition, which supports immunity and forms the basis of a healthy diet. In order to achieve an adequate and balanced diet, a person should take the appropriate amount of nutrients at the appropriate time for himself. A meal plan with correctly determined timing and portion sizes should be implemented to achieve this. A study has found that there was a reduction in the number of meals after the pandemic (21). As a result of the study conducted by Ammar and et al, it was found that individuals lost control of eating and there was an increase in the number of meals (22). Although food consumption did not change in the study, there was no statistically significant difference between educational status (p=0.052) and chronic disease (p=0.436). However, differences were found in the changes in food consumption of individuals during this period depending on sex (p<0.001) and marital

status (p=0.001). Upon examining the data, it was found that married individuals and women increased their food consumption more than single individuals and men, respectively. This may be attributed to the possibility that married individuals and women tend to lead a more regular lifestyle.

During the COVID-19 pandemic, it was recommended to avoid a sedentary lifestyle, with exercises to be performed at home (30 minutes per day of moderate-intensity or 20 minutes per day of vigorous-intensity) (23). The study conducted by Özenoğlu and colleagues found a decrease in the participants' physical activity levels (19). As a result of a systematic review, the common finding among the 66 studies examined was a decrease in physical activity levels (24). A study conducted with university students found an increase in physical activity levels (25). Upon examining the study, a significant difference was found between physical activity levels and all parameters. Among individuals with changes in physical activity/sport status, women showed a greater decrease in physical activity/sport compared to men (p=0.008), and married individuals showed a greater decrease compared to single individuals (p<0.001) As education level increased, individuals' participation in physical activity/sport decreased. Among individuals with changes in physical activity/sport status, those without chronic diseases showed a greater increase in physical activity/sport compared to those with chronic diseases (p=0.005).

In a study conducted in Italy, it was found that 37.4% of the 3,533 participants preferred healthier foods, while 35.8% preferred less healthy foods (17). Another study conducted in Mexico reported that 37.2% of the participants exhibited less healthy eating behaviors (26). In this study conducted in Turkey, participants reported adopting less healthy eating habits. However, no statistically significant differences were found between changing eating habits and sex (p=0.234), marital status (p=0.256), and the presence of chronic diseases (p=0.071). However, a significant difference was found between changing eating habits and education level (p=0.003). As education level increased, less attention was paid to healthy eating. Additionally, differences in individuals' income levels may have influenced their access to healthy foods.

Limitations of study

This study was conducted online, and individuals' self-reports were considered accurate. Therefore, effects such as information and recall biases may occur, and participants may have provided inaccurate responses. Additionally, the condition of individuals who have experienced multiple COVID-19 infections was not assessed.

CONCLUSION

It has been observed that COVID-19 infection has both direct and indirect effects on individuals' lifestyles. The measures taken against the infection have had an impact on individuals' eating habits and physical activity levels. This study, which analyzes the changes in eating habits and physical activity behaviors of individuals who have contracted COVID-19, found that participants did not pay attention to healthy eating and physical activity after the infection. The effects of regular physical activity on health preservation and enhancement have been clinically proven. To help individuals minimize these negative effects and increase their awareness, nutrition education could be provided by dietitians, and education on physical activity behaviors could be organized by physiotherapists. Further research in this area could be conducted. This would be beneficial for gaining more knowledge and increasing awareness regarding preventive measures for future epidemic diseases.

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The Carotid Conundrum: Evaluating Stenting Versus Endarterectomy in Modern Practice

Stenting vs. Surgery in Carotid Stenosis: Age and Risk Considerations

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Abstract: Objective: The objective of this review is to evaluate the clinical outcomes, safety, and efficacy of carotid artery stenting (CAS) compared to carotid endarterectomy (CEA) in the management of carotid artery stenosis, with a focus on risk stratification based on patient age and symptomatic status. This stratification is essential to ensure personalized treatment and improve clinical outcomes.

Methods: The review includes a comprehensive analysis of randomized controlled trials (RCTs) and meta-analyses comparing CAS and CEA in both symptomatic and asymptomatic patients. Particularly, recent meta-analyses, such as the one conducted by Müller et al. (2021), have provided more granular data on the differential outcomes of CAS and CEA in various patient subgroups, further informing clinical decision-making. Key endpoints include perioperative stroke, myocardial infarction (MI), and restenosis rates. Secondary outcomes such as quality of life and procedural recovery times were also considered in certain trials, providing a broader perspective on patient outcomes.

Results: The results indicate that CAS carries a higher periprocedural stroke risk compared to CEA, particularly in older patients, whereas CEA is associated with a higher risk of perioperative MI. Long-term follow-up data show elevated restenosis rates after CAS. Meta-analyses show that Carotid Endarterectomy (CEA) significantly reduces the risk of perioperative stroke, particularly in patients over 70 years of age, highlighting the critical role of age in determining procedural outcomes and long-term success rates. Long-term follow-up data suggests that CAS is associated with higher restenosis rates compared to CEA, especially in patients with significant plaque calcification. This finding underscores the importance of thorough preoperative imaging and careful patient selection when opting for CAS, particularly in high-calcification cases.

Conclusion: While CAS is a viable option for younger, low-risk patients, CEA remains the preferred choice for older individuals due to its lower stroke risk and well-established efficacy. Personalized treatment decisions should be based on individual patient characteristics, including age, comorbidities, and anatomical factors.

Keywords: Carotid artery stenosis, Carotid endarterectomy (CEA), Carotid artery stenting (CAS), Risk stratification, Vascular surgery

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Abbreviations and acronyms:

CAS: Carotid Artery Stenting

CEA: Carotid Endarterectomy

MI: Myocardial Infarction

RCT: Randomized Controlled Trial

TIA: Transient Ischemic Attack

NASCET: North American Symptomatic Carotid Endarterectomy Trial

ECST: European Carotid Surgery Trial

CREST: Carotid Revascularization Endarterectomy vs. Stenting Trial

ICSS: International Carotid Stenting Study

AHA: American Heart Association

ASA: American Stroke Association

TCAR: Transcarotid Artery Revascularization

CPD: Cerebral Protection Device

MRA: Magnetic Resonance Angiography

CTA: Computed Tomography Angiography

INTRODUCTION

Carotid artery stenosis represents a significant risk factor for ischemic stroke and remains a primary cause of morbidity and mortality worldwide. Despite advancements in medical therapy, the optimal management of this condition remains a subject of intense debate, particularly in balancing procedural risks with long-term outcomes. Treatment for carotid stenosis includes both carotid endarterectomy (CEA), a traditional surgical procedure, and carotid artery stenting (CAS), a less invasive endovascular approach. Each of these interventions has its distinct advantages and potential risks, which must be carefully weighed based on patient-specific characteristics and procedural goals. The choice between CAS and CEA has generated considerable debate, as both techniques present distinct risks and benefits based on patient-specific characteristics, such as age, comorbidities, and anatomic considerations. Recent updates in the American Heart Association (AHA) and European Society for Vascular Surgery (ESVS) guidelines emphasize the importance of individualized treatment, with new recommendations focusing on risk-based decision-making, particularly in older populations and high-risk anatomical cases.

CEA has long been the gold standard for symptomatic carotid stenosis due to its robust long-term efficacy in preventing recurrent strokes, with evidence spanning several decades. For instance, randomized controlled trials such as the North American Symptomatic Carotid Endarterectomy Trial (NASCET) and the European Carotid Surgery Trial (ECST) demonstrated that CEA significantly reduced the risk of stroke in patients with symptomatic high-grade carotid stenosis (1,2). CAS, introduced as a minimally invasive alternative, has gained favor particularly for patients who are at high surgical risk or who have anatomical factors unfavorable for surgery, such as high carotid bifurcation or complex cervical anatomy (3). However, its long-term safety and efficacy, particularly in high-risk populations, remain areas of active investigation.

Several studies, including the CREST (Carotid Revascularization Endarterectomy vs. Stenting Trial) and ICSS (International Carotid Stenting Study), have provided comparative insights on the efficacy of CAS and CEA. CREST, one of the largest randomized trials, found that both procedures were effective in reducing stroke risk over the long term. However, specific differences emerged, particularly in perioperative outcomes: CEA was associated with a lower risk of periprocedural stroke, while CAS had a lower incidence of periprocedural myocardial infarction (MI), highlighting the procedural trade-offs between these two treatments (3,4). Long-term data indicate that CEA provides superior stroke prevention compared to CAS, particularly in patients with symptomatic carotid artery stenosis (5). CEA is associated with a higher incidence of perioperative myocardial infarction, while CAS offers a reduced risk of this complication, making it more suitable for younger patients (6).

The development of cerebral protection devices (CPDs) has improved the safety profile of CAS,

mitigating risks related to embolic stroke, a concern especially prevalent in older patients undergoing the procedure. There is evidence suggesting that the learning curve associated with CAS may contribute to higher complication rates in centers with less experience, although these rates decline as operators become more proficient (6). This advancement has made CAS more accessible for a broader range of patients. Nevertheless, studies continue to show that CEA may be preferable for older patients and those with increased plaque burden or calcification, given its lower stroke risk profile in these groups (1,2,4). In older patients, particularly those over 75 years, studies have shown that the risk of embolic stroke during CAS is significantly higher compared to CEA, despite the use of cerebral protection devices (4).

In light of these findings, clinical guidelines, including those from the American Heart Association (AHA) and American Stroke Association (ASA), suggest that treatment decisions be tailored to individual risk profiles. CAS is recommended for patients who are poor surgical candidates due to high-risk anatomical or clinical characteristics, whereas CEA remains the preferred choice for symptomatic patients without significant surgical contraindications (3). The decision-making process thus requires a nuanced understanding of patient anatomy, comorbidity burden, and procedural risk, underscoring the importance of a patient-centered approach in managing carotid artery stenosis. Current guidelines emphasize the importance of individualized treatment, tailoring the choice between CEA and CAS based on patient-specific factors such as age, comorbidities, and plaque morphology (2).

ETIOLOGY AND PATHOPHYSIOLOGY

Carotid artery stenosis (CAS) primarily results from atherosclerosis, which involves the progressive accumulation of lipids, inflammatory cells, and connective tissue within the arterial wall. This plaque buildup narrows the arterial lumen, impeding blood flow to the brain and raising the risk of ischemic stroke due to either thromboembolism or plaque rupture (4). Atherosclerotic changes in the carotid arteries are frequently associated with systemic conditions such as hypertension, hyperlipidemia, diabetes, and smoking, all of which contribute to endothelial dysfunction and promote atherogenesis(1,2).

In the pathophysiological progression of carotid atherosclerosis, plaque instability plays a crucial role. Unstable plaques—characterized by a lipid-rich core, thin fibrous cap, and infiltration of inflammatory cells—are more prone to rupture, releasing embolic debris into cerebral circulation, which can lead to transient ischemic attacks (TIA) or strokes. Studies have demonstrated that plaques with higher inflammatory cell infiltration and neovascularization, which develop as the plaque matures, are more vulnerable to rupture and therefore more likely to result in symptomatic CAS (3).

Hemodynamic forces also play a significant role in CAS pathophysiology. High shear stress at arterial bifurcations, such as the common carotid artery bifurcating into the internal and external carotid arteries, predisposes these areas to plaque formation. Regions of low shear stress tend to accumulate atherogenic lipoproteins, which initiate and propagate the atherosclerotic process. This phenomenon partly explains why the carotid bifurcation is a common site for stenosis, and understanding this mechanism is crucial in assessing both risk and treatment strategies for CAS (1,2).

In advanced cases, calcification of the arterial wall adds to plaque burden, making the stenosis rigid and difficult to treat, especially for stenting procedures. This calcified plaque limits arterial compliance, increases the risk of embolization during endovascular procedures, and complicates the deployment of stents. Hence, patients with heavily calcified lesions are often more suitable candidates for carotid endarterectomy (CEA) than for carotid artery stenting (CAS), which is more effective in pliable vessels with lower calcific burden (4).

Recent research has also highlighted genetic factors that may predispose certain individuals to atherosclerosis and CAS. Gene variants affecting lipid metabolism, inflammation regulation, and endothelial function can exacerbate plaque formation and contribute to carotid artery stenosis in predisposed individuals. Such findings underline the complexity of CAS as a disease of multifactorial origin, where both environmental and genetic influences contribute to its development (3,4).

In summary, carotid artery stenosis is a complex, multifactorial condition involving a combination of atherosclerotic processes, hemodynamic stress, plaque instability, and calcification. Understanding these pathophysiological mechanisms is vital for tailoring treatment approaches and determining the most appropriate intervention, whether it be CAS or CEA, based on individual patient risk factors.

DIAGNOSIS AND CLINICAL FINDINGS

Diagnosis of carotid artery stenosis begins with a clinical assessment for risk factors such as age, hypertension, diabetes, hyperlipidemia, and smoking. Initial non-invasive imaging is typically done with duplex ultrasonography, which provides information on both blood flow and plaque morphology, making it the preferred first-line tool due to its high sensitivity and specificity (1,2).

For further anatomical detail, particularly in symptomatic patients or when surgical intervention is being considered, advanced imaging modalities such as magnetic resonance angiography (MRA) and computed tomography angiography (CTA) are recommended. These techniques offer superior spatial resolution and are valuable in evaluating the extent of stenosis, plaque characteristics, and intracranial vascular conditions. CTA is particularly advantageous for assessing plaque calcification and ulceration, while MRA is more appropriate for patients with contraindications to contrast agents (3,4).

Symptomatic carotid artery stenosis may present as transient ischemic attacks (TIA), amaurosis fugax, or ischemic strokes, all of which require prompt evaluation. Research emphasizes that symptomatic patients, particularly those with high-grade stenosis, have a substantially elevated stroke risk if left untreated. Clinical guidelines strongly advocate for intervention in these cases, with revascularization within two weeks of symptom onset shown to significantly reduce recurrent stroke risk(1,2,4).

Emerging biomarkers, such as inflammatory markers and imaging markers like plaque neovascularization on contrast-enhanced ultrasound, are being explored to identify high-risk asymptomatic patients, providing potential for earlier and more precise treatment approaches (3).

THERAPEUTIC APPROACHES

The management of carotid artery stenosis involves both medical therapy and surgical intervention, tailored to the individual patient's risk profile, severity of stenosis, and symptomatic status. Medical management primarily includes aggressive risk factor modification, with a focus on antiplatelet therapy, statins, and lifestyle changes. Aspirin or clopidogrel is routinely prescribed to reduce thromboembolic events, while statins are essential for managing hyperlipidemia and stabilizing atherosclerotic plaques (1,2,4).

Surgical interventions, specifically carotid endarterectomy (CEA) and carotid artery stenting (CAS), are indicated based on the patient's clinical presentation. CEA has established itself as the gold standard for symptomatic patients with significant stenosis (>70%) due to its proven efficacy in reducing the risk of recurrent stroke (3). Meanwhile, CAS is increasingly utilized in high-risk surgical candidates or patients with unfavorable anatomy for CEA, owing to its minimally invasive nature and quicker recovery times (4).

Recent advancements in endovascular techniques have further expanded treatment options. The introduction of transcarotid artery revascularization (TCAR) combines the benefits of CAS while reducing the risk of embolic complications. TCAR employs

direct carotid access and cerebral protection devices, offering a compelling alternative for patients at high risk for traditional surgical interventions (1,2).

The choice between CEA and CAS should be informed by a thorough assessment of the patient's individual risk factors, including age, comorbid conditions, and anatomical considerations. Guidelines from the American College of Cardiology (ACC) and the American Heart Association (AHA) recommend a personalized approach, emphasizing that both procedures have distinct advantages based on the patient's unique circumstances (3,4).

In summary, the therapeutic landscape for carotid artery stenosis is multifaceted, integrating medical management and surgical interventions tailored to individual patient profiles, with ongoing advancements in endovascular techniques enhancing treatment efficacy and safety.

DISCUSSION

The debate between carotid artery stenting (CAS) and carotid endarterectomy (CEA) is multifaceted, with each approach showing distinct advantages depending on patient characteristics such as age, symptomatic status, and comorbidities. In younger, lower-risk patients, CAS is often favored for its minimally invasive nature, which is associated with a reduced risk of myocardial infarction (MI) (5). Age remains a critical factor in determining treatment outcomes, with CEA favored in older patients due to its lower stroke risk, while CAS may be more suitable for younger patients (8). However, literature indicates that periprocedural stroke rates for CAS are consistently higher than for CEA, particularly in patients over 70, who are more vulnerable to age-related complications and embolization (9). Meta-analyses show that Carotid Endarterectomy (CEA) significantly reduces the risk of perioperative stroke, particularly in patients over 70 years of age, highlighting the critical role of age in determining procedural outcomes and long-term success rates (8).

Meta-analyses, including the CREST (Carotid Revascularization Endarterectomy vs. Stenting Trial), highlight that while CAS and CEA yield comparable long-term outcomes for stroke prevention, the specific risks associated with each procedure vary significantly (5,7). CEA is typically associated with lower perioperative stroke risks, establishing it as the standard treatment for older and symptomatic patients. Conversely, studies show that while CAS reduces MI risk, it presents higher rates of restenosis in long-term follow-ups compared to CEA (9). CEA is associated with a higher incidence of perioperative myocardial infarction, while CAS offers a reduced risk of this complication, making it more suitable for younger patients (6). This difference underscores the necessity of individual patient assessment, where age and comorbidities should play a critical role in the decision-making process. Long-term data suggest that CAS is associated with higher rates of restenosis compared to CEA, particularly in patients with calcified lesions (5). This highlights the need for vigilant post-procedural surveillance in CAS patients, ensuring timely detection and intervention for restenosis. While CAS has gained popularity for its minimally invasive nature, studies consistently report higher rates of restenosis compared to CEA, necessitating careful long-term monitoring (5). Recent meta-analyses and randomized controlled trials demonstrate that CEA carries a lower risk of perioperative stroke, particularly in patients older than 70 years, while CAS is associated with a reduced risk of myocardial infarction, especially in younger patients (3).

The use of cerebral protection devices during CAS has shown effectiveness in lowering the incidence of embolic events. Emerging studies, such as the systematic review by Giudice et al. (2021), have highlighted that cerebral protection devices are particularly beneficial in reducing embolic complications in high-risk elderly patients, although their use has not completely eliminated the heightened stroke risk associated with CAS (9). However, these devices have not completely mitigated the heightened stroke risk associated with the procedure, especially in the elderly (5,7). Furthermore, trials focusing on symptomatic

patients consistently reveal that CEA outperforms CAS in preventing major strokes during the perioperative period (5). A systematic review analyzing high-risk patients, particularly those with severe comorbidities, indicated that although CAS remains a viable alternative, stroke incidence is a significant concern, reinforcing that age and medical history are crucial factors in the choice between procedures (5,6).

Recent advancements, such as transcarotid artery revascularization (TCAR), are also noteworthy in this discussion. The latest AHA guidelines now consider TCAR as a potential alternative for high-risk patients, particularly those with unfavorable anatomical characteristics, offering a less invasive yet effective treatment option (10). TCAR employs a hybrid approach that combines elements of both CAS and traditional surgical techniques, demonstrating promise in mitigating the risks associated with transfemoral CAS. Transcarotid artery revascularization (TCAR) offers a promising alternative by combining the benefits of both CAS and CEA while reducing stroke risk through the use of direct carotid access and cerebral protection (9). Early clinical data are promising, but long-term comparative studies are needed to fully establish TCAR's role in the management of carotid stenosis. By using direct carotid access and cerebral protection devices, TCAR aims to reduce the stroke risks typically seen with traditional stenting methods (5,9). As TCAR continues to evolve, its role in the treatment of carotid artery stenosis could shift the current paradigms in vascular surgery.

In conclusion, the selection between CAS and CEA must consider individual patient profiles, including age, comorbidities, and the specifics of their carotid artery disease. As our understanding of these procedures deepens through ongoing research, the emphasis on personalized treatment plans becomes increasingly important, aiming to optimize outcomes while minimizing procedural risks. The integration of new techniques like TCAR further complicates the landscape but also opens avenues for improved patient care. Ultimately, the continuous exploration of both methods will be essential in refining best practices in managing carotid artery stenosis and preventing future cerebrovascular events.

In the ongoing debate between carotid artery stenting (CAS) and carotid endarterectomy (CEA), the critical takeaway is that no one-size-fits-all solution exists. Both procedures possess unique advantages and disadvantages that must be meticulously weighed against individual patient characteristics such as age, symptomatic status, and comorbidities. For younger, low-risk patients, CAS offers a minimally invasive option with a lower risk of myocardial infarction, making it an appealing choice. However, in older and symptomatic patients, CEA remains the gold standard, particularly due to its lower perioperative stroke risk (5,7).

The growing body of literature emphasizes the importance of individualized treatment plans. Recent advancements in techniques, such as transcarotid artery revascularization (TCAR), showcase the need for continuous innovation in addressing carotid artery stenosis, potentially combining the benefits of both CAS and CEA while minimizing risks (9). As the understanding of these procedures deepens, future clinical guidelines should incorporate emerging evidence to optimize decision-making.

Ultimately, the management of carotid artery disease must be a dynamic process, where the nuances of patient health and the evolution of surgical techniques intersect. Enhanced patient education and shared decision-making will be paramount in achieving the best outcomes. By fostering an informed dialogue between healthcare providers and patients, we can ensure that treatment choices are aligned with individual risk profiles and long-term health goals. Continued research is vital in refining these strategies and providing clinicians with the necessary tools to make informed decisions that ultimately enhance patient care and improve quality of life (5).

CONCLUSION

In navigating the complexities of carotid artery stenosis treatment, it becomes clear that the choice between carotid artery stenting (CAS) and carotid endarterectomy (CEA) should be tailored to the unique characteristics of each patient. CAS presents an attractive option for younger, low-risk individuals due to its minimally invasive nature and reduced myocardial infarction risk. However, for older and symptomatic patients, CEA has established itself as the gold standard, largely due to its lower perioperative stroke risk.

The advancement of techniques like transcarotid artery revascularization (TCAR) adds another layer to this discussion, by potentially bridging the gap between the two modalities, offering an option that combines the strengths of both CAS and CEA. The 2023 AHA guidelines now include TCAR as a recommended option for certain high-risk patients, representing a paradigm shift in the treatment of carotid artery disease, particularly for those who are not ideal candidates for either CEA or traditional CAS. As more evidence emerges, it may represent a third, hybrid approach that could further personalize treatment strategies for diverse patient populations. This evolution in practice underscores the necessity for continuous research and adaptation of treatment protocols that align with the latest clinical findings.

Ultimately, effective management of carotid artery disease hinges on a comprehensive understanding of both procedural options, individual patient profiles, and the ongoing development of surgical techniques. By fostering informed discussions between healthcare providers and patients, we can optimize treatment decisions that prioritize patient safety and enhance long-term health outcomes. Moreover, shared decision-making processes should be supported by comprehensive risk assessment tools that integrate patient preferences and clinical data to guide optimal care. The future of carotid artery disease management lies in a commitment to personalized care, where the specific needs and risks of each patient are at the forefront of decision-making.

KEY POINTS

What is known about the topic?

Carotid artery stenosis is a major cause of ischemic stroke, and its management typically involves either carotid endarterectomy (CEA) or carotid artery stenting (CAS). CEA has been the traditional gold standard for treating symptomatic patients with significant stenosis due to its long-term efficacy in stroke prevention. CAS, a less invasive endovascular procedure, is increasingly used, particularly in patients who are at higher surgical risk or have anatomical constraints unfavorable for surgery. However, CAS has been associated with a higher risk of periprocedural stroke, especially in older patients, whereas CEA carries a higher risk of myocardial infarction (MI). Current clinical guidelines recommend tailoring treatment based on individual patient characteristics, including age, comorbidities, and symptomatic status, while ongoing debates continue regarding the best approach.

What does this study add?

This study provides a comprehensive analysis of the latest randomized controlled trials (RCTs) and meta-analyses comparing the outcomes of CAS and CEA, focusing on specific risk factors such as patient age, symptomatic status, and long-term restenosis rates. It emphasizes the importance of personalized treatment decisions based on individual patient profiles. Furthermore, it explores advancements in stenting techniques, including the use of cerebral protection devices (CPDs) and transcarotid artery revascularization (TCAR), offering a detailed assessment of how these innovations impact procedural outcomes and patient safety.

CONFLICT OF INTEREST STATEMENT

We have no conflict of interest.

STATEMENT ON THE USE OF ARTIFICIAL INTELLIGENCE

No artificial intelligence application was used.

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