2003

Turkish journal of

GERIATRICS

Volume: 28 | Number: 4 | Year: 2025

28th year

The Official Scientific Journal of Turkish Geriatrics Society

e-ISSN: 1307-9948

www.turkgeriatri.org

www.turkgeriatri.org

e-ISSN: 1307-9948

The official scientific journal of Turkish Geriatrics Society

Member of IAGG

OWNER
On Behalf of Turkish Geriatrics Society
Yeşim GÖKÇE KUTSAL

TECHNICAL ASSISTANCE
Pelin ŞAHİN
BAYT Publishing Services

Turkish Journal of Geriatrics is indexed in: Thomson Reuters Science Citation Index Expanded (SCI-Exp) and Social Sciences Citation Index (SSCI) since 2008.And also in Scientific and Technological Research Council of Turkey (TÜBİTAK), Turkish Academic Network and Information Center (ULAKBİM) regional TR index (TR dizin) since 1998.

Published four times
(March, June, September, December) a year

CORRESPONDANCE
Turkish Geriatrics Society
www.turkgeriatri.org
info@geriatri.org
www.geriatri.dergisi.org
editor@geriatri.dergisi.org

Date of Publication: 28 December 2025

Turkish Journal of
GERIATRICS
Volume: 28 • Issue: 4 • Year: 2025

Editorial Board

EDITOR-IN-CHIEF
Yeşim GÖKÇE KUTSAL

EDITORIAL BOARD
Selahattin Fehmi AKÇİÇEK • Alfonso CRUZ-JENTOFT • Peter FERRY
Önder İLGİLİ • Murat KOÇ • Sercan ÖZYURT • Clemens TESCH-ROEMER

STATISTICAL EDITOR
Sevilay KARAHAN

LANGUAGE EDITORS
Harrison G. BLOOM • Patricia BLOOM • Meltem KIRAN-RAW

International Advisory Board

Vladimir ANISIMOV	RUSSIA
Jean-Pierre BAEYENS	BELGIUM
Yitshal BERNER	ISRAEL
Harrison BLOOM	USA
C.J. BULPITT	UK
Robert N. BUTLER	USA
Roger Mc CARTER	USA
Mark CLARFIELD	ISRAEL
Cyrus COOPER	UK
Gaetano CREPALDI	ITALY
Michael FARTHING	UK
Marvin FORMOSA	MALTA
Ghada El-Hajj FULEIHAN	LEBANON
David GELLER	USA
Barry J. GOLDLIST	CANADA
Melvin GREER	USA
Gloria M. GUTMAN	CANADA
Carol HUNTER-WINOGRAD	USA
Alfenso JC JENTOFT	SPAIN
Vladimir KHAVINSON	RUSSIA
John KANIS	UK
Tom KIRKWOOD	UK
Jean-Pierre MICHEL	SWITZERLAND
John E. MORLEY	USA
Robert MOULIAS	FRANCE
Desmond O'NEILL	IRELAND
Sokrates PAPAPOULOS	HOLLAND
Mirko PETROVIC	BELGIUM
Russel REITER	USA
Rene RIZZOLLI	SWITZERLAND
Ego SEEMAN	AUSTRALIA
Walter O. SEILER	SWITZERLAND
Alan SINCLAIR	UK
Raymond C. TALLIS	UK
Adele TOWERS	USA
Guy VANDERSTRATEN	BELGIUM
Alan WALKER	UK
Ken WOODHOUSE	UK
Archie YOUNG	UK

INFORMATION TO AUTHORS

PUBLICATION POLICY

The *Turkish Journal of Geriatrics* is an international, peer-reviewed, open-access scientific journal publishing original articles, reviews, case reports, and other scholarly contributions in geriatrics and gerontology. The journal adheres to the highest standards of academic integrity, transparency, and ethical conduct in scientific publishing.

1. Editorial Policies and Peer Review Process

- **Peer Review Model:** The journal employs a *double-anonymized peer review* system, in which both authors and reviewers remain anonymous throughout the review process to ensure impartiality.
- **Reviewer Selection:** Reviewers are selected from a continually updated database of experts, with consideration of their expertise, publication record, and absence of conflicts of interest. At least two independent reviewers evaluate each manuscript; in cases of discrepancy, additional reviewers may be consulted.
- **Editorial Oversight:** The Editor-in-Chief, along with Associate Editors, oversees the peer review process, ensures compliance with journal standards, and makes the final decision on acceptance, revision, or rejection.
- **Transparency and Objectivity:** Editorial decisions are based solely on scientific merit, originality, clarity, and relevance to the field, and are not influenced by the authors' nationality, institutional affiliation, or personal characteristics.
- **Reviewer Responsibilities:** Reviewers are expected to provide constructive, evidence-based feedback within the agreed timeline and to declare any conflicts of interest. Confidentiality of manuscripts under review must be maintained.
- **Appeals:** Authors may appeal editorial decisions by submitting a detailed rebuttal. Appeals are reviewed by an independent editor or reviewer panel.

2. Policies on Ethics, Conflicts of Interest, Human and Animal Rights, and Informed Consent

- **Conflict of Interest:** All authors, editors, and reviewers are required to disclose any financial or personal relationships that could influence their work. Conflict of Interest forms must be signed and submitted at the time of manuscript submission.
- **Ethics Approval:** For studies involving human participants, a copy of the Ethics Committee/ Institutional Review Board (IRB) approval must be provided. For animal studies, approval from an accredited Animal Care and Use Committee must be submitted.
- **Informed Consent:** Research involving human subjects must include a statement confirming that written informed consent was obtained from all participants, or from legal guardians where applicable. Identifiable personal data must be anonymized or excluded.
- **Research Standards:** Authors must adhere to the principles of the *Declaration of Helsinki (2024), Good Clinical Practice (GCP)*, and *Good Laboratory Practice (GLP)* guidelines.
- **Data Transparency:** Authors should be prepared to share raw data and methodological details upon request by the editors or reviewers, in accordance with FAIR data principles (Findability, Accessibility, Interoperability, and Reusability).
- **Documents and Forms:**
  - Declaration of Helsinki (2024)
  - Author Contribution Form
  - Copyright Transfer Form

3. Roles and Responsibilities of the Editorial Team

- **Technical Check:** The Technical Editor verifies compliance with journal guidelines, scope, formatting requirements, and the presence of required documents (ethical approval, contribution form, copyright transfer).
- **Editorial Review:** Manuscripts that pass the technical check are screened by the Editor-in-Chief or Associate Editors for novelty,

scientific rigor, and fit with the journal's aims and scope.

- **Editorial Independence:** Editors make decisions independently, free from influence by sponsors, institutional affiliations, or commercial interests.
- **Ethical Oversight:** Editors ensure that cases involving suspected misconduct (plagiarism, data fabrication, duplicate submission, authorship disputes) are handled in accordance with COPE (Committee on Publication Ethics) guidelines.

4. Handling Corrections, Retractions, and Editorial Expressions of Concern

- **Corrections:** If significant errors are identified post-publication that do not invalidate the findings, the journal will issue a correction (erratum or corrigendum).
- **Retractions:** In cases of serious misconduct (e.g., plagiarism, falsified data, unethical research), the article will be retracted in line with COPE Retraction Guidelines. The retraction notice will remain permanently linked to the original article.
- **Expressions of Concern:** If evidence of potential misconduct or error arises but is not yet conclusive, the editors may publish an Expression of Concern to alert readers.
- **Post-Publication Discussion:** The journal supports scientific debate and post-publication commentary. Substantive critiques will be considered for publication following editorial and peer review.

5. Open Access and Copyright Policy

- The journal is *open access*, and all articles are published under a Creative Commons license, ensuring free availability of research to the global community.
- Authors retain copyright but grant the journal a license to publish and disseminate their work. A signed Copyright Transfer Agreement is required.

6. Indexing, Archiving, and Research Integrity

- The *Turkish Journal of Geriatrics* follows international standards for indexing and long-term digital preservation, depositing content in recognized repositories to ensure permanent accessibility.
- The journal endorses COPE, ICMJE (International Committee of Medical Journal Editors), and WAME (World Association of Medical Editors) recommendations.

INSTRUCTIONS FOR AUTHORS

Turkish Journal of Geriatrics is the official publication of Turkish Geriatrics Society and is published four times a year. Articles published in the journal are shown at http://www.turkgeriatri.org & http://www.geriatri.dergisi.org

Turkish Journal of Geriatrics is a peer-reviewed journal and is devoted to high standards of scientific rules and publication ethics. The Editorial Board Members of the Journal accept to follow 'Editorial Policy' of the 'Council of Science Editors' (www.councilscienceeditors.org/) and the guidelines provided by the Committee on Publication Ethics (COPE), the World Association of Medical Editors (WAME), the International Committee of Medical Journal Editors (ICMJE) for dealing with scientific misconduct, such as falsification of data, plagiarism, improprieties of authorship, violation of generally accepted research practices and redundant publication and duplicate publication.

Instructions for authors are based on the report of International Committee of Medical Journal Editors (Uniform Requirements for manuscripts Submitted to Biomedical Journals, www.icmje.org).

Manuscripts must be original and not under consideration by another publication at the time of submission. The authors must ensure that they have read and understood the details noted in the publication policy of our journal. Failure to comply can lead to delays in the processing of the manuscript, or even rejection.

Official language of the journal is **English.** Turkish Journal of Geriatrics invites submission of Original Articles based on clinical and laboratory studies. Review Articles are published only after the invitation from the Editorial Board.

Manuscripts and the necessary documents should be submitted online at: Online Manuscript Submission.

Authors are advised to keep a copy of their papers for reference. It is the responsibility of **all authors** to agree on the content of their paper before submission.

As recommended by TUBİTAK ULAKBIM, the authors should get their **ORCID** (Open Researcher and Contributor ID) numbers from the web address free of charge: **http://orcid.org**

Preparation of Manuscript

Papers must be written in English. Authors must have their papers checked for linguistic accuracy by one of the corporations below which have been determined by The Editorial Committee regarding service quality and scientific standards of the journal.

For the language editing of the article and to get the "Formal Certificate of Language Control and Correction", authors can contact to the below addresses:

EDITAGE https://www.editage.com/

WILEY https://www.wiley.com/en-gb

SCRIBENDI https://www.scribendi.com/

AMERICAN JOURNAL EXPERTS https://www.aje.com/

PROTRANSLATE https://www.protranslate.net/tr/

The corrected manuscript should be sent to the journal after it has received the **"formal certificate of language control and correction"** – this certificate should be uploaded to journal on line system with the manuscript.

Articles published in the Turkish Journal of Geriatrics should be prepared in ethical rules. The ethical responsibilities of the articles belong to the authors. For all the studies both conducted on human beings and animals as well as drug research, ethical committee approval should be taken and a signed copy of **"Ethical Committee Approval"** should be uploaded to the journal system.

The manuscripts will not be published without a copy of the "ethical committee approval" document. For all the studies conducted on human beings **"Informed Consent"** of all the participants of the study should be taken.

Authors should obey the rules in **"Helsinki Declaration", "Good Medical Practice Guidelines"**, and **"Good Laboratories Practice Guidelines".**

Names of the patients, protocol numbers, etc which identify participants' identities should not be used in the manuscript. If the editorial board finds necessary, the admitted articles will be reviewed not only by the scientific advisors, but by the ethical advisors of the journal as well. Authors submitting an article must accept this situation.

All of the articles submitted to the Turkish Journal of Geriatrics should fit to the **"Information of authors"** details. The assessment process will not start until this step is completed.

Via online submission 1) English Title, 2) Names, Surnames and Titles of the authors, 3) Institutions, 4) Present communication details should be loaded to the system. Original articles and Invited Reviews should be between 3000-4000 words (including abstract). When a manuscript is submitted, authors must provide a word count for both the abstract and the text. Editors can request that authors shorten their papers further.

The text of observational and experimental articles should be divided into sections with the headings Introduction, Materials and Method, Results, and Discussion. Long articles may need subheadings within some sections (especially the Results and Discussion sections) to clarify their content. Invited reviews and editorials are likely to take their own relevant main headings.

Abstract. A structured abstract of not more than 250 words in English should be structured, including Introduction, Materials and Method, Results, and Conclusion. New and important observations or aspects of the study should be emphasized. Abstracts of the review articles should be a brief overview of the main points from the review. Abstracts should reflect the whole manuscript and the consistency between the text. No abbreviations should be used in this section.

Keywords. Up to six keywords should be provided that might be used by researchers searching bibliographic databases for the paper. The authors have to use terms from the Medical Subjects

Headings list from Index Medicus.(www.nlm.nih.gov/mesh/MBrowser.html)

Introduction. Acquaint the readers with the problem and with the findings of others. Quote the most pertinent papers and state clearly the nature and purpose of the work.

Materials and Method. Your clinical, technical or experimental procedures should be clearly explained. Previously published papers related to methods should be cited. Ethical approval of the study should be mentioned here.

Results. Findings must be described without comment. A concise textual description of the data presented in tables, chats and figures should also be included.

Discussion. Comment on your findings and relate them to those from other authors. You should define their relevance to experimental research or clinical practice.

References. The author is responsible for the accuracy of the references. Citations in the text should be identified by numbers in standart brackets. The list of the references at the end of the paper should be given according to their first appearance in the text. Journal abbreviations should be used as listed in Index Medicus.

INACCESSIBLE DOCUMENTS SUCH AS DISSERTATIONS, REPORTS, CONGRESS PROCEEDINGS, ABSTRACT BOOKS SHOULD NOT BE SHOWN AS REFERENCES.

1. Articles from journals

Piers R, Albers G, Gilissen J, et al. Advance care planning in dementia: recommendations for healthcare professionals. BMC Palliative Care 2018;17(88):1-17.(DOI:10.1186/s12904-018-0332-2).

2. More than 6 authors will be mentioned with the three authors' names

Groessl EJ, Kaplan RM, Rejeski WJ et al. Physical Activity and Performance Impact Long-term Quality of Life in Older Adults at Risk for Major Mobility Disability. Am J Prev Med 2019; 56 (1): 141-146. (DOI: 10.1016/j.amepre.2018.09.006).

3. Books

BG Katzung. Special Aspects of Geriatric Pharmacology, In:Bertram G. Katzung,Susan B. Masters, Anthony J. Trevor (Eds). Basic and Clinical Pharmacology. 10th edition, Lange, Mc Graw Hill, USA 2007, pp 983-90.

4. Articles or documents from electronic publications:

World Health Organization. Global Health and Aging [e-book] NIH Publication; 2011. [Internet]. Available from: http://www.who.int/ageing/publications/global_health.pdf. Accessed: 09.09.2019.

Access date, DOI or ID numbers of the articles should be mentioned. The UPDATED reference should be available in the referred web address.

Tables. Tables should be supplement not duplicate the text. Each table should be typed (double spaced) on a separate sheet and numbered consecutively with arabic numerals. Place explanatory matters in footnotes. Footnotes to tables should be indicated by lower-case superscript letters. Each table must be cited in text in consecutive order.

Illustrations. Illustrations should be limited to those essential for the text. The same results should be presented as either graphs or tables not as both. All figures, whether photographs, graphs, or diagrams, should be numbered consecutively and shown in the text. The publisher reserves the right to reduce or enlarge illustrations. Arrows, letters, and numbers should be inserted professionally.

Graphs, figures, and illustrations should be placed in the main text. And also separate files should be prepared for graphs, figures, and illustrations (each one on a separate file),

The authors should supply the electronic files for all figures and illustrations including photographs as gif or jpeg images with a minimum resolution of 600 dpi.

Micrographs should have an internal magnification marker; the magnification should also be stated in the caption. Legends must be brief, self-sufficient explanations of the illustrations in no more than four or five lines. Remarks such as "For explanation, see text" should be avoided. The legends should also be typed at the end of the text.

Screening resolution. The image should be at least 600 dpi resolution. For the web site resolution, 300 dpi is acceptable.

Measurements. Metric system should be used for all types of measurements.

Abbreviations and Symbols. Only standard abbreviations should be used in the main text. In the first use, long version of the abbreviation should be written. Abbreviations and Symbols should not be used in abstract and title sections.

Acknowledgement. Authors can thank to the persons, institutions, etc in this section.

Conflict of Interest. The authors should state whether there is a conflict of interest or not.

Review Articles. The journal is open only for "Invited Reviews".

Besides their article, there are 5 important documents that the authors should send:

I. For all the articles **Application Fee Receipt**
II. For all the studies signed copy of **"Ethical Committee Approval Document"** (including all the names of the authors) (For all the studies conducted on human beings, "informed consent" of the participants should be taken).
III. **"Copyright Transfer Form"** with all of the authors' signatures,
IV. **"Author Contribution Form"** with all of the authors' signatures,
V. Copy of **"Certificate of Language Control and Correction".**

The manuscript cannot be sent out for review if the submissions are received without these 5 documents. These documents should be uploaded in related sections of the online system.

Attention ! Last Control Before Submission (Checklist for Submitted Articles)

All of the articles submitted to the Turkish Journal of Geriatrics should fit to the "information of authors' details in the below address:

http://geriatri.dergisi.org/static.php?id=7

The review process will not start until all the below steps are completed.

1. Letter of submission written for the chief editor.
2. E-mail address as well as postal address, official telephone number of the corresponding author.
3. Affiliations (in English) and ORCID numbers (http://orcid.org) of all the authors.
4. For the language editing of your article and to get the "Certificate of Language Control and Correction", you can contact to:

EDITAGE https://www.editage.com/

WILEY https://www.wiley.com/en-gb

SCRIBENDI https://www.scribendi.com/

AMERICAN JOURNAL EXPERTS https://www.aje.com/

PROTRANSLATE https://www.protranslate.net/tr/

5.English heading.

6. English "structured" abstract (250 words at maximum).
7. Keywords in accordance with Medical Subjects Headings-MeSH List (up to 6 words) (https://meshb.nlm.nih.gov/search)
8. Article divided into appropriate sections.
9. All figures (with subtitles) and tables (with titles) cited (should be 5 at maximum)
10. Complete and accurate references (references should be 25 at maximum with the DOI numbers) written according to the rules and of the journal (http://geriatri.dergisi.org/static.php?id=7).
11. Original articles should not exceed 4000 words (including abstract).

In order to start the evaluation process, the below 5 documents should be sent through the online system for all the articles:

I. For all the articles **Application Fee Receipt**
II. For all the studies signed copy of **"Ethical Committee Approval Document"** (including all the names of the authors) (For all the studies conducted on human beings, "informed consent" of the participants should be taken).
III. **"Copyright Transfer Form"** with all of the authors' signatures,
IV. **"Author Contribution Form"** with all of the authors' signatures,
V. Copy of **"Certificate of Language Control and Correction".**

Turkish Journal of
GERIATRICS
Volume: 28 • Issue: 4 • Year: 2025

Contents

EDITORIAL

FROM THE EDITOR IN CHIEF IX
Yeşim GÖKÇE KUTSAL

EDITORIAL ARTICLE

GERIATRIC REHABILITATION IN AN AGEING WORLD: CHALLENGES, OPPORTUNITIES, AND THE FUTURE OF PERSON-CENTERED CARE 433
Yeşim GÖKÇE KUTSAL

ORIGINAL ARTICLES

RISK FACTORS FOR POSTOPERATIVE PULMONARY COMPLICATIONS AFTER MAJOR ABDOMINAL SURGERY IN PATIENTS AGED 65 YEARS AND OLDER: A RETROSPECTIVE OBSERVATIONAL STUDY 439
Arif TİMUROĞLU, Mustafa Kemal ŞAHİN

THE EFFECT OF OPTIC NERVE SHEATH DIAMETER ON PROGNOSIS AND ITS PERIOPERATIVE EVALUATION IN GERIATRIC ISCHEMIC CEREBROVASCULAR PATIENTS 449
Barış ASLANOĞLU, Kamuran AYDIN, Sezer Onur GUNARA, Barış ALTUN

EXAMINING PRESCRIPTION DRUG USE AND HEALTH CARE ACCESS AMONG OLDER ADULTS IN RURAL AREAS: A CROSS-SECTIONAL STUDY BASED ON THE HEALTH BELIEF MODEL 457
Yağmur ÖZKAYA, Büşra DEMİR ÇETİNKAYA, Gülden HAKVERDİ, Eyüp Can POLAT, Gülbin ÖZÇELİKAY

TURKISH CULTURAL ADAPTATION AND VALIDATION OF THE SYMPTOMS OF EARLY DEMENTIA-11 QUESTIONNAIRE 470
Oğulcan ÇÖME, Nezaket SABIR, Tuğçe YÜKSEL, Gizem LİMNİLİ, Nilgün ÖZÇAKAR

THE ROLE OF FRAILTY INDEX IN PREDICTING POSTOPERATIVE COMPLICATIONS IN GERIATRIC VASCULAR SURGERY PATIENTS 482
Sercan TAK, Okan YAMAN, Erkan İRİZ, Mustafa Hakan ZOR, Abdullah ÖZER, Gürsel Levent OKTAR, Başak KOÇAK, Fatih ÖNCÜ

FRAILTY AND ASA SCORE AS INDEPENDENT PREDICTORS OF EARLY POSTOPERATIVE COGNITIVE DYSFUNCTION IN OLDER SURGICAL PATIENTS: A PROSPECTIVE COHORT STUDY 493
Gülistan BARCA ÖNEN, Feray GÜRSOY

BARRIERS AND FACILITATORS TO PHYSICAL ACTIVITY PARTICIPATION IN OLDER ADULTS: A TÜRKİYE–USA COMPARISON 502
Gülşah ŞAHİN, Hongdao MENG, Debra DOBBS, Ebru YALÇIN

TRENDS AND GLOBAL RESEARCH PATTERNS IN GERIATRIC REHABILITATION: A 10-YEAR BIBLIOMETRIC ANALYSIS 512
İbrahim ULUDOĞAN, Ayşe Merve ÇIRACIOĞLU

THE RADIOLOGICAL RISK FACTORS AFFECTING MECHANICAL FAILURE IN THE SURGICAL TREATMENT WITH PROXIMAL FEMORAL NAIL OF INTERTROCHANTERIC FRACTURES IN ELDERLY PATIENTS: A RETROSPECTIVE COHORT STUDY 525
Ahmet AKSOY, Ahmet ASLAN, Hamza Can AKDENİZ

THE EFFECT OF INCREASED FRAILTY ON MYOCARDIAL INJURY AFTER NON-CARDIAC SURGERY (MINS) IN ELDERLY PATIENTS UNDERGOING ORTHOPEDIC SURGERY: A PROSPECTIVE, COHORT STUDY 534
İsmail DUYMAZ, Hacer Şebnem TÜRK, Pınar SAYIN, Leyla KILINÇ, Mustafa Bilgehan AYIK, Ayşe SURHAN ÇINAR, Sibel OBA

THE RELATIONSHIP BETWEEN OBSTRUCTIVE SLEEP APNEA SYNDROME, CHRONIC DISEASES AND QUALITY OF LIFE IN GERIATRIC PATIENTS ATTENDING THE SLEEP UNIT 545
Hasan TÜLE, Elçin BALCI

MICROBIOLOGICAL PROFILES AND CLINICAL OUTCOMES OF BLOODSTREAM INFECTIONS IN GERIATRIC PATIENTS ADMITTED TO INTENSIVE CARE UNITS: A SINGLE-CENTER EXPERIENCE 554
Nuray ARI, Ayşe SAĞMAK TARTAR, Sümeyra KAYALI, Serhat DAYAN, Bahar TANIK ŞİMŞEK, Hatice Handan AKBULUT

www.turkgeriatri.org



From The Editor In Chief

The topics addressed in articles published in the Turkish Journal of Geriatrics since its inception in 1998 provide valuable insights into thematic orientations and evolving trends within the field of geriatrics.

The titles of early publications indicate a predominant focus on foundational themes such as the socio-demographic characteristics of older adults, assessments of functional status, living conditions within institutional care settings, and general epidemiological patterns. These early studies are largely descriptive in nature, emphasizing activities of daily living, the prevalence of chronic diseases, and broad evaluations of the health and social needs of the elderly. Collectively, these themes reflect the journal's initial role in documenting the characteristics of the aging population and the challenges it faces.

In contrast, articles published in subsequent years demonstrate a more clinically sophisticated and thematically diversified profile. Recent issues feature prominent attention to topics such as frailty, sarcopenia, multimorbidity, perioperative and emergency care outcomes, dysphagia, and predictors of mortality and hospitalization. Polypharmacy and inappropriate medication use have become recurrent subjects, underscoring a growing concern for pharmacological safety. Psychosocial determinants—including loneliness, sleep quality, treatment adherence, and social exclusion—have gained increased visibility, indicating heightened awareness of the multidimensional factors shaping healthy aging. Furthermore, research on functional performance, nutritional status, body composition, and rehabilitation has expanded notably in recent years.

Overall, the journal exhibits a clear transition from early descriptive studies to more specialized, outcome-oriented, and multidisciplinary research. This evolution highlights the journal's increasingly significant scientific contribution, aligning closely with global priorities and contemporary directions in geriatric medicine.

Yeşim GÖKÇE KUTSAL

EDITORIAL ARTICLE

GERIATRIC REHABILITATION IN AN AGEING WORLD: CHALLENGES, OPPORTUNITIES, AND THE FUTURE OF PERSON-CENTERED CARE

Turkish Journal of Geriatrics
2025; 28(4):433–438

DOI: 10.29400/tjgeri.2025.460

Yeşim GÖKÇE KUTSAL

Hacettepe University, Dept of Physical Medicine and Rehabilitation (retired), Ankara, Türkiye

INTRODUCTION

According to reports by the United Nations, the global population is ageing, although this growth may stabilize by the end of the century. By the late 2070s, the number of individuals aged ≥65 years is projected to reach approximately 2.2 billion—surpassing the global population of those under 18 years. By the mid-2030s, nearly 265 million individuals are expected to be aged ≥80 years, outnumbering infants. Even rapidly developing nations will experience substantial population ageing over the next three decades, necessitating strategic investments in health and long-term care systems, the sustainability of social protection mechanisms, and the development of emerging technologies (1).

As life expectancy increases, the prevalence of chronic diseases, functional impairment, and age-related physiological decline also rises. Consequently, geriatric rehabilitation has become a cornerstone of contemporary healthcare. Physiatrists—specialists in Physical Medicine and Rehabilitation—play a pivotal role in restoring function, maximizing independence, and enhancing quality of life in older adults with complex medical conditions.

Modern geriatric rehabilitation extends far beyond conventional therapeutic modalities. Older adults frequently present with multimorbidity, frailty, cognitive impairment, sensory deficits, polypharmacy, and social vulnerability—factors that necessitate a personalized, holistic approach integrating medical stabilization with functional recovery. Such an approach requires interdisciplinary collaboration and individualized rehabilitation pathways. Concurrently, global health systems face increasing pressures—shorter hospital stays, cost constraints, and workforce shortages—further underscoring the need for systematic, evidence-based rehabilitation practices.

Correspondence

Yeşim GÖKÇE KUTSAL
e-mail : ygkutsal@gmail.com

Received : Dec 09, 2025
Accepted: Dec 10, 2025

Cite this article as:
Gökçe Kutsal Y. Geriatric Rehabilitation in an Ageing World: Challenges, Opportunities, and the Futureof Person-Centered Care. Turkish Journal of Geriatrics 2025; 28(4):433–438. doi: 10.29400/tjgeri.2025.460

The content of this journal is licensed under the Creative Commons Attribution-NonCommercial 4.0 International License.

Recognizing the Unique Clinical Challenges in Older Adults

Older adults commonly present with atypical and nonspecific symptoms that complicate diagnosis and treatment planning. Manifestations may include generalized symptoms such as reduced activity, remaining in bed, or diminished oral intake, rather than symptoms localized to a specific organ system. Underreporting of symptoms—such as hearing loss, urinary incontinence, constipation, nocturnal leg pain, and cognitive changes—is also frequent, since these issues are often misattributed to normal ageing.

Multimorbidity and diminished physiological reserve across multiple organ systems contribute to atypical disease presentations and unpredictable therapeutic responses. Polypharmacy adds further complexity. During history-taking, clinicians must thoroughly review prescribed, over-the-counter, and supplemental medications, as discrepancies between prescribed and actual usage are common (2).

GERIATRIC REHABILITATION

Geriatric rehabilitation is emerging as an essential component of healthcare worldwide. Hospitalization rates rise with age, and functional decline during hospitalization represents a major concern: approximately 30% of patients aged ≥70 years develop hospitalization-associated disability, increasing to 40% among frail individuals. Many older adults do not regain pre-hospitalization functional levels or return home following discharge. Consequently, rehabilitation needs rise sharply after age 65, though the duration, content, and structure of rehabilitation programs vary considerably across countries (3).

The global increase in older adult populations underscores the importance of preventive strategies and structured rehabilitation programs. In many low- and middle-income countries, reducing hospital stays and promoting "ageing in place" have become central policy goals. Efficient resource allocation requires identifying those most likely to benefit from timely, context-appropriate, and high-quality rehabilitation interventions (4).

The World Health Organization Definition Within the ICF Framework

The World Health Organization (WHO) defines geriatric rehabilitation as "a multidimensional approach consisting of diagnostic and therapeutic interventions aimed at optimizing functional capacity, promoting activity, and maintaining functional reserve and social participation in disabled older adults." Its major objectives include improving activities of daily living, enhancing social engagement, and strengthening overall quality of life. Chronological age, cognitive impairment, or place of residence should not be used as exclusion criteria for rehabilitation participation (5).

Unlike disability in younger adults—typically arising from discrete injury or disease—functional decline in older adults often develops subacutely, without a clear precipitating event. Hospitalization and immobility further increase risks for complications such as infections, pressure injuries, and delirium (5).

SUCCESSFUL REHABILITATION

Principles of a Successful Rehabilitation Program

Key principles are summarized in Table 1, including early initiation of rehabilitation, thorough functional assessment, collaborative goal-setting, realistic expectations, and active patient participation. Rehabilitation planning must also address psychological well-being, support needs, and minimization of unnecessary medications.

Essential aspects include (A) individualized treatment planning and (B) comprehensive pre-rehabilitation assessment (Table 2), encompassing physical examination, sensory and continence evaluation, gait and mobility assessment, nutritional status, functional capacity, mental health screening,



Table 1. Principles for a Successful Rehabilitation Program

1. Rehabilitation should begin as early as possible.
2. The patient's functional status must be thoroughly assessed.
3. Realistic goals should be established collaboratively with the patient and their family, with expectations clearly communicated.
4. Restoration of function should be prioritized; if this is not achievable, an appropriate and sustainable functional balance should be established.
5. The patient, family, and healthcare team should jointly determine the most appropriate rehabilitation setting.
6. A structured and goal-oriented rehabilitation plan should be developed.
7. The patient should be encouraged to actively participate in all stages of the process.
8. The patient's psychological status should be assessed, and appropriate support should be provided.
9. Clear evaluation criteria for follow-up and outcome assessment should be defined.
10. Polypharmacy should be avoided, the number of medications prescribed should be minimized whenever possible.
11.The rehabilitation team should remain up to date with emerging technologies and participate in continuous professional development.

Table 2. Core Considerations

Planning must be individualized	1- Reduced physiological capacity must be taken into consideration. 2- The program should address the person's specific needs and be customized to their particular medical condition (e.g., hip fracture, stroke). 3- The goal is to achieve the targeted level of functional status. 4- Throughout the process, factors such as fatigue, medical stability, and level of participation should be closely monitored. 5- Additionally, a post- discharge rehabilitation plan should be established.
A comprehensive assessment should be conducted before initiating rehabilitation.	1- Physical health (History taking, physical exam, assessment of visual and auditory functions) 2- Continence assessment 3- Evaluation of gait, mobility, and fall risk 4- Nutritional assessment 5- Functional capacity (Activities of daily living, instrumental activities of daily living, performance measures) 6- Mental health (Cognitive screening and assessment, depression screening and assessment) 7- Social support (Social history, assessment and referral of support systems, caregiver burden, financial status) 8- Environmental adequacy

social and environmental assessment, and support evaluation.

Goal-setting is optimized by applying the SMART framework—Specific, Measurable, Achievable, Relevant, and Time-limited (6).

Determinants of Patient Satisfaction

Patient satisfaction in geriatric rehabilitation depends on appropriate information provision, opportunities for self-expression, physical and psychosocial support, shared decision-making,

motivational environments, and structured home-based rehabilitation with regular follow-up (7).

Additional determinants are listed in Table 3, including patient-centered communication, interdisciplinary teamwork, professional competence, clear information exchange, and adequate organizational infrastructure. From the healthcare provider perspective, two primary outcome indicators determine rehabilitation quality: (A) achievement of rehabilitation goals and (B) patient satisfaction at discharge (8).

CHALLENGES

Common Health Challenges in Older Adults

Older adults typically experience multiple interrelated conditions rather than a single disease. Common challenges include chronic illnesses (e.g., arthritis, hypertension, diabetes), cognitive decline, polypharmacy, mental health disorders, malnutrition, and sensory impairments (Table 4). These underscore the necessity of integrated, multidisciplinary rehabilitation models.

Current Systemic Challenges in Geriatric Rehabilitation

Major obstacles include:

1. Rapid population ageing and rising demand for specialized rehabilitation services.
2. Multimorbidity and comorbidities complicating clinical decision-making.
3. Cognitive impairments that limit participation and communication.
4. Resource constraints, including workforce shortages and inadequate funding.
5. Technological barriers limiting digital access for older adults.
6. Social and environmental barriers, including isolation and non-adaptive living environments.

Nevertheless, these challenges simultaneously present opportunities for innovation and system transformation.

Table 3. Additional Factors Influencing Rehabilitation

Patient-centered approach	Effective communication between the patient and the healthcare team
Patient satisfaction	Involving the patient in assessments & taking their perspectives into account
Therapeutic environment	Should ensure that patients feel safe and secure
Caregivers	Provision of information to the patient and informal caregivers
Consultation	Consultation regarding the rehabilitation process
Collaboration	Interdisciplinary collaboration within the rehabilitation team
Professionalism	Professionalism of the team members
Organizational aspects	Allocating sufficient time for appropriate planning

Table 4. Common Health Challenges in Older Adults

Chronic Conditions	Arthritis, hypertension, diabetes, heart disease, and osteoporosis.
Cognitive Decline	Increased risk of dementia, including Alzheimer's disease.
Polypharmacy Risks	Increased side effects and interactions due to multiple medications.
Mental Health Issues	Depression, anxiety, and loneliness are prevalent but underdiagnosed.
Malnutrition & Weight Changes	Often due to reduced appetite, dental issues, or difficulty preparing meals.
Sensory Impairments	Vision (e.g., cataracts, macular degeneration) and hearing loss.



OPPORTUNITIES

Advancing Geriatric Rehabilitation

Emergent strategies include:

1. Preventive rehabilitation and targeted lifestyle modifications to delay functional decline.
2. Interdisciplinary care models integrating all relevant health professionals.
3. Community-based programs fostering physical activity and social engagement.
4. Supportive policy initiatives and investment in ageing-friendly systems.
5. Telehealth and remote rehabilitation, enhancing access in underserved regions.
6. Technological innovations, including Artificial Intelligence (AI)-based personalization, wearable devices for continuous monitoring, and virtual reality rehabilitation.

AI offers significant clinical, social, and economic potential (Table 5), though its ethical application mandates careful regulation (9).

AI, Ageism, and Future Considerations

The WHO highlights persistent ageism embedded within AI systems. Older adults remain underrepresented in training datasets, leading to biased algorithms. Furthermore, technologies are frequently designed *for* rather than *with* older adults (10). Equitable AI use requires appropriately representative datasets, inclusive policies to prevent digital exclusion, and active participation of older adults in ethical review, regulatory, and standard-setting processes (9,10).

RETHINKING GERIATRIC REHABILITATION

Future directions should include:

1. Addressing existing gaps, particularly the persistence of "one-size-fits-all" rehabilitation models.
2. Advancing personalization through data-driven but human-centered decision support systems.
3. Fostering innovation that integrates emerging technologies without eroding human connection.
4. Promoting equity and ensuring accessibility across rural, low-income, and marginalized populations.

Healthy ageing emphasizes not merely life prolongation but the preservation of dignity, autonomy, and meaningful engagement—core goals of effective rehabilitation.

Ethical and Legal Dimensions

The integration of new technologies into geriatric rehabilitation must uphold privacy, autonomy, informed consent, and dignity. Technology should serve to complement—not substitute—the human relationships central to rehabilitation. Ethical concerns encompass autonomy, potential age-related discrimination, and disparities in access; legal issues include accountability for technological failures and maintaining data confidentiality within gerontechnology.

Table 5. AI offers significant potential across multiple domains

Medically	AI enables early detection and personalized management of age-related diseases through predictive analytics and diagnostic tools, thereby improving health outcomes and autonomy.
Socially	From a social perspective, AI-powered technologies such as virtual companions and communication aids can mitigate loneliness and cognitive decline, fostering social engagement among older adults.
Economically	AI-driven systems can optimize eldercare services and resource allocation, supporting caregivers and reducing societal costs.

FINAL WORDS

In older adults, the primary goal of rehabilitation extends beyond functional restoration to the holistic enhancement of quality of life through comprehensive, problem-solving approaches. However, access to rehabilitation remains unequal across socioeconomic, cultural, and geographic contexts. Sustainable progress requires embedding rehabilitation into health policy frameworks while maintaining a person-centered philosophy.

Despite significant challenges—multimorbidity, limited resources, and digital inequities—substantial opportunities exist to strengthen geriatric rehabilitation worldwide. Prioritizing personalized care, community-based initiatives, preventive strategies, and ethically grounded technological innovation can markedly improve quality of life for older adults in an increasingly ageing global population.

REFERENCES

1. United Nations. Global Issues: Ageing. [Internet]. Available from: https://www.un.org/en/global-issues/ageing. Accessed: 01.11.2025.
2. Gökçe Kutsal Y. Geriatric Rehabilitation. In: Beyazova M, Gökçe Kutsal Y (Eds): Physical Medicine and Rehabilitation. Güneş Tıp Kitabevleri Ltd. Şt, Ankara 2016, pp:1459-74 (inTurkish).
3. Covinsky KE, Pierluissi E, Johnston CB. Hospitalization-associated disability: "She was probably able to ambulate, but I'm not sure." JAMA. 2011;306(16):1782–93. doi:10.1001/jama.2011.1556.
4. Achterberg WP, Cameron ID, Bauer JM, et al. Geriatric rehabilitation-state of the art and future priorities. J Am Med Dir Assoc. 2019;20(4):396-8. doi: 10.1016/j.jamda.2019.02.014.
5. Grund S, Gordon AL, van Balen R, Bachmann S, Cherubini A, Landi F, Stuck AE, Becker C, Achterberg WP, Bauer JM, Schols JMGA. European consensus on core principles and future priorities for geriatric rehabilitation: consensus statement. Eur Geriatr Med. 2020 Apr;11(2):233-238. doi: 10.1007/s41999-019-00274-1.
6. Woodford H. Ageing. In: Essential Geriatrics, 4th edition. ISBN: 978-1-0321-4656-0 (hbk), CRC Press, Tylor & Francis Group, Boca Raton and London 2022, pp: 23.
7. Lubbe AL, van Rijn M, Groen WG, Hilhorst S, Burchell GL, Hertogh CMPM, Pol MC. The quality of geriatric rehabilitation from the patients' perspective: a scoping review. Age Ageing. 2023 Mar 1;52(3):afad032. doi: 10.1093/ageing/afad032.
8. Janssen MM, Vos W, Luijkx KG. Development of an evaluation tool for geriatric rehabilitation care. BMC Geriatr. 2019 Aug 2;19(1):206. doi: 10.1186/s12877-019-1213-0.
9. Chu CH, Nyrup R, Leslie K, Shi J, Bianchi A, Lyn A, McNicholl M, Khan S, Rahimi S, Grenier A. Digital Ageism: Challenges and Opportunities in Artificial Intelligence for Older Adults. Gerontologist. 2022 Aug 12;62(7):947-955. doi: 10.1093/geront/gnab167.
10. WHO Ageism in artificial intelligence for health. Policy Brief. 9 February 2022. ISBN: 978 92 4 004079 3 [Internet]. Available from:https://www.who.int/publications/i/item/9789240040793 Accessed:10.8.2025.

ORIGINAL ARTICLE

RISK FACTORS FOR POSTOPERATIVE PULMONARY COMPLICATIONS AFTER MAJOR ABDOMINAL SURGERY IN PATIENTS AGED 65 YEARS AND OLDER: A RETROSPECTIVE OBSERVATIONAL STUDY

Turkish Journal of Geriatrics
2025; 28(4):439–448

DOI: 10.29400/tjgeri.2025.461

Arif TİMUROĞLU
Mustafa Kemal ŞAHİN

Dr. Abdurrahman Yurtaslan Ankara Oncology Training and Research Hospital, Department of Anesthesiology, Yenimahalle, Türkiye

Abstract

Introduction: Postoperative pulmonary complications are among the most frequent and serious causes of morbidity and mortality in older surgical patients. Age-related physiological changes, reduced respiratory reserve, and comorbidities increase their vulnerability to adverse respiratory outcomes. The incidence and risk factors of postoperative pulmonary complications were evaluated in older adults undergoing major abdominal surgery.

Materials and Method: This retrospective study included 239 patients aged ≥65 years who underwent elective major abdominal surgery. Clinical and perioperative data were analyzed, and postoperative pulmonary complications—such as bronchospasm, infiltration, infection, atelectasis, pneumothorax, or acute respiratory distress syndrome—were assessed. Logistic regression identified independent predictors.

Results: The incidence of postoperative pulmonary complications was 22.2% (n=53). Patients with complications were older ($p < 0.001$) and slightly higher intraoperative positive end-expiratory pressure levels ($p = 0.007$), although other ventilatory parameters were not fully available. Multivariate analysis identified age (OR = 1.097; $p = 0.005$), positive end-expiratory pressure (OR = 1.452; $p = 0.014$), ASA ≥ 3 (OR = 30.532; $p < 0.001$), and upper abdominal surgery (OR = 2.322; $p = 0.022$) with the caveat that positive end-expiratory pressure evaluation was limited by the retrospective study design as independent risk factors.

Conclusion: Advanced age, high American Society of Anesthesiologists scores, upper abdominal surgery, and higher intraoperative PEEP were associated with increased postoperative pulmonary complication risk in elderly abdominal surgery patients. Due to limitations in available ventilatory data, the association of PEEP with complications should be interpreted cautiously. Optimizing preoperative status may help reduce complications and improve postoperative outcomes in this population.

Keywords: Postoperative Complications; Pneumonia; Geriatrics; General Surgery.

Correspondence

Arif TİMUROĞLU
Phone : +905072601980
e-mail : ariftimuroglu@yahoo.com

Received : Oct 22, 2025
Accepted: Dec 01, 2025

Cite this article as:
Timuroğlu A, Şahin MK. Risk Factors for Postoperative Pulmonary Complications After Major Abdominal Surgery in Patients Aged 65 Years and Older: A Retrospective Observational Study. Turkish Journal of Geriatrics 2025; 28(4):439–448. doi: 10.29400/tjgeri.2025.461

The content of this journal is licensed under the Creative Commons Attribution-NonCommercial 4.0 International License.

INTRODUCTION

Approximately 300 million surgical procedures are performed worldwide each year, and this number continues to rise (1) . For older adult patients, postoperative pulmonary complications (PPCs) are among the major determinants of both morbidity and mortality, and the associated risk factors are emphasized in perioperative guidelines (2). The reported incidence of PPCs varies between 5% and 24%, and advanced age is a strong predictor (3,4). Advancements in surgical and anesthetic techniques will challenge the limits of safe perioperative care and may lead to a rise in the incidence of PPCs.

Although there is no universal consensus on the definition of PPCs, most definitions include postoperative pneumonia (POP), atelectasis, postoperative respiratory failure, pulmonary aspiration, and acute respiratory distress syndrome (ARDS) (5). Postoperative pneumonia is particularly noteworthy among these because it occurs frequently and is strongly associated with morbidity and mortality; the 30-day mortality rate for POP cases has been reported to be 21%, and it prolongs hospitalization by 7–9 days (6,7). Its annual cost to the United States healthcare system is approximately USD 11.9 billion (8).

The heightened risk of PPCs in older adult patients is closely linked to the physiological changes associated with aging. Between the ages of 25 and 80, lung function and aerobic capacity decline by approximately 40% (9). Pulmonary mechanics, cardiac output, muscle oxidative capacity, and ventilatory flexibility also decrease with age, and alveolar hypoventilation and impairments in bronchial secretion clearance become more common (10,11). Collectively, these alterations heighten older adults' risk of postoperative respiratory insufficiency and failure. Oncologic, cardiac, and thoracic surgeries as well as pulmonary comorbidities, such as chronic obstructive pulmonary disease (COPD), further increase the likelihood of PPCs (12–16).

The aim of this study was to determine the incidence rate and risk factors of postoperative pulmonary complications in older adults following major abdominal surgery. The study followed a retrospective design, and PPCs were defined based on the European Perioperative Clinical Outcome (EPCO) criteria, including bronchospasm, pulmonary infiltration, suspected pulmonary infection, atelectasis, pneumothorax, and ARDS. While advanced age, ASA score, and upper abdominal surgery are known risk factors, few studies have comprehensively evaluated intraoperative ventilation parameters and postoperative analgesia strategies in geriatric patients, highlighting the novelty of the present study.

MATERIALS AND METHOD

This single-centre, retrospective, observational study included patients aged 65 years or older who underwent elective major abdominal surgery at a tertiary care hospital in Ankara, Türkiye between January 1, 2022, and December 31, 2024. A total of 507 patients who underwent major abdominal surgery during the study period were screened, of whom 272 were aged 65 years or older. After reviewing the medical records, 239 patients had complete essential perioperative and outcome data required for PPC assessment and were included in the final analysis. Patients were excluded if they were younger than 65 years, underwent emergency surgery, had incomplete core perioperative data, or had a pre-existing tracheostomy or chronic mechanical ventilation. Data were obtained from the hospital information system, anesthesia records, operating room forms, and postoperative follow-up notes. The demographic data included age, sex, height, weight, and body mass index (BMI). Preoperative clinical characteristics, such as The American Society of Anesthesiologists (ASA) score, smoking status, presence of COPD, history of cerebrovascular events, steroid use, and proton pump inhibitor use, were recorded. The type of



operation (upper or lower abdomen, open or laparoscopic), presence of bowel resection, use of nasogastric tube, and duration of surgery were the surgical variables considered, and the need for intensive care and type of postoperative analgesia were the postoperative variables. Intraoperative ventilation parameters, specifically the fraction of inspired oxygen (FiO_2) and positive end expiratory pressure (PEEP) levels, were documented. In addition, postoperative analgesia methods were systematically recorded and analysed, which, together with detailed ventilation parameters, provide a more comprehensive assessment of PPC risk factors in this underrepresented population.

All patients received a standardized anaesthetic protocol consisting of sevoflurane inhalation anaesthesia combined with remifentanil infusion. PEEP levels were recorded. Due to the retrospective nature of the study, PEEP settings were determined according to the attending anaesthesiologist's discretion. Other ventilatory parameters, such as tidal volume, minute ventilation, and driving pressure, were not available for all patients. Therefore, PEEP is presented descriptively, acknowledging that it cannot be fully interpreted in isolation. No other variations in anaesthetic management were applied.

The PPCs in this study were defined according to the EPCO criteria and included bronchospasm, pulmonary infiltration, suspected pulmonary infection, atelectasis, pneumothorax, and ARDS.

Statistical analyses were performed using Statistical Package for the Social Sciences software (IBM SPSS Statistics for Windows, Version 24.0). Categorical variables were expressed as counts and percentages, and continuous variables were presented as mean ± standard deviation values or medians (interquartile range [IQR]), depending on the data distribution. The chi-square test or Fisher's exact test was used to compare categorical variables, and an independent sample t-test or the Mann–Whitney U test was applied for continuous variables. Variables with $p < 0.10$ in a univariate analysis were included in multivariate logistic regression models to identify the independent risk factors of PPCs. The results of the multivariate regressions were reported as odds ratios (ORs) with 95% confidence intervals (CIs) and p-values. P-values < 0.05 were considered statistically significant.

This study was approved by the Local Ethics Committee (Decision No: 2025-10/154, Date: 02.10.2025). Individual informed consent was waived due to the retrospective design.

RESULTS

A total of 239 geriatric surgical patients were included in the study. The baseline demographic, clinical, and surgical characteristics of the patients are summarized in Table 1. The incidence of PPCs was 22.2% (n=53). The mean age of the participants was 71.85 ± 5.21 years. Most patients (75.7%) had an ASA score ≥3, and 29.7% underwent upper abdominal surgery, 70.3% lower abdominal surgery.

The associations between the demographic and clinical variables and PPCs are summarized in Tables 2 and 3. No significant relationship was found between the PPCs and patient sex, smoking history, or BMI. In contrast, ASA score ($p < 0.001$), surgical incision site (p=0.013), and the presence of COPD (p=0.003) were significantly associated with PPCs. The continuous variables, including age and intraoperative PEEP, were significantly associated with PPC development. Patients who developed PPCs were older (74.4 ± 5.4 years vs. 71.1 ± 4.9 years; $p < 0.001$) and had higher PEEP levels (4.9 ± 1.2 cmH_2O vs. 4.4 ± 1.6 cmH_2O; p=0.007) than those who did not develop PPCs. The median PEEP value was 5 cmH_2O (IQR 4-5), and there was no significant difference between laparoscopic and open surgeries (Mann–Whitney U=5534.5; Z=–0.496; p=0.620). Continuous variables including age, FiO_2, PEEP, and BMI were not normally distributed; thus, median (interquartile range) values are reported in Table 1. For variables where median values were

Table 1. Patients' Demographic, Clinical, and Surgical Characteristics

Characteristic	Category / Descriptive Statistics	n (%) / Value
Sex	Female	104 (43.5)
	Male	135 (56.5)
ASA Score	2	58 (24.3)
	3	169 (70.7)
	4	12 (5.0)
Type of Surgery	Upper abdomen	71 (29.7)
	Lower abdomen	168 (70.3)
Surgical Approach	Open	172 (72.0)
	Laparoscopic	67 (28.0)
Duration of Surgery	>2 hours	207 (86.6)
Postoperative Analgesia	Multimodal	95 (39.7)
	IV PCA	86 (36.0)
	Parenteral	51 (21.3)
	Epidural PCA	5 (2.1)
	Oral	2 (0.8)
Postoperative Pulmonary Complications	-	53 (22.2)
Smoking	-	84 (35.1)
COPD	-	30 (12.6)
CVA	-	5 (2.1)
Preoperative Antibiotic Prophylaxis	-	149 (62.3)
Bowel Resection	-	124 (51.9)
Nasogastric Tube	-	197 (82.4)
Age (years)	Median (Q1–Q3)	71 (68–75)
FiO2 (%)	Median (Q1–Q3)	40 (40–45)
PEEP (cmH2O)	Median (Q1–Q3)	5 (4–5)
BMI (kg/m²)	Median (Q1–Q3)	26.35 (23.75–29.38)

ASA; American Society of Anesthesiologists physical status classification system, PCA; Patient-Controlled Analgesia, IV PCA; Intravenous Patient-Controlled Analgesia, COPD: Chronic Obstructive Pulmonary Disease, CVA; Cerebrovascular Accident (Stroke), FiO2; The fraction of inspired oxygen, PEEP; positive end expiratory pressure, BMI; body mass index

identical between groups (e.g., PEEP), mean ± SD is also presented to aid interpretation (Table 3). Recruitment manoeuvres were documented in only 74 patients, of whom 11 received manoeuvres; statistical analysis was not performed due to the small sample size.

Binary logistic regression analysis was conducted using age as a continuous variable (Table 4). The results showed that age (OR: 1.097; 95% CI: 1.028–1.171; p=0.005), PEEP (OR: 1.452; 95% CI: 1.080–1.951; p=0.014), ASA ≥ 3 (OR: 30.532; 95% CI: 5.293–176.132; p < 0.001), and upper abdominal surgery (OR: 2.322; 95% CI: 1.129–4.774; p=0.022) were independent risk factors for PPCs. BMI was not a statistically significant risk factor (p=0.512).



Table 2. Patient and Surgical Characteristics and Postoperative Pulmonary Complications

Variable		n	PPCs (%)	p value
Sex	Female	104	23.1	0.768
	Male	135	21.5	
ASA classification	II	58	6.9	**<0.001**
	III	169	23.7	
	IV	12	75.0	
Type of surgery	Upper abdomen	71	32.4	**0.013**
	Lower abdomen	138	17.9	
Surgical approach	Open	172	25.0	0.092
	Laparoscopic	67	14.9	
Smoking history	Yes	84	26.2	0.271
	No	155	20.0	
COPD	Yes	30	43.3	**0.003**
	No	209	19.1	
Preoperative antibiotic prophylaxis	Yes	149	25.5	0.111
	No	90	16.7	
Nasogastric tube	Present	197	23.9	0.175
	Absent	42	14.3	
Duration of surgery	<2 hours	32	15.6	0.338
	≥2 hours	207	23.2	
Postoperative analgesia	IV PCA	86	10.5	**0.007**
	Parenteral	51	29.4	
	Multimodal	95	0.5	
	Other	7	0	

Comparisons between categorical variables and the incidence of postoperative pulmonary complications were performed using Pearson's chi-square test or Fisher's exact test, as appropriate. ASA; American Society of Anesthesiologists physical status classification system, IV PCA; Intravenous Patient-Controlled Analgesia, COPD; Chronic Obstructive Pulmonary Disease, PPCs; Postoperative Pulmonary Complications

Table 3. Continuous perioperative variables according to the presence of postoperative pulmonary complications

Variable	PPCs (+) (n=53)	PPCs (–) (n=186)	Mann–Whitney U	p-value
Age (years)	74 (70.5–78)	70 (67–74)	3118.0	**<0.001**
FiO_2 (%)	40 (40–45), 43.8 ± 6.6	40 (40–43), 42.0 ± 3.6	4228.5	0.056
PEEP (cmH_2O)	5 (5–6), 4.9 ± 1.2	5 (4–5), 4.4 ± 1.6	3789.0	**0.007**
BMI (kg/m^2)	25.3 (24–29)	26.9 (23–29)	4420.5	0.252

Data are presented as median (interquartile range), mean ± standard deviation. Continuous variables were not normally distributed; therefore, comparisons between groups were performed using the Mann–Whitney U test. For variables where median values were identical between groups (e.g., PEEP), mean ± standard deviation is also provided to aid interpretation. PPCs; Postoperative Pulmonary Complications; FiO_2; The Fraction of Inspired Oxygen; PEEP; Positive End-Expiratory Pressure; BMI; Body Mass Index.

Table 4. Multivariate Logistic Regression Analysis of Independent Risk Factors for Postoperative Pulmonary Complications

Variable	B	S.E.	Wald	p-value	Exp(B)	95% CI Exp(B)
Age (years)	0.093	0.033	7.814	**0.005**	1.097	1.028 – 1.171
PEEP (cmH_2O)	0.373	0.151	6.099	**0.014**	1.452	1.080 – 1.951
BMI (kg/m²)	-0.027	0.042	0.431	0.512	0.973	0.897 – 1.056
ASA (≥3 vs <3)	3.419	0.894	14.620	**<0.001**	30.532	5.293 – 176.132
Surgical site (upper vs lower abdomen)	0.842	0.368	5.247	**0.022**	2.322	1.129 – 4.774
Constant	-10.399	2.893	12.920	0.000	0.000	–

Binary logistic regression was performed using age as a continuous variable. Exp(B) represents the odds ratio for developing postoperative pulmonary complications. Reference categories: ASA <3, lower abdominal surgery. Model fit: -2 Log likelihood = 206.528, Cox & Snell R^2 = 0.176, Nagelkerke R^2 = 0.270. Hosmer-Lemeshow test: χ^2 = 11.946, df = 8, p = 0.154, indicating good fit. PEEP; Positive End-Expiratory Pressure; BMI; Body Mass Index, ASA; American Society of Anesthesiologists

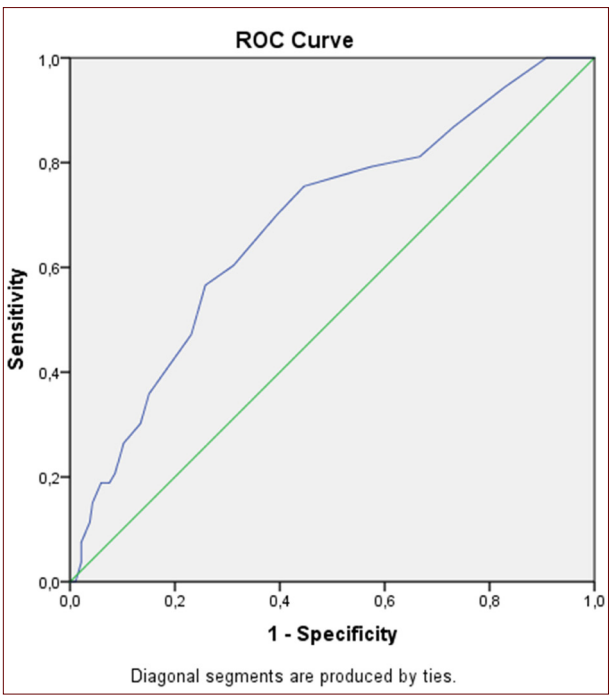


Figure 1. ROC Curve for Age Predicting PPCs. ROC curve illustrates the predictive ability of age for postoperative pulmonary complications. The area under the curve was 0.684 (95% CI, 0.602–0.765; p < 0.001). The optimal cut-off value for age was 70.5 years, which provided the best combination of sensitivity and specificity for identifying patients at risk of PPCs. ROC; The Receiver Operating Characteristic; PPCs; Postoperative Pulmonary Complications

The predictive performance of age was evaluated using receiver operating characteristic (ROC) analysis (Figure 1). The area under the curve (AUC) was 0.684 (95% CI: 0.602–0.765; p< 0.001), and the optimal cutoff value was determined to be 70.5 years. A second binary logistic regression analysis using this cutoff value showed that patients older than 70.5 years had a 3.3-fold increased risk of PPCs (OR: 3.325; 95% CI: 1.567–7.056; p=0.002). PEEP (OR: 1.531; 95% CI: 1.133–2.069; p=0.006), ASA ≥3 (OR: 32.180; 95% CI: 5.599–184.945; p< 0.001), and upper abdominal surgery (OR: 2.154; 95% CI: 1.053–4.407; p=0.036) remained independent risk factors, and BMI remained nonsignificant (p=0.384).



These findings indicate that advanced age (>70.5 years), high intraoperative PEEP levels, high ASA scores, and upper abdominal surgery significantly increase the risk of PPCs in geriatric surgical patients.

DISCUSSION

Advanced age, high ASA scores, upper abdominal surgery, and increased intraoperative PEEP were identified as independent risk factors for PPCs in older adult patients who underwent abdominal surgery. Among these, ASA classification, comorbidities, and upper abdominal surgery showed the strongest associations with PPCs, while BMI and intraoperative FiO_2 did not have significant effects.

These findings indicate that patient- and surgery-related factors are important predictors of PPCs risk, but the role of intraoperative ventilation parameters is less clear.

Although age, ASA classification, and upper abdominal surgery are widely recognized PPCs risk factors, this study contributes to the literature by focusing specifically on a geriatric population undergoing major abdominal surgery and by incorporating detailed intraoperative ventilation parameters, which are not routinely evaluated in similar studies. Additionally, the use of standardized EPCO criteria and the assessment of postoperative analgesia methods (patient-controlled analgesia vs. parenteral analgesia) provide further practical insights for perioperative management in elderly surgical patients.

The patients who developed PPCs were older and had slightly higher intraoperative PEEP levels than those without any complications. The median PEEP value was 5 cmH_2O in both groups, but the interquartile range was higher in the PPCs group. Considering that PEEP is generally a protective factor against alveolar collapse and is expected to reduce pulmonary complications, this finding seems surprising. However, this association can likely be explained by confounding by indication. Anesthesiologists may have applied higher PEEP to patients considered high risk due to advanced age, a high ASA score, or complex surgery. Thus, the observed relationship likely reflects a strategy applied to high-risk patients rather than a causal effect of PEEP on complications.

The literature shows that the use of a low tidal volume and low driving pressure reduces postoperative respiratory failure, ventilation requirement, and PPCs incidence (17–19). However, evidence regarding the additional benefits of high PEEP levels or recruitment maneuvers is inconsistent. A recent meta-analysis revealed that these interventions do not provide significant benefits (20). The present study's findings similarly suggest that PEEP may be a strategy adopted for high-risk patients rather than an independent risk factor.

Pulmonary comorbidities increase PPCs risk substantially. COPD affects more than 11.6% of the population over 65 years and is associated with reduced exercise tolerance, dyspnea, and limitations in daily activities (21). COPD has been reported to be an independent risk factor for PPCs (14). In our study, the incidence of PPCs was higher among patients with COPD.

Postoperative analgesia management is important for reducing PPCs. More specifically, patient-controlled analgesia (PCA) has been shown to reduce PPCs incidence. In a 2024 study by He et al., elderly patients who received intravenous or epidural PCA when undergoing major abdominal surgery had lower PPCs rates (OR: 0.208; 95% CI: 0.121–0.358; $p < 0.001$) (22). Our findings are consistent with previous reports, with lower PPCs rates seen in patients who received PCA (especially intravenous PCA) and higher complication rates seen in those who received parenteral analgesia. This indicates that appropriate postoperative analgesia selection may help prevent pulmonary complications in elderly patients.

In the literature, the PPCs incidence rates reported for older adult surgical patients vary. Peng et al. conducted a multicenter prospective study of 12,240 geriatric patients and found a PPCs incidence of 15.9% (23). Zhou et al. performed a nomogram study for elderly patients undergoing noncardiac thoracic surgery and reported PPCs incidence rates of 31.4–34.9% in a 30-day period (24). In our study, the incidence among patients aged ≥ 65 who underwent major abdominal surgery was 22.2%. These differences may be due to variations in surgical types, patient populations, risk prediction models, and PPCs definitions, which should be taken into account when comparing our findings with those of previous studies.

Surgical type also affects PPCs risk. Complication rates of around 18.8% have been reported for oncologic surgeries (15). Radical cystectomy is associated with a PPCs incidence of 5.6%, along with significantly increased 30-day mortality and hospital stays (25). POP rates of 3.3% and 25%, respectively, have been reported for cardiac and thoracic surgeries, with COPD and long surgical durations among the risk factors (12,13,16).

The present study's findings have important implications for anesthesia practice and perioperative care protocols. Patients of advanced age, with ASA ≥ 3, and undergoing upper abdominal surgery are at high risk for PPCs and require close perioperative monitoring. Analgesia choice plays a critical role in reducing PPCs risk. Our study findings as well as the literature show that PPCs rates reduce with PCA administration (22). This suggests that intravenous or epidural PCA may reduce complications in elderly surgical patients.

Preoperative optimization strategies are equally important. Smoking cessation, nutritional support, and treatment for pulmonary comorbidities such as COPD can improve patients' physiological reserves and reduce PPCs risk. Cardiopulmonary exercise testing, pulmonary function tests, and frailty assessments can facilitate the early identification of high-risk patients, allowing for targeted interventions. The selective monitoring of high-risk patients, appropriate analgesia management, and preoperative optimization can notably reduce PPCs.

The strengths of the present study include its focus on the elderly surgical population, which is underrepresented in the literature, and the use of detailed perioperative variables, especially intraoperative ventilation parameters, which allowed for a comprehensive and reliable analysis of PPCs risk factors. Further, the use of EPCO criteria provided standardized, objective definitions, which enhanced the reliability of findings. The study also has some limitations. Its retrospective design limited causal inference and may have introduced data issues such as missing records. The single-center setting limits the generalizability of the results. The impact of ventilation parameters may not have been fully captured because of the use of average PEEP values without assessing intraoperative dynamics. Lastly, imbalance between the analgesia subgroups (e.g., very few patients in the epidural PCA group) limited the statistical analysis of analgesia effects on PPCs. Postoperative pain scores (e.g., The visual analogue scale) were not systematically recorded due to the retrospective design. Therefore, the adequacy of pain control could not be directly assessed, and only the type of analgesic method (PCA vs. parenteral analgesia) could be evaluated. Finally, detailed ventilatory parameters such as tidal volume, minute ventilation, and driving pressure were not available for all patients. Consequently, PEEP is reported descriptively, and its isolated evaluation should be interpreted cautiously.

In the future, researchers should consider adopting prospective, multicenter, randomized controlled study designs to identify PPCs risk factors more reliably. Investigating various ventilation strategies (PEEP, tidal volume, and FiO_2) in a forward-looking manner could help clarify the impact of intraoperative management on complications. Research on the use of prehabilitation and analgesia



methods in elderly populations may also provide practical guidance for clinical care.

This study showed that advanced age, high ASA scores, upper abdominal surgery, and intraoperative PEEP are potential risk factors for PPCs in elderly patients who have undergone abdominal surgery. However, the findings related to PEEP do not exclude the possibility of confounding by indication. The appropriate selection of analgesia methods and preoperative optimization strategies may contribute to reducing PPCs risk in the older adult surgical population. Close perioperative monitoring of high-risk patients, tailored analgesia management, and prehabilitation interventions are practical measures that can meaningfully improve the outcomes of this vulnerable group. Overall, the results emphasize the importance of patient- and surgery-specific characteristics in PPCs development and highlight the need for prospective, large-scale, controlled studies to better understand the role of ventilation parameters.

Conflict of Interest: The authors have no conflicts of interest to declare.

REFERENCES

1. Weiser TG, Haynes AB, Molina G, et al. Estimate of the global volume of surgery in 2012: an assessment supporting improved health outcomes. The Lancet 2015 Apr;385:S11. doi:10.1016/S0140-6736(15)60806-6.
2. Chow WB, Rosenthal RA, Merkow RP, Ko CY, Esnaola NF. Optimal Preoperative Assessment of the Geriatric Surgical Patient: A Best Practices Guideline from the American College of Surgeons National Surgical Quality Improvement Program and the American Geriatrics Society. J Am Coll Surg 2012 Oct;215(4):453–66. doi:10.1016/j.jamcollsurg.2012.06.017.
3. Madsen HJ, Meguid RA, Bronsert MR et al. Associations between preoperative risks of postoperative complications: Results of an analysis of 4.8 Million ACS-NSQIP patients. The American Journal of Surgery 2022 Jun;223(6):1172–8. doi:10.1016/j.amjsurg.2021.11.024.
4. Meguid RA, Bronsert MR, Juarez-Colunga E, Hammermeister KE, Henderson WG. Surgical Risk Preoperative Assessment System (SURPAS). Ann Surg 2016 Jul;264(1):23–31. doi:10.1097/SLA.0000000000001678.
5. Abbott TEF, Fowler AJ, Pelosi P. et al. A systematic review and consensus definitions for standardised end-points in perioperative medicine: pulmonary complications. Br J Anaesth 2018 May;120(5):1066–79. doi:10.1016/j.bja.2018.02.007.
6. Hall JC, Tarala RA, Hall JL, Mander J. A Multivariate Analysis of the Risk of Pulmonary Complications After Laparotomy. Chest 1991 Apr;99(4):923–7. doi:10.1378/chest.99.4.923.
7. Rello J, Ollendorf DA, Oster G. et al. Epidemiology and Outcomes of Ventilator-Associated Pneumonia in a Large US Database. Chest 2002 Dec;122(6):2115–21. doi:10.1378/chest.122.6.2115.
8. Linde-Zwirble W, Bloom J, Mecca R, Hansell D. Postoperative pulmonary complications in adult elective surgery patients in the US: severity, outcomes and resources use. Crit Care 2010;14(Suppl 1):P210. doi:10.1186/cc8442.
9. Roman MA, Rossiter HB, Casaburi R. Exercise, ageing and the lung. European Respiratory Journal 2016 Nov;48(5):1471–86. doi:10.1183/13993003.00347-2016.
10. Cardús J, Burgos F, Diaz O, Roca J. et al. Increase in Pulmonary Ventilation–Perfusion Inequality with Age in Healthy Individuals. Am J Respir Crit Care Med 1997 Aug 1;156(2):648–53. doi:10.1164/ajrccm.156.2.9606016.
11. Fleg JL, Morrell CH, Bos AG. et al. Accelerated Longitudinal Decline of Aerobic Capacity in Healthy Older Adults. Circulation 2005 Aug 2;112(5):674–82. doi:10.1161/CIRCULATIONAHA.105.545459.
12. Ailawadi G, Chang HL, O'Gara PT. et al. Pneumonia after cardiac surgery: Experience of the National Institutes of Health/Canadian Institutes of Health Research Cardiothoracic Surgical Trials Network. J Thorac Cardiovasc Surg 2017 Jun;153(6):1384-1391.e3. doi:10.1016/j.jtcvs.2016.12.055.
13. Chughtai M, Gwam CU, Khlopas A, et al. The Incidence of Postoperative Pneumonia in Various Surgical Subspecialties: A Dual Database Analysis. Surg Technol Int 2017;30:45–51.
14. Conde M, Lawrence V. Postoperative pulmonary infections. BMJ Clin Evid 2008;2008:2201.

15. Liu JB, Berian JR, Liu Y, Ko CY, Weber SM. Trends in perioperative outcomes of hospitals performing major cancer surgery. J Surg Oncol 2018 Sep 21;118(4):694–703. doi:10.1002/jso.25171.

16. Schussler O, Alifano M, Dermine H. et al. Postoperative Pneumonia after Major Lung Resection. Am J Respir Crit Care Med 2006 May 15;173(10):1161–9. doi:10.1164/rccm.200510-1556OC.

17. Futier E, Constantin JM, Paugam-Burtz C. et al. A Trial of Intraoperative Low-Tidal-Volume Ventilation in Abdominal Surgery. New England Journal of Medicine 2013 Aug;369(5):428–37. doi:10.1056/NEJMoa1301082.

18. Neto AS, Hemmes SNT, Barbas CS V. et al. Association between driving pressure and development of postoperative pulmonary complications in patients undergoing mechanical ventilation for general anaesthesia: a meta-analysis of individual patient data. Lancet Respir Med 2016 Apr;4(4):272–80. doi:10.1016/S2213-2600(16)00057-6.

19. Severgnini P, Selmo G, Lanza C. et al. Protective Mechanical Ventilation during General Anesthesia for Open Abdominal Surgery Improves Postoperative Pulmonary Function. Anesthesiology 2013 Jun;118(6):1307–21. doi:10.1097/ALN.0b013e31829102de.

20. Campos NS, Bluth T, Hemmes SNT. et al. Intraoperative positive end-expiratory pressure and postoperative pulmonary complications: a patient-level meta-analysis of three randomised clinical trials. Br J Anaesth 2022 Jun;128(6):1040–51. doi:10.1016/j.bja.2022.02.039.

21. Incalzi RA, Scarlata S, Pennazza G, Santonico M, Pedone C. Chronic Obstructive Pulmonary Disease in the elderly. Eur J Intern Med 2014 Apr;25(4):320–8. doi:10.1016/j.ejim.2013.10.001.

22. He Q, Lai Z, Peng S, Lin S. et al. Postoperative pulmonary complications after major abdominal surgery in elderly patients and its association with patient-controlled analgesia. BMC Geriatr 2024 Sep 10;24(1):751. doi:10.1186/s12877-024-05337-y.

23. Peng X, Zhu T, Chen G, Wang Y, Hao X. A multicenter prospective study on postoperative pulmonary complications prediction in geriatric patients with deep neural network model. Front Surg 2022 Aug 9;9. doi:10.3389/fsurg.2022.976536.

24. Zhou Y, Wang H, Lu D. et al. Development and validation of a nomogram for predicting postoperative pulmonary complications in older patients undergoing noncardiac thoracic surgery: a prospective, bicentric cohort study. BMC Geriatr 2025 Mar 13;25(1):169. doi:10.1186/s12877-025-05791-2.

25. Xia L, Taylor BL, Guzzo TJ. Characteristics and Associated Factors of Postoperative Pulmonary Complications in Patients Undergoing Radical Cystectomy for Bladder Cancer: A National Surgical Quality Improvement Program Study. Clin Genitourin Cancer 2017 Dec;15(6):661–9. doi:10.1016/j.clgc.2017.04.009.

ORIGINAL ARTICLE

THE EFFECT OF OPTIC NERVE SHEATH DIAMETER ON PROGNOSIS AND ITS PERIOPERATIVE EVALUATION IN GERIATRIC ISCHEMIC CEREBROVASCULAR PATIENTS

Turkish Journal of Geriatrics
2025; 28(4):449–456

DOI: 10.29400/tjgeri.2025.462

Barış ASLANOĞLU[1]
Kamuran AYDIN[1]
Sezer Onur GUNARA[2]
Barış ALTUN[3]

[1] Diyarbakir Gazi Yasargil Training and Research Hospital, Neurosurgery, Diyarbakir, Türkiye

[2] Gaziantep Sehitkamil State Hospital, Neurosurgery, Gaziantep, Türkiye

[3] Nusaybin State Hospital, Neurosurgery, Mardin, Türkiye

Correspondence

Barış ASLANOĞLU
Phone : +904122580060
e-mail : drbarisaslanoglu08@gmail.com

Received : Oct 22, 2025
Accepted: Dec 01, 2025

Cite this article as:
Aslanoğlu B, Aydın K, Gunara SO et al. The Effect of Optic Nerve Sheath Diameter on Prognosis and Its Perioperative Evaluation in Geriatric Ischemic Cerebrovascular Patients. Turkish Journal of Geriatrics 2025; 28(4):449–456. doi:10.29400/tjgeri.2025.462

Abstract

Introduction: This study evaluates the prognostic value of optic nerve sheath diameter measurement as a noninvasive indicator of elevated intracranial pressure and its potential role in guiding decompressive surgical decision-making in elderly patients with ischemic stroke.

Materials and Method: This multicenter retrospective observational study included patients over 65 years of age who were hospitalized with middle cerebral artery infarction between 2023 and 2025. Patients with intracranial mass lesions, hydrocephalus, orbital pathology, or a history of head trauma were excluded. Preoperative and postoperative optic nerve sheath diameter measurements were obtained using computed tomography at a distance of 3 mm posterior to the optic disc. Clinical and radiological parameters, including Glasgow Coma Scale, Glasgow Outcome Scale, infarct volume, and degree of midline shift, were systematically analyzed.

Results: A total of 97 patients were included (57.7% female; mean age 75.3 ± 8.5 years). The mean preoperative optic nerve sheath diameter was 4.21 ± 0.81 mm. Increased preoperative optic nerve sheath diameter, larger infarct volume, and greater midline shift were significantly associated with lower Glasgow Outcome Scale scores ($p = 0.035$). An optic nerve sheath diameter threshold above 4.4 mm predicted poorer outcomes, while postoperative optic nerve sheath diameter variation showed no significant correlation with prognosis

Conclusion: Preoperative optic nerve sheath diameter measurement may serve as a rapid, noninvasive, and reliable parameter for prognostication and for supporting early surgical decision-making in elderly patients with ischemic stroke. However, individualized multidisciplinary evaluation remains crucial given the complex clinical profile of this population.

Keywords: Ischemic Stroke; Intracranial Pressure; Decompressive Craniectomy; Prognosis.

The content of this journal is licensed under the Creative Commons Attribution-NonCommercial 4.0 International License.

INTRODUCTION

Stroke is defined as a neurological dysfunction lasting longer than 24 hours that develops due to causes other than vascular pathologies, and it is reported to be the second most common cause of death among non-communicable diseases, following cardiovascular diseases (1). Clinically, stroke is classified into two main groups: ischemic and hemorrhagic. In the literature, approximately 65.3% of strokes are reported to be ischemic and 34.7% hemorrhagic in origin (1).

In the geriatric population, the high prevalence of comorbidities and polypharmacy presents significant challenges in stroke management. Epidemiological data indicate that 30–65% of elderly individuals use five or more medications concurrently (2). In geriatric patients, drug–drug and drug–disease interactions resulting from comorbidities, the increased prevalence of concomitant diseases, the need for additional treatments targeting these conditions, and prolonged rehabilitation processes all contribute to added clinical management challenges and increased healthcare costs. Indeed, the global costs associated with stroke were estimated at USD 891 billion in 2017 and are projected to reach USD 2.31 trillion by 2050 (1). This highlights that geriatric stroke is not only a clinical concern but also a major public health issue with substantial economic and social implications. Therefore, preventing stroke in the geriatric population, identifying risk factors at an early stage, and implementing timely and appropriate treatment strategies are of critical importance in reducing morbidity and mortality.

Stroke may lead to increased intracranial pressure (ICP), which can result in secondary brain injury in addition to primary damage and fatal outcomes through cerebral herniation (3). Hence, the measurement of intracranial pressure is crucial for both mortality and morbidity outcomes. In recent years, stroke management protocols have emphasized the "time is brain" approach, underscoring the decisive role of early intervention in determining prognosis (4). Therefore, noninvasive and rapid assessment of intracranial pressure offers a vital advantage in clinical management. While transcranial Doppler ultrasonography can be used for intracranial pressure evaluation, the measurement of optic nerve sheath diameter (ONSD) has gained increasing attention as an indirect indicator of intracranial pressure in recent years (5).

Axonal loss, glial proliferation, and reduced microvascular perfusion associated with aging form the primary mechanisms predisposing to optic nerve atrophy. Furthermore, the increased prevalence of systemic vascular diseases such as hypertension, diabetes mellitus, and atherosclerosis in elderly individuals adversely affects optic nerve perfusion and accelerates the atrophic process (6). As a result of these structural changes, the optic nerve sheath diameter may show relatively lower values in older populations. Therefore, consideration of age-related anatomical and pathological changes when assessing optic nerve sheath diameter is clinically important to avoid false-positive results (7).

Although various parameters are used to determine the indications for decompressive craniectomy, predicting treatment outcomes in patients over 65 years of age with comorbidities can help both to reduce mortality and morbidity through timely surgical intervention and to prevent complications associated with unnecessary invasive procedures. Since there are no studies in the literature examining the efficacy of optic nerve sheath diameter measurements in guiding decompressive surgical decisions in elderly individuals, this study aims to evaluate whether measuring the optic nerve sheath diameter in patients treated for cerebrovascular events can serve as an additional marker in determining the indications for decompressive surgery.

MATERIALS AND METHOD

The study was approved by the Non-Interventional Clinical Research Ethics Committee of Diyarbakır Gazi Yaşargil Training and Research Hospital



(Approval No: 527, dated 27/06/2025). The study was conducted in accordance with the principles of the Declaration of Helsinki from its design stage through to completion. This was a multicenter, observational, retrospective study.

Patients who presented with ischemic stroke between 2023 and 2025 at Diyarbakır Gazi Yaşargil Training and Research Hospital and Gaziantep Şehitkamil State Hospital were included in the study. Patients over the age of 65 were involved in the study. Patients with intracranial space-occupying lesions, hydrocephalus, orbital pathologies that could affect optic nerve sheath diameter, transient ischemic attack, or conditions such as head trauma that could cause cerebral edema or increase intracranial pressure and thus affect ONSD, and patients with other identified causes that could affect ONSD measurements were excluded from the study. Only patients with middle cerebral artery infarction were included to achieve standardization by eliminating the potential prognostic variability related to lesion location.

The variables included in the study were patients' age, sex, development of hemorrhagic infarction or performance of thrombectomy, three-dimensional measurement of the ischemic area, surgical history, lesion side, Glasgow Coma Scale (GCS), Glasgow Outcome Scale (GOS), degree of shift, and ONSD. In operated patients, postoperative ONSD was also measured.

All preoperative and postoperative computed tomography (CT) scans were performed using a 128-slice Philips (Incisive) CT scanner available at our hospital. In operated patients, postoperative ONSD measurements were obtained from brain CT images taken within the first 24 hours after surgery.

In our study as well, the ONSD measurement was performed 3 mm behind the disc, which is the most preferred location, since an increase of up to 60% occurs at a distance of 3 mm from the disc (8). The ONSD was measured manually in the section where the optic nerve and its sheath were clearly visualized, in a mediolateral oblique plane. All measurements were performed using the same window settings (WW 50, WL 250) and identical brightness and contrast levels.

All data were evaluated separately by two researchers and then included in the study. Clinical findings of the patients were added afterward to ensure a blinded study design.

Statistical Analysis

Data were analyzed using IBM SPSS V20 (Chicago, USA). In the study, descriptive statistics were presented as numbers and percentages for categorical variables, and as arithmetic mean and standard deviation for continuous variables. Pearson's Chi-square test was used to assess categorical data. The conformity of the data to a normal distribution across groups was examined using the Kolmogorov–Smirnov/Shapiro–Wilk test. The results of the analyses were expressed as mean ± standard deviation for continuous variables. ROC analysis was performed to determine the cut-off value. A p-value of less than 0.05 was considered significant.

RESULTS

A total of 97 patients who were followed up due to ischemic stroke, including both operated and non-operated patients, were included in the study. Of these, 57.7% were female and 42.3% were male. The mean age of the patients was 75.28 ± 8.46 years (range: 65–100 years). Hypertension was present in 61.9% of the patients, diabetes mellitus in 15.5%, and coronary artery disease in 41.2%. Various additional comorbidities (chronic renal failure, pneumonia, and liver disorders) were identified in 16.5% of the patients.

Occlusion was located in the right middle cerebral artery in 47.4% of patients and in the left middle cerebral artery in 52.6%. Hemorrhagic infarction was detected in 37.1% of the patients, and 40.2%

Table 1. Evaluation of outcomes based on patient data

GOS	1 (n=46)	2 (n=12)	3 (n=13)	4 (n=17)	5 (n=9)	p
Age	74,11±8,37	76,42±9,84	77,23±7,91	78,76±8,4	70,44±5,29	0,104
GCS	5,21±1,98	6,83±1,4	9,31±1,8	11,53±1,18	13,11±0,6	0,000
Volume	5222±2151	4923±1822	4068±1377	3209±1959	1978±492	0,000
Shift	8,11±6,18	4,42±3,03	3,92±3,57	2,16±4,16	0	0,000
The Mean Preop ONSD	4,4±0,83	4,27±0,79	4,33±0,79	3,8±0,68	3,73±0,66	0,035
	n=15	n=3	n=2	n=2	n=0	
The Mean Postop ONSD	4,34±0,50	3,71±1,05	4,65±0.2	2,5±3,54	0	0,111

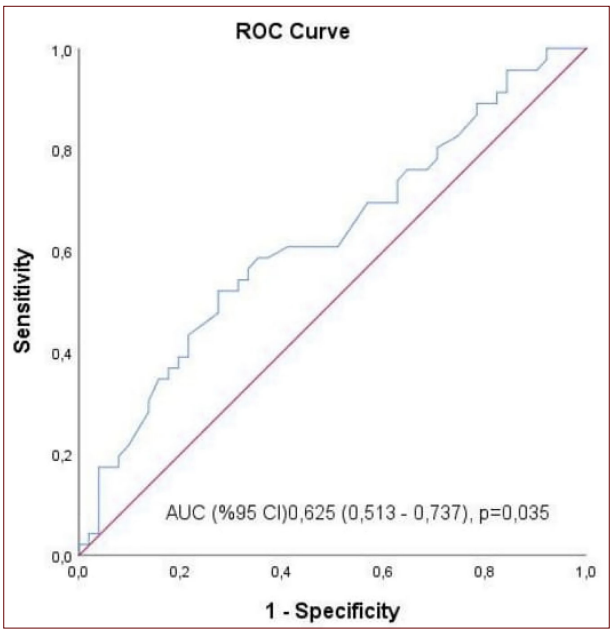


Figure 1. ROC analysis of preoperative ONSD and GOS

underwent thrombectomy. Decompressive surgery was performed in 21.6% of the cases. The mean infarct volume was measured as 4377.10 ± 2149.47 mm^2 (range: 294–11130).

The GCS scores of the patients ranged from 3 to 14, with a mean of 7.80 ± 3.38. The degree of midline shift measured on brain CT ranged from 0 to 19 mm, with a mean of 5.30 ± 5.65 mm. The GOS scores ranged from 1 to 5, with a mean of 2.28 ±1.44.

The mean preoperative ONSD was measured as 4.21 ± 0.81 mm, while in operated patients the mean postoperative ONSD was 4.11 ± 1.10 mm.

According to GOS results, a lower admission GCS, larger infarct volume, greater degree of midline shift, and higher preoperative ONSD were all associated with lower GOS scores (Table 1– GOS). However, no significant relationship was found between postoperative ONSD measurements and GOS outcomes.

Upon comparison of preoperative ONSD measurements with GOS outcomes, an ONSD value greater than 4.4 mm was found to be statistically associated with lower GOS scores (AUC [95% CI] = 0.625 [0.513–0.737], p = 0.035) (Figure 1).

When admission GCS was evaluated, it was observed that as the volume and the degree of midline shift increased, GCS decreased (p = 0.000). As GCS increased, both the admission ONSD and postoperative ONSD values decreased (p = 0.004 and p = 0.001, respectively).

Hemorrhage developed in 41.5% of male patients and 33.9% of female patients. When the occurrence of hemorrhage was evaluated in relation to comorbidities, it was found to be significantly less frequent in patients with coronary artery disease (p = 0.010). Although GOS scores were lower in patients who developed hemorrhage, this difference was not statistically significant (p = 0.525). Among



patients who developed hemorrhage, both the admission and postoperative ONSD values were higher compared with those without hemorrhage; however, only the change in admission ONSD was statistically significant (p = 0.07 / 0.132).

DISCUSSION

Stroke is characterized by neurological dysfunction lasting longer than 24 hours due to non-vascular pathologies and is one of the leading causes of mortality and morbidity worldwide. Clinically, it is classified into two main types: ischemic and hemorrhagic. In the literature, approximately 65.3% of all stroke cases are reported to be ischemic, while 34.7% are hemorrhagic (1).The majority of ischemic strokes (85%) are acute in nature, and when the etiological distribution is examined, it has been reported that 51% of cases are due to middle cerebral artery occlusion, 13% to lacunar artery occlusion, 11% to vertebrobasilar system occlusion, 7% to posterior cerebral artery occlusion, and 5% to anterior cerebral artery occlusion (9). Hemorrhagic strokes most commonly (50%) occur in the basal ganglia, while 10–20% occur in the cerebral lobes, 15% in the thalamus, 10–20% in the pons and brainstem, and 10% in the cerebellum (10). Stroke leads not only to acute complications but also to significant long-term neurological, cognitive, and functional impairments. Common post-stroke sequelae include motor deficits, spasticity, aphasia, dysphagia, depression, epileptic seizures, cognitive decline, and dementia (11). Furthermore, prolonged immobilization and neurological dysfunction increase the risk of developing secondary complications such as pneumonia, deep vein thrombosis, pulmonary embolism, and infections (12). These factors contribute to higher mortality rates and markedly reduced quality of life in stroke patients.

In our study, only ischemic strokes caused by middle cerebral artery occlusion were evaluated, with occlusion detected in the right middle cerebral artery in 47.4% of patients and in the left middle cerebral artery in 52.6%.

Epidemiological data indicate that 52.6% of strokes occur in men and 47.4% in women, with the mean age at first stroke being 72.9 years for women and 68.6 years for men (13). Moreover, the risk of stroke approximately doubles after the age of 55, and the overall prevalence of stroke in populations aged 65 years and older has been reported to be 7.4% (14). In line with these findings, the fact that nearly three-quarters of all strokes occur in individuals over 65 years of age demonstrates that age is one of the most significant independent risk factors for stroke development (15).

According to data from the World Health Organization (WHO) and the World Stroke Organization (WSO), approximately 12 million new stroke cases occur annually, and around 7 million people die due to stroke each year. The WHO estimates that by 2050, the number of individuals who have experienced a stroke will exceed 1.5 billion (16). Furthermore, stroke-related mortality rates are expected to increase by 50%, while morbidity rates are projected to rise by 31% (1). Considering that 47% of strokes occur in individuals aged 70 years and older, and that 67% of stroke-related deaths occur within this age group (17), it is evident that stroke represents a major public health concern in the geriatric population, not only in terms of clinical outcomes but also due to its economic and social implications. Therefore, in this age group, stroke prevention, early identification of risk factors, and prompt implementation of appropriate treatment strategies are of critical importance.

Sex differences are also regarded as an important determinant in stroke epidemiology and clinical outcomes. Although the literature generally reports a higher incidence of stroke in men, in our study, 57.7% of the patients were female and 42.3% were male. This finding can be explained by the inclusion of only individuals aged 65 years and older and the longer life expectancy observed in wom-

en. Similarly, WHO data indicate that in older age groups, the prevalence of stroke is higher in women compared to men (17).

When stroke types were examined, it was revealed that 63.9% of cases were ischemic and 37.1% were hemorrhagic, ratios largely consistent with those reported in the literature (9). Although hemorrhagic strokes occur less frequently, they are generally associated with more severe clinical courses and higher mortality rates (18). In our study, GOS scores were lower in the hemorrhagic stroke group, though the difference was not statistically significant.

Nevertheless, the higher prevalence of hemorrhagic stroke among men was consistent with literature findings. Interestingly, a lower rate of hemorrhagic stroke was observed in patients with concomitant coronary artery disease, possibly suggesting the influence of cardiovascular protective treatments (e.g., antiplatelet or statin use).

In stroke management, decompressive craniectomy is recommended as a life-saving option, particularly in cases with high ICP, malignant cerebral edema, or hemorrhages exerting mass effect (>30–50 mm^2 cross-sectional area) (19). However, the effectiveness of surgery in elderly patients remains a controversial issue. The DESTINY II study demonstrated that surgery significantly reduced mortality but provided limited functional improvement in the elderly population (20). Similarly, a large-scale meta-analysis involving 1,657 patients reported that decompressive surgery reduced mortality across all age groups; however, mortality rates rose significantly after the age of 60 (21). These findings underscore that age and comorbidities are major factors influencing surgical outcomes. In our study, 61.9% of patients had hypertension, 15.5% had diabetes mellitus, 41.2% had coronary artery disease, and 16.5% had other comorbidities (chronic renal failure, pneumonia, liver disorders).

The timing of surgery is also critically important for prognosis. It has been emphasized that decompressive hemicraniectomy performed within the first 48 hours is highly effective in reducing mortality and improving functional outcomes (20). Randomized controlled trials have shown significant benefits when surgery is performed within the first 48 hours after symptom onset, whereas exceeding this period limits the effect on mortality and functional recovery (22). Thus, the "48-hour rule" underscores the urgency of surgical decision-making, especially in patients with malignant middle cerebral artery infarction. However, it has been reported that invasive ICP monitoring may increase the risk of complications in elderly or comorbid patients (23). At this point, non-invasive ONSD measurement emerges as a safe and rapid alternative.

In our study, higher admission ONSD values were found to be associated with poor clinical course and lower GOS scores. The relationship between ONSD and ICP has been validated in idiopathic intracranial hypertension, head trauma, and animal studies, with values above 4.8–5.2 mm generally considered pathological (24). Given that most literature data have been obtained from young and middle-aged populations, these threshold values may correspond to relatively lower measurements in the elderly. In the study by Avcı et al., it was reported that ONSD decreases in populations aged 65 and above (25). In our series, ONSD values above 4.4 mm were found to be significantly associated with lower GOS scores.

The observation that admission ONSD values were higher, particularly in the hemorrhagic stroke group, suggests that this measurement may be valuable in predicting prognosis and surgical need. Conversely, no significant relationship was found between postoperative ONSD changes and clinical outcomes. The lack of correlation between postoperative ONSD and GOS may be explained by the multifactorial nature of post-surgical pressure regulation. In patients with comorbidities, surgical stress and additional treatment requirements may influence GOS, suggesting that postoperative ONSD measurements have limited prognostic value.

Our study demonstrates that ONSD, particularly at the time of admission, may serve as a non-invasive, rapid, and reliable prognostic marker. The more pronounced increase in ONSD observed in hemorrhagic strokes suggests that early ONSD measurements may support surgical indication in this patient group. However, it was concluded that using postoperative ONSD alone as a risk determinant in geriatric patients is not appropriate. Given the prevalence of comorbidities and polypharmacy in the elderly population, it is evident that surgical decision-making should be approached in a multidisciplinary manner.

CONCLUSION

In our study, the relationship between ONSD and the effectiveness of decompressive surgical decisions in stroke patients aged 65 and older was evaluated. Our findings showed that preoperative ONSD values above 4.4 mm were significantly associated with lower GOS scores. This result suggests that ONSD may serve as a non-invasive, rapid, and reliable indicator to guide early surgical decision-making.

Although increased ONSD values at admission may indicate that early decompression, before clinical deterioration and infarct expansion, could be associated with better GOS outcomes, multidisciplinary assessment should not be neglected due to comorbidities.

REFERENCES

1. Feigin VL, Abate MD, Abate YH, et al. Global, regional, and national burden of stroke and its risk factors, 1990–2021: a systematic analysis for the Global Burden of Disease Study 2021. The Lancet Neurology. 2024;23(10):973–1003. doi: 10.1016/S1474-4422(24)00369-7
2. Doumat G, Daher D, Itani M, Abdouni L, El Asmar K, Assaf G. The effect of polypharmacy on healthcare services utilization in older adults with comorbidities: a retrospective cohort study. BMC Primary Care. 2023;24:120. doi:10.1186/s12875-023-02070-0
3. Harary M, Dolmans RGF, Gormley WB. Intracranial pressure monitoring—Review and avenues for development. Sensors (Basel). 2018;18(2):465. doi:10.3390/s18020465
4. Saver JL. Time is brain—quantified. Stroke. 2006;37(1):263–266. doi:10.1161/01.STR.0000196957.55928.ab
5. Zhu S, Cheng C, Wang LL, Zhao DJ, Zhao YL, Liu XZ. Prognostic values of optic nerve sheath diameter for comatose patients with acute stroke: an observational study. World Journal of Clinical Cases. 2022;10(33):12175–12183. doi:10.12998/wjcc.v10.i33.12175
6. Repka MX, Quigley HA. The effect of age on normal human optic nerve fiber number and diameter. Ophthalmology.1989;96(1):26–32.
7. Panda-Jonas S, Xu L, Yang H, Wang YX, Jonas SB, Jonas JB. Optic nerve head morphology in young patients after antiglaucomatous filtering surgery. Acta Ophthalmol. 2014;92(1):59–64. doi: 10.1111/j.1755-3768.2012.02570.x
8. Aydin Ozturk P, Asena M. Determination of ventriculoperitoneal shunt dysfunction using optic nerve sheath diameter measurement on CT scan in pediatric patients with hydrocephalus. Childs Nerv Syst. 2021;37(6):1895–1900. doi: 10.1007/s00381-021-05097-9
9. Bogenschutz KM, Fisher DS, Wright GW. Acute ischemic stroke: a guideline-based overview of evaluation and management. JAAPA. 2025;38(5):13–20. doi:10.1097/01.JAA.0000000000000203
10. Chen S, Zeng L, Hu Z. Progressing haemorrhagic stroke: categories, causes, mechanisms and managements. J Neurol.2014;261(11):2061–2078. doi:10.1007/s00415-014-7291-1
11. Hankey GJ. The role of nutrition in the risk and burden of stroke: an update of the evidence. Stroke. 2017;48(11):3168–3174. doi:10.1161/STROKEAHA.117.016993
12. Westendorp WF, Nederkoorn PJ, Vermeij JD, Dijkgraaf MG, van de Beek D. Post-stroke infection: a systematic review and meta-analysis. BMC Neurology. 2011;11:110. doi:10.1186/1471-2377-11-110.
13. Appelros P, Stegmayr B, Terént A. Sex differences in stroke epidemiology: a systematic review. Stroke.2009;40(4):1082–1090. doi:10.1161/STROKEAHA.108.540781

14. Kuriakose D, Xiao Z. Pathophysiology and treatment of stroke: present status and future perspectives. Int J Mol Sci.2020;21(20):7609. doi:10.3390/ijms21207609

15. Yousufuddin M, Young N. Aging and ischemic stroke. Aging (Albany NY). 2019;11(9):2542–2544. doi:10.18632/aging.101931

16. Michel JP, Leonardi M, Martin M, Prina M. WHO's report for the decade of healthy ageing 2021–30 sets the stage for globally comparable data on healthy ageing. Lancet Healthy Longev. 2021;2(3):e121–e122. doi: 10.1016/S2666-7568(21)00002-7

17. Feigin VL, Brainin M, Norrving B, Martins SO, Pandian J, Lindsay P, et al. World Stroke Organization: Global Stroke Fact Sheet 2025. Int J Stroke. 2025;20(2):132–144. doi:10.1177/17474930241308142

18. Caplan LR. Introduction and perspective. In: Caplan LR (ed). Caplan's Stroke: A Clinical Approach. Cambridge University Press, USA; 2016. pp. 1–18.

19. Fotakopoulos G, Gatos C, Georgakopoulou VE, et al. Role of decompressive craniectomy in the management of acute ischemic stroke (Review). Biomed Rep. 2024;20(2):33. doi:10.3892/br.2024.1721

20. Robertson FC, Dasenbrock HH, Gormley WB. Decompressive hemicraniectomy for stroke in older adults: a review. J Neurol Neuromed. 2017;2(1):1–7. doi: 10.29245/2572.942X/2017/2.942X/2017/1.1103

21. Dasenbrock HH, Robertson FC, Aziz-Sultan MA, et al. Patient age and the outcomes after decompressive hemicraniectomy for stroke: a nationwide inpatient sample analysis. Neurocrit Care.2016;25(3):371–383. doi:10.1007/s12028-016-0287-1

22. Vahedi K, Hofmeijer J, Juettler E, et al. Early decompressive surgery in malignant infarction of the middle cerebral artery: a pooled analysis of three randomised controlled trials. Lancet Neurol.2007;6(3):215–222. doi:10.1016/S1474-4422(07)70036-4

23. Zangbar B, Rafieezadeh A, Prabhakaran K, et al. Intracranial pressure monitoring in patients with geriatric trauma may not improve outcome but is associated with increases in resource utilization. Trauma Surg Acute Care Open. 2025;10(1):e001644. doi:10.1136/tsaco-2024-001644

24. Kimberly HH, Shah S, Marill K, Noble V. Correlation of optic nerve sheath diameter with direct measurement of intracranial pressure. Acad Emerg Med. 2008;15(2):201–204. doi:10.1111/j.1553-2712.2007.00031.x

25. Avci M, Kozaci N, Komut E, Komut S, Caliskan G, Tulubas G. The measurement of elderly volunteers' optic nerve sheath diameters by ocular ultrasonography. Medicina (Kaunas). 2019;55(8):413. doi:10.3390/medicina55080413

ORIGINAL ARTICLE

EXAMINING PRESCRIPTION DRUG USE AND HEALTH CARE ACCESS AMONG OLDER ADULTS IN RURAL AREAS: A CROSS-SECTIONAL STUDY BASED ON THE HEALTH BELIEF MODEL

Turkish Journal of Geriatrics
2025; 28(4):457–469

DOI: 10.29400/tjgeri.2025.463

Yağmur ÖZKAYA[1]
Büşra DEMİR ÇETİNKAYA[1]
Gülden HAKVERDİ[2]
Eyüp Can POLAT[1]
Gülbin ÖZÇELİKAY[3]

[1] Erzincan Binali Yildirim University, Faculty of Pharmacy, Erzincan, Türkiye

[2] Sivas Cumhuriyet University, Faculty of Medicine, Sivas, Türkiye

[3] Ankara University, Faculty of Pharmacy, Ankara, Türkiye

Correspondence

Yağmur ÖZKAYA
Phone : +904462245344
e-mail : ykilicdagi@erzincan.edu.tr

Received : Oct 03, 2025
Accepted: Nov 28, 2025

Cite this article as:
Özkaya Y, Demir Çetinkaya B, Hakverdi G. et al. Examining Prescription Drug Use and Health Care Access among Older Adults in Rural Areas: A Cross-Sectional Study Based on the Health Belief Model. Turkish Journal of Geriatrics 2025; 28(4):457–469. doi: 10.29400/tjgeri.2025.463

Abstract

Introduction: Medication adherence is critical for achieving desired health outcomes, particularly in older rural patients with limited healthcare access. This study, structured according to the Health Belief Model explored the correlation between health beliefs regarding medication intake and adherence in older rural patients with chronic disease who used prescription medication.

Materials and Method: A cross-sectional survey was conducted with 206 community-dwelling adults aged ≥65 years in rural villages of the Gemerek district (Sivas, Turkey). Health beliefs and adherence were assessed using validated HBM and ARMS-7 scales.

Results: The structural model fitted very well overall ($\chi^2/df = 1.65$; RMSEA = 0.041; SRMR = 0.036; CFI = 0.982; TLI = 0.976). Among the predictors, perceived barriers had a significant negative impact on medication adherence. ($\beta = –0.31$; $p < 0.01$). In contrast, perceived benefits ($\beta = 0.39$; $p < 0.01$) and self-efficacy ($\beta = 0.36$; $p < 0.01$) were positively and significantly related with regard to adherence. The other dimensions were not significant predictors.

Conclusion: These findings highlight the key role of psychosocial determinants in medication use among older adults in rural communities. To enhance medication use among older rural patients, education and counselling by primary care physicians and pharmacists should focus on reducing perceived barriers and increasing patients' self-efficacy. Implementing such targeted strategies may improve continuity of care and help older adults manage their treatments more confidently. Ultimately, strengthening these supports could contribute to better health outcomes and a higher quality of life in rural aging populations.

Keywords: Medication Adherence; Health Belief Model; Rural Population; Aged, Geriatrics.

The content of this journal is licensed under the Creative Commons Attribution-NonCommercial 4.0 International License.

INTRODUCTION

In older adults with chronic diseases, the regular use of prescribed medications is important for the treatment of diseases and maintenance of quality of life (1,2). Older patients with chronic diseases living in rural areas face several difficulties in using prescription medications. Limited access to health services and low health literacy are the main obstacles to medication adherence among older patients living in rural areas (3). Rapid population aging and geographical inequalities may hinder the continuity of treatment for older adults living in rural areas (4). Studies have shown that transportation and financial barriers are the reasons why older adult patients living in rural areas have limited access to health services (5,6). These obstacles negatively affect the management of older adult patients (7). Studies conducted in different regions of Turkey have confirmed the high rates of inappropriate medication use among older adults living in rural areas (8,9). In addition to environmental factors, many psychosocial factors, such as patients' beliefs, perceptions, and motivations for using medications, greatly affect medication adherence in chronic diseases (10,11).

The Health Belief Model (HBM) provides a comprehensive framework for understanding health behaviours by integrating psychosocial determinants. The HBM is a powerful theoretical approach for investigating individuals' health behaviours. The HBM argues that individuals' health behaviours are influenced by their perceptions and beliefs about their health (12). As a psychological model, the HBM helps individuals predict various health practice behaviours, such as avoiding illness, participating in health screenings, and adhering to prescription drug treatments. According to this model, individuals with high sensitivity to their health exhibit positive health behaviours when they receive warnings that threaten their health. The HBM emphasises the role of individuals' personal beliefs and perceptions in making health-related decisions (13,14). Previous research in Turkey has not examined medication adherence among older adults in rural areas within the Health Belief Model framework. This study therefore extends the model by integrating factors such as rural isolation, limited healthcare access, and multimorbidity, offering novel insights into the psychosocial determinants of medication use in underserved elderly populations.

Many studies have reported that educational programs based on the HBM have a positive effect on medication adherence and behavioural outcomes in chronic diseases (15,16). These findings highlight the importance of psychosocial factors in promoting medication adherence. Individuals with positive health beliefs consistently demonstrate higher compliance (17,18). Few studies have examined the effects of HBM structures on medication adherence among the rural older adults with limited access to healthcare services. This study addresses this gap in the literature and aims to identify the key psychological factors affecting medication adherence. Based on this research objective, the following hypotheses were developed.

Hypotheses:

H1: Perceived susceptibility positively influences medication adherence.

H2: Perceived severity positively influences medication adherence.

H3: Health motivation positively influences medication adherence.

H4: Perceived benefits positively influence medication adherence.

H5: Perceived barriers negatively influence medication adherence.

H6: Self-efficacy positively influences medication adherence.



MATERIALS AND METHOD

Design of Research

This descriptive study was a cross-sectional quantitative study guided by the HBM. This study aimed to establish the salient factors for prescription drug-taking behaviours among older respondents from rural localities. Data collection involved the administration of structured questionnaires to establish health beliefs and psychosocial determinants of medication-taking behaviour.

Population and Sample of the Research

The population consisted of individuals aged ≥ 65 years who resided in rural towns of the district of Gemerek (Sivas Province), with at least one diagnosed long-standing disease and at least one prescription drug user on a regular basis. Older individuals with the cognitive ability to respond to the survey were considered. Patients with severe cognitive impairment, disease-preventing communication, absence of long-standing disease, refusal, or lack of informed consent were excluded. To ensure the diversity and representativeness of the population, the villages were aggregated according to their distance from the public hospital of the district, as long as the differences in access to healthcare varied. Three villages covering three distance classes were selected. In this manner, the variation in space ensured by the experiences of older adults living with varying possibilities of access was maintained.

A multistage cluster sampling method was used. In the first stage, three villages from the Gemerek district acted as clusters. In the second stage, all older persons aged at least 65 years who met the participation eligibility criteria for the study were approached to achieve diversity in healthcare facility access. To ensure population diversity and representativeness, three villages representing different distance categories were selected. The survey was administered to older adults with chronic illnesses from these three villages who visited the district public hospital for prescription refills or routine follow-up care. This approach minimized potential sampling bias and ensured the inclusion of participants with varying access to healthcare. Face-to-face questionnaires were used for the data collection. To minimize interviewer bias and ensure consistency, all data were collected by two trained researchers who had prior experience conducting community-based surveys with older adults. Before data collection, the researchers jointly reviewed each item to ensure uniform understanding and standardized administration. During fieldwork, both researchers followed the same interview protocol and provided clarifications when necessary without influencing participants' answers. Participants were informed of the purpose, procedures, and anonymity of the study, and written informed consent was obtained. Participation was voluntary, and respondents were made aware of their right to withdraw at any time of their choice. An ethical basis for anonymity and confidentiality was strictly followed. The study was conducted between March and July 2025, following the approval of the ethics committee on February 28, 2025. A total of 206 eligible participants were enrolled, offering sufficient power and extended generalisability of the results. The district of Gemerek was selected owing to its representation of the normative old-age population of the countryside and its distance from healthcare facilities, which ensured space diversity and the practicality of logistics. The study was conducted in three villages representing different distances from the district center. Although the sample was drawn from a single district, the distance-stratified cluster design ensured variability in healthcare access and socio-demographic conditions, supporting representativeness within the district. However, the findings should be interpreted with caution when generalizing to the national level.

In an a priori power analysis for the Structured Equation Model, at least 104 participants (medium

effect, f_2 = 0.15, α_2 = 0.05, power$_2$ = 0.80) were needed for six HBM constructs predicting medication adherence to the Adherence to Refills and Medications Scale-7 (ARMS-7). For smaller effects of f = 0.10–0.08, at least 150–184 participants were needed. For the model complexity correction, 200 participants were included, and 206 participants were enrolled.

Data Collection Tools

This survey recorded participants' sociodemographic and clinical data, such as age, sex, marital status, education, family income, and social security. Questions regarding health and medication use, illness and medication types and numbers, disease duration, use of healthcare facilities, drug refill practices, and transportation to healthcare facilities were recorded. Medication use beliefs were assessed using the Health Belief Scale for Medication Use, a 35-item measure of six constructs: perceived susceptibility, severity, benefits, barriers, health motivation, and self-efficacy. Items were scored on a five-point Likert scale (from 1 = strongly disagree to 5 = strongly agree). The Turkish version has strong test-retest reliability with Cronbach's α = 0.91 and subscale values between 0.80 and 0.93 (19). As the scale measures general beliefs and behaviors related to medication use rather than age- or gender-specific content, it was deemed suitable for older adults. Its construct validity in this study was confirmed by CFA with excellent fit indices (CFI = 0.99, RMSEA = 0.017). The full item list of the Health Belief Scale for Medication Use is provided in Supplementary Table 1. The ARMS developed by Kripalani et al. was later adapted into Turkish by Gökdoğan and Kes through forward/back translation and expert review (20,21).

Statistical Analysis

The analyses were conducted using LISREL 8, Lavaan in R, and SPSS (v23). Missing values, outliers, and data normality were assessed.

Table 1. Sociodemographic and Clinical Characteristics of the Participants (n = 206)

Variable	Category	n	%
Gender	Female	120	58.3
	Male	86	41.7
Age (years)	65–69	62	30.1
	70–74	66	32.0
	75–79	41	19.9
	≥80	37	18.0
Education level	Primary school or less	134	65.0
	Middle/High school	52	25.2
	University or higher	20	9.8
Marital status	Married	115	55.8
	Widowed	78	37.9
	Single/Divorced	13	6.3
Number of chronic conditions	1 condition	70	34.0
	2 conditions	78	37.9
	≥3 conditions	58	28.2
Most common chronic diseases	Hypertension	144	70.0
	Type 2 diabetes	78	37.9
	Osteoarthritis	87	42.2
	Coronary heart disease	58	28.2
	Chronic Obstructive Pulmonary Disease	31	15.0
Number of medications used	1–3 medications	58	28.2
	4–6 medications	97	47.1
	≥7 medications	51	24.8
Duration of medication use	<5 years	42	20.4
	5–10 years	94	45.6
	>10 years	70	34.0
Health insurance	Social Security Institution (SGK)	143	69.4
	Bağ-Kur (Self-employed, 4B)	34	16.5
	Pension Fund (4C)	20	9.7
	None / General Health Insurance	9	4.4
Mode of transport to facility	Shared minibus	80	38.8
	Municipal bus	38	18.4
	Walking	30	14.6
	Personal vehicle	34	16.5
	Taxi	24	11.7
Travel time to hospital	<15 minutes	32	15.5
	15–30 minutes	88	42.7
	31–60 minutes	60	29.1
	>60 minutes	26	12.6
Distance to hospital	<5 km	45	21.8
	5–10 km	92	44.7
	11–20 km	49	23.8
	>20 km	20	9.7

Descriptive frequency analyses were performed for sociodemographic information and drug use behaviour. Multivariate normality was confirmed (Mardia coefficient, skewness/kurtosis). The HBM subdimensions were modelled as independent variables and ARMS-7 adherence as the outcome. Given the prior Turkish validation of both scales, confirmatory factor analysis was used to assess construct validity, and Cronbach's alpha test was used to assess reliability. The direct effects of HBM constructs on adherence were tested using structural equation modelling.

This study was approved by the Ethics Committee for Health and Sports Sciences of Erzincan Binali Yıldırım University (Session No. 02, Decision No. 02/08, 28 February 2025). The study was conducted in accordance with the principles of the Declaration of Helsinki, and informed consent was obtained from all participants. In addition, the reporting of this research followed the STROBE guidelines for cross-sectional studies.

RESULTS

Among the 206 participants, 58.3% were women, and the largest age group was 70–74 years (32.0%). Most participants had a low level of education (65.0% primary school or below), and 55.8% were married. Two-thirds of the patients reported having ≥2 chronic diseases, most often hypertension (70.0%). Nearly half of the patients used 4–6 medications daily (47.1%). Most were insured by Social Security Institution (SGK) (69.4%), travelled mainly by shared minibuses (38.8%), and reached healthcare within 15–30 min (42.7 %).

Two-thirds of the participants avoided taking medicines without a physician's advice (67.0%), although many kept unused drugs at home (69.9%). Over half of the participants (54.9 %) had difficulty reading package inserts. Social factors were evident, with 39.8% of respondents using medicines recommended by relatives or friends. Interest in digital health tools was low (28.2%), 37.9% used herbal products, and 52.0% reported over-the-counter use (Table 2).

Table 2. Participants' Medication-Related Behaviors (n = 206)

Question / Variable	Response	n	%
Do you use medications without consulting a physician?	Yes	68	33.0
	No	138	67.0
Do you keep unused medications at home?	Yes	144	69.9
	No	62	30.1
Can you read/understand the package insert?	Yes	93	45.1
	No	113	54.9
Do you take medications based on relatives' advice?	Yes	82	39.8
	No	124	60.2
Are you willing to use telemedicine/telepharmacy?	Yes	58	28.2
	No	148	71.8
Do you use herbal (phytotherapeutic) products?	Yes	78	37.9
	No	128	62.1
Do you use over-the-counter (OTC) medications?	Yes	107	52.0
	No	99	48.0

The Health Belief Scale for Medication Use and ARMS-7 Medication Adherence Scale used in this study have been validated and widely applied in the Turkish population. Their factor structures were not redeveloped; instead, their fit was confirmed using confirmatory factor analysis (CFA). Their factor structure was not re-estimated; rather, their fit was assured for this sample using a CFA. Both scales showed a good fit, exceeding the accepted thresholds (Table 3).

Table 4 presents the psychometric properties of the instrument. All instrument subscales possessed high internal consistency, as their Cronbach's alpha values varied between 0.857 and 0.950. Their composite reliabilities varied between 0.888 and 0.971, and their AVE values varied between 0.636 and 0.893, all of which were higher than the accepted values. In addition, the square root of each AVE exceeded its inter-construct correlation, thereby ensuring discriminant validity. These results confirm that the instruments are valid and reliable for determining health beliefs and medication-taking behaviours among older people residing in rural areas.

Structural path analysis showed that perceived benefits ($\beta = 0.39$, $t = 4.80$, $p < 0.01$) and self-efficacy ($\beta = 0.36$, $t = 4.50$, $p < 0.01$) were positively and significantly associated with medication adherence, while perceived barriers ($\beta = –0.31$, $t = –3.90$, $p < 0.01$) had a significant negative effect. Perceived susceptibility ($\beta = 0.05$), perceived severity ($\beta = 0.08$), and health motivation ($\beta = 0.06$) were not

Table 3. Confirmatory Factor Analysis (CFA) Fit Indices for the Scales Used in the Study

Fit Index	Excellent Fit	Acceptable Fit	Health Belief Scale for Medication Use	ARMS-7 Medication Adherence Scale
χ^2/df	$0 \leq \chi^2/df < 2$	$2 \leq \chi^2/df \leq 3$	1.058	1.142
p-value	$0.05 \leq p \leq 1$	$0.01 \leq p \leq 0.05$	0.168	0.316
RMSEA	$0 < RMSEA < 0.05$	$0.05 \leq RMSEA \leq 0.10$	0.017	0.026
SRMR	$0 \leq SRMR \leq 0.05$	$0.05 < SRMR \leq 0.10$	0.042	0.010
NNFI (TLI)	$0.97 \leq NNFI \leq 1$	$0.95 \leq NNFI \leq 0.97$	0.99	0.99
CFI	$0.97 \leq CFI \leq 1$	$0.95 \leq CFI \leq 0.97$	0.99	1.000

Note. χ^2/df = Chi-square / degrees of freedom ratio; p-value = Probability value; RMSEA = Root Mean Square Error of Approximation; SRMR = Standardized Root Mean Square Residual; NNFI (TLI) = Non-Normed Fit Index (Tucker–Lewis Index); CFI = Comparative Fit Index.

Table 4. Validity and Reliability of the Measurement Tools

Scale Dimension	Cronbach's α	Composite Reliability (CR)	Average Variance Extracted (AVE)	$\sqrt{AVE}$
Perceived Susceptibility	0.931	0.948	0.751	0.866
Perceived Severity	0.905	0.926	0.677	0.823
Health Motivation	0.890	0.913	0.636	0.797
Perceived Benefits	0.857	0.888	0.664	0.815
Perceived Barriers	0.917	0.933	0.699	0.836
Self-Efficacy	0.923	0.939	0.689	0.830
Taking Medication	0.950	0.971	0.893	0.945
Refilling Medication	0.914	0.947	0.855	0.923



Table 5. Structural Paths and Hypothesis Testing Results

Hypothesis	Path (HBM Dimension → Outcome)	β (Std.)	t	Result
H1	Perceived Susceptibility → Medication Adherence	0.05	1.10	Not supported
H2	Perceived Severity → Medication Adherence	0.08	1.25	Not supported
H3	Health Motivation → Medication Adherence	0.06	1.18	Not supported
H4	Perceived Benefits → Medication Adherence	0.39	4.80*	Supported
H5	Perceived Barriers → Medication Adherence	−0.31	−3.90*	Supported
H6	Self-Efficacy → Medication Adherence	0.36	4.50*	Supported

Note: β = standardized coefficient. *p < 0.05. HBM = Health Belief Model.

significant predictors (p > 0.05) (Table 5). Overall, the HBM constructs explained 45% of the variance in adherence (R^2 = 0.45), indicating that adherence among older adults was most strongly influenced by perceived benefits, barriers, and self-efficacy.

Independent-samples t-tests and one-way ANOVA were used to examine differences in medication adherence (ARMS-7) and HBM subscale scores according to sociodemographic variables (age, sex, marital status, education, insurance, etc.). Analyses were performed on data that met the normality assumptions. No significant differences were observed between any of the sociodemographic groups (p > 0.05)

DISCUSSION

Demographic variables such as age, sex, health insurance, transportation, and the number of chronic diseases in older adult patients did not show statistically significant differences in medication adherence (p > 0.05). In parallel with the findings of our study, Pan et al. reported that HBM structures, such as perceived barriers and benefits, significantly affected medication adherence in their study of older adult patients with hypertension, but demographic variables did not significantly affect medication adherence (17). Demographic variables did not exert much influence on drug intake in this sample because of the psychosocial structure depicted in the study model. Studies have shown that the explanatory effect of demographic variables on health behaviour is weakened or completely eliminated in studies established with a research model in which factors such as perceived susceptibility, perceived benefits, and barriers are included (18). These results revealed that demographic and environmental factors, as well as health beliefs and perceptions, had a stronger effect on medication adherence in older adult patients living in rural areas.

The research model established for this study determined that the three subdimensions of the Health Belief Scale (perceived benefits, perceived barriers, and self-efficacy) had significant and strong effects on adherence to medication. However, the perceived susceptibility, perceived seriousness, and health motivation dimensions of the HBM did not significantly affect medication adherence. These findings are consistent with those of previous studies established within the framework of the HBM. In studies conducted within the scope of the HBM, dimensions such as perceived benefit, barrier, and self-efficacy are often identified as the most reliable predictors of health behaviours. The effects of other dimensions of the HBM on health behaviours are weak and inconsistent (22, 23). Although perceived susceptibility, severity, and health motivation were not significant predictors in the present study, this may be because of the unique contextual and cultural factors in the rural elderly population. Many older adults with chronic

illnesses may have long adapted to their conditions and, as a result, may no longer perceive their health status as a significant threat. Similar findings have been reported in previous studies based on the Health Belief Model, where constructs such as perceived benefits, perceived barriers, and related beliefs like self-efficacy demonstrated stronger associations with health behavior than susceptibility and severity (17,18,22,23). This consistency across studies supports the current findings and indicates that in older populations, medication adherence is more strongly shaped by practical and self-efficacy-related factors rather than by perceived risk or motivation.

The most striking finding of this study was that perceived barriers had a significant negative effect on the medication adherence. This result closely aligns with the existing literature, highlighting the role of perceived barriers in shaping medication adherence behaviours in older adults. Similarly, studies conducted on older adult patients with chronic diseases have reported that perceived barriers to medication and treatment adherence negatively impact adherence. Studies on older adult patients have highlighted the need to systematically identify perceived barriers to improving medication and treatment adherence (18). One of the most important findings of this study was the positive effect of self-efficacy on adherence to medication. This finding is consistent with studies showing that self-efficacy has a strong and positive effect on medication and treatment adherence (24). Similarly, the strong effect of self-efficacy on medication adherence was emphasised in a study conducted by Wang et al. on multimorbid older adult patients (25).

The results of this study provide a comprehensive perspective on the psychosocial and behavioural mechanisms affecting medication adherence in older adult patients with at least one chronic disease who live in rural areas. The importance of patient-centred interventions aimed at improving the health beliefs and perceptions of older adult patients living in rural areas to improve medication and treatment compliance has been demonstrated. These findings have practical implications for rural health care and pharmacy services. Improving medication adherence among older adults can be supported through pharmacist-led counseling, community-based education programs, and the use of telepharmacy to improve medication monitoring and access in remote areas.

Strengths and Limitations

This study has several strengths. It is one of the few studies in Turkey that applies the Health Belief Model to understand medication adherence among older adults living in rural areas. The study used validated scales with strong psychometric properties, and data were collected through face-to-face interviews by experienced researchers, which helped ensure response accuracy. However, this study has certain limitations. The study sample was limited to older adults (≥65 years of age) with chronic illnesses living in rural villages in the Gemerek district, limiting generalizability. Due to the use of self-reported assessment instruments (HBM scale, ARMS-7), recall bias and biases due to subjective perceptions are possible. Because the study used a self-reported data collection tool, the accuracy of the responses is limited by the participants' personal perceptions and statements. Although the model explained 45% of adherence variance, the remaining unexplained portion may be related to unmeasured variables such as health literacy, cognitive status, or social support. Future studies could explore these factors and examine possible mediating or moderating effects to strengthen the theoretical framework and improve model fit.

CONCLUSION

This study is one of the few evaluating drug-taking factors as a salient health outcome for those with rural residence based on the health belief model.



The findings indicate self-efficacy, perceived benefits and barriers have significant impacts on medication use for older patients with rural residence. These results have implications for education, counseling and support-oriented interventions for medication use improvement for older patients with rural residence. These findings indicate the need for practical approaches to support safer and more regular medication use in older adults living in rural areas.

Funding: This research received no external funding.

Acknowledgments: The authors thank all participants for their time and for sharing their experiences, which contributed meaningfully to this study.

Conflicts of Interest: The authors declare no conflict of interest.

REFERENCES

1. Khaiser UF, Sultana R, Das R, et al. Medication adherence and quality of life among geriatric patients: Insights from a hospital-based cross-sectional study in India. PLoS One. 2024;19(11):e0302546. doi:10.1371/journal.pone.0302546
2. Ruksakulpiwat S, Schiltz NK, Irani E, Josephson RA, Adams J, Still CH. Medication adherence of older adults with hypertension: a systematic review. Patient Prefer Adherence. 2024;18:957-975. doi:10.2147/PPA.S459678
3. Yu P, Song X, Shi J, et al. Frailty and survival of older Chinese adults in urban and rural areas: results from the Beijing Longitudinal Study of Aging. Arch Gerontol Geriatr. 2012;54(1):3-8. doi:10.1016/j.archger.2011.04.020
4. Cakmur H. Frailty among elderly adults in a rural area of Turkey. Med Sci Monit. 2015;21:1232-1242. doi:10.12659/MSM.893400
5. Goins RT, Williams KA, Carter MW, Spencer SM, Solovieva T. Perceived barriers to health care access among rural older adults: a qualitative study. J Rural Health. 2005;21(3):206-213. doi:10.1111/j.1748-0361.2005.tb00084.x
6. Cabañero-Garcia E, Martinez-Lacoba R, Pardo-Garcia I, Amo-Saus E. Barriers to health, social and long-term care access among older adults: a systematic review of reviews. Int J Equity Health. 2025;24(1):1-13. doi:10.1186/s12939-025-02429-y
7. Horvat M, Eržen I, Vrbnjak D. Barriers and facilitators to medication adherence among the vulnerable elderly: a focus group study. Healthcare MDPI. 2024;12(17):1723. doi:10.3390/healthcare12171723
8. Berker E, Kilit TP, Özyiğit F. Evaluation of potentially inappropriate drug use in older adult outpatients using the Turkish inappropriate medication use in the elderly criteria in Kütahya Province, Turkey. Istanbul Med J. 2023;24(3):193-200. doi:10.4274/imj.galenos.2023.81226
9. Alan H, Cubukcu M, Guzel EC, Yildiz LM. Evaluation of medicine use behaviors of adult patients in a rural area: a cross-sectional study from Turkey. J Family Med Prim Care. 2024;13(12):5506-5511. doi:10.4103/jfmpc.jfmpc_53_24
10. Bilgin A, Doner A, Erdogan Yuce G, Muz G. The effect of biopsychosocial-spiritual factors on medication adherence in chronic diseases in Turkey using structural equation modeling. J Relig Health. 2025;64(1):1-21. doi:10.1007/s10943-025-02317-3
11. Emre N, Poyraz B, Özşahin A, Edirne T. Self-efficacy and medication adherence in individuals with hypertension living in rural areas. Mersin Univ Med Fak Lokman Hekim J Med Hist Folk Med. 2025;15(1):264-273. doi:10.31020/mutftd.1549558 (in Turkish)
12. Jones CL, Jensen JD, Scherr CL, Brown NR, Christy K, Weaver J. The health belief model as an explanatory framework in communication research: exploring parallel, serial, and moderated mediation. Health Commun. 2015;30(6):566-576. doi:10.1080/10410236.2013.873363
13. Subedi S, Leal Filho W, Adedeji A. An assessment of the health belief model (HBM) properties as predictors of COVID-19 preventive behaviour. J Public Health. 2023;1-11. doi:10.1007/s10389-023-02109-7
14. Kam BS, Lee SY. Integrating the health belief model into health education programs in a clinical setting. World J Clin Cases. 2024;12(33):6660-6669. doi:10.12998/wjcc.v12.i33.6660
15. Joho AA. Using the Health Belief Model to explain the patient's compliance to anti-hypertensive treatment in three district hospitals-Dar es Salaam, Tanzania: a cross section study. East Afr Health Res J. 2021;5(1):50-58. doi:10.24248/eahrj.v5i1.651

16. Wang HM, Chen Y, Shen YH, Wang XM. Evaluation of the effects of health education interventions for hypertensive patients based on the health belief model. World J Clin Cases. 2024;12(15):2578-2587. doi:10.12998/wjcc.v12.i15.2578

17. Pan Q, Zhang C, Yao L, et al. Factors influencing medication adherence in elderly patients with hypertension: a single center study in Western China. Patient Prefer Adherence. 2023;17:1679-1688. doi: 10.2147/PPA.S418246

18. Park HY, Seo SA, Yoo H, Lee K. Medication adherence and beliefs about medication in elderly patients living alone with chronic diseases. Patient Prefer Adherence. 2018;12:175-181. doi:10.2147/PPA.S151263

19. Erci B, Çiçek Z. Reliability and Validity of Drugs Use Health Belief Scale in Adult Women. Int Arch Nurs Health Care. 2017; 3:064. doi:10.23937/2469-5823/1510064 (in Turkish)

20. Kripalani S, Risser J, Gatti ME, Jacobson TA. Development and evaluation of the Adherence to Refills and Medications Scale (ARMS) among low-literacy patients with chronic disease. Value Health. 2009;12(1):118-123. doi:10.1111/j.1524-4733.2008.00400.x

21. Gökdogan F, Kes D. Validity and reliability of the Turkish Adherence to Refills and Medications Scale. Int J Nurs Pract. 2017;23(5):e12566. doi:10.1111/ijn.12566

22. Jeon HO, Chae MO, Kim A. Effects of medication adherence interventions for older adults with chronic illnesses: a systematic review and meta-analysis. Osong Public Health Res Perspect. 2022;13(5):328-340. doi:10.24171/j.phrp.2022.0168

23. Carpenter CJ. A meta-analysis of the effectiveness of health belief model variables in predicting behavior. Health Commun. 2010;25(8):661-669. doi:10.1080/10410236.2010.521906

24. Prakash DD, Lucas A, Jayaraman S, George OK, Gowri M. Medication adherence, self-efficacy, and attitude toward the management of coronary artery disease among elderly with coronary artery disease. J Indian Acad Geriatr. 2025;21(2):94-99. doi:10.4103/jiag.jiag_4_25

25. Wang W, Luan W, Zhang Z, Mei Y. Association between medication literacy and medication adherence and the mediating effect of self-efficacy in older people with multimorbidity. BMC Geriatr. 2023;23(1):378. doi:10.1186/s12877-023-04072-0



Ek Tablo 1. İlaç Kullanmaya İlişkin Sağlık İnanç Ölçeği Maddeleri

Boyut	Madde No	Madde
Duyarlılık Algısı (Perceived Susceptibility)	1	Reçetesiz ilaç kullanmaktan zarar görme ihtimalim çok yüksek.
	2	Reçetesiz ilaç kullanmaktan dolayı ilaç alerjisi (zehirlenme) olma ihtimalim yüksektir.
	3	Reçetesiz ilaç kullanırsam ölebilirim.
	4	Reçetesiz ilaç kullanırsam vücudum, organlarım zarar görür.
	5	Başkalarının önerdiği ilaçlar bana zarar verir.
	6	Zarar vereceği için benim ilaçlarımı başkalarına önermem.
Önemseme / Ciddiyet Algısı (Perceived Severity)	7	İlaç alerjisi (zehirlenme) beni korkutur.
	8	İlaçların vücuda verdiği zararları/yan etkileri düşündüğümde strese girerim.
	9	Reçetesiz ilaç alerjisini (zehirlenme) düşünmekten korkarım.
	10	Reçetesiz ilaç kullanmanın zararları/yan etkilerinde yaşayacağım problemler çok uzun bir süre devam edecektir.
	11	Reçetesiz ilaç kullanmam çevremle olan ilişkimde bana olan güveni sarsar.
	12	Bilinçsiz ve reçetesiz ilaç kullanmam hayatımda ciddi değişiklikler yapabilir.
Sağlık Motivasyonu (Health Motivation)	13	Sağlık problemlerimi erkenden teşhis ettirmek isterim.
	14	Sağlıklı olmak benim için çok önemlidir.
	15	Sağlığımı geliştirmek için yeni bilgileri araştırırım.
	16	Doğru ilaç kullanmak için yeni bilgileri öğrenirim.
	17	Sağlığımı geliştirecek bilgi ve davranışların önemli olduğunu düşünürüm.
	18	Reçeteli ilaç kullanırım.
Yarar Algısı (Perceived Benefit)	19	Reçeteli ilaç kullanmak benim yararıma olur.
	20	Reçeteli ilaç kullanmak iyileşmemi sağlar.
	21	Reçeteli ilaç kullanmak ilaç zehirlenmelerini (alerjilerini) en aza indirebilir veya tamamen engeller.
	22	Reçeteli ilaç kullanmak yasal haklarımı korur.
Engel Algısı (Perceived Barrier)	23	Reçete ile ilaç almak prosedürlerden dolayı benim için çok zor.
	24	Reçeteli ilaç alma prosedürleri çok zamanımı alıyor.
	25	Reçeteli ilaç almada bana yardım edecek biri yok.
	26	Reçetesiz ilaçlar beni iyileştirdiği için sıkıcı prosedürlere uymam gerekmez.
	27	İlaç iyi geliyorsa reçeteli olması gerekmez.
	28	Reçeteli ilaç almak için zamanım yok.
Öz-Etkililik (Self-Efficacy)	29	Reçeteli ilaç almanın prosedürünü biliyorum.
	30	İlaçlarımı doğru bir şekilde kullanabilirim.
	31	İlaçlarımı doğru bir şekilde kullanarak iyileşebilirim.
	32	Bana anlatılanlardan bilgiler edinebilirim ve ilaçlarımı doğru kullanabilirim.
	33	İlaçlarımı doğru bir şekilde kullanmak için gerekli bilgileri edinebilirim.
	34	İlaçlarımı doğru dozlarda kullanabilirim.
	35	İlaçlarımı önerilen zaman aralıklarında kullanabilirim.

Supplementary Table 1. Items of the Health Belief Scale for Medication Use

Subscale	Item No	Item
Perceived Susceptibility	1	I am very likely to be harmed by using non-prescribed medications.
	2	I have a high chance of experiencing medication allergy (poisoning) due to using non-prescribed drugs.
	3	I may die if I use non-prescribed medications.
	4	My body or organs may be harmed if I use non-prescribed medications.
	5	Medications recommended by others may harm me.
	6	I do not recommend my medications to others because they may cause harm.
Perceived Severity	7	Medication allergy (poisoning) frightens me.
	8	I become stressed when I think about the harmful effects/side effects of medications.
	9	I am afraid of thinking about non-prescribed medication allergy (poisoning).
	10	The problems caused by side effects of non-prescribed medications may last for a long time.
	11	Using non-prescribed medications may undermine others' trust in me.
	12	Using non-prescribed medications unconsciously may cause serious changes in my life.
Health Motivation	13	I would like to diagnose my health problems early.
	14	Being healthy is very important to me.
	15	I seek new information to improve my health.
	16	I learn new information to use medications properly.
	17	I believe it is important to practice behaviours that improve my health.
	18	I use prescribed medications.
Perceived Benefit	19	Using prescribed medications is beneficial for me.
	20	Using prescribed medications helps me recover.
	21	Using prescribed medications can reduce or completely prevent medication poisoning (allergies).
	22	Using prescribed medications protects my legal rights.
Perceived Barrier	23	Getting prescribed medication is very difficult for me due to the procedures.
	24	The procedures to obtain prescribed medications take a lot of my time.
	25	I do not have anyone to help me obtain prescribed medications.
	26	I do not need to follow lengthy procedures because non-prescribed medications help me.
	27	If a medication works, it does not need to be prescribed.
	28	I do not have time to get prescribed medications.
Self-Efficacy	29	I know the procedure for obtaining prescribed medications.
	30	I can take my medications correctly.
	31	I can recover by using my medications correctly.
	32	I can obtain information and use my medications correctly based on what I am told.
	33	I can obtain the necessary information to use my medications correctly.
	34	I can take my medications at the correct doses.
	35	I can take my medications at the recommended intervals.



Likert tip:

1 = Kesinlikle katılmıyorum

2 = Katılmıyorum

3 = Kararsızım

4 = Katılıyorum

5 = Kesinlikle katılıyorum

Likert scale:

1 = Strongly disagree

2 = Disagree

3 = Neutral

4 = Agree

5 = Strongly agree

Turkish Journal of Geriatrics
2025; 28(4):470–481

DOI: 10.29400/tjgeri.2025.464

Oğulcan ÇÖME
Nezaket SABIR
Tuğçe YÜKSEL
Gizem LİMNİLİ
Nilgün ÖZÇAKAR

Dokuz Eylul University, Family Medicine Clinic, Izmir, Türkiye

ORIGINAL ARTICLE

TURKISH CULTURAL ADAPTATION AND VALIDATION OF THE SYMPTOMS OF EARLY DEMENTIA-11 QUESTIONNAIRE

Abstract

Introduction: Dementia is a major public health challenge worldwide and in Türkiye, where the aging population is rising. Early detection enables timely management and caregiver support. The Symptoms of Early Dementia-11 Questionnaire is a brief informant-based screening tool developed in Japan but has not been validated for Turkish use.

Materials and Method: This methodological, cross-sectional study translated and culturally adapted the Symptoms of Early Dementia-11 Questionnaire into Turkish. Between August and September 2025, 200 community-dwelling adults aged 65 years or older were enrolled. Informants completed the questionnaire, and participants underwent the Mini-Mental State Examination. Internal consistency was measured with Cronbach's alpha and McDonald's omega. Construct validity was tested with confirmatory factor analysis, and convergent validity with Spearman correlation.

Results: The Turkish version showed strong internal consistency (Cronbach's alpha 0.834; McDonald's omega 0.823). Confirmatory factor analysis supported a one-factor model with excellent fit (Comparative Fit Index 1.000, Tucker–Lewis Index 1.001, Root Mean Square Error of Approximation 0.000, Standardized Root Mean Square Residual 0.086). Questionnaire scores were strongly and inversely correlated with Mini-Mental State Examination scores (rho –0.911, $p<0.001$). Higher scores occurred among women, those with lower education or socioeconomic status, unmarried participants, and individuals with a family history of dementia (all $p<0.01$).

Conclusion: The Turkish Symptoms of Early Dementia-11 Questionnaire is brief, culturally appropriate, and reliable, supporting early detection of cognitive decline and timely interventions to reduce the burden of dementia.

Keywords: Dementia; Early Diagnosis; Neuropsychological Tests; Validation Study; Aged; Turkey.

Correspondence

Oğulcan ÇÖME
Phone : +905398612323
e-mail : ogulcancome@gmail.com

Received : Oct 06, 2025
Accepted: Nov 28, 2025

Cite this article as:
Çöme O, Sabır N, Yüksel T et al. Turkish Cultural Adaptation and Validation of the Symptoms of Early Dementia-11 Questionnaire. Turkish Journal of Geriatrics 2025; 28(4):470–481. doi: 10.29400/tjgeri.2025.464

The content of this journal is licensed under the Creative Commons Attribution-NonCommercial 4.0 International License.

INTRODUCTION

Dementia is one of the leading public health challenges of the 21st century, with its prevalence rising in parallel with the global trend of population aging. According to the World Health Organization, more than 55 million people worldwide are currently living with dementia, and nearly 10 million new cases are diagnosed each year. This number is expected to triple by 2050, with the most rapid increase observed in low- and middle-income countries where demographic transitions occur faster (1). In Türkiye, where the proportion of older adults is steadily increasing, dementia represents a growing burden not only for the health system but also for families and society at large (2). The rising demand for diagnostic, therapeutic, and supportive services necessitates strengthening early detection strategies, particularly in primary care settings where most older adults are first evaluated (3).

Early recognition of cognitive decline provides critical opportunities for timely intervention (4). Although no curative treatment for dementia currently exists, early diagnosis allows for better management of comorbidities, initiation of non-pharmacological interventions, caregiver education, and more effective planning of health and social care services (5). Early detection can help preserve older adults' quality of life and autonomy while reducing stress for their families (6,7). However, achieving timely diagnosis remains challenging in everyday practice, as symptoms of early dementia are often subtle, nonspecific, or dismissed as normal aging by patients and their families (8). This highlights the importance of systematic and structured screening in the first line of care.

Primary care occupies a central position in this process. Family physicians are usually the first health professionals to encounter older adults with memory complaints or subtle functional decline (6). Moreover, family medicine is built on holistic care, addressing health's biological, psychological, and social dimensions (9). This makes primary care the ideal context for the early detection of dementia, as it enables evaluation of cognitive changes in relation to the broader life circumstances of patients. At the same time, primary care consultations are often limited by time and workload constraints. In Türkiye, as in many other countries, physicians must assess multiple health needs during brief encounters, leaving little room for lengthy cognitive testing (10). Therefore, there is a pressing need for screening instruments that are short, easy to administer, culturally appropriate, and psychometrically sound.

Existing tools for cognitive assessment vary in their suitability for primary care. Widely used instruments such as the Mini-Mental State Examination (MMSE) or the Montreal Cognitive Assessment (MoCA) require direct patient testing and often take longer than feasible in a routine consultation. Furthermore, factors such as education, language, and sociocultural background can influence performance-based cognitive tests, potentially leading to under- or overdiagnosis in specific populations (11). In busy primary care settings, there is a preference for tools that can be applied quickly, are sensitive to early changes, and integrate seamlessly into the overall evaluation of the patient.

The Symptoms of Early Dementia-11 Questionnaire (SED-11Q) is a brief informant-based screening tool designed to detect early dementia. Initially developed in Japan, the SED-11Q consists of 11 items addressing changes in daily activities, memory, communication, and social behaviour. Its administration requires only a few minutes and relies on input from family members or caregivers familiar with the patient's everyday functioning. By focusing on observable behaviours rather than formal test performance, the SED-11Q minimizes patient burden and allows for a more ecological assessment of cognitive decline (12). Several studies have demonstrated its sensitivity and specificity in distinguishing individuals with early dementia from those without, suggesting its potential as a practical screening tool in real-world clinical practice.

Despite its demonstrated utility in other contexts, the SED-11Q has not yet been validated

for use in Türkiye. Without cultural and linguistic adaptation, direct application of such tools risks misinterpretation of items and reduced diagnostic accuracy. Cultural norms, daily life activities, and social expectations differ across populations, and screening instruments must reflect these variations to ensure validity (13). Moreover, psychometric evaluation in the target population is necessary to establish reliability, internal consistency, and factor structure. Given the increasing demand for dementia screening in Türkiye, adapting the SED-11Q to Turkish and evaluating its psychometric properties is both timely and essential.

Another key consideration is the role of primary care physicians in integrating dementia screening into everyday practice. In the Turkish health system, family physicians are expected to provide comprehensive care to all registered patients, including older adults with chronic conditions and functional decline (14). However, in the absence of validated, brief, and user-friendly screening tools, the detection of dementia often occurs late, after functional impairment has already progressed (15). This limits opportunities for early intervention and places additional strain on health and social care services. Establishing a validated Turkish version of the SED-11Q will equip primary care physicians with a practical instrument that can be easily implemented during routine visits, supporting efficiency and comprehensiveness in care.

The present study was conducted to address this gap. Specifically, our objective was to translate, culturally adapt, and evaluate the psychometric properties of the Turkish version of the SED-11Q in a primary care setting. By assessing validity and reliability in a representative sample of older adults, this study aims to provide family physicians with an evidence-based tool for the early detection of dementia, thereby contributing to holistic patient care and strengthening the capacity of primary care to respond to the growing challenge of cognitive decline in aging populations.

MATERIALS AND METHOD

Study design

This study employed a methodological and cross-sectional design to evaluate the validity and reliability of the Turkish version of the Symptoms of Early Dementia-11 Questionnaire (SED-11Q). The study was conducted between August and September 2025.

Setting

The research was conducted at Dokuz Eylul University Training Family Health Centers, Izmir, Türkiye. These centers provide comprehensive primary care services and constitute an appropriate setting for dementia screening, as they serve a large and diverse population of older adults.

Participants and sample size

The target population consisted of community-dwelling older adults aged 65 years and above who presented to the participating family health centers during the study period. Sample size was determined based on recommendations for psychometric validation studies, which suggest at least 5–10 participants per item for internal consistency analysis (16). Since the SED-11Q includes 11 items, a minimum of 110 participants was required. In addition, confirmatory factor analysis (CFA) is generally recommended with a sample size of at least 200 participants to ensure stable model estimation (17). Accordingly, the study aimed to include 200 participants.

Eligible participants were approached during their visits to the centers, informed about the study, and invited to participate voluntarily. Written informed consent was obtained from all participants before data collection.

Inclusion and exclusion criteria

The inclusion criteria were 65 years or older, willingness to participate voluntarily, and adequate proficiency in Turkish. Exclusion criteria included



a history of psychiatric illness (such as major depression or schizophrenia) or advanced sensory impairment (vision or hearing loss) that would prevent the completion of the questionnaires. The absence of such diagnoses was confirmed through the national electronic health record system.

Instruments

Sociodemographic Information Form. The researchers prepared a short form to collect demographic and health-related characteristics, including age, gender, education, marital status, occupational history, socioeconomic level, chronic diseases, family history of dementia, and household context.

Symptoms of Early Dementia-11 Questionnaire (SED-11Q). In Japan, Maki et al. (2013) originally developed the SED-11Q as an informant-administered screening tool to detect early dementia (12). It consists of 11 dichotomous (yes/no) items evaluating changes in cognition, behaviour, and daily functioning over the past year. Higher scores indicate a greater likelihood of cognitive decline. The original instrument demonstrated strong reliability (Cronbach's α=0.89) and validity. In the clinical setting with physicians and other medical staff, the statistically optimal cut-off value is 2/3. In contrast, in community-dwelling older individuals, a cut-off value of 3/4 is recommended for detecting dementia. In addition, two supplementary questions—concerning the presence of delusions and illusions—are included but not scored; if either is present, medical consultation is recommended.

Translation and cultural adaptation

The translation and adaptation process followed internationally accepted guidelines for cross-cultural adaptation of self-report measures (18). First, two independent researchers conducted the forward translation into Turkish. Although they were not fully bilingual, both were academically competent and experienced in the field, with sufficient proficiency in English and expertise in health-related terminology. The research team synthesized a consensus version. This version was then back-translated into English by an independent bilingual translator who was blinded to the original instrument. A committee of family medicine and geriatrics experts reviewed translated version ensure semantic, conceptual, and cultural equivalence. The prefinal version was pilot tested with a small group of older adults (n=20) to assess clarity and cultural appropriateness. Minor adjustments were made based on participant feedback, resulting in the final Turkish version of the SED-11Q.

Data collection

Data were collected face-to-face by trained family physicians at the participating health centers during routine patient visits. Informants (family members or caregivers) completed the SED-11Q based on their observations of the participant's behavior and functioning over the past year. In addition, the MMSE was administered to assess cognitive status.

Statistical analysis

Descriptive statistics (mean, standard deviation, frequency, and percentage) were used to summarize participant characteristics. Internal consistency of the SED-11Q was assessed using Cronbach's alpha and McDonald's omega coefficients. Item–total correlations were examined to evaluate the contribution of each item to the overall scale. Construct validity was examined through confirmatory factor analysis (CFA). Model fit was evaluated using both badness-of-fit and goodness-of-fit indices, including the Root Mean Square Error of Approximation (RMSEA), Standardized Root Mean Square Residual (SRMR), Goodness-of-Fit Index (GFI), Normed Fit Index (NFI), Non-Normed Fit Index or Tucker–Lewis Index (TLI), Comparative Fit Index (CFI), Incremental Fit Index (IFI), Relative Fit Index (RFI), and McDonald Fit Index (MFI).

Acceptable model fit was defined as CFI, TLI, NFI, IFI, RFI, and GFI values ≥ .95, RMSEA< .05 (90% CI< .08), and SRMR< .10.

Known-groups validity was tested by comparing SED-11Q scores across sociodemographic subgroups (e.g., gender, education, marital status, occupational history, socioeconomic level, presence of chronic disease, family history of dementia, and household context) using Mann-Whitney U or Kruskal-Wallis tests, as appropriate. Correlations between SED-11Q and MMSE scores were assessed using Spearman's rank correlation coefficient. The significance threshold was set at p< 0.05.

Ethics

The study protocol was reviewed and approved by the Dokuz Eylul University Faculty of Medicine Ethics Committee (Decision No:2025/25-03, Date: 30.07.2025). All participants and their informants provided written informed consent. Data were collected anonymously, and confidentiality was maintained throughout the study.

RESULTS

The analysis included 200 participants aged 65 years and older. Table 1 compares SED-11Q and

Table 1. Comparison of SED and MMSE Scores by Sociodemographic Characteristics

Variable	Category	n	SED Median (min–max)	Test statistic (U/H)	p	MMSE Median (min–max)	Test statistic (U/H)	p
Gender	Female	105	3,24 (0-11)	U=3464,5	< .001	22,90 (6-30)	U=6249,5	.002
	Male	95	1,93 (0-11)	25,0 (7-30)				
Education	Literate	31	4,29 (0-10)	H=34,223	< .001	20,74 (11-30)	H =24,544	< .001
	Primary/Secondary	89	3,20 (0-11)			22,88 (6-30)		
	High school	43	1,72 (0-8)			25,81 (14-30)		
	University+	37	0,89 (0-4)			26,75 (14-30)		
Marital status	Married	133	2,18 (0-11)	U=5718,5	< .001	24,66 (6-30)	U=3279,0	.002
	Single	67	3,50 (0-10)			22,38 (11-30)		
Occupational history	Education	20	1,30 (0-7)	H=20,660	< .001	26,65 (16-30)	H=16,450	< .001
	Health	6	3,33 (1-5)			22,66 (19-28)		
	Service	105	2,17 (0-11)			24,62 (6-30)		
	Never worked	69	3,63 (0-10)			22,10 (10-30)		
Socioeconomic level	Low	37	4,32 (0-10)	H=31,943	< .001	20,35 (11-30)	H=28,451	< .001
	Middle	114	2,72 (0-11)			23,79 (6-30)		
	High	49	1,10 (0-7)			26,81 (16-30)		
Chronic disease	Present	183	2,70 (0-11)	U=1337,5	.331	23,79 (6-30)	U=1617,5	.785
	Absent	17	1,76 (0-6)			25,00 (18-30)		
Family history of dementia	Present	55	3,58 (0-11)	U=2913,5	.003	22,30 (6-30)	U=4787,0	.028
	Absent	145	2,26 (0-10)			24,50 (7-30)		
Living situation	Alone	34	3,00 (0-10)	U=2524,5	.324	23,17 (11-30)	U=3173,5	.251
	With family	166	2,54 (0-11)			24,04 (6-30)		

SED: Symptoms of Early Dementia-11 Questionnaire, MMSE: Mini-Mental State Examination, n: number, min: minimum, max: maximum



MMSE scores across sociodemographic and clinical subgroups.

Gender. Women had significantly higher SED-11Q scores (median=3.24, range 0–11) compared with men (median=1.93, range 0–11) (U=3464.5, p< .001), indicating more reported dementia-related symptoms. In contrast, men demonstrated higher MMSE scores (median=25.0, range 7–30) than women (median=22.9, range 6–30) (U=6249.5, p=.002).

Education. There were marked differences across education groups. Participants who were literate without formal education had the highest SED-11Q scores (median=4.29, range 0–10), whereas university graduates had the lowest (median=0.89, range 0–4) (H=34.223, p< .001). Conversely, MMSE scores increased steadily with education level, from a median of 20.74 (range 11–30) among literates to 26.75 (range 14–30) among those with university education (H=24.544, p< .001).

Marital status. Single participants had higher SED-11Q scores (median=3.50, range 0–10) compared to married individuals (median=2.18, range 0–11) (U=5718.5, p< .001). Similarly, married participants exhibited significantly higher MMSE scores (median=24.66, range 6–30) than single participants (median=22.38, range 11–30) (U=3279.0, p=.002).

Occupational history. Occupational background was also associated with both scales. Those who had never worked showed the highest SED-11Q scores (median=3.63, range 0–10), while participants with an education-related occupation had the lowest (median=1.30, range 0–7). Differences were statistically significant (H=20.660, p< .001). For MMSE, the highest scores were again observed among those with an education-related occupation (median=26.65, range 16–30), whereas the lowest were among those who had never worked (median=22.10, range 10–30) (H=16.450, p< .001).

Socioeconomic level. A clear gradient was observed by socioeconomic status. Participants in the low socioeconomic group had the highest SED-11Q scores (median=4.32, range 0–10), while those in the high group had the lowest (median=1.10, range 0–7) (H=31.943, p< .001). Similarly, MMSE scores were lowest in the low socioeconomic group (median=20.35, range 11–30) and highest in the high socioeconomic group (median=26.81, range 16–30) (H=28.451, p< .001).

Chronic disease. No significant differences were found in either SED-11Q (U=1337.5, p=.331) or MMSE scores (U=1617.5, p=.785) between participants with and without chronic diseases.

Family history of dementia. Participants with a family history of dementia had significantly higher SED-11Q scores (median=3.58, range 0–11) compared with those without (median=2.26, range 0–10) (U=2913.5, p=.003). MMSE scores were also lower among participants with a family history of dementia (median=22.30, range 6–30) than those without (median=24.50, range 7–30) (U=4787.0, p=.028).

Household Context. No significant differences were observed in SED-11Q or MMSE scores between participants living alone and those living with family (p > .05 for both).

In addition to group comparisons, the relationship between SED-11Q and MMSE scores was examined using Spearman's rank correlation (Table 2). A strong, negative correlation was observed between total SED-11Q and MMSE scores (ρ=–0.911, p< .001). This indicates that

Table 2. Spearman's Correlation Between SED Total and MMSE Total

Variables	ρ (Spearman's rho)	p	95% CI	Effect size (Fisher's z)	SE (z)
SED total – MMSE total	–0.911	< .001	[–0.932, –0.884]	–1.535	0.079

SED: Symptoms of Early Dementia-11 Questionnaire, MMSE: Mini-Mental State Examination, SE: Standard Error

as dementia-related symptoms reported on the SED-11Q increased, cognitive performance as measured by the MMSE decreased. The correlation was statistically significant, with a 95% confidence interval ranging from –0.932 to –0.884. The effect size (Fisher's z=–1.535, SE=0.079) further confirmed the robustness of this inverse relationship.

The psychometric evaluation of the Turkish version of the SED-11Q demonstrated strong validity and reliability indices (Table 3). Bartlett's test of sphericity was statistically significant ($\chi^2(55)=2200.72$, $p< .001$), indicating that the data were factorable. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.830 overall, with individual item values ranging from 0.774 to 0.915, exceeding the recommended threshold of 0.80 and confirming that the sample was adequate for factor analysis.

Confirmatory factor analysis (CFA) supported the one-factor structure of the scale. The chi-square test of model fit was non-significant ($\chi^2(44)=41.91$, $p=.561$), suggesting good model fit. All incremental fit indices were excellent: CFI=1.000, TLI=1.001, NFI=0.982, RFI=0.977, IFI=1.001, GFI=0.986, and MFI=1.005, all exceeding the recommended cutoff of 0.95. Absolute fit indices also supported the model: RMSEA=0.000 (90% CI [0.000, 0.044], p=.978), indicating excellent fit (< .05), and SRMR=0.086,

Table 3. Validity and Reliability Indices of the Scale

Test / Index	Value	Interpretation / Criteria
Bartlett's Test of Sphericity	$\chi^2(55) = 2200.72$, $p < .001$	Factorable data
KMO (Overall)	.830	Meritorious (>.80)
KMO (items)	.774 – .915	Adequate sampling adequacy
Chi-square Model Fit	$\chi^2(44) = 41.91$, $p = .561$	Good fit (non-significant)
CFI	1.000	Excellent (> .95)
TLI	1.001	Excellent (> .95)
NFI	.982	Excellent (> .95)
RFI	.977	Excellent (> .95)
IFI	1.001	Excellent (> .95)
RMSEA	.000 (90% CI [.000, .044]), p = .978	Excellent (< .05)
SRMR	.086	Acceptable (< .08–.10)
GFI	.986	Excellent (> .95)
MFI	1.005	Excellent (> .95)
Hoelter's N (α = .05)	288.15	Adequate (> 200)
Hoelter's N (α = .01)	327.22	Adequate (> 200)
Factor Loadings	0.409 – 0.951	good ≥ 0.40
Reliability – Cronbach's α	.834	Good (> .80)
Reliability – McDonald's ω	.823	Good (> .80)
Item-level Reliability	0.378 – 0.627	Good (> .30)

KMO: Kaiser–Meyer–Olkin, CFI: Comparative Fit Index, TLI: Tucker Lewis Index, NFI: Norm Fit Index, RFI: Relative Fit Index, IFI: Incremental Fit Index, RMSEA: Root Mean Square Error of Approximation, SRMR: Standardized Root Mean Square Residual, GFI: Goodness-of-Fit Index, MFI: McDonald Fit Index



within the acceptable range (< .08–.10). Hoelter's N was 288.15 at α=.05 and 327.22 at α=.01, above the 200 threshold, further supporting model adequacy and sample size sufficiency. The majority of items loaded strongly on the latent construct (≥ 0.60), while only item 10 (0.409) approached the lower acceptable limit. All items exceeded the minimum recommended loading of 0.30, indicating that each item contributed meaningfully to the single-factor solution and confirming the construct validity of the scale.

Reliability analyses showed high internal consistency. Cronbach's alpha was 0.834 and McDonald's omega was 0.823, both exceeding the accepted criterion of 0.80, indicating good reliability. All coefficients exceeded the commonly recommended minimum of 0.30, indicating that each item contributed meaningfully to the overall internal consistency of the instrument.

DISCUSSION

This study translated, culturally adapted, and psychometrically validated the Turkish version of the SED-11Q for use in primary care. The findings demonstrated that the instrument possesses strong validity and reliability, confirming its suitability as a practical screening tool for the early detection of dementia in community-dwelling older adults. To our knowledge, this is the first study to adapt and validate the SED-11Q in Türkiye, addressing a significant gap in dementia screening tools available for primary care physicians.

Interpretation of Key Findings

The Turkish version of the SED-11Q demonstrated high internal consistency, with Cronbach's α and McDonald's ω both exceeding 0.80. These results are comparable to those of the original Japanese validation, where Cronbach's α was reported at 0.89 (12). This suggests that the Turkish adaptation retained the conceptual integrity and coherence of the original items, despite differences in language and cultural context.

CFA supported a one-factor model with excellent fit indices across multiple criteria (CFI, TLI, RMSEA, SRMR)(19). Reinforcing its conceptualization as a brief, focused measure of observable dementia-related symptoms. The adequacy of model fit, together with the high Kaiser-Meyer-Olkin value, underscores the appropriateness of applying this scale in the Turkish context.

Convergent validity was strongly supported by the significant negative correlation between SED-11Q and MMSE scores (ρ=–0.911, p <.001). This magnitude of correlation indicates a powerful correlation according to Cohen's guidelines (20). The strength of this relationship suggests that the SED-11Q captures clinically relevant changes that align closely with objective cognitive performance, while also reflecting real-world functional decline observable to caregivers.

Known-groups validity analyses further strengthened the evidence for construct validity. Higher SED-11Q scores were observed among women, participants with lower education or socioeconomic status, unmarried individuals, and those with a family history of dementia. These patterns mirror well-established epidemiological findings that female gender, lower education, and lower socioeconomic position are associated with higher dementia risk (21). Such associations may also reflect contextual or reporting biases rather than true cognitive decline. Lower education, limited health literacy, or cultural norms can influence how informants perceive and report daily functioning, potentially leading to overestimation of impairment. While the SED-11Q captures current cognitive functioning more directly than retrospective measures, sociodemographic disparities may still affect score interpretation. Thus, differences across groups should be interpreted with caution, and future studies should explore ways to adjust for these potential biases.

Comparison with Previous Studies

In Japanese cohorts, the tool has been shown to discriminate effectively between healthy individuals, those with mild cognitive impairment, and those with dementia (12). Similarly, our findings suggest that the Turkish version can differentiate between groups expected to vary in dementia risk, supporting its cross-cultural applicability. Furthermore, studies of other informant-based questionnaires, such as the Informant Questionnaire on Cognitive Decline in the Elderly (IQCODE), have demonstrated similar advantages in detecting early dementia across diverse cultural settings (22). The present study extends this literature by confirming that the SED-11Q offers comparable psychometric strength while retaining the practical advantage of brevity.

Similar validation and implementation studies conducted in different cultural settings have highlighted challenges such as varying levels of health literacy, differences in informant familiarity with the patient's daily functioning, and resource limitations in primary care. These cultural and practical factors should be considered when applying informant-based cognitive screening tools across diverse populations (23,24).

Implications for Primary Care

Primary care settings are uniquely positioned for early dementia detection (25), yet practical challenges such as limited time and competing health demands often impede systematic screening (26). The Turkish SED-11Q requires only a few minutes to administer and relies on informant input, reducing patient burden and consultation time. Its demonstrated validity and reliability suggest that it could be feasibly integrated into routine visits, particularly for patients with memory complaints or functional decline. Adopting this tool could help family physicians identify cases warranting further evaluation, initiate early interventions, and facilitate timely referral to specialized care.

Strengths and Limitations

This study has several strengths. It followed internationally recognized translation and cultural adaptation guidelines, ensuring semantic and conceptual equivalence across languages. The sample size was sufficient for both reliability testing and CFA, exceeding recommended thresholds.

Nonetheless, some limitations should be acknowledged. First, the cross-sectional design precludes assessing test–retest reliability and predictive validity over time. Second, although the MMSE is widely used, it has limitations related to educational and cultural bias, which may have influenced the strength of correlations observed. Additionally, no standardized diagnostic tool based on DSM classification was applied to verify the absence of psychiatric disorders, and the forward translators were not fully bilingual, both representing minor methodological limitations. Specific chronic conditions were not recorded, although most participants had at least one chronic disease, which may be clinically relevant. Additionally, in line with the original study, other informant-based instruments such as the IQCODE were not used for comparison, as they include items related to advanced dementia stages and no other informant-based tool with established Turkish validity and reliability was available. Finally, the study was conducted in a single metropolitan region, and findings may not fully capture cultural or linguistic nuances across Türkiye's diverse areas.

Future Directions

Multicenter studies including rural and culturally diverse populations will be essential to confirm generalizability. Additionally, implementation research could evaluate how best to integrate the SED-11Q into primary care workflows, including its acceptability among physicians and caregivers. Future studies should also include detailed data on chronic disease subtypes to better interpret their

potential effects on cognitive outcomes. Finally, research examining the tool's role in guiding early interventions, caregiver support, and health system planning would extend its impact beyond screening.

CONCLUSION

In summary, the Turkish version of the SED-11Q demonstrated strong validity and reliability, supporting its use as a brief and practical instrument for dementia screening in primary care. By providing family physicians with a culturally adapted, psychometrically robust tool, this study contributes to strengthening early detection strategies in Türkiye. Early identification of dementia can facilitate timely interventions, preserve quality of life for older adults, and reduce the burden on families and health systems.

Declaration of Interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Funding Statement: We would like to clarify that this project received no external funding.

Acknowledgments: We would like to thank the participants for their time and willingness to share their experiences, which made this study possible.

Declaration of generative AI and AI-assisted technologies: During the preparation of this work, the author(s) used ChatGPT-4o (OpenAI, 2025) in order to improve grammar, language clarity, and phrasing. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

Data Availability Statement: The data supporting the findings of this study are available upon reasonable request from the corresponding author. Due to ethical considerations and participant confidentiality, data cannot be shared publicly.

REFERENCES

1. Chowdhary N, Barbui C, Anstey KJ, et al. Reducing the risk of cognitive decline and dementia: WHO recommendations. Front Neurol 2022;12:765584. doi:10.3389/fneur.2021.765584.
2. Güner M, Koca M, Ceylan S, et al. Prevalence and general characteristics of dementia: a nationwide population-based study of electronic health records in Türkiye. Turk J Med Sci 2024;54(4):644-51. doi:10.55730/1300-0144.5833.
3. Reiss AB, de Levante Raphael D, Chin NA, Sinha V. The physician's Alzheimer's disease management guide: early detection and diagnosis of cognitive impairment, Alzheimer's disease and related dementia. AIMS Public Health 2022;9(4):661-89. doi:10.3934/publichealth.2022047.
4. Morley JE, Morris JC, Berg-Weger M, et al. Brain health: the importance of recognizing cognitive impairment: an IAGG consensus conference. J Am Med Dir Assoc 2015;16(9):731-9. doi:10.1016/j.jamda.2015.06.017.
5. Janicki MP, Keller SM. Why do we need national guidelines for adults with intellectual disability and dementia? Alzheimers Dement (Amst) 2015;1(3):234-40. doi:10.1016/j.dadm.2015.05.005.
6. Aliberti MJR, Avelino-Silva TJ, Suemoto CK. Maximizing early dementia detection through Medicare annual wellness visits. JAMA Netw Open 2024;7(10):e2437162. doi:10.1001/jamanetworkopen.2024.37162.
7. Ng C, Cai X, Wong G. Help-seeking difficulty and burden in dementia caregivers upon reaching an early detection service. Innov Aging 2018;2(Suppl 1):533-4. doi:10.1093/geroni/igy023.1970.
8. Porsteinsson AP, Isaacson RS, Knox S, Sabbagh MN, Rubino I. Diagnosis of Early Alzheimer's Disease: Clinical Practice in 2021. J Prev Alzheimer's Dis 2021;8(3):371-386. doi:10.14283/jpad.2021.23.
9. Hodgson J, Trump L, Wilson G, Garcia-Huidobro D. Medical Family Therapy in Family Medicine. In: Hodgson J, et al., eds. Medical Family Therapy. 2nd ed. Cham: Springer; USA 2018, pp:17-59.
10. Koc Okudur S, Dokuzlar O, Usarel C, Soysal P, Isik AT. Validity and reliability of Rapid Cognitive Screening Test for Turkish older adults. J Nutr Health Aging 2019;23(1):68-72. doi:10.1007/s12603-018-1115-5.
11. de Jonghe JFM, Appels B, Goudsmit M, Wouters H. Cognitive screening for dementia: crossing four essential borders. Eur Geriatr Med 2014;5(Suppl 1):S25-6. doi:10.1016/S1878-7649(14)70095-0.

12. Maki Y, Yamaguchi T, Yamaguchi H. Symptoms of Early Dementia-11 Questionnaire (SED-11Q): a brief informant-operated screening for dementia. Dement Geriatr Cogn Dis Extra 2013;3(1):131-42. doi:10.1159/000350460.

13. Czerwinski-Alley NC, Chithiramohan T, Subramaniam H, Beishon L, Mukaetova-Ladinska EB. The effect of translation and cultural adaptations on diagnostic accuracy and test performance in dementia cognitive screening tools: a systematic review. J Alzheimers Dis Rep 2024;8(1):659-75. doi:10.3233/ADR-230198.

14. Yavuz E, Yayla ME, Kırımlı E, et al. Daily Workload And Service Profile Of Family Physicians In Turkey: A Snapshot Of One-Day Work. Konuralp Med J 2020;12(2):175-182. doi:10.18521/ktd.659576 (in Turkish)

15. Rosteius K, Frissen L, de Boer B, et al. Digital approaches to routine cognitive screening for older adults in primary care settings. Innov Aging 2024;8(Suppl 1):677. doi:10.1093/geroni/igae098.2211.

16. Boateng GO, Neilands TB, Frongillo EA, Melgar-Quiñonez HR, Young SL. Best practices for developing and validating scales for health, social, and behavioral research: a primer. Front Public Health 2018;6:149. doi:10.3389/fpubh.2018.00149.

17. Kline RB, Little TD. Structural Equation Modeling. In: Kline RB (Ed). Principles and Practice of Structural Equation Modeling. 4th edition, Guilford Press, New York, USA 2016, pp 1-534.

18. Beaton DE, Bombardier C, Guillemin F, Ferraz MB. Guidelines for the process of cross-cultural adaptation of self-report measures. Spine (Phila Pa 1976) 2000;25(24):3186-91. doi:10.1097/00007632-200012150-00014.

19. Hu LT, Bentler PM. Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. Struct Equ Modeling 1999;6(1):1-55. doi:10.1080/10705519909540118.

20. Cohen J. Statistical Power Analysis. In: Cohen J (Ed). Statistical Power Analysis for the Behavioral Sciences. 2nd edition, Routledge, New York, USA 2013, pp 1-567.

21. Livingston G, Huntley J, Sommerlad A, et al. Dementia prevention, intervention, and care: 2020 report of the Lancet Commission. Lancet 2020;396(10248):413-46. doi:10.1016/S0140-6736(20)30367-6.

22. Jorm AF. The Informant Questionnaire on Cognitive Decline in the Elderly (IQCODE): a review. Int Psychogeriatr 2004;16(3):275-93. doi:10.1017/S1041610204000390.

23. Iatraki E, Simos PG, Bertsias A, et al. Cognitive screening tools for primary care settings: examining the 'Test Your Memory' and 'General Practitioner assessment of Cognition' tools in a rural aging population in Greece. Eur J Gen Pract. 2017;23(1):172–179. doi:10.1080/13814788.2017.1324845

24. Nielsen TR. Cognitive assessment in culturally, linguistically, and educationally diverse older populations in Europe. Am J Alzheimers Dis Other Demen. 2022;37:15333175221117006. doi:10.1177/15333175221117006

25. Fowler NR, Partrick KA, Taylor J, et al. Implementing early detection of cognitive impairment in primary care to improve care for older adults. J Intern Med 2025;298(1):31-45. doi:10.1111/joim.20098.

26. Fernandes B, Goodarzi Z, Holroyd-Leduc J. Optimizing the diagnosis and management of dementia within primary care: a systematic review of systematic reviews. BMC Fam Pract 2021;22(1):166. doi:10.1186/s12875-021-01523-3.



Supplementary Material 1.
Erken Dönem Demans Belirtileri-11 Anketi SED-11Q-TR
Lütfen aşağıdaki soruları uygun yanıtları daire içine alarak cevaplayınız.
(Fiziksel sorunlardan –örneğin ağrı– kaynaklanan güçlükleri hariç tutunuz).
Gerekirse lütfen yardım isteyiniz.
Hastanın son bir aydaki günlük yaşamı nasıldı?

Soru	EVET	HAYIR	Bilmiyorum / Geçerli değil
Hasta aynı şeyleri tekrar tekrar anlatıyor veya soruyor mu?	☐	☐	☐
Hasta olayların bağlamını anlamakta zorlanıyor mu?	☐	☐	☐
Hasta giyim kuşamına ve kişisel bakımına karşı ilgisiz hale geldi mi?	☐	☐	☐
Hasta musluğu kapatmayı, kapıyı kapatmayı unutuyor veya evi gerektiği gibi temizleyemiyor mu?	☐	☐	☐
Aynı anda iki şey yaparken birini unutuyor mu?	☐	☐	☐
Hasta ilaçlarını düzenli şekilde kullanamaz hale geldi mi?	☐	☐	☐
Daha önce hızlı yaptığı işleri (örneğin ev işleri) yapmak artık daha uzun sürüyor mu?	☐	☐	☐
Hasta plan yapamaz hale geldi mi?	☐	☐	☐
Hasta karmaşık konuları anlayamıyor mu?	☐	☐	☐
Hasta eskisi kadar istekli değil mi, hobilerini bıraktı mı?	☐	☐	☐
Hasta öncesine göre daha huzursuz veya şüpheci mi?	☐	☐	☐

TOPLAM SED-11Q SKORU

Soru	EVET	HAYIR	Bilmiyorum / Geçerli değil
Hasta sanrılar yaşıyor mu? (Örneğin, eşyalarının çalındığını iddia etmek gibi)	☐	☐	☐
Hasta olmayan şeyleri görüyor mu? (Örneğin, halüsinasyonlar)	☐	☐	☐

Bu iki sorudan herhangi birine "Evet" yanıtı verildiğinde, daha kapsamlı bir tıbbi değerlendirme önerilir.

ORIGINAL ARTICLE

THE ROLE OF FRAILTY INDEX IN PREDICTING POSTOPERATIVE COMPLICATIONS IN GERIATRIC VASCULAR SURGERY PATIENTS

Turkish Journal of Geriatrics
2025; 28(4):482–492

DOI: 10.29400/tjgeri.2025.465

Sercan TAK[1]
Okan YAMAN[1]
Erkan İRİZ[1]
Mustafa Hakan ZOR[1]
Abdullah ÖZER[1]
Gürsel Levent OKTAR[1]
Başak KOÇAK[1]
Fatih ÖNCÜ[2]

[1] Gazi University, Faculty of Medicine, Department of Cardiovascular Surgery, Ankara, Türkiye

[2] Gazi University, Faculty of Medicine, Department of Radiology, Ankara, Türkiye

Correspondence

Sercan TAK
Phone : +903122025610
e-mail : sercantak@gmail.com

Received : Oct 04, 2025
Accepted: Nov 25, 2025

Cite this article as:
Tak S, Yaman O, İriz E et al. The Role of Frailty Index in Predicting Postoperative Complications in Geriatric Vascular Surgery Patients. Turkish Journal of Geriatrics 2025; 28(4):482–492. doi: 10.29400/tjgeri.2025.465

Abstract

Introduction: This study aims to assess the predictive efficacy of the modified Frailty Index for 30-day postoperative outcomes in elderly patients undergoing vascular surgery and to evaluate its additional value compared with conventional tools.

Materials and Method: This retrospective cohort study examined 155 consecutive patients aged ≥ 65 years who underwent elective vascular surgery. The preoperative 11-item modified Frailty Index was calculated using National Surgical Quality Improvement Program variables. The primary endpoint was 30-day mortality, and secondary endpoints included surgical site infection, myocardial infarction, septic shock, reintubation, stroke, and acute kidney injury.

Results: The mean age was 71.98 ± 5.59 years. The 30-day mortality rate was 16.8%. The modified Frailty Index was higher in non-survivors than in survivors (3.96±1.48 vs 1.96±1.11, p<0.001) and showed excellent mortality prediction (Area Under the Curve=0.851, 95% CI: 0.778-0.924), with a threshold of 2.5 (sensitivity 84.6%, specificity 73.6%). In the multivariate analysis, adjusting for age, sex, American Society of Anesthesiologists score, and Geriatric Nutritional Risk Index, the modified Frailty Index remained associated with mortality (adjusted OR=2.79, 95% CI, 1.52-5.13; p=0.001). Each point increase correlated with higher risk of surgical site infection (OR=1.55, 95% CI: 1.19-2.03, p=0.001), myocardial infarction (OR=2.46, 95% CI: 1.27-4.78, p=0.008), septic shock (OR =2.46, 95% CI: 1.27-4.78, p=0.008), reintubation (OR=2.70, 95% CI: 1.82-4.02, p<0.001), and renal failure (OR=2.05, 95% CI: 1.43-2.94, p< 0.001).

Conclusions: The 11-item modified Frailty Index predicted adverse outcomes in geriatric vascular surgery patients. Its use in risk stratification may improve perioperative management.

Keywords: Frailty; Vascular Surgical Procedures; Geriatrics; Risk Assessment; Mortality.

The content of this journal is licensed under the Creative Commons Attribution-NonCommercial 4.0 International License.

INTRODUCTION

The global demographic shift toward an aging population has led to an increase in elderly patients requiring vascular surgery (1). Advanced age is associated with higher perioperative morbidity and mortality, particularly in vascular surgery patients with significant comorbidities and systemic atherosclerotic disease (2). However, chronological age alone cannot predict surgical risk, as it fails to account for varying physiological reserves and functional capacity in elderly patients (3).

The concept of frailty has emerged as a comprehensive approach to geriatric surgery risk assessment. Frailty is a clinical syndrome characterized by decreased physiological reserves and increased vulnerability to adverse outcomes following stressors (4). Unlike chronological age, frailty captures the cumulative impact of age-related decline across multiple organ systems, providing a more accurate assessment of surgical risk (5). The Frailty Index (FI), described by Rockwood and Mitnitski, quantifies frailty as the proportion of accumulated health deficits relative to total potential deficits (6). The modified Frailty Index (mFI), derived from the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database, represents a simplified adaptation of the original FI (7). Studies have demonstrated the mFI's prognostic value across surgical specialties (8, 9). In vascular surgery, Ehlert validated an 11-item mFI in over 72,000 patients, showing a superior prediction of mortality compared to traditional tools (10). Karam et al. found that a simplified frailty index independently predicted mortality and adverse outcomes in vascular surgery patients (11).

Despite these promising findings, several gaps exist in the literature. First, validation studies have focused on North American populations, thus limiting data from other regions and healthcare systems. Second, although mortality has been the primary focus, analyses of the relationship between frailty and specific postoperative complications remain limited. Third, the optimal mFI cutoff values lack consistency across vascular surgery procedures. Recent systematic reviews have emphasized the need for standardized frailty assessment methodologies and reporting (12). Variations in mFI calculation methods and outcome definitions limit evidence synthesis and guideline development.

Most existing studies have used large administrative databases that lack granular clinical details to understand frailty and adverse outcomes. This study evaluated the predictive performance of an 11-item mFI in geriatric patients undergoing vascular surgical procedures at a tertiary center (13). Our primary objective was to determine the association between the mFI and 30-day mortality. Secondary objectives included assessing the mFI's relationship with postoperative complications, determining optimal cut-off values, and evaluating its incremental predictive value over traditional risk factors.

We hypothesized that the mFI would demonstrate superior discriminatory ability compared to conventional risk factors and would be independently associated with both mortality and major postoperative complications in geriatric vascular surgery patients.

MATERIALS AND METHOD

This retrospective cohort study at Gazi University Faculty of Medicine of a tertiary center with a high-volume vascular surgery program was approved by the Institutional Review Board (Protocol Number: E-77082166-604.01-1297517). The requirement for informed consent was waived owing to the retrospective design and minimal risk. This study followed the STROBE guidelines for cohort studies (14). The study included consecutive patients aged ≥65 years who underwent elective vascular surgical procedures between January 1, 2022, and December 31, 2024. Inclusion criteria were patients aged 65 years or older who underwent elective vascular operations, including lower-extremity

revascularization, endovascular aortic aneurysm repair (EVAR), or carotid endarterectomy, with complete preoperative data for modified Frailty Index (mFI) calculation. Exclusion criteria were emergency procedures, concurrent nonvascular operations, previous enrollment, or incomplete 30-day follow-up data.

The sample size calculation was based on studies reporting 30-day mortality rates of 10-20% in geriatric vascular surgery populations (10, 15). To detect an odds ratio of 2.5 for high versus low frailty (mFI ≥3 vs. <3) with 80% power and α=0.05, assuming a 1:3 ratio of high to low frailty, a minimum sample size of 142 patients was required. To ensure sufficient power, 155 patients were included in this study. The research personnel extracted clinical data from the electronic medical records using standardized forms. The data were independently verified, and discrepancies were resolved through consensus. The inter-rater reliability for the modified Frailty Index was assessed in 30 patients (19.4% of the cohort) by both reviewers, showing excellent agreement (κ=0.94, 95% Confidence Interval: 0.87-1.00). Discrepancies were resolved through consensus between the reviewers and consultation with a senior attending surgeon. The following variables were collected.

Demographic and clinical variables

The demographic and clinical characteristics of the included patients were comprehensively recorded. Core demographic data collected included age, sex, and body mass index (BMI). The American Society of Anesthesiologists (ASA) Physical Status Classification was used to assess the patients' general health status and perioperative risk. Furthermore, preoperative laboratory values were reviewed to obtain information on patients' physiological reserves and nutritional status. Surgical procedure-related data were also documented in detail, including procedure type and the surgical approach (open vs. endovascular), as well as the patient's preoperative wound status.

Frailty assessment

The 11-item modified Frailty Index was calculated based on the presence or absence of the following NSQIP-derived variables as previously validated by Ehlert et al. (15):

1. Diabetes mellitus (insulin-dependent or non-insulin-dependent)
2. Congestive heart failure within 30 days before surgery
3. Hypertension requiring medication
4. History of transient ischemic attack or cerebrovascular accident
5. Functional status (partially or totally dependent vs. independent)
6. History of myocardial infarction within six months
7. History of cerebrovascular accident with neurological deficit
8. Chronic obstructive pulmonary disease or pneumonia within 30 days
9. History of percutaneous coronary intervention or coronary artery bypass grafting
10. Impaired sensorium (confusion, delirium, or altered mental status)
11. Preoperative open wound or wound infection

Each variable was scored as 0 (absent) or 1 (present), with the mFI calculated as the sum of the positive variables (range 0-11). The inter-rater reliability for the mFI calculation was assessed in a subset of 30 patients and demonstrated excellent agreement (κ=0.94).

Nutritional assessment: The Geriatric Nutritional Risk Index (GNRI) was calculated using the formula: GNRI=[1.489 × albumin (g/dL)] + [41.7 × (current weight/ideal weight)] (16). The perfect weight was calculated using the Lorentz formula as follows (17): The ideal weight was calculated using the Lorentz formula as follows: for men, ideal weight (kg)=height (cm) - 100 - [(height - 150)/4]; for women, ideal weight (kg)=height (cm) - 100 - [(height - 150)/2.5].



Outcome measures

Primary endpoint: Thirty-day all-cause mortality, defined as death from any cause within 30 days of the index surgical procedure.

Secondary endpoints: Secondary endpoints comprised major postoperative complications occurring within 30 days of the index surgery. These complications were rigorously assessed and documented, including surgical site infection (categorized as superficial, deep incisional, or organ/space), myocardial infarction (defined by troponin elevation with appropriate clinical correlation), and septic shock (requiring vasopressor support in the presence of confirmed or suspected infection). Furthermore, respiratory complications such as reintubation (unplanned endotracheal intubation following initial extubation) were evaluated. Finally, the assessment included specific organ system failures such as stroke (a new neurological deficit confirmed by imaging) and dialysis-requiring acute kidney injury (new requirement for renal replacement therapy).

All outcomes were adjudicated by two independent reviewers using standardized definitions based on the ACS-NSQIP criteria, with disagreements resolved by a third reviewer.

Missing data analysis

Missing data were identified in seven patients (4.5% of the cohort), including preoperative albumin level (n=4, 2.6%), functional status assessment (n=2, 1.3%), and wound status documentation (n=1, 0.6%). Data on albumin levels were missing before routine preoperative laboratory protocols were established. Functional status data were missing in patients transferred from facilities with incomplete documentation, while one case of missing wound status was clarified through a surgical note review. A complete case analysis was performed as missing data were below 5% and Missing Completely at Random (Little's test, p=0.312). Sensitivity analysis excluding patients with missing data showed no significant difference in primary outcomes, with odds of <5%.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics (version 27.0; IBM Corp., Armonk, NY, USA). Continuous variables' normality was assessed using the Shapiro-Wilk test and reported as mean ± standard deviation or median (interquartile range). Categorical variables are presented as frequencies and percentages. Groups were compared using Student's t-test or Mann-Whitney U test for continuous variables and χ^2 test or Fisher's exact test for categorical variables. Multivariate logistic regression was used to identify the independent outcome predictors. Variables with $p<0.10$ in univariate analysis were included in multivariable models using a forward stepwise approach (entry $p<0.05$, removal $p>0.10$). Multicollinearity was evaluated using variance inflation factors, with VIF>5 indicating collinearity. Model discrimination was assessed using ROC curve analysis with AUC and 95% confidence intervals. The cutoff values were determined using Youden's index. Calibration was evaluated using the Hosmer-Lemeshow test. For secondary endpoints, the Benjamini-Hochberg procedure controlled the false discovery rate at 5%. A complete case analysis was performed for datasets with <5% of missing data. Tests were two-sided, with $p<0.05$ considered significant, following STROBE guidelines.

RESULTS

During the study period, 187 patients aged ≥ 65 years underwent elective vascular surgery. After applying the exclusion criteria, 155 patients were included in the final analysis. The mean age of the cohort was 71.98 ± 5.59 years, with an age range of 65 to 89 years, and 135 (87.1%) of the patients were male. The distribution of the surgical procedures was as follows: EVAR, 81 patients (52.3%); lower-extremity revascularization, 54 patients (34.8%); and carotid endarterectomy, 20 patients (12.9%).

Table 1. Baseline Characteristics by 30-Day Mortality Status

Characteristic	Overall (n=155)	Survivors (n=129)	Non-survivors (n=26)	p-value
Age (years), mean ± SD	71.98 ± 5.59	71.5 ± 5.2	74.1 ± 6.8	0.032
Male gender, n (%)	135 (87.1)	114 (88.4)	21 (80.8)	0.025
BMI (kg/m²), mean ± SD	26.28 ± 4.00	26.5 ± 3.8	25.2 ± 4.9	0.156
ASA Score, mean ± SD	2.77 ± 0.59	2.6 ± 0.5	3.2 ± 0.7	<0.001
Procedure Type, n (%)				0.089
Lower extremity revascularization	54 (34.8)	42 (32.6)	12 (46.2)	
EVAR	81 (52.3)	71 (55.0)	10 (38.5)	
Carotid endarterectomy	20 (12.9)	16 (12.4)	4 (15.4)	
Wound Status, n (%)				0.041
None	137 (88.4)	118 (91.5)	19 (73.1)	
Clean/Contaminated/Infected	18 (11.6)	11 (8.5)	7 (26.9)	
mFI Score, mean ± SD	2.30 ± 1.39	1.96 ± 1.11	3.96 ± 1.48	<0.001
GNRI, mean ± SD	99.34 ± 8.69	101.2 ± 8.1	91.8 ± 8.9	<0.001

Abbreviations: SD, Standard Deviation; BMI, Body Mass Index; ASA, American Society of Anesthesiologists; EVAR, Endovascular Aortic Repair; mFI, modified Frailty Index; GNRI, Geriatric Nutritional Risk Index

Baseline demographic and clinical characteristics were stratified according to the 30-day mortality outcomes. Continuous variables are expressed as mean ± SD, while categorical variables are expressed as n (%). Abbreviations: mFI, modified Frailty Index; ASA for American Society of Anesthesiologists, GNRI for Geriatric Nutritional Risk Index, and EVAR, endovascular aortic aneurysm repair. Statistical analyses were performed using the t-test for continuous variables and the χ^2 test for categorical variables.

Table 2. Frequency of Modified Frailty Index Components (n=155)

mFI Component	n (%)
Hypertension	138 (89.0)
Diabetes mellitus	90 (58.1)
History of PCI/CABG	64 (41.3)
COPD/Pneumonia	45 (29.0)
History of TIA/CVA	38 (24.5)
Congestive heart failure	32 (20.6)
History of MI	28 (18.1)
Functional dependence	25 (16.1)
CVA with neurological deficit	22 (14.2)
Preoperative open wound	18 (11.6)
Impaired sensorium	5 (3.2)

Abbreviations: PCI, percutaneous coronary intervention; CABG, coronary artery bypass grafting; COPD, chronic obstructive pulmonary disease; TIA, transient ischemic attack; CVA, cerebrovascular accident; MI, myocardial infarction

The distribution of the individual components constituting the 11-item modified Frailty Index was presented. Abbreviations: PCI, percutaneous coronary intervention; CABG, coronary artery bypass grafting; COPD, chronic obstructive pulmonary disease; TIA, transient ischemic attack; CVA, cerebrovascular accident; MI, myocardial infarction.

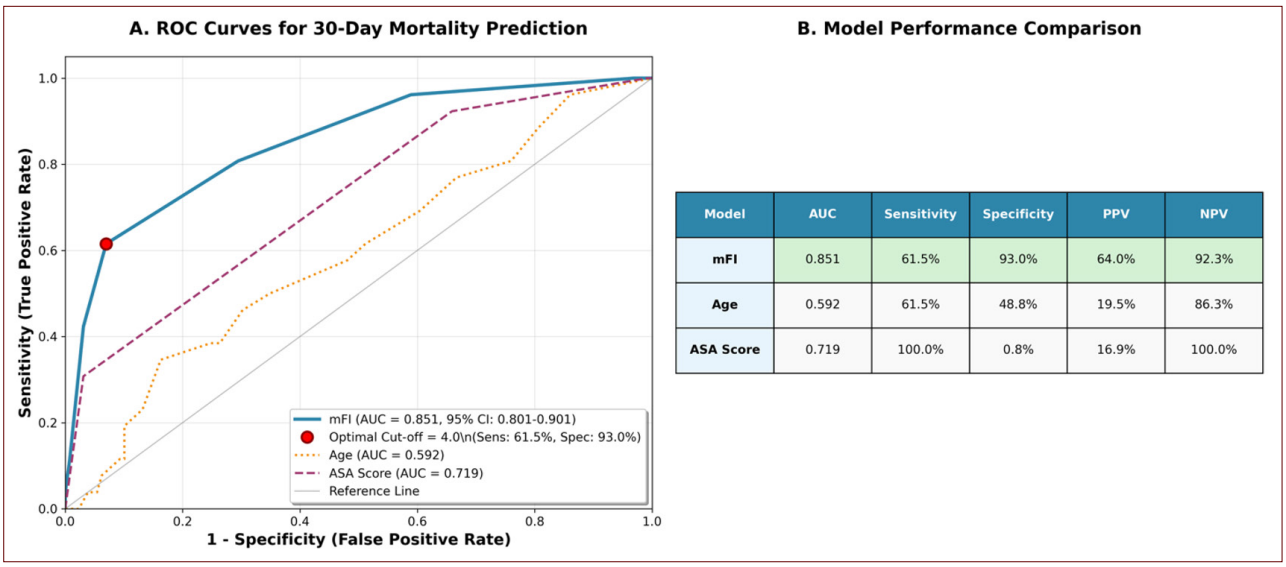
The baseline characteristics stratified by 30-day mortality status are shown in Table 1. Patients who succumbed within 30 days were significantly older (74.1 ± 6.8 years compared to 71.5 ± 5.2 years, p=0.032), more likely to be female (19.2% compared to 11.6%, p=0.025), and exhibited higher American Society of Anesthesiologists (ASA) scores (3.2 ± 0.7 compared to 2.6 ± 0.5, p<0.001) and modified Frailty Index (mFI) scores (3.96 ± 1.48 compared to 1.96 ± 1.11, p<0.001). Additionally, the GNRI scores were significantly lower among non-survivors (91.8 ± 8.9) than among survivors (101.2 ± 8.1, p< 0.001).

Distribution of mFI components

The frequencies of individual mFI components are listed in Table 2. The most prevalent components were hypertension (89.0%), diabetes mellitus (58.1%), and a history of percutaneous coronary intervention (PCI) and coronary artery bypass grafting (CABG) (41.3%). In contrast, an impaired sensorium (3.2%) and preoperative open wounds (11.6%) were the least prevalent components.

Primary outcome: Thirty-day mortality was observed in 26 patients, representing 16.8% (95% CI: 11.3-23.7%). A significant difference was noted in the distribution of the mFI scores between survivors and non-survivors. Specifically, among patients with an mFI ≤2, the mortality rate was 7.3% (8/109), whereas it was 39.1% (18/46) among those with an mFI ≥3 (p<0.001).

ROC analysis for mortality prediction: The mFI exhibited excellent discriminatory capability for predicting 30-day mortality, with an AUC of 0.851 (95% CI: 0.778-0.924, p< 0.001) (Figure 1). The optimal cutoff value, as determined by Youden's index, was 2.5, resulting in a sensitivity of 84.6% (95% CI: 65.1-95.6%) and a specificity of 73.6% (95% CI: 65.0-81.2%). The positive predictive



Model	AUC	Sensitivity	Specificity	PPV	NPV
mFI	0.851	61.5%	93.0%	64.0%	92.3%
Age	0.592	61.5%	48.8%	19.5%	86.3%
ASA Score	0.719	100.0%	0.8%	16.9%	100.0%

Figure 1. ROC curve analysis for the modified frailty index predicting 30-day mortality

The receiver operating characteristic (ROC) curve for the modified Frailty Index in predicting 30-day mortality (n=155) demonstrated an area under the curve (AUC) of 0.851, with a 95% confidence interval (CI) ranging from 0.778 to 0.924, and a p-value of less than 0.001. The optimal cutoff value was determined to be 4, yielding a sensitivity of 84.6%, specificity of 73.6%, negative predictive value (NPV) of 95.9%, and positive predictive value (PPV) of 40.7%. The diagonal line on the ROC curve represents random chance, corresponding to an AUC of 0.50.

Table 3. Multivariable logistic regression analysis for 30-day mortality

Variable	Adjusted OR	95% CI	p-value
mFI (per 1-point increase)	2.79	1.52-5.13	0.001
Female gender	16.72	2.52-110.77	0.004
GNRI (per 1-point increase)	0.78	0.69-0.88	<0.001

Model C-statistic=0.887; Hosmer-Lemeshow p=0.600

Abbreviations: OR, Odds Ratio; CI, Confidence Interval; mFI, modified Frailty Index; GNRI, Geriatric Nutritional Risk Index

Independent predictors of 30-day mortality were determined using a forward stepwise logistic regression analysis. Variables with a p-value of less than 0.10 in the univariate analysis were considered for inclusion in the model. Abbreviations used are as follows: OR, odds ratio; CI, confidence interval; mFI, modified Frailty Index; GNRI=Geriatric Nutritional Risk Index. The model's C-statistic was 0.887, and the Hosmer-Lemeshow test yielded a p-value of 0.600.

Table 4. Secondary outcomes by mFI score categories

Outcome	Overall n (%)	mFI ≤2 n (%)	mFI ≥3 n (%)	p-value	Adjusted OR*	95% CI	p-value
Any complication	70 (45.2)	40 (36.7)	30 (65.2)	0.002	1.89	1.31-2.73	0.001
Surgical site infection	37 (23.9)	20 (18.3)	17 (37.0)	0.014	1.55	1.19-2.03	0.001
Reintubation	21 (13.5)	8 (7.3)	13 (28.3)	<0.001	2.70	1.82-4.02	<0.001
Dialysis-requiring AKI	17 (11.0)	7 (6.4)	10 (21.7)	0.006	2.05	1.43-2.94	<0.001
Myocardial infarction	4 (2.6)	1 (0.9)	3 (6.5)	0.048	2.46	1.27-4.78	0.008
Septic shock	4 (2.6)	1 (0.9)	3 (6.5)	0.048	2.46	1.27-4.78	0.008
Stroke	4 (2.6)	2 (1.8)	2 (4.3)	0.344	1.66	0.91-3.01	0.096

*Adjusted for age, sex, ASA score, and GNRI

Abbreviations: AKI, Acute Kidney Injury; OR, Odds Ratio; CI: Confidence Interval

This study examined the 30-day postoperative complications in patients categorized into low-(mFI ≤2) and high-risk (mFI ≥3) groups. This analysis specifically focused on the incidence of acute kidney injury (AKI). Adjusted odds ratios (ORs) were determined by accounting for variables, such as age, sex, ASA score, and GNRI score. Additionally, p-values were adjusted for multiple comparisons using the Benjamini-Hochberg procedure.

value was 40.7% (95% CI: 28.1-54.3%), while the negative predictive value was 95.9% (95% CI: 90.1-98.7%).

Multivariable analysis for mortality

Variables with a p-value less than 0.10 in the univariate analysis, including age, sex, ASA score, mFI, GNRI, and wound status, were incorporated into the multivariable model. The final model identified the mFI, female sex, and GNRI as independent predictors of 30-day mortality (Table 3). The model exhibited good calibration (Hosmer-Lemeshow χ^2=6.42, p=0.600) and discrimination (C-statistic=0.887).

Secondary Outcomes

The overall complication rate was 45.2% (n=70/155). The most prevalent complications included surgical site infections (23.9%), reintubation (13.5%), and acute kidney injury requiring dialysis (11.0%) (Table 4).

Following correction for multiple testing using the Benjamini-Hochberg procedure, all associations, except for stroke, remained statistically significant (adjusted p<0.05).

Subgroup Analysis by Procedure Type

Due to the limited sample sizes within the individual procedure groups, a formal statistical comparison was not conducted. Nevertheless, the descriptive analysis revealed consistent trends across procedure types, indicating that higher mFI scores were associated with increased complication rates in all groups (EVAR: 38.3 % vs. 65.0 %, p= 0.089; lower extremity: 35.7 % vs. 66.7 %, p= 0.041; and carotid: 31.3 % vs. 75.0%, p= 0.074 for mFI ≤2 vs. ≥3, respectively).

DISCUSSION

This single-center retrospective cohort study showed that the 11-item mFI was an independent predictor of 30-day mortality and major complications in geriatric patients undergoing vascular surgery. Our findings contribute to the literature on frailty assessment in surgical populations and have implications in clinical practice. The key finding was the mFI's exceptional discriminatory capacity in predicting 30-day mortality, with an AUC of 0.851. This performance surpassed previous studies, where Ehlert and colleagues reported AUC values of 0.63 to 0.66 for mFI in predicting mortality following vascular procedures (15). This discrepancy may be attributed



to several factors, including our exclusive focus on geriatric patients (≥65 years), homogeneous single-center setting with standardized perioperative protocols, and comprehensive data collection with rigorous outcome adjudication.

The mortality rates in the low- and high-frailty groups highlight the clinical significance of our findings. Patients with an mFI ≥3 showed 5.4-fold higher mortality than those with an mFI ≤2 (39.1% vs. 7.3%). This risk stratification aids in preoperative counseling and decision-making. The negative predictive value of 95.9% for mFI <2.5 indicates excellent prognosis in low-frailty patients, reassuring both patients and clinicians considering surgery.

Our findings corroborate those of previous studies. The independent association between mFI and mortality (adjusted OR: 2.79, 95% CI: 1.49-5.02 per point increase) aligns with the effect sizes in other surgical populations (8, 9). Our study showed that the impact of frailty extends beyond mortality to various postoperative morbidities.

The secondary outcomes showed that frailty affected multiple organ systems and recovery. Strong associations with reintubation (OR: 2.70, 95% CI: 1.82-4.02), dialysis-requiring acute kidney injury (OR: 2.05, 95% CI: 1.43-2.94), and surgical site infection (OR: 1.55, 95% CI: 1.19-2.03) indicated that frail patients had reduced physiological reserves across the respiratory, renal, and immune systems. These findings support frailty as a syndrome characterized by decreased physiological reserves and increased vulnerability to stressors (4). The absence of an association between mFI and stroke may be due to the low event rate (2.6%), resulting in insufficient power to detect an association. This limitation suggests the need for larger, multicenter studies. The mFI can be calculated using readily available clinical data, making it feasible for pre-operative assessment protocols. The mFI utilizes the existing ACS-NSQIP variables, which are routinely collected in most healthcare systems.

For high-risk patients (mFI ≥ 3), three key interventions should be considered. Preoperative optimization through geriatric assessment, nutritional support, and prehabilitation may enhance physiological reserves (16, 18). Intensive perioperative monitoring can enable prompt recognition of complications. Patient counseling should include frailty-based risk estimates for informed decision making.

The integration of the mFI into clinical practice can affect healthcare resource allocation and quality improvement. High-risk patients may benefit from specialized geriatric surgery pathways, enhanced nursing ratios, or intensive care resources. Risk-adjusted outcome reporting using frailty metrics provides more meaningful benchmarking than age-based adjustment.

Several methodological strengths enhanced the validity of our findings. Consecutive patient enrollment minimizes selection bias, whereas comprehensive outcome assessment with independent adjudication reduces measurement errors. Our rigorous statistical approach, including model calibration and correction for multiple testing, strengthens our conclusions.

The AUC value (0.851) was significantly higher than that in comparable studies (0.63-0.66) (10, 15). Bootstrap validation yielded an optimism-corrected AUC of 0.852, showing no overfitting. Several factors can explain this performance. Our mortality rate (16.8%) exceeded the literature rates (3-8%), enabling better risk stratification. Our single-center design provided results consistent with standardized protocols. The inclusion of elective cases may have resulted in a high-risk group. The higher female mortality (35% vs. 14%, p=0.0437) and small group size (n=20) may have influenced the metrics. While the findings show a strong mFI predictive value, multicenter prospective studies with larger samples are needed for generalizability.

In our study, it is noteworthy that the female gender variable demonstrates an unusually high

odds ratio in our regression model (OR: 16.72; 95CI: 2.52–110.77). This finding is primarily a reflection of sample imbalance in our study (with 87.1% of the cohort being male). The small subgroup of female patients (n=20) and the high mortality rate observed within this group (%35) led to a wide confidence interval for the estimated OR value, thereby reducing statistical precision. This high OR value should be interpreted as a statistical anomaly reflecting risk concentration in a small subgroup, rather than a generalization, and the clinical implications of such findings must be verified by studies with larger and more balanced cohorts.

The 11-item mFI, although validated, represents a simplified frailty assessment that may not capture all the domains. Cognitive function, social support, and functional measures were not directly included, omitting the important aspects that affect surgical outcomes (19). Future research should explore combining mFI with other geriatric assessment tools. The clinical utility of risk prediction tools depends on their performance versus alternatives. Traditional risk assessments include the Lee Cardiac Risk Index, ASA Physical Status Classification, and procedure-specific calculators (20). Studies suggest that the mFI may outperform these tools (10), although direct comparisons in our cohort would strengthen the evidence for clinical adoption.

The superior performance of the mFI reflects its comprehensive evaluation of physiological reserves across multiple systems compared with traditional risk factors. The optimal approach may involve integrating the mFI with other validated risk-prediction tools.

Key research priorities have emerged. First, prospective multicenter validation studies are needed to confirm the generalizability across healthcare systems and populations. Second, studies assessing mFI-guided perioperative optimization strategies could demonstrate the utility of frailty-based risk stratification. Third, economic analyses of frailty assessments could inform health care policies. Fourth, developing dynamic frailty assessment tools to track changes over time may enhance the prognostic accuracy and guide care planning.

Investigating the mechanisms linking frailty to adverse outcomes could help to identify therapeutic targets and develop interventions for high-risk patients.

Despite its limitations, the strengths of this study and its potential contributions to clinical practice enhance the reliability of the results. The most significant contribution of the study is our focus on high-risk geriatric patients and the exceptional discriminatory capacity of the 11-item mFI in predicting 30-day mortality (AUC: 0.851). This performance is superior to similar studies in the existing literature. Methodologically, the consecutive patient enrollment minimizes selection bias, while the comprehensive outcome assessment with independent adjudication reduces measurement errors. Additionally, our rigorous statistical approach, including model calibration and correction for multiple testing, strengthens our conclusions. In terms of contribution to clinical practice, the high negative predictive value of the mFI (%95.9) offers a reassuring prognostic tool for patients with low frailty. The strategies we recommend for high-risk patients (mFI ≥ 3), such as preoperative optimization, intensive perioperative monitoring, and frailty-based risk counseling, can help to improve perioperative management and facilitate the more efficient allocation of healthcare resources. The easy calculability of the mFI makes it a valuable risk stratification tool that is feasible to integrate into clinical workflows.

Limitations

Our study has several limitations that restrict its generalizability. Our single-center retrospective design limits the applicability of the findings to other healthcare systems and populations, and does not entirely exclude the influence of potential unknown confounding factors. The predominantly



male cohort (%87.1), which reflects the typical vascular surgery demographics, may severely limit the applicability of the findings to female patients. Given the higher mortality rate observed in females, these potential sex-specific differences warrant further investigation in future studies. Furthermore, the 30-day follow-up period may have missed late complications and long-term functional outcomes, which are particularly critical for the geriatric population with prolonged recovery times. Finally, the sample size restricted us from conducting reliable subgroup analyses according to the procedure type. Future multicenter prospective studies require larger samples and extended follow-up periods to improve the generalizability of the findings.

CONCLUSIONS

This study showed that the 11-item mFI independently predicted adverse outcomes in geriatric patients undergoing vascular surgery. The index demonstrated excellent discrimination (AUC: 0.851) and a strong association with clinical outcomes, supporting its use in preoperative risk assessment. Patients with mFI scores ≥ 3 require enhanced preoperative optimization and monitoring, whereas those with low scores can expect favorable outcomes. mFI-based risk stratification can improve patient outcomes through personalized care and resource optimization. Future research should focus on multicenter validation and evaluation of mFI-guided interventions in vascular surgery.

Acknowledgments: The authors would like to express their gratitude to the nursing staff and data management team for their invaluable assistance with the data collection. The authors acknowledge the use of Paperpal by Editage (Cactus Communications Services Pte Ltd., Singapore) for providing professional English language editing support during the preparation of this manuscript.

Funding: This research received no specific grants from any funding agency in the public, commercial, or not-for-profit sector.

Conflicts of Interest: The authors declare no conflict of interest related to this work.

Data Availability Statement: The datasets used and analyzed during the current study are available from the corresponding author upon reasonable request, subject to institutional review board approval, and data use agreements.

REFERENCES

12. Etzioni DA, Liu JH, Maggard MA, Ko CY. The aging population and its impact on the surgery workforce. Ann Surg. 2003;238(2):170-177.doi:10.1097/01.SLA.0000081085.98792.3d.
13. Goodney PP, Beck AW, Nagle J, Welch HG, Zwolak RM. National trends in lower extremity bypass surgery, endovascular interventions, and major amputations. J Vasc Surg. 2009;50(1):54-60. doi:10.1016/j.jvs.2009.01.035.
14. Kim SW, Han HS, Jung HW, et al. Multidimensional frailty score for the prediction of postoperative mortality risk. JAMA Surg. 2014;149(7):633-640. doi:10.1001/jamasurg.2014.241.
15. Clegg A, Young J, Iliffe S, Rikkert MO, Rockwood K. Frailty in elderly people. Lancet. 2013;381(9868):752-762.doi:10.1016/S0140-6736(12)62167-9.
16. Lin HS, Watts JN, Peel NM, Hubbard RE. Frailty and post-operative outcomes in older surgical patients: a systematic review. BMC Geriatr. 2016;16(1):157. doi:10.1186/s12877-016-0329-8.
17. Panayi AC, Orkaby AR, Sakthivel D, et al. Impact of frailty on outcomes in surgical patients: A systematic review and meta-analysis. Am J Surg. 2019;218(2):393-400.doi:10.1016/j.amjsurg.2018.11.020.
18. Rockwood K, Mitnitski A. Frailty in relation to the accumulation of deficits. J Gerontol A Biol Sci Med Sci. 2007;62(7):722-727.doi:10.1093/gerona/62.7.722.
19. Ogata T, Sadakari Y, Nakane H, et al. The five-item modified frailty index predicts long-term outcomes in elderly patients undergoing colorectal cancer surgery. World J Surg Oncol. 2023;21(1):268. doi:10.1186/s12957-023-03150-2.

20. Searle SD, Mitnitski A, Gahbauer EA, Gill TM, Rockwood K. A standard procedure for creating a frailty index. BMC Geriatr. 2008;8(1):24. doi:10.1186/1471-2318-8-24.

21. Mrdutt MM, Papaconstantinou HT, Robinson BD, Bird ET, Isbell CL. Preoperative Frailty and Surgical Outcomes Across Diverse Surgical Subspecialties in a Large Health Care System. J Am Coll Surg. 2019;228(4):482-490.doi:10.1016/j.jamcollsurg.2018.12.036.

22. Karam J, Tsiouris A, Shepard A, Velanovich V, Rubinfeld I. Simplified frailty index to predict adverse outcomes and mortality in vascular surgery patients. Ann Vasc Surg. 2013;27(7):904-908.doi:10.1016/j.avsg.2012.09.015.

23. Al-Damluji MS, Smolderen KG, Meng C, et al. Frailty and outcomes following revascularization of lower-extremity peripheral artery disease: Insights from the Vascular Quality Initiative (VQI). Vasc Med. 2022;27(3):251-257. doi:10.1177/1358863X221083701.

24. Matsumoto T, Yamashita S, Yoshiga R, et al. Use of the 11-Item Modified Frailty Index to Determine Accurate Prognosis and Revascularization Strategy in Patients Undergoing Vascular Bypass Surgery for Intermittent Claudication. Ann Vasc Surg. 2023;91:201-209.doi:10.1016/j.avsg.2022.10.025.

25. Cuschieri S. The STROBE guidelines. Saudi J Anaesth. 2019;13(Suppl 1):S31-S34.doi:10.4103/sja.SJA_543_18.

26. Ehlert BA, Najafian A, Orion KC, et al. Validation of a modified Frailty Index to predict mortality in vascular surgery patients. J Vasc Surg. 2016;63(6):1595-1601 e1592.doi:10.1016/j.jvs.2015.12.023.

27. Jia Z, El Moheb M, Nordestgaard A, et al. The Geriatric Nutritional Risk Index is a powerful predictor of adverse outcome in the elderly emergency surgery patient. J Trauma Acute Care Surg. 2020;89(2):397-404.doi:10.1097/TA.0000000000002741.

28. Huang C-Y, Su W-T, Tsai C-H, et al. The Impact of Ideal Body Weight Estimation on Geriatric Nutritional Risk Index (GNRI) Classification and Outcomes in Elderly Trauma Care. Formosan Journal of Surgery. 2025:doi:10.1097/fs9.0000000000000229.

29. Carli F, Bousquet-Dion G, Awasthi R, et al. Effect of Multimodal Prehabilitation vs Postoperative Rehabilitation on 30-Day Postoperative Complications for Frail Patients Undergoing Resection of Colorectal Cancer: A Randomized Clinical Trial. JAMA Surg. 2020;155(3):233-242. doi:10.1001/jamasurg.2019.5474.

30. Robinson TL, Gogniat MA, Miller LS. Frailty and Cognitive Function in Older Adults: A Systematic Review and Meta-Analysis of Cross-Sectional Studies. Neuropsychol Rev. 2022;32(2):274-293. doi:10.1007/s11065-021-09497-1.

31. Look Fong B, Schindler A, Salmon D, Sharma S, Rahimi M. Vasculator: Development of a vascular surgery risk assessment toolbox. JVS-Vascular Insights. 2024;2:doi:10.1016/j.jvsvi.2023.100029.

Turkish Journal of Geriatrics
2025; 28(4):493–501

DOI: 10.29400/tjgeri.2025.466

Gülistan BARCA ÖNEN[1]
Feray GÜRSOY[2]

[1] Aydın State Hospital, Clinic of Anesthesiology and Reanimation, Aydın, Türkiye

[2] Aydın Adnan Menderes University Faculty of Medicine, Department of Anesthesiology and Reanimation, Aydın, Türkiye

Correspondence

Gülistan BARCA ÖNEN
Phone : +905456792096
e-mail : barcaonen@hotmail.com

Received : Sep 24, 2025
Accepted: Nov 22, 2025

Cite this article as:
Barca Önen G, Gürsoy F. Frailty and ASA Score as Independent Predictors of Early Postoperative Cognitive Dysfunction in Older Surgical Patients: A Prospective Cohort Study. Turkish Journal of Geriatrics 2025; 28(4):493–501. doi: 10.29400/tjgeri.2025.466

ORIGINAL ARTICLE

FRAILTY AND ASA SCORE AS INDEPENDENT PREDICTORS OF EARLY POSTOPERATIVE COGNITIVE DYSFUNCTION IN OLDER SURGICAL PATIENTS: A PROSPECTIVE COHORT STUDY

Abstract

Introduction: As the global population ages, the prevalence of age-related decline and geriatric syndromes has increased. Postoperative cognitive dysfunction is a frequent but under-recognized complication in older patients. Frailty, characterized by reduced physiological reserve, may heighten vulnerability to cognitive decline after hospitalization and surgery. Although both conditions have been studied separately, their direct association remains unclear. This study investigated the relationship between frailty, geriatric syndromes, and postoperative cognitive dysfunction to improve understanding of perioperative cognitive vulnerability.

Materials and Method: A total of 305 patients aged ≥65 years were classified into four groups: outpatients, patients without recent surgery, and surgical patients under spinal or general anesthesia. Frailty was assessed with the Fatigue, Resistance, Ambulation, Illnesses, and Loss of weight scale and the 11-item Modified Frailty Index. Cognitive function was evaluated with the Montreal Cognitive Assessment at baseline and on day three. A decline of more than one standard deviation was defined as postoperative cognitive dysfunction.

Results: Postoperative cognitive dysfunction occurred in 46% of patients. Univariate analysis showed associations with age, chronic disease, geriatric syndromes, American Society of Anesthesiologists physical status score, and frailty. Multivariate analysis identified age, American Society of Anesthesiologists score, and frailty as independent predictors. Patients aged ≥85 years and those in American Society of Anesthesiologists class III had 11.6- and 3.2-fold higher risk, respectively. Frail and pre-frail individuals had 11.3- and 4.2-fold higher risk, respectively

Conclusion: Advanced age, higher American Society of Anesthesiologists score, and frailty markedly increased the risk of postoperative cognitive dysfunction. Routine frailty screening may help identify vulnerable patients and guide preventive strategies.

Keywords: Geriatrics; Frailty; Neuropsychological Tests; Cognitive Dysfunction.

The content of this journal is licensed under the Creative Commons Attribution-NonCommercial 4.0 International License.

INTRODUCTION

The global increase in the older population has drawn attention to age-related health challenges and their impacts on surgical outcomes. With advancing age, postoperative complications, particularly postoperative cognitive dysfunction (POCD), have become a growing concern. POCD is associated with prolonged hospital stay, increased morbidity, and reduced quality of life. In recent years, a growing number of studies have explored the relationship between anesthesia, surgery, and cognitive decline in older patients (1).

Although several factors have been proposed, the mechanisms underlying POCD remain unclear. Potential contributors include microembolic events during surgery; patient-related vulnerabilities such as preexisting cognitive impairment or functional decline; and perioperative factors such as immobility, sleep disturbance, malnutrition, dehydration, alcohol use, or polypharmacy. Hemodynamic instability, hypoxia, hypercapnia, hyperglycemia, and electrolyte imbalance have also been implicated. Despite these associations, the precise etiology of POCD has not been clearly established (2). Cognitive decline can arise from hospitalization alone, independent of surgery or anesthesia exposure (3). The diagnosis of POCD is further complicated by the lack of specific clinical markers and the need for standardized pre- and postoperative neurocognitive testing (1).

In addition to POCD, geriatric syndromes represent a cluster of nonspecific multifactorial conditions that are common in old age—including functional decline, immobility, falls, incontinence, and malnutrition—that often overlap beyond a single disease category and contribute to vulnerability, disability, and poor surgical outcomes (4).

Frailty is a related concept that has been increasingly investigated. Introduced in the 1980s, frailty is a state of reduced physiological reserves and resilience, attributed to a cumulative decline across multiple organ systems. It clinically manifests as weight loss, fatigue, sarcopenia, immobility, and impaired balance or gait (5). Frailty increases the risk of morbidity, mortality, and poor functional recovery after surgery. With the growing proportion of frail older adults, frailty assessment has become a crucial component of perioperative care. Recognizing frailty enables clinicians to identify patients at high risk of adverse outcomes and tailor interventions, such as optimization before surgery, enhanced monitoring, and targeted rehabilitation (6).

Based on these considerations, our study aimed to investigate the combined effects of frailty and geriatric syndrome on the postoperative cognitive function in older patients undergoing surgery. We sought to identify factors contributing to POCD while also highlighting areas that can inform perioperative strategies to improve outcomes in this vulnerable population.

MATERIALS AND METHOD

The study was conducted at A.A.M. University Hospital between January 2022 and August 2023 with approval from the Aydın Adnan Menderes University Faculty of Medicine Clinical Research Ethics Committee (Decision No: 2021/181, dated December 20, 2021). Patients aged ≥65 years, classified as American Society of Anesthesiologists (ASA) I–III, hospitalized for at least three days post-surgery, conscious, and fluent in Turkish, were eligible. The exclusion criteria were as follows: intracranial, cardiac, or emergency operations; psychiatric or neurological disease; substance dependence; and postoperative intensive care unit (ICU) intubation. Written informed consent was obtained from all participants. Power analysis based on prior studies determined 300 participants, ensuring 95% power and a 0.05 error margin, with 75 patients per group.

Patients were categorized into four groups: G1—outpatients (control); G2—inpatients without surgery in the last six months, hospitalized for ≥3 days; G3—patients undergoing surgery with spinal anesthesia; and G4—patients undergoing surgery with general anesthesia, both with ≥3 days of hospitalization.



Detailed demographic and clinical data, including age, sex, body weight, education, chronic diseases, medications, depression, geriatric syndromes, and surgical details, were collected preoperatively and postoperatively from the patients or relatives. ASA and surgical risk scores were also calculated. Intraoperative data, such as the anesthesia method, hemodynamics, transfusion, and analgesia, were obtained from the anesthesia records.

Frailty was assessed using the FRAIL scale and the 11-item Modified Frailty Index. Cognitive status was evaluated with the Montreal Cognitive Assessment (MoCA) at baseline in all groups, and additionally on the 3rd day of hospitalization in G2 and on postoperative day 3 in G3 and G4. POCD was defined using the "1 standard deviation rule," meaning a decline of more than one standard deviation compared to baseline test results was considered indicative of POCD

Statistical Analysis

The normality of quantitative variables was assessed using the Kolmogorov–Smirnov test. Data are presented as mean ± standard deviation or median (25th–75th percentile), as appropriate, while categorical variables are expressed as frequencies and percentages.

Group comparisons were performed using the Mann–Whitney U or Kruskal–Wallis tests for independent samples, and the Wilcoxon signed-rank or Friedman tests for dependent measures, as appropriate. Specifically, comparisons of MoCA test scores between groups were analyzed using the Kruskal–Wallis test, whereas preoperative and postoperative (day 3) MoCA scores within the same group were compared using the Wilcoxon signed-rank test.

Associations between categorical variables were evaluated using the chi-squared test. Logistic regression analysis was applied to determine independent predictors of POCD. Statistical significance was set at $p< 0.05$.

RESULTS

Demographics

The study cohort included 305 patients (50.2% female) with a mean age of 73.9±7.5 years, body mass index (BMI) of 26.5 ± 5.9 kg/m^2, and ASA score of 2.0 ± 0.8. Most patients (81%) had only primary education; 29.5% were aged 75–84, and 12.8%

Table 1. Demographic characteristics, comorbidities, geriatric syndromes, lifestyle factors, and medical history

	n	%
Sex		
Female/ Male	153/152	50.2/49.8
Educational Status		
Primary school	247	81.0
Middle school	47	15.4
High school and above	11	3.6
Chronic Disease		
Present	249	81.6
Absent	56	18.4
Geriatric Syndrome		
Present	175	57.4
Absent	130	42.6
Alcohol Use		
Present	20	6.6
Absent	285	93.4
Surgical Operations in the Last 6 Months		
Present	27	8.9
Absent	278	91.1
History of Depression in the Last 6 Months		
Present	38	12.5
Absent	267	87.5
	Mean±SD	
Age (years)	73.90±7.50	
BMI (kg/m2)	26.49±5.94	
Total Number of Chronic Diseases	1.7±1.24	
ASA Score	2.02±0.76	
Total Number of Geriatric Syndromes	1.03±1.02	
Total Number of Drugs Used	2.7±1.9	

were ≥85 years. At least one chronic disease was present in 81.6% of patients, geriatric syndromes in 57.4%, depression in 12.5%, and alcohol use in 6.6%. On average, patients had 1.7 chronic diseases, 1.0 geriatric syndromes, and were taking 2.7 medications each (Table 1).

Comparative statistical results

POCD was observed in 46% of the study population. Univariate logistic regression analysis was conducted to assess the impact of age, chronic diseases, geriatric syndromes, ASA score, history of depression, and frailty scale variables on POCD, revealing that age, chronic diseases, geriatric syndromes, ASA score, and frailty were significantly correlated with an increased risk of POCD. Given the interdependence and mutual influence of these risk factors (such as chronic diseases and ASA scores), a multivariate logistic regression analysis was conducted incorporating these variables. The suitability of the multivariate analysis model was evaluated using the Hosmer-Lemeshow test, indicating that the model was appropriate (p=0.871).

Multiple logistic regression analyses demonstrated that age, ASA score, and frailty were associated with an increased risk of POCD. Patients aged 75-84 years had a 3.526-fold higher likelihood of POCD than those aged 65-74 years (p=0.001),

Table 2. Logistic regression analysis results of risk factors affecting POCD

	Univariate Logistic Regression Odds Ratio (95% CI)	p-value	Multivariate Logistic Regression Odds Ratio (95% CI)	p-value
Age Group				
65-74 Years*	1		1	
75-84 Years	5.001 (2.611-9.603)	**<0.001**	3.526 (1.640-7.582)	**0.001**
≥85 Years	33.402 (7.638-146.077)	**<0.001**	11.653 (2.350-57.793)	**0.003**
Chronic Disease				
Absent*	1		1	
Present	2.492 (1.196-5.194)	**0.015**	1.050 (0.345-3.195)	0.932
Geriatric Syndrome				
Absent*	1		1	
Present	4.460 (2.544-7.818)	**<0.001**	1.147 (0.527-2.497)	0.648
ASA Score				
1*	1		1	
2	1.879 (0.959-3.682)	0.066	0.867 (0.370-2.033)	0.742
3	13.091 (5.763-29.737)	**<0.001**	3.298 (1.139-9.553)	**0.028**
History of Depression				
Absent*	1			
Present	2.112 (0.833-5.352)	0.115		
FRAIL Frailty Score				
Normal*	1		1	
Pre-frail	5.744 (2.290-14.407)	**<0.001**	4.166 (1.538-11.286)	**0.005**
Frail	35.875 (13.790-93.329)	**<0.001**	11.288 (3.628-35.128)	**<0.001**

ASA, American Society of Anesthesiologists; CI, confidence interval.



while patients aged ≥85 years had an 11.65-fold higher likelihood than those aged 65-74 years (p=0.003). Patients with an ASA score of III had a 3.298 times higher risk of developing POCD than those with an ASA score of I (p=0.028). Additionally, patients classified as pre-frail according to the FRAIL scale had a 4.166-fold higher risk of POCD than normal patients (p=0.005), whereas frail patients had an even greater risk, with a rate of 11.288-fold increase compared with normal patients (p< 0.001) (Table 2).

Analysis of FRAIL scale scores by age group revealed that the young-old category (65–74 years) had the highest number of non-frail individuals. The prevalence of frailty was significantly higher in the middle-old (75-84 years) and very old subjects (≥85 years) (p< 0.001). Analysis of frailty status distribution by age group demonstrated a significantly elevated proportion of frail individuals among subjects aged ≥85 years compared with other age groups (p< 0.001) (Table 3). In contrast, the frailty status was comparable among all four study groups (p >0.05).

No significant differences were observed in baseline MoCA test scores among the four groups (p >0.05). On day 3, G2 patients had significantly higher MoCA test scores than G3 and G4 patients 4 (p=0.004). Day 3 MoCA scores in G2, G3, and G4 were significantly lower than baseline scores (p< 0.001) (Table 4).

Analyzing the impact of ICU stay on the change in MoCA test scores from baseline revealed a significant decrease in the MoCA test scores in G3 and G4 patients who were monitored in the postoperative ICU (p< 0.001). Furthermore, upon analyzing the impact of postoperative ICU stay on the occurrence of POCD, we found that 94.5% (n=52) of patients observed in the ICU developed POCD, compared with 42.1% of patients (n=40) who did not receive postoperative intensive care (p< 0.001) (Table 5).

Table 3. Comparison of frailty status across age groups using the FRAIL scale.

	65-74 Years n (%)	75-84 Years n (%)	≥85 Years n (%)	p-value
FRAIL frailty scale				
Normal	72 (40.9)*	9 (10.0)	1 (2.6)	**<0.001**
Pre-frail	60 (34.1)	31 (34.4)	4 (10.3)*	
Frail	44 (25.0)	50 (55.6)*	34 (87.1) †	

*p < 0.05 versus baseline. †p < 0.05 versus reference comparison group.

Table 4. Comparison of baseline and day MoCA test scores between groups

	MoCA Score-baseline Mean ± SD	MoCA Score-day 3 Mean ± SD	p-value
Group 1	20.06 ± 4.88	-	-
Group 2	22.33 ± 3.74	20.76 ± 4.66*†	**<0.001**
Group 3	20.83 ± 4.81	17.76 ± 6.79*	
Group 4	21.91± 3.51	18.05 ± 5.42*	
p-value	0.056	**0.004**	

MoCA; Montreal Cognitive Assessment , *p < 0.05 versus baseline. †p < 0.05 versus reference comparison group.

Table 5. Comparison of MoCA test scores by postoperative intensive care unit length of stay

		Postoperative Intensive Care Unit Stay (days) (Mean ± SD)		p-value
		Present (n = 55)	Absent (n = 97)	
Group 3	Difference in MoCA Test Score	6.54 ± 2.87	1.46 ± 1.72	**<0.001**
Group 4	Difference in MoCA Test Score	6.32 ± 3.73	1.93 ± 2.35	

MoCA; Montreal Cognitive Assessment.

DISCUSSION

A key finding of our study was the marked decline in cognitive function observed on postoperative day 3. Univariate logistic regression analysis revealed that chronic diseases, geriatric syndrome, ASA score, and frailty were associated with an increased risk of POCD. Considering the interdependence of these factors, multivariate regression analysis identified that age, ASA score, and frailty were independent predictors. Specifically, patients aged ≥85 years had an 11.6-fold higher risk of POCD, frail patients had an 11.2-fold higher risk, and patients with ASA III had a 3.2-fold higher risk.

The reported incidence of POCD in older adults varies widely, ranging from 10% to 54% (7), with some studies reporting rates as high as 72% in the immediate postoperative period, decreasing to 30% by six months (8). Our observed incidence of 46% falls within this range.

ASA score has also been reported as a risk factor for POCD. Raats et al. (9) reported a 2.6-fold increase in POCD with ASA ≥III. Likewise, we observed that ASA III was independently associated with a 3.3-fold increase in POCD risk. A high ASA score reflects multiple comorbidities and diminished physiological reserve, which likely predisposes patients to perioperative cognitive decline.

Frailty is a robust predictor of poor outcomes in older patients undergoing surgery. Eyigor et al. (10) reported frailty rates of 31% in those aged 65–74, 53% in 75–84, and 61.5% in patients aged ≥85 years. Chang et al. (11) also documented an age-related increase. Our results confirmed these patterns, with frailty being more common in the advanced age groups.

Chronic disease burden is another key factor. Gülbayrak et al. (12) reported a 56.3% prevalence in those aged ≥60 years, while Özdemir et al. (13) reported 78.8% in ≥65-year-olds. Our cohort had even higher rates, with 82% of patients having at least one chronic condition. Multimorbidity and polypharmacy have been reported to increase frailty and worsen surgical outcomes (14,15). Our cohort had even higher rates, with 82% of patients having at least one chronic condition. Our data align with these findings, although the number of comorbidities was not a significant predictor of POCD when age and frailty were taken into account.

Polypharmacy has been strongly linked to frailty in studies conducted in France, the Netherlands and Japan (15,16). Our cohort exhibited widespread medication use (89%), reflecting a high comorbidity burden. These results suggest that comorbidities, polypharmacy, and frailty form an interrelated cluster that amplifies the vulnerability to POCD.

The relationship between frailty and POCD is increasingly recognized. Evered et al. (17) found that preoperative frailty predicts postoperative neurocognitive disorders after hip replacement. Mahanna-Gabriel et al. (18) documented a higher incidence of POCD in frail than in non-frail patients undergoing noncardiac surgery. Susano et al. (19) reported that frailty is a predictor of delirium after spinal surgery, while Makary et al. (20) linked frailty with postoperative complications in a large prospective cohort study. Our results align with



this finding, suggesting that frailty is a central determinant of POCD. However, in our study, we did not identify a direct effect of geriatric syndromes on POCD; nevertheless, it should be considered that patients with geriatric syndromes may be more prone to frailty.

Hospitalization may also contribute to PCOD. Park et al. (3) demonstrated that older individuals can experience cognitive decline during hospitalization, independent of surgical or anesthetic exposure. Similarly, our results suggest that hospitalization may precipitate POCD through mechanisms such as environmental change, immobility, sleep disruption, and treatment-related stress.

The type of anesthesia used has also been extensively studied. Davis et al. (21) reviewed 16 studies and found no consistent differences between the use of general and regional anesthesia. Rasmussen et al. (22) reported lower early POCD with regional anesthesia, but no long-term differences. Our findings align with this, showing POCD occurrence after both general and regional anesthesia. Although laboratory studies have suggested possible neurotoxic effects of anesthetics (23,24), clinical evidence remains inconclusive. Therefore, patient vulnerability appears to be a more important determinant of POCD than anesthesia itself. Therefore, patient vulnerability appears to be a more important determinant of POCD than anesthesia itself.

ICU stay was identified as another major risk factor. The reported rates of cognitive impairment in ICU patients range from 20% to 80%, depending on comorbidities. McNicoll et al. (25) found that >70% of older ICU patients experienced cognitive decline. In our study, 94.5% of ICU patients developed POCD compared with 42% of non-ICU patients, confirming ICU exposure as a substantial risk factor. This may reflect a combination of critical illness, advanced age, frailty, and ICU-related stressors.

Overall, our findings emphasize that POCD in older patients is multifactorial. Age, frailty, the ASA score, and ICU stay emerged as the most important risk factors. Chronic diseases and polypharmacy indirectly contributed to increased frailty. Education may play a protective role; however, in our cohort, its impact was limited by generally low levels of education. The type of anesthesia appears to be less influential, whereas hospitalization itself plays a notable role. These insights underscore the importance of routine frailty screening, optimization of comorbidities, careful perioperative planning, and minimization of ICU exposure where possible. Tailored rehabilitation and enhanced recovery protocols should be considered to reduce the incidence and impact of POCD in older patients undergoing surgery.

CONCLUSION

POCD remains a significant postoperative complication in older surgical patients. This study demonstrated that advanced age, high ASA score, and frailty are independent predictors of early postoperative cognitive dysfunction, whereas the type of anesthesia was not a determining factor. These findings emphasize the importance of routine assessment of frailty and comorbidities during preoperative evaluation.

Based on our results, integrating frailty assessment into the preoperative phase may allow earlier identification of high-risk patients. Close perioperative monitoring, individualized management, and avoidance of unnecessary ICU admissions in frail individuals could contribute to reducing the frequency of POCD. Routine implementation of frailty screening in clinical practice may strengthen risk stratification and help improve postoperative cognitive outcomes and quality of life in older adults.

Future research should include long-term cognitive follow-up and investigate whether targeted frailty interventions, perioperative optimization strategies, and standardized postoperative care protocols can reduce the incidence and severity of POCD.

Limitations

This study was conducted at a single center with short-term cognitive follow-up limited to postoperative day 3, which restricts the generalizability of the findings and prevents conclusions about long-term cognitive trajectories. The use of MoCA and the 1 standard deviation threshold may overestimate POCD incidence, particularly in individuals with low educational attainment. Depth of anesthesia, intraoperative hemodynamics, and postoperative analgesia protocols could not be standardized, which may influence cognitive outcomes. Although multivariate analyses were performed, residual confounding cannot be entirely excluded.

Acknowledgments: None.

Clinical trial number: Not applicable.

Author contributions: GBÖ, FG: conceived the idea and developed the original study plan; FG: verified the analytical methods; GBÖ: wrote the content of the manuscript; FG: supervised the development of the manuscript. All authors critically revised the draft manuscript and approved the final manuscript.

Funding: No funding was received for this research.

Data availability: The data supporting the findings of this study are available from the corresponding author upon request.

Consent to Participate declaration: Not applicable

Ethics approval and consent to participate: This study was conducted in accordance with the ethical principles of the Declaration of Helsinki and relevant national regulations governing human research. Ethical approval was obtained from the A. A. M. University Faculty of Medicine Clinical Research Ethics Committee (Decision No: 2021/181, dated 20 December 2021). Prior to participation, all patients and/or their legally authorized representatives were informed verbally and in writing about the purpose, methods, and potential risks of the study. Written informed consent was obtained from each participant or their legal guardian. All collected data were kept confidential and used solely for scientific purposes. No interventions outside of routine clinical practice were performed as part of this study.

Consent for publication: Not applicable.

Conflict of interest statement: All authors declare no conflict of interest.

REFERENCES

1. Bekker AY, Weeks EJ. Cognitive function after anaesthesia in the elderly. Best Pract Res Clin Anaesthesiol. 2003;17(2):259-72. doi:10.1016/s1521-6896(03)00005-3.
2. Scott JE, Mathias JL, Kneebone AC. Postoperative cognitive dysfunction after total joint arthroplasty in the elderly: a meta-analysis. J Arthroplasty. 2014;29(2):261-7.e1. doi:10.1016/j.arth.2013.06.007.
3. Park D, Kim HS, Kim JH. The effect of all-cause hospitalization on cognitive decline in older adults: a longitudinal study. BMC Geriatr. 2023;23(1):61. doi:10.1186/s12877-022-03701-4.
4. Cigolle CT, Langa KM, Kabeto MU, et al. Geriatric conditions and disability: the Health and Retirement Study. Ann Intern Med. 2007;147(3):156-64. doi:10.7326/0003-4819-147-3-200708070-00004.
5. Heuberger RA. The frailty syndrome: a comprehensive review. J Nutr Gerontol Geriatr. 2011;30(4):315-68. doi:10.1080/21551197.2011.623931.
6. Bouillon K, Kivimaki M, Hamer M, et al. Measures of frailty in population-based studies: an overview. BMC Geriatr. 2013;13:64. doi:10.1186/1471-2318-13-64.
7. Fournier A, Krause R, Winterer G, et al. Biomarkers of postoperative delirium and cognitive dysfunction. Front Aging Neurosci. 2015;7:112. doi:10.3389/fnagi.2015.00112.
8. Deo H, West G, Butcher C, et al. The prevalence of cognitive dysfunction after conventional and computer-assisted total knee replacement. Knee. 2011;18(2):117-20. doi:10.1016/j.knee.2010.03.006.
9. Raats JW, van Eijsden WA, Crolla RM, et al. Risk factors and outcomes for postoperative delirium after major surgery in elderly patients. PLoS One. 2015;10(8):e0136071. doi:10.1371/journal.pone.0136071.



10. Eyigor S, Kutsal YG, Duran E, et al. Frailty prevalence and related factors in the older adult-FrailTURK Project. Age (Dordr). 2015;37(3):9791. doi:10.1007/s11357-015-9791-z.
11. Chang CI, Chan DC, Kuo KN, et al. Prevalence and correlates of geriatric frailty in a northern Taiwan community. J Formos Med Assoc. 2011;110(4):247-57. doi:10.1016/S0929-6646(11)60037-5.
12. Gulbayrak C, Acik Y, Oguzoncul AF, et al. Frequency and cost of chronic diseases in the elderly admitted to Yenimahalle Training and Research Health Center. Eurasian J Med. 2003;35:7-12. (in Turkish). doi:10.1000/exampledoi028.
13. Ozdemir L, Kocoglu G, Sumer EH, et al. Prevalence and risk factors of some chronic diseases in the elderly population in Sivas city center. Cumhuriyet Univ Fac Med J. 2005;27(3):89-94. (in Turkish).
14. Rolland Y, Dupuy C, Abellan van Kan G, et al. Treatment strategies for sarcopenia and frailty. Med Clin North Am. 2011;95(3):427-38. doi:10.1016/j.mcna.2011.02.008.
15. Herr M, Robine JM, Pinot J, et al. Polypharmacy and frailty: prevalence, relationship, and impact on mortality in a French sample of 2350 old people. Pharmacoepidemiol Drug Saf. 2015;24(6):637-46. doi:10.1002/pds.3772.
16. Yuki A, Otsuka R, Tange C, et al. Polypharmacy is associated with frailty in Japanese community-dwelling older adults. Geriatr Gerontol Int. 2018;18(10):1497-500. doi:10.1111/ggi.13507.
17. Evered LA, Vitug S, Scott DA, et al. Preoperative frailty predicts postoperative neurocognitive disorders after total hip joint replacement surgery. Anesth Analg. 2020;131(5):1582-8. doi:10.1213/ANE.0000000000004893.
18. Mahanna-Gabrielli E, Zhang K, Sieber FE, et al. Frailty is associated with postoperative delirium but not with postoperative cognitive decline in older noncardiac surgery patients. Anesth Analg. 2020;130(6):1516-23. doi:10.1213/ANE.0000000000004773.
19. Susano MJ, Grasfield RH, Friese M, et al. Brief preoperative screening for frailty and cognitive impairment predicts delirium after spine surgery. Anesthesiology. 2020;133(6):1184-91. doi:10.1097/ALN.0000000000003523.
20. Makary MA, Segev DL, Pronovost PJ, et al. Frailty as a predictor of surgical outcomes in older patients. J Am Coll Surg. 2010;210(6):901-8. doi:10.1016/j.jamcollsurg.2010.01.028.
21. Davis N, Lee M, Lin AY, et al. Postoperative cognitive function following general versus regional anesthesia: a systematic review. J Neurosurg Anesthesiol. 2014;26(4):369-76. doi:10.1097/ANA.0000000000000120.
22. Rasmussen LS, Johnson T, Kuipers HM, et al. Does anaesthesia cause postoperative cognitive dysfunction? A randomised study of regional versus general anaesthesia in 438 elderly patients. Acta Anaesthesiol Scand. 2003;47(3):260-6. doi:10.1034/j.1399-6576.2003.00057.x.
23. Krenk L, Rasmussen LS, Kehlet H. New insights into the pathophysiology of postoperative cognitive dysfunction. Acta Anaesthesiol Scand. 2010;54(8):951-6. doi:10.1111/j.1399-6576.2010.02268.x.
24. Bittner EA, Yue Y, Xie Z. Anesthetic neurotoxicity in the elderly, cognitive dysfunction and Alzheimer's disease: a brief review. Can J Anaesth. 2011;58(2):216-23. doi:10.1007/s12630-010-9418-x.
25. McNicoll L, Pisani MA, Zhang Y, et al. Delirium in the intensive care unit: occurrence and clinical course in older patients. J Am Geriatr Soc. 2003;51(5):591-8. doi:10.1034/j.1600-0579.2003.00201.x.

ORIGINAL ARTICLE

BARRIERS AND FACILITATORS TO PHYSICAL ACTIVITY PARTICIPATION IN OLDER ADULTS: A TÜRKİYE–USA COMPARISON

Turkish Journal of Geriatrics
2025; 28(4):502–511

DOI: 10.29400/tjgeri.2025.467

Gülşah ŞAHİN[1]
Hongdao MENG[2]
Debra DOBBS[2]
Ebru YALÇIN[3]

[1] Canakkale Onsekiz Mart University, Sport Sciences Faculty, Canakkale, Türkiye

[2] University of South Florida, School of Aging Studies, Florida, ABD

[3] Canakkale Onsekiz Mart University, School of Graduate Studies, Canakkale, Türkiye

Correspondence

Gülşah ŞAHİN
Phone : +902862182313
e-mail : nazgulsah@hotmail.com

Received : Sep 21, 2025
Accepted: Nov 22, 2025

Cite this article as:
Şahin G, Meng H, Dobbs D et al. Barriers and Facilitators to Physical Activity Participation in Older Adults: A Türkiye–USA Comparison. Turkish Journal of Geriatrics 2025; 28(4):502–511. doi: 10.29400/tjgeri.2025.467

Abstract

Introduction: Although physical activity is a key component of healthy aging, engagement levels among older adults are influenced by sociocultural, economic, and environmental factors that vary across countries. This study aimed to compare these barriers and facilitators of physical activity participation among American and Turkish older adults.

Materials and Method: Data were collected from 128 older adults (64 per country), aged ≥65 years and older, through structured interviews and surveys conducted in parks and senior activity centers in Türkiye, and Florida, United States. The San Diego Health and Exercise Questionnaire and the Structured Interview Questions on Physical Activity Participation Factors were utilized to assess participation patterns and influencing factors. A mixed-methods research design was employed; qualitative data from interviews were analyzed using content analysis, and cross-country differences in questionnaire responses were assessed using the chi-squared test.

Results: Turkish participants reported significantly higher psychological (χ^2 =15.7-42.5, $p<0.001$), individual (χ^2=3.9-8.4, $p<0.05$), social (χ^2=20.2-52.5, $p<0.001$) and environmental (χ^2=27.2-34.2, $p<0.001$) barriers compared to their American older adults. Structured interviews result further showed that social pressure (χ^2= 8.5-39.2, $p<0.001$), gender influence (χ^2=7.3-66.0, $p<0.05$) had more pronounced effects on Turkish older adults. Additionally, Turkish participants reported limited access to exercise facilities and insufficient support($p<0.05$).

Conclusion: Older adults in Türkiye face more pronounced sociocultural and infrastructural barriers to physical activity compared with their counterparts in the United States. Addressing these challenges requires comprehensive reforms in education, economic investment, and cultural awareness. Without targeted and sustainable interventions, opportunities for active aging will remain limited. Culturally informed strategies are essential to promote equitable access to physical activity and to enhance the overall health and well-being of older adults in Türkiye.

Keywords: Aging; Exercise; Social Support; Environment; Culture; Motivation.

The content of this journal is licensed under the Creative Commons Attribution-NonCommercial 4.0 International License.

INTRODUCTION

Physical activity and exercise are essential for maintaining both physical and cognitive health in later life (1). Regular physical activity improves muscle endurance, strength, and cardiovascular health, thereby delaying age-related decline in physical and mental functioning. Conversely, physical inactivity is a notable risk factor that negatively affects cognitive function, physical ability, and quality of life (2,3,4,5).

The World Health Organization has set a global target to reduce physical inactivity by 15% by 2030. Nevertheless, the increase in sedentary behavior following the COVID-19 pandemic has led to mental and physical health problems (6,7). In Türkiye, the ratio of the population aged over 65 years to the general population has increased by 2.3 times compared to the 1935 data. According to TUİK (2024) data, the ratio of the older population to the general population is expected to be 12.9% in 2030, 16.3% in 2040, 22.6% in 2060, and 25.6% in 2080. Along with the increasing older population, sedentary lifestyles are also growing rapidly in Türkiye (8). National reports indicate that many older adults avoid sports or regular exercise despite the well-documented health benefits of physical activity.

In older adults, physical activity levels are influenced by disease, motivation, environment, economic conditions, and socialization (9-13). Previous studies have identified numerous barriers to regular physical activity, including limited time, poor or variable health status, fear of injury, accessibility and safety concerns, cost, lack of information, and low self-discipline or motivation. These barriers significantly reduce participation in exercise, which is essential for maintaining health and preventing disease (14,15,16). Moreover, the design of facilities and the surrounding environment plays a critical role in shaping daily activity patterns among older adults and must be designed to facilitate social interaction, accessibility, and adaptation to physical limitations (16). Factors that motivate participation in regular physical activity include healthcare provider recommendations, intergenerational and family support, evidence of contribution to physical or motor skill development, health benefits, group interaction, and psychosocial factors, such as enjoyment of being with friends (17,18).

However, efforts to identify motivating factors and to improve facilities, conditions, and organizational structure that support physical activity remain limited in Türkiye. Understanding these factors and comparing them with other societies exhibiting higher physical activity may provide new insights for developing effective strategies to enhance participation among Turkish older adults.

In the present study, we conducted a direct comparison between Turkish and American older adults to identify key determinants of physical activity participation. The research aimed to clearly distinguish quantitative and qualitative findings to capture the diversity of cross-cultural facilitators and barriers. Additionally, the study sought to examine the sociocultural, economic, and environmental factors contributing to low physical activity participation among older adults in Türkiye and to contrast these with the factors associated with a higher participation rate in United States.

MATERIALS AND METHOD

Study Population and Ethical Considerations

Study Sample: This study was conducted in collaboration with the School of Aging Studies, University of South Florida which was selected as the comparison group due to the higher physical activity levels among older adults and its well-established support systems. Florida was selected because of its substantial older population, providing an ideal setting for recruiting participants aged 65 and older. As of 2023, Florida had approximately 5 million residents aged 65 and over, representing about 21.7% of its population, the second highest number of older adults among the United States (U.S. Census, 2024). In 2024, 10.6% of the population in Türkiye was aged 65 years and over.

Participants: The study included sixty-four volunteers aged 65 years and over from each country. Participants were community-dwelling, without physical disabilities, and of any gender or ethnicity, and with or without chronic diseases. Participants were selected through convenience sampling, a non-probability method based on accessibility, geographical proximity, availability, and willingness to participate. This approach enabled the inclusion of participants who met pre-determined criteria relevant to this study. Data collection continued until interviews provided no new information, indicating a sufficient sample size.

Ethics: The study protocol was reviewed and approved by the University of South Florida Institutional Review Board (IRB#STUDY007071, date: 30.04.2024). All participants were fully informed about the purpose, procedures, and benefits of the study. The participating organizations provided verbal assent or written permission. Verbal informed consent was obtained before interviews. To maintain anonymity, no personal identifying information was collected, and all responses were treated confidentially. The study was conducted in accordance with the principles of the Declaration of Helsinki and relevant national regulations regarding research with human subjects.

Data Collection

This study was conducted using mixed methods (quantitative and qualitative).

Interview method: A Structured interview was conducted, with validity confirmed through consultation with experts in Gerontology and Sports Sciences. The "Structured Interview Questions on Physical Activity Participation Factors" were designed to comprehensively address all dimensions of the research topic and maintain logical relationships and integrity with each other and the study objectives as "Always vs Never". Open-ended questions were also included to capture participants' perceptions, including positive, negative, advantageous, and disadvantageous aspects.

Survey method: The San Diego Health on Exercise Questionnaire (SDHEQ) was used to determine participants' attitudes toward physical activity. The questionnaire consists of 16 items focused on perceived barriers to exercise, such as individual factors, social pressure, and family responsibility (19). The questionnaire was translated into Turkish for Turkish participants. Although the Turkish version of the SDHEQ has been translated, it has not undergone formal psychometric validation.

Statistical Analysis

SDHEQ and Structured interview responses were analyzed using chi-square tests for "Always and Never" responses. Open-ended responses were analyzed via inductive content analysis. Chi-squared analyses were conducted without adjustment for potential confounding variables due to the exploratory nature of the study and limited sample size. The content analysis followed an inductive approach, meaning that codes and themes were derived directly from raw data without imposing pre-existing categories. First, the researcher reviewed all transcripts to ensure content familiarity. Repeated words, phrases, and meaningful expressions were manually identified and coded. These codes were not predefined; instead, they emerged naturally from participants' language and experiences. A second independent coder was used in the coding process to enhance the reliability of the analysis. Both coders independently analyzed the same dataset using a pre-determined coding framework. Inter-coder agreement, assessed using Cohen's kappa coefficient (0.41-0.60), indicated a moderate level of agreement, supporting the acceptability of the analytical procedure. Given the manageable size of the dataset, coding and theme generation were conducted manually, which allowed close engagement with the data. The process was systematic and transparent, and involved repeated cycles of reading, coding, clustering, and interpretation. Statistical analyses were conducted

using SPSS version 26.0 (IBM Corp., Armonk, NY, USA), with significance set at $p<0.05$.

RESULTS

Although demographic characteristics revealed similar ages and distributions across both groups, notable disparities were observed in the educational level and prevalence of chronic diseases. Notably, 70% of Turkish participants reported having at least one noncommunicable chronic disease, compared with 41% of American participants.

Nearly all-American participants (98%) had a university education, whereas only 16 Turkish participants reported the same, with a considerable proportion having only middle or high school education (Table 1).

Sociocultural and Psychological Barriers in Turkish Older Adults

Significant differences were observed between the groups regarding barriers to physical activity, with Turkish older adults consistently reporting higher levels of psychological, individual, social, and environmental barriers than their American counterparts (all $p < 0.001$). Turkish participants reported significantly more psychological barriers, including self-consciousness about appearance, discouragement, and lack of enjoyment ($\chi^2>15$, $p<0.001$). Turkish participants also experienced more individual constraints, such as a lack of discipline, time, and energy (Table 2).

Environmental limitations, such as a lack of facilities and equipment, were a major concern among Turkish participants ($p<0.001$). Socially, Turkish participants reported high levels of isolation, citing lack of company, skills, and knowledge as substantial deterrents to exercise participation.

Cultural Norms, Social Pressure, and Gender: Major Determinants in Türkiye

Table 3 highlights further disparities from the Structured Interview Questions on Physical Activity

Table 1. Distribution of Participants

Categories		American (n=64)	Turkish (n=64)
Ages (n)	65-69	10	12
	70-74	21	25
	75-79	18	24
	80-86	15	3
Gender	Men	12 (19%)	15 (23%)
	Women	52 (81%)	49 (77%)
Noncommunicable chronic disease	No	38 (59%)	19 (30%)
	Yes	26 (41%)	45 (70%)
Education level	No	-	3 (5%)
	Elementary	-	5 (7%)
	Middle school	-	16 (25%)
	High school	1 (2%)	30 (47%)
	University and post	63 (98%)	10 (16%)
Marital status	Single	21 (33%)	1 (1%)
	Married	25 (39%)	33 (52%)
	Other (divorced, widow)	18 (28%)	30 (47%)

Table 2. The Differences of SDHEQ Answers between American and Turkish Older Adults

Questions Groups	Barrier Questions	χ^2 Value	p-value
Psychological Barriers	Self-consciousness about looks	15.719	< 0.001
	Discouragement	21.888	< 0.001
	Lack of enjoyment	42.535	< 0.001
Individual Barriers	Lack of self-discipline	4.613	< 0.05
	Lack of time	8.402	< 0.05
	Lack of energy	3.896	< 0.05
Environmental Barriers	Lack of equipment	34.218	< 0.001
	Lack of facilities	27.236	< 0.001
Social Barriers	Lack of company	52.509	< 0.001
	Lack of skills	29.452	< 0.001
	Lack of knowledge	20.167	< 0.001

Table 3. Differences in Structured Interview Questions on Physical Activity Participation Factors Answers between American and Turkish Older Adults

Question Groups	Barrier Questions	χ^2 Value	p-value
Social Pressure	Does social pressure keep you from exercising?	39.237	<0.001
	Do your social responsibilities prevent you from exercising?	33.655	<0.001
	Would you give up exercise for your family responsibilities?	8.533	<0.05
Gender Influence	Does your gender keep you from exercising?	46.298	<0.001
Judgment and Support	Do people around you judge you for exercising?	19.661	<0.001
	Do people around you support you in exercising?	16.633	<0.001
Facilities and Accessibility	Do local governments organize campaigns to encourage you to exercise?	5.314	<0.05
	Are you supported by your family to exercise with your peers?	4.571	<0.05
	Are you supported by your relatives in transportation to exercise?	4.068	<0.05
Family Influence and approval	Does your family keep you from exercising?	12.302	<0.001
	Do you think you have the courage to start a physical activity program?	14.582	<0.001
	Do you feel that you have to get the approval of your family members to start the exercise program?	51.139	<0.001
	If your family members do not approve, would you stop participating in the exercise program?	36.009	<0.001
Societal Encouragement and Community Norms	Do you feel like your society encourages you to exercise?	7.334	<0.05
	Is there an exercise place close to your home for older adults?	25.530	<0.001
	Is it commonplace in your community to go to the gym?	66.005	<0.001
	Do your relatives and friends have regular exercise?	21.312	<0.001
	Do relatives support each other in exercising?	25.393	<0.001
Government and Policy	Do you feel that the administration of your country supports your efforts in physical activity?	12.955	<0.001



Participation Factors. Turkish older adults reported higher perceived social pressure ($p<0.001$), family-related obligations, and gender-based limitations hindering their participation in physical activity. The question "Does your gender keep you from exercising?" showed an alarming discrepancy ($\chi^2 = 46.298$, $p<0.001$), emphasizing the cultural impact of gender roles in Türkiye. Family influence emerged as a critical barrier, with Turkish participants significantly more likely to feel the need for family approval before initiating a physical activity program ($p<0.001$), and a significant portion reported they would quit if their family disapproved. These findings strongly suggest that Turkish older adults do not perceive exercise as an autonomous decision. One of the most striking statements during the interviews came from a 72-year-old woman from Türkiye, who stated, "My son says it's shameful for a woman of my age to go to the park alone." This statement underscores the strong social restrictions and family pressures that serve as considerable cultural barriers to physical activity among older Turkish women.

Institutional and Environmental Barriers

Another key finding was the limited institutional and infrastructural support perceived by Turkish older adults, who reported significantly less government, local, and community support for physical activity initiatives ($p<0.001$). Access to exercise-friendly environments and local campaigns was also rated markedly lower than in the United States, highlighting an important policy and planning gap. Additionally, societal norms regarding frequent exercise and group behaviors differed considerably. Turkish participants were much less likely to report that their peers or relatives engaged in regular exercise ($p<0.001$), indicating a broader cultural disconnect from active aging norms.

DISCUSSION

This study identified five key areas for improvement: motivation, environment, economic conditions, and sociocultural issues.

Motivation and Intrinsic Factors

Intrinsic motivation is a key factor in older adults' participation in physical activity (11), as reflected by the high levels observed among older adults in the United States, particularly in Tampa (Table 2). Institutional efforts to promote an active lifestyle through programs designed to enhance both individual and social motivation. These programs encourage older adults to remain physically to preserve their health, improve their quality of life, and engage in social activities (Tables 2 and 3). Program directors and community committees organized promotional events and meetings to maximize engagement and sustain participation. In contrast, physical activity programs for older adults in Türkiye are generally irregular and lack consistency, accessibility, and long-term sustainability. Initiating and maintaining participation remains a major challenge due to low motivation, limited resources, and insufficient organizational support. Furthermore, there no currently institutions offering ongoing, structured, or unstructured exercise programs specifically designed for older adults. Turkish participants reported significantly higher levels of psychological barriers, such as self-consciousness, discouragement, and lack of enjoyment, than their American counterparts ($p<0.001$, Table 2). They also exhibited higher levels of individual barriers, including difficulties with discipline, time management, and energy ($p<0.05$).

Environmental and Infrastructural Disparities

Older adults in Türkiye reported significantly fewer and less accessible opportunities for physical activity compared with their American counterparts ($p<0.05$, Table 3). Although some urban areas offer parks and recreational spaces, these often lack age-friendly infrastructure, including proper walking paths, safe sidewalks, and accessible facilities. Participation in social and physical activities is frequently limited by their declining health, financial insecurity, and limited transportation options (11,20). Structured interventions have been shown to substantially

enhance engagement levels and health outcomes in this population (12). In Tampa, collaborations between municipal authorities, community organizations, and educational institutions have led to the implementation of well-designed exercise programs and professional training initiatives that effectively increase participation. Community-based programs that incorporate structure, accountability, and opportunities for social interaction have been particularly effective in motivating individuals with limited mobility (21). Moreover, neighborhood design and access to local facilities have been shown to reduce barriers to participation (22,23). However, the lack of senior centers and supportive environments in Türkiye further restricts opportunities for regular physical activity ($p<0.001$, Table 2). Addressing these challenges requires local governments to prioritize the development of inclusive, sustainable physical activity programs and to invest in accessible, affordable senior centers.

Economic and Educational Barriers

In Tampa, personal financial status generally does not constrain participation in physical activity, as retirement income enable older adults to prioritize their health and quality of life. Many older adults are aware of the long-term health and cost-saving benefits of maintaining an active lifestyle. In contrast, older adults in Türkiye encounter more pronounced financial constraints that often limit engagement in regular physical activity. The lack of disposable income, coupled with insufficient access to low-cost or free exercise programs, represents a significant barrier to participation. Educational attainment was also higher among American older adults than their Turkish counterparts (Table 1), potentially exacerbating disparities in health literacy and motivation (24). The combination of financial insecurity and lower education levels in Türkiye appears to substantially hinder both intrinsic motivation and the adoption of health-promoting behaviors.

Sociocultural Norms and Gender Dynamics

The physical activity is widely regarded as a routine and integral component of daily life for older adults in U.S. Participation in exercise programs is socially accepted, and individuals rarely encounter judgment from family members or peers (Table 3). This normative cultural attitude supports a more active and autonomous lifestyle in later life. In contrast, sociocultural perceptions in Türkiye present substantial barriers to physical activity. Exercise is often perceived as optional or even inappropriate, particularly for older women, as social restrictions, fear of judgment, and limited societal acceptance frequently discourage their participation (Table 3). Although family members in Turkish society are generally caring and involved, they might unintentionally restrict older adults' independence by making health decisions on their behalf or by underestimating the value of regular exercise. Turkish older adults also reported lower self-esteem and greater hesitation to engage in physical activity than their American counterparts (Table 2). Addressing these barriers requires culturally sensitive public education campaigns and inclusive community-based initiatives aimed at reframing physical activity as a normative and essential aspect of aging. Healthcare professionals and community service providers should prioritize the development of both gender-neutral and responsive programs to promote equitable participation (25).

Institutional Support and Interdisciplinary Collaboration

Interview data confirmed that fitness trainers, along with professional and motivational support, played a key role in promoting participation in physical activity. In the present study, American older adults perceived significantly greater governmental and administrative support for engagement in physical activity ($p<0.001$, Table 3). In Türkiye, the absence of a systematic collaboration between health professionals and exercise specialists represents a



barrier to widespread participation. Strengthening connections among healthcare services, social care systems, and community programs has the potential to substantially enhance physical activity rates among older Turkish adults.

Cross- Cultural Measurement Considerations

It is important to interpret cross-cultural comparisons with caution. Although the instruments employed in this study provided valuable insight, they were not specifically developed or culturally validated for Turkish older adults. To the best of our knowledge, no existing scale provides a fully standardized, culturally sensitive assessment of physical activity barriers and facilitators across both Türkiye and the United States. Consequently. Therefore, some of the observed differences between the two countries may partly reflect measurement limitations rather than purely socio-cultural factors.

Limitations

This study has several methodological limitations that should be considered when interpreting the findings. First, the sample was small and selected via convenience sampling from urban parks and senior centers, which may limit the generalizability of the results. Second, chi-squared analyses were conducted without adjustment for potential confounders due to the exploratory nature of the study and limited statistical power, which should be considered when interpreting the quantitative results. Third, although qualitative data were analyzed systematically and coding and integration within the mixed-methods design were somewhat limited, and inter-coder agreement was assessed using Cohen's kappa, multiple rounds of independent coding and consensus discussions were not performed. This may slightly limit reproducibility; however, the detailed coding process provides reasonable confidence in the qualitative findings. Finally, the cross-sectional design precludes causal inference, and potential confounders such as health status, family responsibilities, and access to healthcare could not be fully controlled. Future studies employing larger, representative samples, culturally validated instruments, and multivariate analyses to strengthen conclusions and enhance cross-cultural comparability.

CONCLUSIONS

Older adults' participation in physical activity is influenced by environmental access, institutional support, and cultural attitudes. Enhancing participation in Türkiye requires investment in inclusive public spaces, sustainable programs, and culturally sensitive interventions, particularly for older women. Promoting active aging is both a health objective and a societal responsibility, requiring coordinated action across multiple sectors.

Acknowledgement: We thank all the participants and the Scientific and Technological Research Council of Türkiye (TUBITAK), Science Fellowships, and the Grant Program Directorate.

Conflict of Interest Statement: The authors declare no conflicts of interest regarding the publication of this article.

Funding: This study was supported by the Scientific and Technological Research Council of Türkiye (TUBITAK), Science Fellowships, and the Grant Program Directorate.

REFERENCES

1. Rhodes RE, Janssen I, Bredin SS, et al. Physical activity: Health impact, prevalence, correlates and interventions. Psychology & Health,2017; 32(8), 942-975.doi: 10.1080/08870446.2017.1325486.
2. Bull FC, Al-Ansari SS, Biddle S, et al. World Health Organization 2020 guidelines on physical activity and sedentary behavior. Br J Sports Med. 2020 Dec;54(24):1451-1462. doi:10.1136/bjsports-2020-102955.

3. Szychowska A, Drygas W. Physical activity as a determinant of successful aging: a narrative review article. Aging clinical and experimental research, 2022;34(6),1209-1214. doi:10.1007/s40520-021-02037-0.
4. Izquierdo-Gomez R, Martínez-Gómez D, Shields N, et al. The role of physical activity in the association between disability and mortality among US older adults: a nationwide prospective cohort study. GeroScience, 2024; 46(3),3275-3285.doi:10.1007/s11357-024-01072-9.
5. Hämäläinen O, Tirkkonen A, Savikangas T, et al. Low physical activity is a risk factor for sarcopenia: a cross-sectional analysis of two exercise trials on community-dwelling older adults. BMC Geriatrics, 2024; 24(1), 212. doi:10.1186/s12877-024-04764-1.
6. İlgili Ö, Kutsal YG. Impact of COVID-19 among the elderly population. Turkish Journal of Geriatrics, 2020. 23(4), 419-423. doi:10.31086/tjgeri.2020.179
7. Stockwell S, Trott M, Tully M, et al. Changes in physical activity and sedentary behaviors from before to during the COVID-19 pandemic lockdown: A Systematic Review, BMJ Open Sport Exerc Med 2021; 7,1-8. doi:10.1136/bmjsem-2020-000960.
8. Ozmete E. (2016). Türkiye Active and Healthy Aging Research. 2016. Republic of Turkey, Ministry of Health, General Directorate of Health Promotion. e-book. Available from:https://yasam.ankara.edu.tr/wpcontent/uploads/sites/259/2019/05/turkiye_aktif_ve_saglikli_yaslanma_arastirmasi-
9. Spiteri K, Broom D, Bekhet AH, et al. Barriers and motivators of physical activity participation in middle-aged and older adults a systematic review. Journal of Aging and Physical Activity, 2019;27(6), 929-944. doi:10.1123/japa.2018-0343.
10. Schmidt LL, Johnson S, Genoe MR, et al. Social interaction and physical activity among rural older adults: a scoping review. Journal of Aging and Physical Activity, 2021; 30(3),495-509. doi:10.1123/japa.2021-0046.
11. Townsend BG, Che JT, Wuthrich VM. Barriers and facilitators to social participation in older adults: a systematic literature review. Clinical Gerontologist, 2021;44(4), 359-380. doi:10.1080/07317115.2020.1863890.
12. Meredith SJ, Cox NJ, Ibrahim K, et al. Factors that influence older adults' participation in physical activity: a systematic review of qualitative studies. Age and Ageing,2023; 52(8), 1-15. doi:10.1093/ageing/afad145.
13. Chen Y, Hou L, Li Y, et al. Barriers and motivators to promotion of physical activity participation for older adults with mild cognitive impairment or dementia: an umbrella review. International Journal of Nursing Studies, 2023;143,104493. doi: 10.1016/j.ijnurstu.2023.104493.
14. Aslan D, Özcebe H, Temel F, et al. What influences physical activity among elders? A Turkish experience from Ankara, Turkey. Arch Gerontol Geriatr, 2008; 46, 79-88. doi:10.1016/j.archger.2007.03.001.
15. Yen IH, Anderson LA. Built environment and mobility of older adults: important policy and practice efforts, J Am Geriatr Soc, 2012;(60)951-56.doi:10.1111/j.1532-5415.2012.03949.x.
16. Haselwandter EM, Corcoran MP, Folta SC, et al.The built environment, physical activity, and aging in the United States: A state of the science review, J Aging Phys Act, 2015; 23(2),323-29. doi:10.1123/japa.2013-0151.
17. Costello E, Kafchinski M, Vrazel J, et al. Motivators, Barriers, and Beliefs Regarding Physical Activity in an Older Adult Population. Journal of Geriatric Physical Therapy, 2011; 34(3):138-147.doi:10.1519/JPT.0b013e31820e0e71.
18. Gothe NP, Kendall BJ. Barriers, motivations, and preferences for physical activity among female African American older adults. Gerontol Geriatr Med, 2016; 2.1-8. doi: 10.1177/2333721416677399.
19. Mouton CP, Calmbach WL, Dhanda R, et al. Barriers and benefits to leisure-time physical activity among older Mexican Americans. Arch Fam Med, 2000;9(9):892-7. doi:10.1001/archfami.9.9.892.
20. Willie-Tyndale D,Holder-Nevins D,Mitchell-Fearon K, et al. Participation in social activities and the association with socio-demographic and health-related factors among community-dwelling older adults in Jamaica. Journal of Cross-Cultural Gerontology, 2016; 31(4),427-447. doi:10.1007/s10823-016-9297-x.
21. Kokorelias KM, Ripat J, Barclay R, et al. A park-based group mobility program for older adults with difficulty walking outdoors: a qualitative process evaluation of the Getting Older Adults Outdoors(GO-OUT) randomized controlled trial. BMC Geriatrics, 2025; 25(1),16. doi:10.1186/s12877-024-05611-z.
22. Lai DW L, Li J, Lee VWP, Dong X. Environmental Factors Associated with Chinese Older Immigrants' Social Engagement. Journal of the American Geriatrics Society, 2019;67(3),571-576.doi:10.1111/jgs.15899.



23. Li X, Zhang W, Zhang W, et al. Level of physical activity among middle-aged and older Chinese people: evidence from the China health and retirement longitudinal study. BMC Public Health, 2020; 20,1682.doi:10.1186/s12889-020-09671-9.

24. Kilgour AH, Rutherford M, Higson J, et al.Barriers and motivators to undertaking physical activity in adults over 70 a systematic review of the quantitative literature. Age and Ageing, 2024; 53(4).doi:10.1093/ageing/afae080.

25. Ong CH, Pham BL, Levasseur M, et al. Sex and gender differences in social participation among community-dwelling older adults:a systematic review. Frontiers in Public Health, 2024;12,1335692. doi:10.3389/fpubh.2024.1335692.

ORIGINAL ARTICLE

TRENDS AND GLOBAL RESEARCH PATTERNS IN GERIATRIC REHABILITATION: A 10-YEAR BIBLIOMETRIC ANALYSIS

Turkish Journal of Geriatrics
2025; 28(4):512–524

DOI: 10.29400/tjgeri.2025.468

İbrahim ULUDOĞAN
Ayşe Merve ÇIRACIOĞLU

Eskisehir City Hospital, Physical Medicine and Rehabilitation, Eskisehir, Türkiye

Abstract

Inroduction: As life expectancy increases globally and populations age swiftly, the significance of geriatric rehabilitation has grown progressively each year. The objective of this study was to conduct a systematic bibliometric analysis of the scientific literature on geriatric rehabilitation published in the last decade.

Materials and Method: The Web of Science Core Collection database was used to examine scientific papers on geriatric rehabilitation from 2015 to 2025. We used VOSviewer and Bibliometrix to do bibliometric analyses. The research analyzed yearly publication trends, contributions by country, productivity of authors and institutions, prominent journals, collaboration networks, citation distributions, co-citation analyses, keywords, and commonly cited references.

Results: We found a total of 666 publications, of which 588 were original articles and 78 reviews. The average yearly increase in publications was 4.97%. The Netherlands ranked first in both publication numbers and international collaborations, followed by Germany and Australia. Vrije University Amsterdam and Leiden University were among the most productive universities. Commonly used keywords were "rehabilitation," "geriatric rehabilitation," "older adults," "aging," and "frailty." In the last few years, the keywords "virtual reality," "index," "consensus," "hospitalization," and "quality of life" have become more popular.

Conclusion: Our analysis shows that research on geriatric rehabilitation has been steadily increasing over the past ten years. Research in this domain has predominantly concentrated on functional enhancement; however, recent years have witnessed an expansion in technological applications and multidisciplinary methodologies. These kinds of studies are expected to help future research and health policy.

Keywords: Geriatrics; Rehabilitation; Bibliometrics.

Correspondence

İbrahim ULUDOĞAN
Phone : +902226114000
e-mail : ibrahimuludogan15@hotmail.com

Received : Oct 09, 2025
Accepted: Nov 22, 2025

Cite this article as:
Uludoğan İ, Çıracıoğlu AM. Trends and Global Research Patterns in Geriatric Rehabilitation: A 10-Year Bibliometric Analysis. Turkish Journal of Geriatrics 2025; 28(4):512–524.
doi: 10.29400/tjgeri.2025.468

The content of this journal is licensed under the Creative Commons Attribution-NonCommercial 4.0 International License.



INTRODUCTION

Rehabilitation is a multidisciplinary health service aimed at augmenting individuals' functional capacity, facilitating independent living, and enhancing quality of life. The World Health Organization (WHO) states that rehabilitation is a comprehensive and organized set of actions designed to reduce health-related disabilities and enhance functional levels.

Longer life expectancy, a high number of chronic diseases, and an aging population have all made rehabilitation services more critical than ever. The United Nations' 2022 report says that by 2050, about 16% of the world's population will be 65 years old or older (1). Geriatric rehabilitation is crucial for enabling older adults to remain independent and maintain their quality of life.

Geriatric rehabilitation encompasses the management of sarcopenia, frailty, declines in physical performance, cardiopulmonary diseases, nutritional deficiencies, cognitive decline, and the increased risk of falls associated with aging. It is a comprehensive approach that considers psychological and social factors alongside physical function. A multidisciplinary team of geriatricians, physiatrists, physiotherapists, occupational therapists, psychologists, and social workers provides care. This team designs and carries out personalized treatment plans for each person based on their needs. Cruz-Jentoft and associates highlighted the significance of geriatric rehabilitation in addressing age-related muscle mass deterioration that may restrict autonomy (2).

The increasing demand in this sector is directly affecting scientific research trends. Bibliometric methods, which are statistical and mathematical tools used to look at academic patterns in a field, are being used more and more to learn about the development dynamics and research directions of the geriatric rehabilitation literature. Nonetheless, studies specific to the field are still quite limited. Azizan et al. have done two bibliometric studies that stand out. The first one looks at SCOPUS data from 1948 to 2022, and the second one looks at SCOPUS and Web of Science (WoS) data from 1947 to 2023. Both claim that the number of publications has increased significantly over the last 25 years. The United States has the most publications, followed by Germany and Canada. Some of the most common keywords are "rehabilitation," "aged," and "hip fracture" (3,4).

The objective of our study is to methodically analyze the scientific literature on geriatric rehabilitation published in the past decade. We use bibliometric analysis to find out about current publication trends, popular research topics, and patterns of international collaboration. Our goal is to help future studies.

MATERIALS AND METHOD

This bibliometric study seeks to discern trends and global research patterns in geriatric rehabilitation by analyzing scientific publications indexed in the Web of Science Core Collection (WoS-CC) from the past decade. The search strategy was delineated as Topic Search (TS)=("geriatric rehabilitation" OR "rehabilitation in older adults" OR "rehabilitation in the elderly" OR "rehabilitation of the aged").

A database search was conducted on May 17, 2025, encompassing studies published within the last decade (2015–2025). In total, 666 records were identified, comprising 588 original research articles and 78 review articles. The analysis encompassed authors, countries, institutions, citations, co-citation trends, journals, keywords, and references.

In our study, publication counts, citation counts, and h-indexes for authors, countries, and institutions were obtained from the Web of Science Core Collection (WoS-CC) database. Document and reference citation analyses and keyword analyses were performed using Bibliometrix, an R-based open-source bibliometric analysis software. This software thoroughly analyzes WoS-CC data and lets you look at critical bibliometric factors like yearly publication trends, productivity

indicators, collaboration metrics, citation analyses, bibliographic structure, and thematic evolution (5). VOSviewer (version 1.6.20, Leiden University, Leiden, the Netherlands) was also used to make network maps based on co-authorship, keyword co-occurrence, and co-citation, as well as to analyze journal publication numbers and citation patterns.

RESULTS AND DISCUSSION

Publication outputs

Bibliometric analyses utilizing primary databases demonstrate a consistent increase in scientific output regarding geriatric rehabilitation in recent years. Azizan and colleagues assert that the inaugural scientific publication in the domain was released in 1948. From the middle of the 1990s to 2013, the number of publications increased significantly, but this trend slowed down after that. On the other hand, the number of publications has been going up again since 2019 (3). Fan Zhang and colleagues published a bibliometric study in 2024 that found a significant rise in research articles on geriatric assessment from 2004 to 2023. In 2022, the number of articles published each year reached a high of 415 (6).

Our results align broadly with existing literature. We found 666 publications in our analysis of the years from 2015 to 2025. Of these, 588 were original research articles and 78 were reviews. The 4.97% average annual increase suggests that interest in the field has resumed. Figure 1 illustrates that both the number of publications and the number of citations increase significantly, particularly after 2020. People think this rise is because older adults needed more health care, care, and rehabilitation during the COVID-19 pandemic. The pandemic's effects on health care and society increased scientific interest in geriatric rehabilitation, which has been seen in the number of publications.

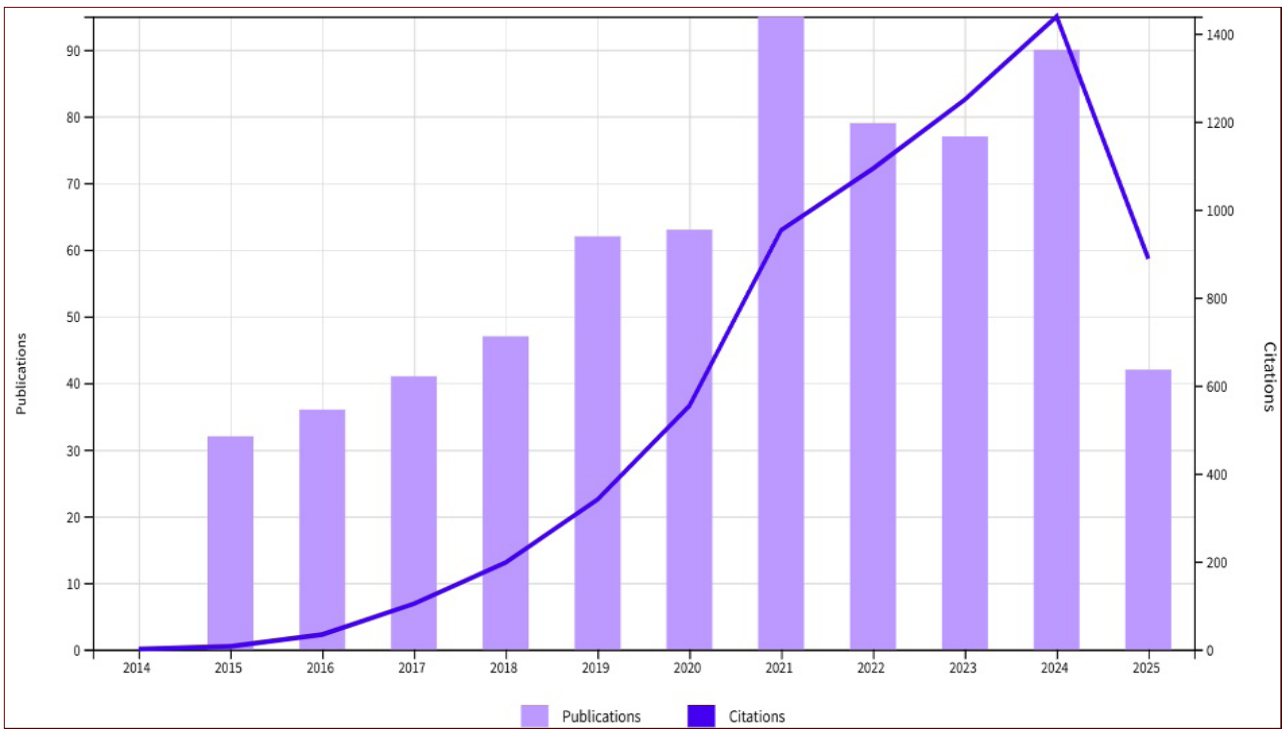


Figure 1. Bibliometric Overview of the Analyzed Publications Annual growth trends in publications and citations (WoS-CC)



Countries/Regions

Table 1 shows the number of publications by country. Of the 62 countries studied, the Netherlands has the most publications (n = 175), followed by Germany (n = 102) and Australia (n = 82). The United States (AC: 12.33) and China (AC: 13.43) have the highest mean citations per paper, which means that research published in these countries has a significant impact on science. In a separate study of geriatric assessment publications from 2004 to 2023, the US was the top country contributor, followed by Italy (14.98%), France (10.16%), the UK (10.11%), Germany (7.54%), Canada (7.19%), the Netherlands (6.60%), Spain (6.55%), Australia (6.08%), and China (5.76%) (6).

Figure 2 illustrates how countries collaborate. The Netherlands and Germany are in the top spots, which indicates that they are essential not only because of the number of publications they produce but also due to the numerous international

Table 1. Key Metrics of the Top 10 Countries, Authors, and Institutions by Publication Count

Countries	P	TC	AC	Authors	P	TC	AC	Institutions	P	C
Netherlands	175	2009	11.59	Maier AB	46	410	8.1	Vrije University Amsterdam	78	808
Germany	102	1014	9.94	Achterberg WP	39	532	13.3	Leiden University	51	564
Australia	82	901	11.12	Reijnierse EM	31	338	10.9	University of Melbourne	50	469
Canada	56	424	7.57	Schols JMGA	24	513	21.38	University of Amsterdam	47	652
USA	52	641	12.33	Bauer JM	23	312	13.57	Royal Melbourne Hospital	45	400
China	49	658	13.43	Hertogh CMPM	21	288	13.71	National University of Singapore	44	321
Switzerland	45	664	10.34	Lim WK	19	252	13.26	Ruprecht Karls University Heidelberg	43	519
Singapore	44	321	7.3	Gordon AL	18	329	18.28	Maastricht University	40	599
Spain	38	396	10.42	Meskers CGM	18	142	7.89	Radboud University Nijmegen	19	268
Israel	34	185	5.44	Wattel EM	18	227	12.61	Tel Aviv University	19	101

P: Publication, TC: Times Cited, AC: Average Cited, C: Citation

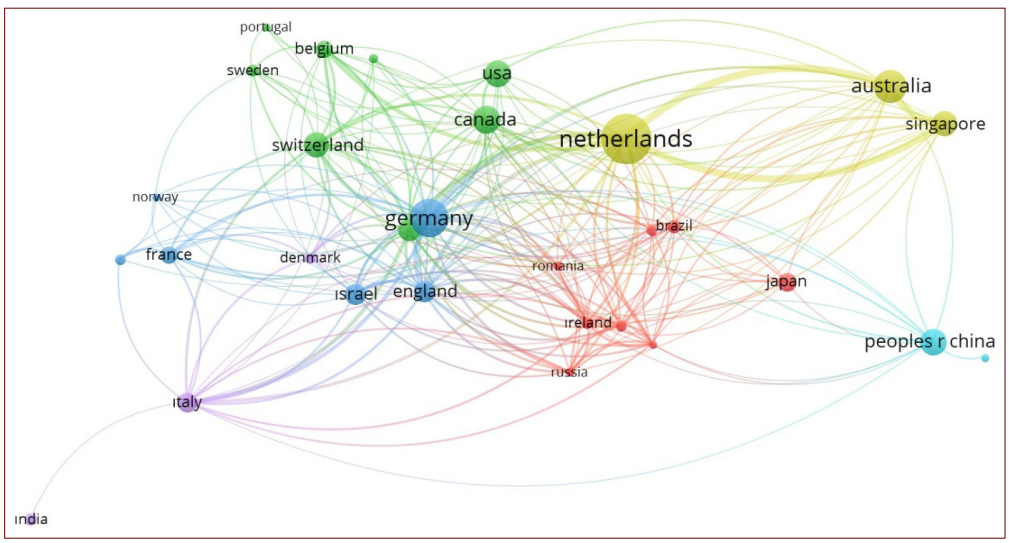


Figure 2. Cross-Country Collaboration Network Generated by VOSviewer

research projects in which they are involved. The relatively large older populations in these countries likely motivate extensive research into age-related conditions.

Authors

The top ten authors who have helped in this area are listed in Table 1. Maier tops the list with 46 publications, followed by Achterberg with 39 publications and Reijnierse with 31 publications. Maier, Achterberg, and Schols are also notable for their scientific impact, as shown by their high citation counts and h-index values.

Figure 3a shows the authors who are most often cited together. The colored clusters show groups of researchers who work in similar fields and are often cited together. Folstein, Mahoney, Tinetti, Podsiadlo, and Cameron are some of the most important people in the red cluster. They focus on evaluating older adults' cognitive and physical function and activities of daily living. The green cluster has Grund, Bachmann, and Covinsky, who are experts in health services, models of care, and functional decline. Rockwood, Katz, Lawton, and Guralnik are all well-known for their work on geriatric assessment scales and frailty, which are part of the yellow cluster. The blue cluster includes experts like Cruz-Jentoft, Cederholm, and Beaudart, who are working on sarcopenia and nutrition. This group is also connected to the European Society for Clinical Nutrition and Metabolism (ESPEN) and EWGSOP guidelines. Folstein, Guralnik, and Rockwood are examples of authors in more central positions with the most co-citation counts. They connect different clusters.

Institute

Table 1 shows the ten institutions that published the most papers. With 78 publications, Vrije Universiteit Amsterdam (n = 78) ranked first, followed by Leiden University (n = 51) and the University of Melbourne (n = 50). Four Dutch universities are in the top ten, which is interesting. This pattern indicates that the Netherlands is a leading player in geriatric rehabilitation, both in terms of the number of services it offers and the number of institutions

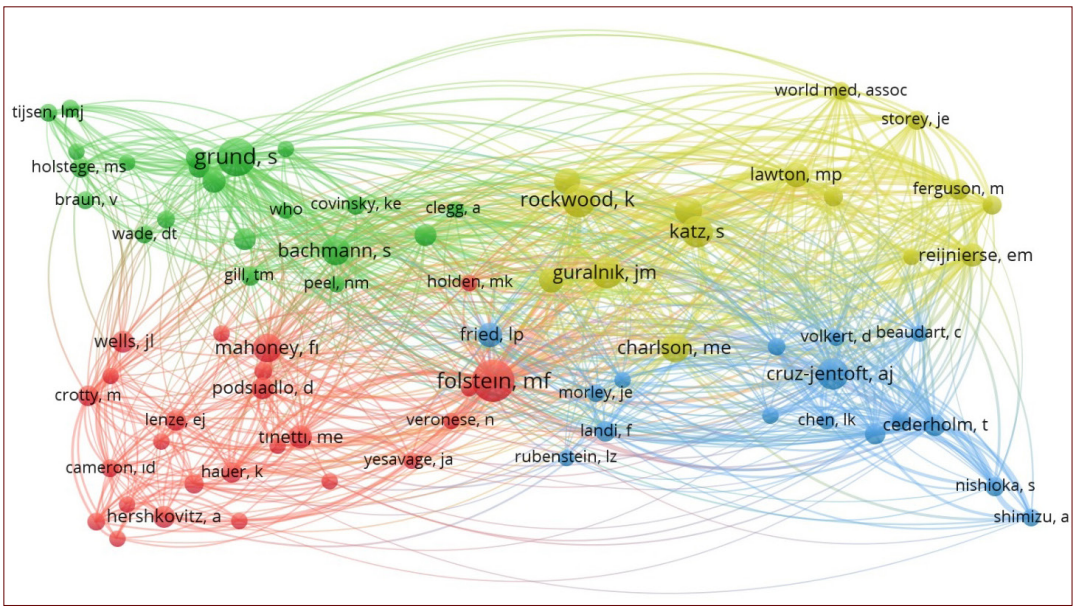


Figure 3a. Co-cited authors network (VOSviewer)



it collaborates with. As the older population increases, the growth of research, health policy initiatives, and collaboration among universities in this area strengthens this trend. The inclusion of institutions like the University of Melbourne (Australia), the National University of Singapore, Heidelberg University (Ruprecht-Karls-Universität Heidelberg, Germany), and Maastricht University (Netherlands) indicates that geriatric rehabilitation research encompasses a broad geographic scope.

Journals

Table 2 shows the ten journals with the most articles and citations in geriatric rehabilitation. BMC Geriatrics, the Journal of the American Medical Directors Association, and European Geriatric Medicine are the top three journals in terms of both publication and citation counts. These titles are the most critical places in the field.

Figure 3b displays the journals that are most often cited together in geriatric rehabilitation. Age

Table 2. Key Metrics of the Top 10 Journals by the Most Publications and Citations

Most publication	P	C	Most-cited	P	C
BMC Geriatrics	38	483	Journal of the American Medical Directors Association	27	582
Journal of the American Medical Directors Association	27	582	BMC Geriatrics	38	483
European Geriatric Medicine	26	355	European Geriatric Medicine	26	355
Journal of Clinical Medicine	17	105	Age and Ageing	10	170
Disability and Rehabilitation	16	158	Disability and Rehabilitation	16	158
Archives of Physical Medicine and Rehabilitation	12	146	Archives of Gerontology and Geriatrics	8	154
Nutrients	12	104	Archives of Physical Medicine and Rehabilitation	12	146
Aging Clinical and Experimental Research	11	140	Clinical Rehabilitation	11	140
Clinical Rehabilitation	11	111	Aging Clinical and Experimental Research	11	111
Topics in Geriatric Rehabilitation	11	16	Journal of Clinical Medicine	17	105

P: Publication, C: Citation, BMC: BioMed Central

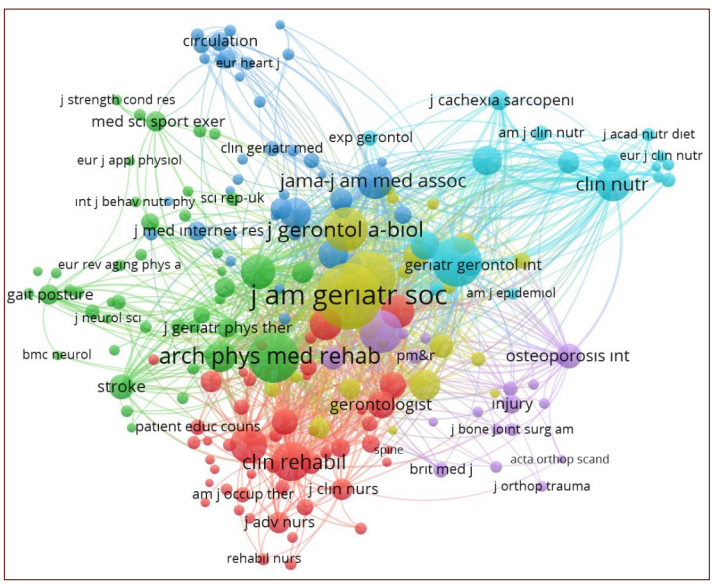


Figure 3b. Co-cited journals network (VOSviewer)

and Ageing, the Journal of the American Geriatrics Society, and The Journals of Gerontology: Series A – Biological Sciences are some of the most critical geriatrics journals in the yellow cluster. The green cluster includes journals that focus on rehabilitation and exercise, such as the Archives of Physical Medicine and Rehabilitation, the Journal of Geriatric Physical Therapy, Gait & Posture, and Medicine & Science in Sports & Exercise. Some of the clinical rehabilitation and physical medicine journals in the red cluster are Clinical Rehabilitation, the Journal of Rehabilitation Medicine, and the European Journal of Physical and Rehabilitation Medicine. The blue and turquoise clusters focus on nutrition and sarcopenia. They include Clinical Nutrition, the Journal of Cachexia, Sarcopenia, and Muscle, and The Journal of the American Medical Association. The purple cluster includes Osteoporosis International and The Journal of Bone and Joint Surgery, which are both about bone health and osteoporosis. The Journal of the American Geriatrics Society, the Archives of Physical Medicine and Rehabilitation, and Age and Ageing are the three journals that are most often cited together.

Citations

Table 3 shows the ten most-cited studies on rehabilitation for older people. The global and local citation counts are used to judge these works separately. The randomized controlled trial by Liu et al. that examined how well respiratory rehabilitation worked in older adults after COVID-19 is the most cited paper in the world, with 434 citations. This shows how the pandemic has affected the field (7). The research conducted by Bouwstra et al. regarding

Table 3. Key Metrics of the Top 10 Most Global and Local Cited Documents

Most Global Cited Documents	C	First Author	Journal	Year
Respiratory Rehabilitation in Elderly Patients with COVID-19: A Randomized Controlled Study (7)	434	Liu K.	Complementary Therapies in Clinical Practice	2020
Measurement Properties of the Barthel Index in Geriatric Rehabilitation (8)	137	Bouwstra H.	Journal of the American Medical Directors Association	2019
Impacts of Robot Implementation on Care Personnel and Clients in Elderly Care Institutions (9)	119	Melkas H.	Journal of Stroke and Cerebrovascular Diseases	2020
Prevalence of Stroke-Related Sarcopenia: A Systematic Review and Meta-Analysis (16)	113	Su Y.	Journal of Stroke and Cerebrovascular Diseases	2020
Assessing Minimal Detectable Changes and Test-Retest Reliability of the Timed Up and Go Test and the 2-Minute Walk Test in Patients with Total Knee Arthroplasty (17)	107	Yüksel E.	The Journal of Arthroplasty	2017
Cardiac Rehabilitation in Older Adults (18)	97	Schopfer W.	Canadian Journal of Cardiology	2016
European Consensus on Core Principles and Future Priorities for Geriatric Rehabilitation: Consensus Statement (15)	87	Grund S.	European Geriatric Medicine	2020
Factors Influencing Home Discharge After Inpatient Rehabilitation of Older Patients: A Systematic Review (19)	85	Everink IHJ.	BMC Geriatrics	2016
Prevalence of Malnutrition Comparing the GLIM Criteria, ESPEN Definition, and Malnutrition Risk in Geriatric Rehabilitation Patients (20)	75	Clark AB.	Clinical Nutrition	2020
Rehabilitation Interventions for Older Individuals with Cognitive Impairment Post-Hip Fracture: A Systematic Review (21)	71	Resnick B.	Journal of the American Medical Directors Association	2016

C: Citation ,GLIM:Global Leadership Initiative on Malnutrition; ESPEN: European Society for Clinical Nutrition and Metabolism; MST: Malnutrition Screening Tool, BMC: BioMed Central

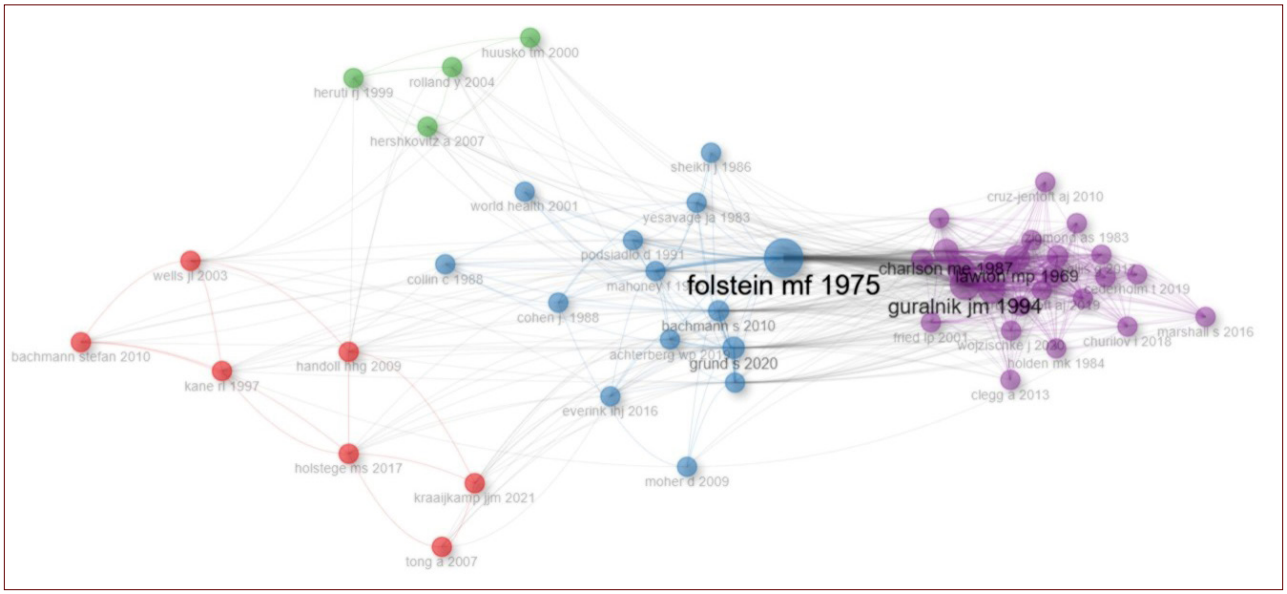


Figure 3c. Co-cited documents network (Biblioshiny)

the measurement properties of the Barthel Index is ranked second, with 137 global citations (8). Melkas et al. are in third place with 119 global citations for their study of how robotic technologies are used in elder care services and how they affect them (9). In the most cited set, topics such as post-stroke sarcopenia, robot-assisted care systems, and the relationship between nutrition and function stand out.

Figure 3c shows the co-citation network in the literature on rehabilitation for older people. There are four main groups: cognitive assessment, physical functioning, care organization, and rehabilitation for specific patient types. The blue cluster is all about testing cognitive skills, and the Mini-Mental State Examination (MMSE) created by Folstein et al. is at the heart of it (10). The purple cluster is based on Guralnik's Short Physical Performance Battery (SPPB), which connects physical function closely with mortality, care needs, and quality of life (11). The red cluster contains the systematic review by Bachmann (2010) about the impact of inpatient rehabilitation on functionality, home care, and mortality (12). The studies in the green cluster examine the effectiveness of hip-fracture rehabilitation for individuals with cognitive impairment. They suggest that even if MMSE scores are low, these patients still benefit significantly and should be included in rehabilitation programs.

Keywords

Commonly used keywords were "rehabilitation," "geriatric rehabilitation," "older adults," "aging," and "frailty." In the last few years, words like "virtual reality," "index," "consensus," "hospitalization," "quality of life," "risk," and "older adults" have received a lot of attention. These terms have become more common since 2021. They point to the growing importance of technology, measurement and assessment methods, and a multidisciplinary focus on quality of life in older adults (Figure 4a).

Figure 4b illustrates the thematic clustering of prominent concepts in geriatric rehabilitation. The words "geriatric rehabilitation" and "rehabilitation" are the most important ones in the center, and they are surrounded by color-coded clusters. The red cluster includes service models and technological uses like telemedicine, virtual reality, post-acute care,

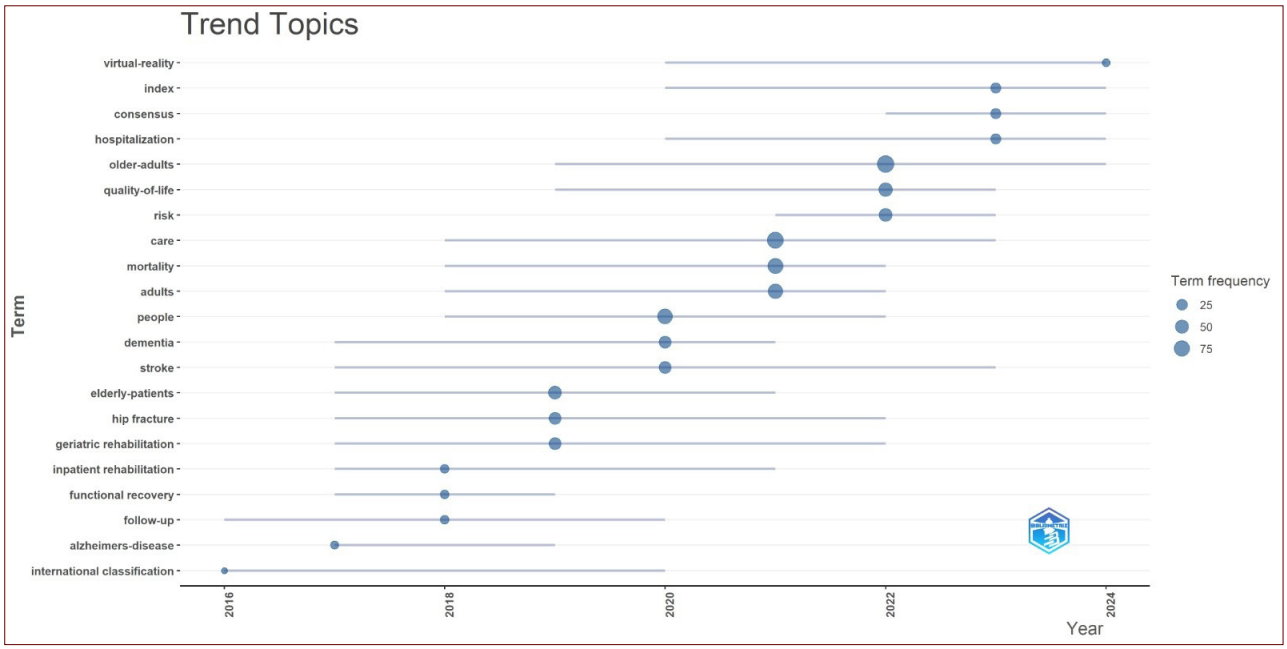


Figure 4a. Trend Topics in Keywords (Biblioshiny).

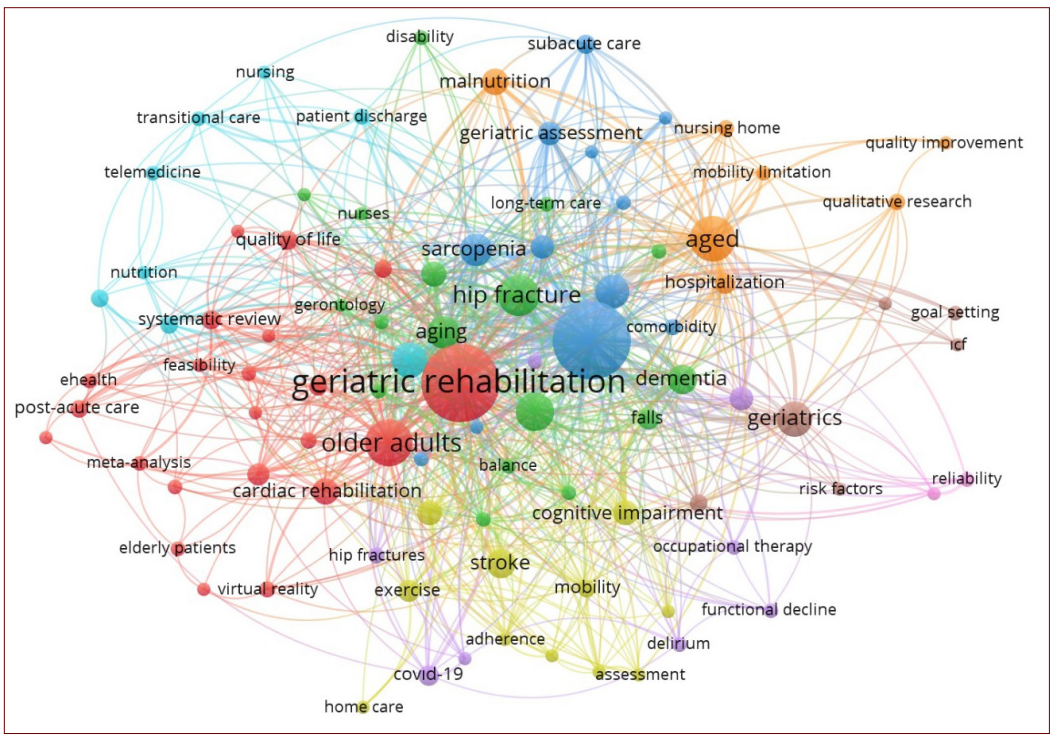


Figure 4b. Co-occurrence Analysis of Keywords (VOSviewer)

and cardiac and pulmonary rehabilitation. The blue cluster is all about clinical conditions and tests, such as sarcopenia, geriatric assessment, and subacute care. The turquoise cluster includes services that help with care transitions, such as discharge, nursing care, telemedicine, and nutrition. The green cluster has themes about hip fractures, aging, dementia, and falls. The yellow cluster has themes about cognitive impairment, stroke, mobility, and exercise assessment. The orange/pink cluster focuses on improving quality, measuring outcomes, and measurement tools, as well as home-based care. The purple cluster is about COVID-19, delirium, functional status, and occupational therapy. The strong connections between these keyword networks suggest that geriatric rehabilitation will keep changing in the next few years in terms of care systems, new technologies, clinical assessments, nutrition, and quality of life.

References

Table 4 shows the sources that have the most local citations. The MMSE, created by Folstein in 1975, is at the top with 132 citations (10). The Short Physical Performance Battery, created by Guralnik in 1994, and the systematic review by Bachmann from 2010 come next (11,12).

Figure 5 displays the most commonly co-cited sources in geriatric rehabilitation. Folstein, Guralnik, and Rockwood are the most frequently cited references. The works of Folstein (1975) and Rockwood (2005) in the green cluster concentrate on cognitive screening, comorbidity, and frailty (10,13). The red cluster has the 2019 guidelines by Cruz-Jentoft and Cederholm that focus on how to diagnose sarcopenia and how to eat well. These papers are often cited because they show how critical muscle mass and nutrition are for older

Table 4. Key Metrics of the Top 10 Most Local Cited References

References	C	First Author	Journal	Year
Mini-Mental State: A Practical Method for Grading the Cognitive State of Patients for the Clinician (10)	132	Folstein, M	Journal of Psychiatric Research	1975
A Short Physical Performance Battery Assessing Lower Extremity Function: Association with Self-Reported Disability And Prediction of Mortality and Nursing Home Admission (11)	71	Guralnik, J	The Journals of Gerontology, Series A: Biological Sciences and Medical Sciences	1994
Inpatient Rehabilitation Specifically Designed for Geriatric Patients: Systematic Review and Meta-Analysis of Randomized Controlled Trials (12)	62	Bachmann S	BMJ	2010
European Consensus on Core Principles and Future Priorities for Geriatric Rehabilitation: Consensus Statement (15)	61	Grund S	European Geriatric Medicine	2020
Functional Evaluation: the Barthel Index (22)	60	Mahoney FI	Maryland State Medical Journal	1965
The Montreal Cognitive Assessment (MoCA): A Brief Screening Tool for Mild Cognitive Impairment (23)	54	Nasreddine ZS	Journal of the American Geriatrics Society	2005
A global clinical measure of fitness and frailty in elderly people (13)	53	Rockwood K	Canadian Medical Association Journal	2005
Studies of Illness in the Aged: The Index of ADL – A Standardized Measure of Biological and Psychosocial Function (24)	48	Katz S	Journal of the American Medical Association	1963
Assessment of Older People: Self-Maintaining and Instrumental Activities of Daily Living (25)	45	Lawton MP	The Gerontologist	1969

C: Citation, BMJ: British Medical Journal

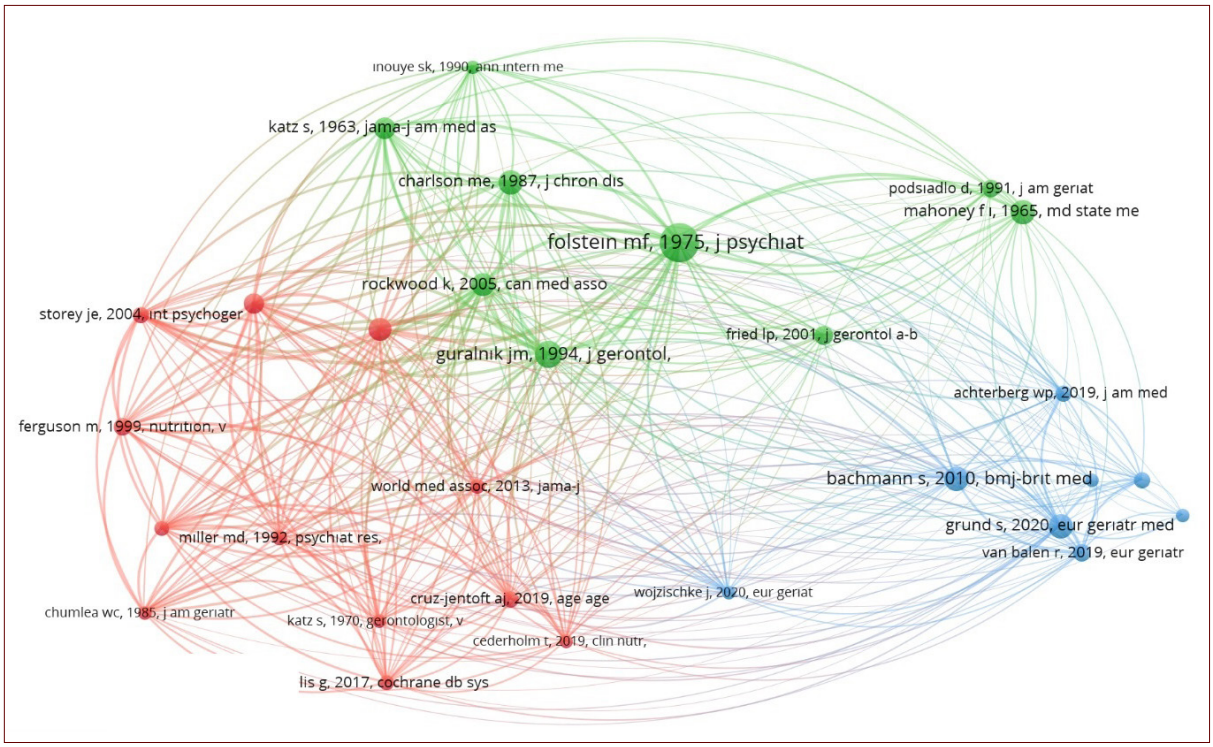


Figure 5. Co-cited references network (VOSviewer)

adults (2,14). The blue cluster, which includes Grund (2020) and Bachmann (2010), talks about European care models and structural ways to organize and combine geriatric rehabilitation services (12,15). When you consider all these results together, they suggest that geriatric rehabilitation services in Europe are well-coordinated.

This study has both strengths and limitations.

As one of the few bibliometric analyses focusing on geriatric rehabilitation, it offers a comprehensive overview of publication trends, collaborations, and research themes over the past decade.However, the analysis was limited to English-language articles indexed in the Web of Science Core Collection, which may have excluded relevant studies from other databases. Moreover, some recently published high-quality papers may not yet have received sufficient citations to be fully represented in the results.

Future studies should combine data from multiple databases and include non-English publications to provide a broader perspective on global research activity.

CONCLUSION

This study delineates the key trends, collaborative networks, and scientific clusters in geriatric rehabilitation by analyzing literature published between 2015 and 2025. The field has consistently increased its academic output over the past decade. In recent years, technology-enabled, multidisciplinary, and function-focused approaches have gained prominence. The increasing significance of subjects like frailty, robot-assisted rehabilitation, and telerehabilitation indicates future research priorities and clinical trajectories. In network analyses, the central roles of countries like the Netherlands, Germany, and Australia show



how important international collaboration is to the field's growth around the world. We anticipate that this study will function as a valuable resource for researchers and policymakers in comprehending trends, collaborative dynamics, and thematic priorities within geriatric rehabilitation.

Funding: None.

Competing interests: The authors declare that they have no competing interests.

Ethical approval: This study did not involve human or animal subjects; therefore, obtaining approval from an ethics committee was deemed unnecessary.

Clinical Trial: Not applicable.

Consent to participate: All authors gave consent to participate.

Consent for Publication: All authors have given written consent for publication.

Author contributions: All authors contributed to the conceptualization and design of the study, as well as to the preparation of materials, data collection, and analysis. All authors read and approved the final manuscript.

REFERENCES

1. Beard JR, Officer A, de Carvalho IA, et al. The World report on ageing and health: a policy framework for healthy ageing. Lancet. 2016;387(10033):2145-2154. doi:10.1016/S0140-6736(15)00516-4.
2. Cruz-Jentoft AJ, Bahat G, Bauer J, et al., Writing Group for the European Working Group on Sarcopenia in Older People 2 (EWGSOP2), and the Extended Group for EWGSOP2. Sarcopenia: revised European consensus on definition and diagnosis. Age Ageing. 2019;48(1):16-31. doi:10.1093/ageing/afy169. Erratum in: Age Ageing. 2019;48(4):601. doi:10.1093/ageing/afz046.
3. Azizan A, Azmi A, Mohd Yusof MYP. Bibliometric analysis on geriatric rehabilitation in Scopus database (1948–2022). Top Geriatr Rehabil. 2024;40(1):60-68. doi:10.1097/TGR.0000000000000423.
4. Azizan A, Rahayu SR. Visualizing the knowledge structure of geriatric rehabilitation: a bibliometric analysis. KEMAS: Journal of Public Health. 2024;19(4):499-510. doi:10.15294/kemas.v19i4.45494.
5. Aria M, Cuccurullo C. Bibliometrix: An R-tool for comprehensive science mapping analysis. J Informetr. 2017;11(4):959-975. doi:10.1016/j.joi.2017.08.007.
6. Zhang F, Xiong Y, Meng X, et al. Bibliometric analysis of comprehensive geriatric assessment from 2004 to 2023. J Multidiscip Healthc. 2024;17:5901-5915. doi:10.2147/JMDH.S488030.
7. Liu K, Zhang W, Yang Y, et al. Respiratory rehabilitation in elderly patients with COVID-19: a randomized controlled study. Complement Ther Clin Pract. 2020;39:101166. doi:10.1016/j.ctcp.2020.101166.
8. Bouwstra H, Smit EB, Wattel EM, et al. Measurement properties of the Barthel Index in geriatric rehabilitation. J Am Med Dir Assoc. 2019;20(4):420-425.e1. doi:10.1016/j.jamda.2018.09.033.
9. Melkas H, Hennala L, Pekkarinen S, et al. Impacts of robot implementation on care personnel and clients in elderly-care institutions. Int J Med Inform. 2020;134:104041. doi:10.1016/j.ijmedinf.2019.104041.
10. Folstein MF, Folstein SE, McHugh PR. Mini-mental state: a practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res. 1975;12(3):189-98. doi:10.1016/0022-3956(75)90026-6.
11. Guralnik JM, Simonsick EM, Ferrucci L, et al. A short physical performance battery assessing lower extremity function: association with self-reported disability and prediction of mortality and nursing home admission. J Gerontol. 1994;49(2):M85-94. doi:10.1093/geronj/49.2.m85.
12. Bachmann S, Finger C, Huss, et al. Inpatient rehabilitation specifically designed for geriatric patients: systematic review and meta-analysis of randomised controlled trials. BMJ. 2010;340:c1718. doi:10.1136/bmj.c1718.
13. Rockwood K, Song X, MacKnight C, et al. A global clinical measure of fitness and frailty in elderly people. CMAJ. 2005;173(5):489-95. doi:10.1503/cmaj.050051.

14. Cederholm T, Jensen GL, Correia MITD, et al., GLIM Core Leadership Committee, GLIM Working Group. GLIM criteria for the diagnosis of malnutrition: a consensus report from the global clinical nutrition community. Clin Nutr. 2019;38(1):1-9. doi:10.1016/j.clnu.2018.08.002.

15. Grund S, Gordon AL, van Balen R, et al. European consensus on core principles and future priorities for geriatric rehabilitation: consensus statement. Eur Geriatr Med. 2020;11(2):233-238. doi:10.1007/s41999-019-00274-1.

16. Su Y, Yuki M, Otsuki M. Prevalence of stroke-related sarcopenia: a systematic review and meta-analysis. J Stroke Cerebrovasc Dis. 2020;29(9):105092. doi:10.1016/j.jstrokecerebrovasdis.2020.105092.

17. Yuksel E, Kalkan S, Cekmece S, et al. Assessing minimal detectable changes and test-retest reliability of the Timed Up and Go test and the 2-minute walk test in patients with total knee arthroplasty. J Arthroplasty. 2017;32(2):426-430. doi:10.1016/j.arth.2016.07.031.

18. 18. Schopfer DW, Forman DE. Cardiac rehabilitation in older adults. Can J Cardiol. 2016;32(9):1088-96. doi:10.1016/j.cjca.2016.03.003.

19. Everink IH, van Haastregt JC, van Hoof SJ, et al. Factors influencing home discharge after inpatient rehabilitation of older patients: a systematic review. BMC Geriatr. 2016;16:5. doi:10.1186/s12877-016-0187-4.

20. Clark AB, Reijnierse EM, Lim WK, et al. Prevalence of malnutrition comparing the GLIM criteria, ESPEN definition and MST malnutrition risk in geriatric rehabilitation patients: RESORT. Clin Nutr. 2020;39(11):3504-3511. doi:10.1016/j.clnu.2020.03.015.

21. Resnick B, Beaupre L, McGilton KS, et al. Rehabilitation interventions for older individuals with cognitive impairment post-hip fracture: a systematic review. J Am Med Dir Assoc. 2016;17(3):200-5. doi:10.1016/j.jamda.2015.10.004.

22. Mahoney FI, Barthel DW. Functional evaluation: the Barthel index. Md State Med J. 1965;14:61-65.

23. Nasreddine ZS, Phillips NA, Bédirian V, et al. The Montreal Cognitive Assessment, MoCA: a brief screening tool for mild cognitive impairment. J Am Geriatr Soc. 2005;53(4):695-9. doi:10.1111/j.1532-5415.2005.53221.x. Erratum in: J Am Geriatr Soc. 2019;67(9):1991. doi:10.1111/jgs.15925.

24. Katz S, Ford AB, Moskowitz RW, Jackson BA, et al. Studies of illness in the aged. The index of ADL: a standardized measure of biological and psychosocial function. JAMA. 1963;185:914-919. doi:10.1001/jama.1963.03060120024016.

25. Lawton MP, Brody EM. Assessment of older people: self-maintaining and instrumental activities of daily living. Gerontologist. 1969;9(3):179-86.

Turkish Journal of Geriatrics
2025; 28(4):525–533

DOI: 10.29400/tjgeri.2025.469

Ahmet AKSOY
Ahmet ASLAN
Hamza Can AKDENİZ

Alanya Alaaddin Keykubat University,
Orthopedics and Traumatology, Antalya, Türkiye

ORIGINAL ARTICLE

THE RADIOLOGICAL RISK FACTORS AFFECTING MECHANICAL FAILURE IN THE SURGICAL TREATMENT WITH PROXIMAL FEMORAL NAIL OF INTERTROCHANTERIC FRACTURES IN ELDERLY PATIENTS: A RETROSPECTIVE COHORT STUDY

Abstract

Introduction: The aim of this study was to determine the rates of mechanical failure in patients who underwent proximal femoral nail fixation for intertrochanteric femur fractures, to identify the radiological risk factors for these failures, and to examine in particular the influence of the tip-apex distance and the femoral neck-shaft angle on treatment outcomes.

Materials and Method: A total of 90 patients who underwent proximal femoral nail fixation for intertrochanteric femoral neck fractures between 2019 and 2024 were retrospectively evaluated. Demographic, clinical, and radiological data were analyzed. The relationship between treatment success and the femoral neck-shaft angle and tip-apex distance was investigated. Statistical analyses included the Mann–Whitney U test, chi-square test, receiver operating characteristic curve analysis, and logistic regression.

Results: Mechanical failure occurred in 66.7% of the patients. In this group, the femoral neck-shaft angle was significantly higher (129.66 ± 7.20°, p=0.037), and the tip-apex distance value was greater (25.25 ± 8.37 mm, p=0.045). Receiver operating characteristic curve analysis revealed cutoff values of 119° for the femoral neck-shaft angle and 27 mm for the tip-apex distance.

Conclusion: The most important factors associated with treatment failure are improper implant positioning with an unfavorable femoral neck-shaft angle and an increased tip-apex distance. Maintaining the femoral neck-shaft angle within the range of 125°–130° and a tip-apex distance of less than 25 mm during surgical planning appears to improve success rates. However, these parameters alone are insufficient, and comprehensive evaluation of all contributing factors remains essential for clinical success.

Keywords: Bone Nails; Fracture Fixation; Hip Fractures; Prosthesis Failure; Treatment Failure.

Correspondence

Ahmet AKSOY
Phone : +905536465250
e-mail : dr.aksoyahmet@gmail.com

Received : Oct 25, 2025
Accepted: Dec 10, 2025

Cite this article as:
Aksoy A, Aslan A, Akdeniz HC. The Radiological Risk Factors Affecting Mechanical Failure in the Surgical Treatment with Proximal Femoral Nail of Intertrochanteric Fractures in Elderly Patients: a retrospective cohort study. Turkish Journal of Geriatrics 2025; 28(4):525–533.doi:10.29400/tjgeri.2025.469

The content of this journal is licensed under the Creative Commons Attribution-NonCommercial 4.0 International License.

INTRODUCTION

Low-energy hip fractures are often seen in patients aged over 60 years and are an important cause of morbidity and mortality (1, 2). As age and the prevalence of osteoporosis increase, there is also an increased frequency of intertrochanteric region fractures, which constitute a significant proportion of all hip fractures. These fractures are generally treated surgically (3). The application of Proximal Femoral Nail (PFN) is often the most preferred surgical treatment method because of the advantages that it can be applied with a minimally invasive technique and allows early mobilisation (4).

In addition to the advantages of PFN used in the surgical treatment of intertrochanteric region fractures, such as osteosynthesis, mechanical properties compatible with femur anatomy, and stability provided in the weight-bearing region, some disadantages have also been reported (5). The success of fracture treatment with PFN can be affected by many biological, biomechanical, and clinical factors. These factors include the type of fracture, nail design, the number of lag screws, tip-apex distance, blade type, reduction quality, the general condition of the patient, patient age, position of the screw and/or blade, experience of the surgeon, osteoporosis status, and bone quality (6). The most important factors affecting poor outcomes are malposition, screw migration, loss of fracture reduction, and implant failure (7). PFN failure occurring because of inability to meet the mechanical loading of the implant can lead to serious outcomes requiring revision surgery. Despite advances in PFN applications for intertrochanteric fractures, treatment is not successful in some elderly patients, and in these cases where PFN treatment is not successful, more invasive and expensive options may be required such as total hip arthroplasty (THA) (8). In the literature there is heterogenous information about the clinical and radiological results of PFN treatment of these fractures (6, 9-11).

The aim of this study was to comprehensively analyze the radiological factors affecting success in patients with intertrochanteric femur fracture treated with PFN.

METHOD

Study Inclusion and Exclusion Criteria

This retrospective study was conducted by examining the files of patients who underwent surgical treatment with PFN because of a femur intertrochanteric fracture in our hospital between 2019 and 2024. The study inclusion criteria were defined as patients with AO/OTA 31-A1, AO/OTA 31-A2, and AO/OTA 31-A3 type intertrochanteric femur fracture who underwent surgical treatment with PFN, had a follow-up period of at least 1 year, had postoperative radiographic records, and attended clinic follow-up appointments regularly. Patients were excluded from the study if they had a pathological fracture (eg. fracture due to malignancy), accompanying neurovascular injuries, open fractures, or if they were immobile.

The files were reviewed of 300 patients in our hospital with intertrochanteric region fracture within the specified dates. The results of 90 patients who met the study criteria were analyzed.

Ethical Approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The study was approved by the Alanya Alaaddin Keykubat University Faculty of Medicine Clinical Research Ethics Committee, (Document date and number:11.12.2024/26-16). The procedures used in this study adhere to the tenets of the Declaration of Helsinki.



Surgical Technique

All the surgical procedures were performed with a standard protocol by a similar surgical team in the same centre. In the operative procedure, the fracture was reduced under C-arm fluoroscopy guidance, then fixated with a femur proximal femoral nail of appropriate length and diameter. For successful reduction and fixation, the criteria of femur neck-shaft angle of a minimum of 125°, and the tip-apex distance <25mm were taken into consideration.

Measurement Methods:

Two-way postoperative hip radiographs of all the patients were taken and recorded in the hospital digital records system. During the follow-up period, complications were recorded such as loss of the femur neck-shaft angle (varus angulation) or the development of cut-out (emergence of the screw or blade outside the femur head). Measurements of the TAD and femur neck-shaft angle were performed on the radiographs and recorded. Failure criteria were defined as varus collapse of the neck-shaft angle and subsequent cut-out.

In addition to radiological measurements, postoperative reduction quality and prognosis were also evaluated according to the Chang reduction criteria. Reduction was classified as good, acceptable, or poor based on alignment, fracture contact, and implant positioning on postoperative anteroposterior and lateral radiographs. This classification was used to further analyze its relationship with mechanical failure.

Statistical analysis

Data obtained in the study were analyzed statistically using SPSS vn. 27.0 software (IBM Corpn., Armonk, NY, USA). Descriptive statistics were stated as mean ± standard deviation (SD) , median, minimum and maximum values for continuous variables and number (n) and percentage (%) for categorrical variables. The conformity of numerical data to normal distribution was analyzed with the Kolmogorov-Smirnov test and the distribution was seen to be not normal. Therefore, the Mann Whitney U-test was used in the comparisons of two independent groups and the Kruskal-Wallis test was used in the comparisons of multiple groups. To determine relationships between categorical data, Monte Carlo Exact Chi-square analysis was applied. Receiver Operating Characteristic (ROC) analysis was performed to determine the diagnostic value of the tip-apex distance value. For 5% type-1 error rate in the analyses, a value of $p<0.05$ was accepted as statistically significant.

RESULTS

Evaluation was made of 90 patients, comprising 41.1% males and 58.9% females with a mean age of 78.02±15.38 years (median, 82.5 years; range, 19-101 years). The PFN treatment was successful in 33.3% of the patients and mechanical failure developed in 66.7%.

The demographic characteristics of the patients are presented in Table 1. According to the AO classfication, 52.2% of the patients had Type A1, and 47.8% had Type A2 fractures. The fractures were left-side in 54.4% of the patients and right-side in 45.6%. PFN was applied with a single screw in 77.8% of the patients and with a double screw in 22.2%.

Patients with traumatic etiology (traffic accident, earthquake, fall from bicycle) were observed only in the failure group ($p=0.015$). No significant difference was determined between the groups in respect of the other demographic variables (age, gender, height, weight, ICU admission, duration of operation) ($p>0.05$).

In the radiological findings, the neck-shaft angle was determined to be 129.66±7.20° in the failure group, and 122.47±15.84° in the successful group, and the difference was statistically significant ($p=0.037$). The TAD value was statistically

Table 1. Patient characteristics according to the success status after PFN operation

Variables	Categories	Failure	Success	p
		N (%)		
Nail number	Single	46 (76.7)	24 (80)	0.718
	Double	14 (23.3)	6 (20)	
Side	Left	33 (55)	16 (53.3)	0.881
	Right	27 (45)	14 (46.7)	
AO type	A1	32 (53.3)	15 (50)	0.765
	A2	28 (46.7)	15 (50)	
Gender	Male	25 (41.7)	12 (40)	0.880
	Female	35 (58.3)	18 (60)	
Etiology	Fall from standing	48 (80)	30 (100)	0.015*
	Traffic accident	5 (8.3)	0 (0)	
	Earthquake	6 (10)	0 (0)	
	Fall from bicycle	1 (1.7)	0 (0)	
ICU admission	No	26 (43.3)	17 (56.7)	0.232
	Yes	34 (56.7)	13 (43.3)	
		Mean±SD Median; Min-max		
Femur neck-shaft angle (degrees)		129.66±7.20 130.50; 108-144	122.47±15.84 125.90; 75.30-145	0.037**
Tip-apex distance(mm)		25.25±8.37 25.50; 8-44	21.43±8.34 22; 5-50	0.045**
Age (years)		75.71±17.25 81.50; 19-97	82.63±9.37 85; 58-101	0.108
Weight (kg)		71.91±13.47 73; 45-105	70.33±14.36 70; 40-95	0.655
Height (cm)		166.28±7.23 165; 150-183	163.23±8.05 160; 150-185	0.057
Length of stay in ICU (days)		1.65±2.42 1; 0-11	1.63±4.24 0; 0-23	0.300
Operation duration (hours)		1.98±1.78 2; 0-8	2.66±1.80 2.50; 0-7	0.062
Length of hospitial stay (days)		6.58±2.83 6; 2-16	9.30±7.23 7; 3-30	0.221

*: Level of statistical significance 0.05 according to the Chi-square analysis

**: Level of statistical significance 0.05 according to the Mann Whitney U-test

significantly greater in the failure group (25.25±8.37 mm) than in the successful group (21.43±8.34 mm) (p=0.045).

In the subgroup analyses, the TAD values of patients applied with double screws were determined to be significantly higher in both the successful and groups (p<0.01). The angle values of patients with A1 type fracture in the failure group were observed to be at a significantly high level (p=0.026). The length of stay in hospital of females in the failure group was seen to be significantly prolonged (p=0.038). The angle values of patients in the failure group who were admitted to ICU were found to be significantly higher (p=0.017).

When the failure group was evaluated according to the Chang reduction criteria, the majority of patients demonstrated inadequate reduction characteristics, including insufficient medial cortical support, suboptimal alignment, and unfavorable implant positioning. In this group, a considerable proportion of patients also showed radiological risk factors such as increased tip–apex distance and non-optimal femoral neck–shaft angles, supporting the association between poor reduction quality and mechanical failure.

In the ROC analysis performed to predict the success status, the Area under the Curve (AUC) was determined to be 0.635 for the angle value (p=0.037), and 0.629 for TAD (p=0.046). At a cut-off value of 119° for the femur neck-shaft angle, sensitivity was found to be 36.7% and specificity 95%. A cut-off value of 27mm for TAD was determined to have 86.7% sensitivity and 48.3% specificity. (Figure 1. ROC curve for the angle value; Figure 2. ROC curve for the tip-apex distance).

In the logistic regression analysis, taking the patient group that resulted in failure as the reference, only the neck-shaft angle was determined

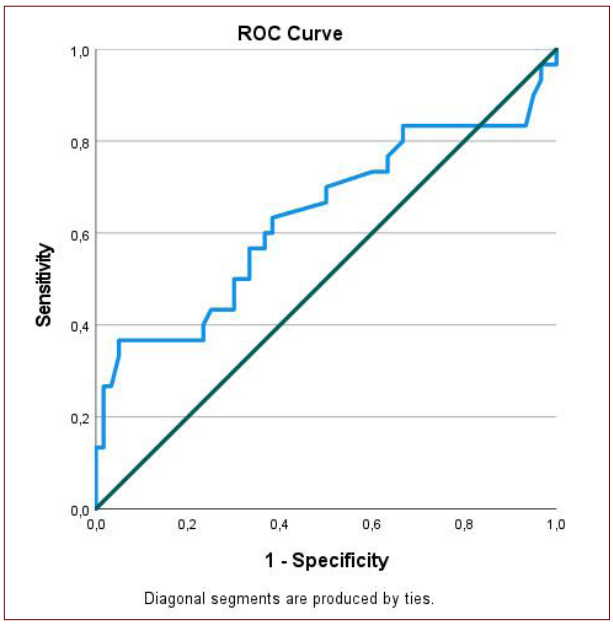


Figure 1. Receiver operating characteristic (ROC) curve of the femoral neck–shaft angle for predicting mechanical failure after proximal femoral nail fixation. The area under the curve (AUC) was 0.635 (p=0.037), with a cut-off value of 119° yielding 36.7% sensitivity and 95% specificity.

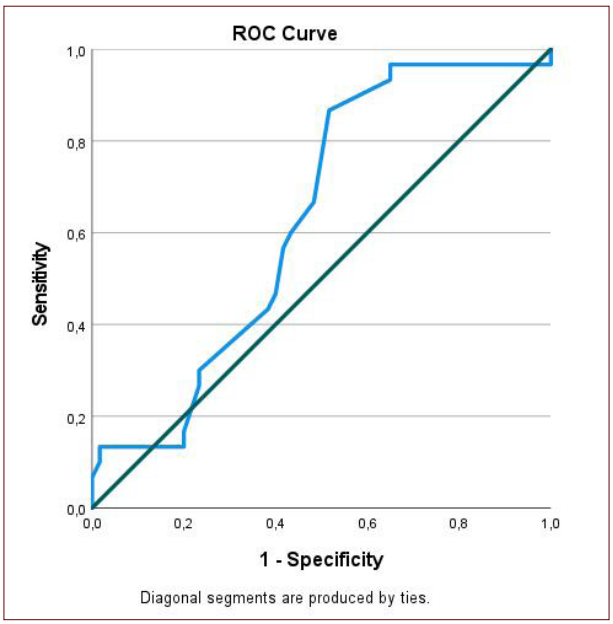


Figure 2. Receiver operating characteristic (ROC) curve of the tip–apex distance (TAD) for predicting mechanical failure after proximal femoral nail fixation. The area under the curve (AUC) was 0.629 (p=0.046), with a cut-off value of 27 mm yielding 86.7% sensitivity and 48.3% specificity.

Table 2. Factors affecting the PFN success status

Factors	Beta	p	OR	95% CI
Number of screws	0.216	0.716	1.241	0.387-3.977
Side	0.173	0.733	1.189	0.439-3.224
AO type	-0.084	0.867	0.920	0.345-2.450
Neck-shaft angle	-0.063	0.018*	0.939	0.891-0.989
Tip-apex distance	-0.051	0.106	0.951	0.894-1.011
Age	0.040	0.073	1.040	0.996-1.087
Gender	0.359	0.492	1.432	0.514-3.994
Fixed	5.019	0.203	151.20	

*:Level of statistical significance 0.05 according to the binary logistic regression analysis, Reference category:successful

to be statistically significant (OR=1.064, 95% CI: 1.011-1.122, p=0.014). An increase of each degree in the angle further decreased the probability of success. TAD and other variables were not found to be statisticaally significant (p>0.05). Only the angle value was included in the multivariate model and the statistical significance was preserved (OR=1.062, 95% CI:1.01-1.114, p=0.010). (Table 2: Factors affecting the success of PFN).

DISCUSSION

The results of this study demonstrated that the radiological parameters of femur neck-shaft angle and tip-apex distance (TAD) directly affect the success of PFN in patients treated surgically with proximal femoral nail (PFN) for femur intertrochanteric fractures.

It has been reported in the literature that the effect on the success of PFN treatment of the femur neck-shaft angle, especially angles >130°, is that it leads to stress concentration by reducing the weight-bearing capacity of the implant (12-14). The significantly greater femur neck-shaft angle (p=0.037) of the unsuccessful patient group in the current study was found to be consistent with the literature. Kim JT et al. (15) reported that an angle in the range of 125°-130° was the most stable biomechanically in cases applied with PFN. Similarly, there are studies in the literature showing that the majority of unsuccessful cases have implants with varus placement (16, 17).

A TAD value >25mm has been reported in the literature to severely increase the risk of cut-out. Nikoloski et al. (18), showed that TAD <20mm could increase the risk of medial perforation, and therefore recommended that keeping TAD >20mm could be safer. In the current study, the TAD value was found to be significantly higher (p=0.045) in the patient group that resulted in failure, but no statistical significance as an independent risk factor was seen in the regression analysis, so these findings were consistent with the literature.

Complex fracture types (eg. intra-articular or multi-fragmented fractures) generally require more care and surgical experience. Achieving anatomic reduction and stable fixation of these types of fractures can be difficult and this can present challenges for the surgeon (19). In the growing geriatric patient population with increased average life expectancy, there is increased ICU admission during and after hip fracture treatment and as there is greater pain in these patients and this has been found to be associated with failure, the effect of systemic factors on surgical outcomes is seen once again (20, 21). In the current study, as trauma in the fracture etiology was only present in



the unsuccessful group (p=0.015) these types of fractures were considered to have increased the surgical difficulties because of the more complex structure.

Although no direct statistically significant difference was observed between the successful results and the AO classification in this study, it was noteworthy that the angle values were higher in the A1 fractures in the unsuccessful group. This indicates that even fractures described as "simple" require more careful stabilisation (22-23).

Even if external factors are minimised in surgeries performed in the same centre with a similar technique, technical details such as implant selection and screw configuration can play an important role in failure. There are single helical blades or double screws according to the implant used in PFN treatment. The rotational stability provided by two screws can be obtained with a single helical blade (23, 24). The higher TAD values in patients applied with surgical treatment using double screws demonstrate that incorrect screw placement increases the risk of complications (4, 5).

An AUC value of 1 in ROC analysis indicates an excellent diagnostic test, whereas if this value is 0.5, it is coincidental, meaning there is no diagnostic value. In the ROC analysis of the current study, the AUC values were 0.635 for femur neck-shaft angle and 0.629 for TAD. These values show that although these parameters were of borderline diagnostic value they should be taken into consideration in the clinical decision-making process (25).

As seen from the results of this study, it is not possible to explain the failure of PFN with a single parameter. Factors such as age, systemic diseases, etiology, implant placement, surgeon's experience, and patient compliance should be evaluated together.

When the reduction quality was interpreted in light of the Chang reduction criteria in the failure group, most cases were found to be consistent with inadequate reduction quality, supporting the prognostic value of these criteria. However, some discrepancies were observed, as mechanical failure also occurred in certain patients who showed relatively acceptable reduction according to Chang criteria but had unfavorable radiological parameters such as increased tip–apex distance or non-optimal femoral neck–shaft angles. This finding indicates that Chang criteria and detailed radiological measurements should be interpreted together rather than independently when predicting mechanical failure after PFN fixation.

The retrospective design of this study, the relatively low number of patients and that it was conducted in a single centre can be evaluated as limitations of the study.

Clinical implications

The findings of this study have important implications for daily clinical practice. Maintaining the femoral neck–shaft angle within the optimal range and keeping the tip–apex distance below critical threshold values during PFN fixation may significantly reduce the risk of mechanical failure in elderly patients with intertrochanteric fractures. These results emphasize the importance of careful intraoperative reduction quality and precise implant positioning. Moreover, the radiological parameters identified in this study may assist surgeons in early identification of high-risk patients, enabling closer postoperative monitoring and timely intervention when necessary. Ultimately, these findings may contribute to improved functional outcomes, reduced revision surgery rates, and lower morbidity in the geriatric population.

Limitations and strengths

This study has several limitations that should be acknowledged. First, its retrospective design limits the ability to establish causal relationships. Second, the relatively small sample size and the single-center nature of the study may restrict the generalizability

of the findings. In addition, although the follow-up period was adequate for evaluating mechanical failure, longer-term outcomes could not be fully assessed. Furthermore, potential confounding factors such as variations in bone quality, comorbidities, and surgeon-related technical differences could not be completely controlled.

Despite these limitations, this study also has important strengths. It provides real-world clinical data from a geriatric population, includes a clearly defined radiological assessment protocol, and offers a comprehensive evaluation of key mechanical risk factors such as femoral neck–shaft angle and tip–apex distance. Moreover, the relatively long follow-up period and the inclusion of detailed radiological measurements strengthen the reliability of the findings and contribute valuable evidence to the existing literature.

Future research in this field should focus on multicenter, prospective studies with larger sample sizes to validate the findings of the present study. Long-term follow-up studies are needed to better evaluate implant survival, functional outcomes, and revision rates. In addition, future studies should investigate the combined effects of bone quality, comorbidities, fracture patterns, and surgical technique on mechanical failure. Advanced imaging methods and computer-assisted surgical planning may also provide more precise evaluation of implant positioning and reduction quality in future clinical practice.

CONCLUSION

The results of this study showed that there was a significant relationship between the main causes of mechanical failure encountered in PFN treatment of inertrochanteric femur fractures and the radiological parameters such as implant angle and TAD. Especially the preservation of the neck-shaft angle at around 125° in implant fixation plays an important role in reducing the risk of cut-out. Similarly, a TAD value <25mm increases implant stability and reduces failure rates. However, neither of these parameters is sufficiently determinative alone, and the clinical outcomes can be optimised only with multifactorial evaluations.

Informed consent: Informed consent was obtained from all individual participants included in the study.

Conflict of Interests: The authors have no conflict of interests related to this article.

Funding sources: The authors declare that this study has received no financial support.

REFERENCES

1. Atay IM, Aslan A, Atay T, Burç H. Prevalence of delirium, risk factors and cognitive functions in elderly hip fracture patients with general and spinal anesthesia. Turk J Geriatr 2012;15(3):273-278.
2. Kannus P, Parkkari J, Sievänen H, et al. Epidemiology of hip fractures. Bone 1996;18(1 Suppl):57S-63S. doi:10.1016/8756-3282(95)00381-9.
3. Cooper C, Campion G, Melton LJ 3rd. Hip fractures in the elderly: a worldwide projection. Osteoporos Int 1992;2(6):285-289. doi:10.1007/BF01623184.
4. Simmermacher RK, Ljungqvist J, Bail H, et al. The new proximal femoral nail antirotation in daily practice: results of a multicentre clinical study. Injury 2008;39(8):932-939. doi:10.1016/j.injury.2008.02.005.
5. Boldin C, Seibert FJ, Fankhauser F, et al. The proximal femoral nail—a minimally invasive treatment of unstable proximal femoral fractures: a prospective study of 55 patients with 15-month follow-up. Acta Orthop Scand 2003;74(1):53-58. doi:10.1080/00016470310013662.
6. Huang J, Wei Q. Comparison of helical blade versus lag screw in intertrochanteric fractures of the elderly treated with proximal femoral nail: a meta-analysis of randomized controlled trials. Joint Dis Rel Surg 2022;33(3):695-704. doi:10.52312/jdrs.2022.789.
7. Pajarinen J, Lindahl J, Michelsson O, et al. Pertrochanteric femoral fractures treated with a dynamic hip screw or a proximal femoral nail: a randomised study comparing postoperative rehabilitation. J Bone Joint Surg Br. 2005 Jan;87(1):76-81. PMID: 15686241.



8. Yu W, Han X, Chen W, et al. Conversion from a failed proximal femoral nail anti-rotation to cemented or uncemented total hip arthroplasty: a retrospective review of 198 hips with previous intertrochanteric femur fractures. BMC Musculoskelet Disord 2020;21(1):791. doi:10.1186/s12891-020-03806-0.
9. Nherera L, Trueman P, Horner A, et al. Comparison of a twin interlocking derotation and compression screw cephalomedullary nail (InterTAN) with a single screw derotation cephalomedullary nail (proximal femoral nail antirotation): a systematic review and meta-analysis for intertrochanteric fractures. J Orthop Surg Res 2018;13(1):46. doi:10.1186/s13018-018-0749-6.
10. Xu H, Liu Y, Sezgin EA, et al. Comparative effectiveness research on proximal femoral nail versus dynamic hip screw in trochanteric fractures: a systematic review and meta-analysis of randomized trials. J Orthop Surg Res 2022;17(1):292. doi:10.1186/s13018-022-03189-z.
11. Tucker A, Warnock M, McDonald S, et al. Fatigue failure of the cephalomedullary nail: revision options, outcomes and literature review. Eur J Orthop Surg Traumatol 2018;28(3):511-520. doi:10.1007/s00590-017-2059-9.
12. Kaufer H. Mechanics of the treatment of hip injuries. Clin Orthop Relat Res. 1980 Jan-Feb;(146):53-61. PMID: 7371269.
13. Haidukewych GJ. Intertrochanteric fractures: ten tips to improve results. J Bone Joint Surg Am. 2009 Mar 1;91(3):712-9. PMID: 19255235.
14. Zhang C, Chen Z, Wang M, et al. Is sliding compression necessary for intramedullary nailing fixation of AO/OTA type A3.3 intertrochanteric fracture? Orthop Surg 2023;15(11):2805-2813. doi:10.1111/os.13875.
15. Kim JT, Jung CH, Shen QH, et al. Mechanical effect of different implant caput-collum-diaphyseal angles after fixation of an unstable intertrochanteric fracture: a finite element analysis. Asian J Surg 2019;42(11):947-956. doi:10.1016/j.asjsur.2019.01.008.
16. Singh NK, Sharma V, Trikha V, et al. Is PFNA-II a better implant for stable intertrochanteric fractures in the elderly? A prospective randomized study. J Clin Orthop Trauma 2019;10(Suppl 1):S71-S76. doi:10.1016/j.jcot.2019.02.004.
17. Hoffmann MF, Khoriaty JD, Sietsema DL, Jones CB. Outcome of intramedullary nailing for intertrochanteric femoral fractures. J Orthop Surg Res 2019;14(1):360. doi:10.1186/s13018-019-1431-3.
18. Nikoloski AN, Osbrough AL, Yates PJ. Should the tip-apex distance rule be modified for the proximal femoral nail antirotation? A retrospective study. J Orthop Surg Res 2013;8:35. doi:10.1186/1749-799X-8-35.
19. Forte ML, Virnig BA, Swiontkowski MF, et al. Ninety-day mortality after intertrochanteric hip fracture: does provider volume matter? J Bone Joint Surg Am 2010;92(4):799-806. doi:10.2106/JBJS.H.01204.
20. Panula J, Pihlajamäki H, Mattila VM, et al. Mortality and cause of death in hip fracture patients aged 65 or older: a population-based study. BMC Musculoskelet Disord 2011;12:105. doi:10.1186/1471-2474-12-105.
21. Kammerlander C, Roth T, Friedman SM,et al. Ortho-geriatric service: a literature review comparing different models. Osteoporos Int 2010;21(Suppl 4):S637-S646. doi:10.1007/s00198-010-1396-x.
22. Werner-Tutschku W, Lajtai G, Schmiedhuber G, et al. Intra- and perioperative complications in the stabilization of per- and subtrochanteric femoral fractures using a proximal femoral nail. Unfallchirurg 2002;105(10):881-885. (in German) doi:10.1007/s00113-002-0416-5.
23. Lenich A, Mayr E, Rüter A, Möckl Ch, Füchtmeier B. First results with the trochanter fixation nail: a report on 120 cases. Arch Orthop Trauma Surg 2006;126(10):706-712. doi:10.1007/s00402-006-0117-6.
24. Sommers MB, Roth C, Hall H, et al. A laboratory model to evaluate cutout resistance of implants for pertrochanteric fracture fixation. J Orthop Trauma 2004;18(6):361-368. doi:10.1097/00005131-200407000-00006.
25. Hanley JA, McNeil BJ. The meaning and use of the area under a receiver operating characteristic curve. Radiology 1982;143(1):29-36. doi:10.1148/radiology.143.1.7063747.

Turkish Journal of Geriatrics
2025; 28(4):534–544

DOI: 10.29400/tjgeri.2025.470

İsmail DUYMAZ
Hacer Şebnem TÜRK
Pınar SAYIN
Leyla KILINÇ
Mustafa Bilgehan AYIK
Ayşe SURHAN ÇINAR
Sibel OBA

Sisli Hamidiye Etfal Training And Research Hospital, Anesthesiology And Reanimation, Istanbul, Türkiye

ORIGINAL ARTICLE

THE EFFECT OF INCREASED FRAILTY ON MYOCARDIAL INJURY AFTER NON-CARDIAC SURGERY (MINS) IN ELDERLY PATIENTS UNDERGOING ORTHOPEDIC SURGERY: A PROSPECTIVE, COHORT STUDY

Abstract

Introduction: The objective of this study was to assess the association between elevated frailty levels and the risk of postoperative myocardial injury in elderly patients undergoing orthopedic procedures.

Materials and Method: All patients aged 65 years and older who underwent surgery at the Orthopedics Department of our hospital between May 1, 2023, and May 1, 2024, were included. Demographic data such as age, sex, comorbidities, and surgical indications were documented preoperatively. Frailty status was assessed using the FRAIL Index and categorized into three groups. Pre-anesthetic baseline measurements of heart rate and mean arterial pressure were obtained before the initiation of anesthesia and subsequently monitored every 10 minutes intraoperatively. Data regarding perioperative blood transfusion, intravenous fluid administration, vasopressor requirement, and anesthesia technique were collected. Troponin T levels were measured at 0, 6, 12, 24, 48, and 72 hours postoperatively. Outcomes assessed included intensive care unit and hospital length of stay, incidence of postoperative complications, and all-cause mortality within 30 days following surgery.

Results: A total of 206 patients were included in the final analysis. Among them, 56.7% were classified as frail, 33.5% as pre-frail, and 9.7% as non-frail. The overall incidence of myocardial injury after non-cardiac surgery was 44.4%, occurring in 63.2% of frail patients, 23.2% of pre-frail patients, and 5.3% of non-frail patients. Thirty-day adverse outcomes and mortality were significantly higher in frail patients, who also demonstrated longer intensive care and hospital stays.

Conclusion: In elderly individuals undergoing orthopedic procedures, greater degrees of frailty are strongly associated with an increased risk of postoperative myocardial injury following non-cardiac surgery.

Keywords: Troponin; Frailty, Aged; Orthopedic Procedures.

Correspondence

Hacer Şebnem TÜRK
Phone : +905324432544
e-mail : hacersebnem@yahoo.com.tr

Received : Nov 09, 2025
Accepted: Nov 11, 2025

Cite this article as:
Duymaz İ, Türk HŞ, Sayın P. et al. The Effect of Increased Frailty on Myocardial Injury After Non-Cardiac Surgery (Mins) in Elderly Patients Undergoing Orthopedic Surgery: A Prospective, Cohort Study. Turkish Journal of Geriatrics 2025; 28(4):534–544.doi:10.29400/tjgeri.2025.470

The content of this journal is licensed under the Creative Commons Attribution-NonCommercial 4.0 International License.

INTRODUCTION

With the worldwide rise in life expectancy and the proportion of elderly individuals, the demand for surgical interventions in this population has been steadily increasing. Among these, orthopedic procedures represent one of the most common surgical needs. However, postoperative morbidity and mortality rates are considerably higher in older patients compared to younger groups. The American Society of Anesthesiologists (ASA) classification has long been used for preoperative risk assessment, yet it has notable limitations in the evaluation of geriatric patients.

Frailty, characterized by reduced physiological reserves and impaired ability to respond to stress due to neuromuscular, metabolic, and immune system decline, has emerged as a key determinant in evaluating surgical risk in older adults. Although it may be observed across all age groups, frailty is particularly valuable in assessing physiological resilience in the elderly (1, 2). Patients with orthopedic hip fractures often present with higher frailty levels, which correlates with increased rates of postoperative complications, prolonged hospitalization, and elevated mortality. Therefore, incorporating frailty assessment into the preoperative evaluation process plays an essential role in predicting outcomes and optimizing perioperative management (3, 4).

Despite advances in perioperative care, cardiovascular complications remain the predominant contributors to postoperative morbidity and mortality in patients undergoing non-cardiac surgery. Myocardial injury after non-cardiac surgery (MINS) is characterized by asymptomatic myocardial damage, diagnosed solely based on postoperative elevations in cardiac troponin levels in the absence of overt clinical signs. Unlike myocardial infarction, MINS does not typically present symptoms or ECG changes, yet it has a strong association with early postoperative mortality. Detecting MINS requires routine monitoring of troponin levels from the preoperative period through the first 72 postoperative hours (5). Despite the growing recognition of MINS as a critical postoperative complication, limited research has specifically examined its association with frailty.

This study primarily aimed to evaluate the effect of elevated frailty levels on the occurrence of postoperative myocardial injury in elderly individuals undergoing orthopedic procedures. Additionally, the study sought to determine the prevalence of frailty in this specific patient cohort.

MATERIALS AND METHOD

This study was designed as a prospective, single-center cohort study. Ethical clearance for the research was secured from our hospital's institutional review board (Approval date: April 18, 2023; Decision No: 2297). All patients aged 65 years and older who underwent surgery at the Orthopedics Department between May 1, 2023, and May 1, 2024, were considered eligible. Informed consent, both written and verbal, was secured from all participants or, when necessary, from their legally authorized representatives. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Patients were excluded from the study if they had a preoperative diagnosis of sepsis, pulmonary embolism, or myocardial infarction within the preceding month, underwent another surgical procedure within the last month, necessitated preoperative tracheal intubation within the intensive care unit or had a postoperative hospital stay shorter than three days.

Demographic variables such as ASA scores, along with comorbidities were recorded. Surgical indications were also documented.

Frailty was evaluated using the FRAIL Index, a brief five-item tool assessing fatigue, resistance, ambulation, comorbid illnesses, and unintentional weight loss. Based on the total score, patients were categorized as follows:

0: Non-frail

1-2: Pre-frail

3-5: Frail and divided into groups

Electrocardiography (ECG) and baseline Troponin T measurements were obtained within 24 hours before surgery. In the operating room, ECG, non-invasive or invasive blood pressure, arterial pressure, and peripheral oxygen saturation (SpO_2) were continuously monitored. Heart rate (HR), mean arterial pressure (MAP), and SpO_2 values were recorded before anesthesia induction and subsequently at 10-minute intervals throughout surgery.

The choice of anesthesia (general or spinal) was determined by an anesthesiologist independent of the study, according to surgical requirements and patient factors. Intraoperative use of blood products, crystalloid administration, and vasopressor requirements were documented. Anesthesia duration was defined as the interval from induction to recovery room transfer, while surgical duration was measured from the initial incision to wound closure.

High-sensitivity Troponin T was measured using the "Elecsys Troponin T hs" assay. Troponin levels were assessed immediately postoperatively (0 h) and at 6, 12, 24, 48, and 72 hours thereafter. Patients with normal baseline values and postoperative hsTnT levels between 20–65 ng/L with an absolute increase of ≥5 ng/L, or any hsTnT ≥65 ng/L, were diagnosed with MINS. ECG was performed in patients with elevated troponin, and cardiology consultation was requested for new ST-segment changes or left bundle branch block.

The length of intensive care stay, total hospitalization period, 30-day postoperative complications, and mortality were documented for all patients.

Statistical Analysis

Statistical analyses were conducted using SPSS version 15.0 (SPSS Inc., Chicago, IL, USA). Categorical variables were expressed as numbers and percentages, while continuous variables were reported as mean ± standard deviation, minimum–maximum, and median values. Group comparisons of categorical variables were performed using the Chi-square test. As numerical variables did not meet normality assumptions, the Kruskal–Wallis test was applied for comparisons among more than two groups. Post-hoc subgroup analyses were conducted using the Mann–Whitney U test with Bonferroni correction. Results with a p-value <0.05 were considered statistically significant.

To determine whether frailty was an independent predictor of MINS, a multivariable logistic regression analysis was performed. Variables entered into the model included age, sex, ASA classification, major comorbidities, intraoperative vasopressor requirement, intraoperative hypotension, and frailty category. Both ENTER and backward stepwise (Backward LR) methods were applied. Model fit was assessed using –2LL, Cox–Snell R^2, and Nagelkerke R^2 statistics, and results were reported as odds ratios (ORs) with 95% confidence intervals (CIs). A *p* value <0.05 was considered statistically significant.

Power Analysis

Sample size was calculated using G*Power version 3.1.9.7 (Franz Faul, Germany). Based on an estimated effect size of d=0.267 derived from the study by Berkay Demiriş, "Evaluation of the Relationship Between Frailty Index and Fracture Risk in Patients 65 Years and Older," a minimum of 147 participants was required to achieve 80% power with a 10% margin of error.

RESULTS

Between April 1, 2023, and April 1, 2024, a total of 672 patients aged 65 years and older underwent orthopedic surgery at our institution. Of these, 285 did not meet the inclusion criteria: 272 patients were expected to have a postoperative hospital stay of less than three days (e.g., day surgery, hand surgery), 11 had undergone another surgical procedure within the preceding month (revision surgery, repeated debridement), and 2 were intubated and monitored in the intensive care unit preoperatively.



Additionally, 45 patients were excluded due to invalid troponin samples, 40 due to incomplete clinical data, and 96 due to premature postoperative discharge, which prevented completion of the 72-hour troponin monitoring protocol. Ultimately, 206 patients fulfilled all eligibility requirements and were included in the final analysis.

When the distribution of the groups is analyzed, there were 69 pre-frail (33.5%), 117 frail (56.7%) and 20 non-frail patients (9.7%) (Table 1). Female gender was predominant in total, frail and pre-frail patients (Table 1). The age distribution differed significantly between the groups. (Table 1) ($p<0.001$).

Table 1. Demographic Data, Anesthesia Duration, Surgical Duration, Length of Stay in Hospital and ICU, Amount of Bleeding

		Frailty				
		Total	**Pre-Frail**	**Frail**	**Not Frail**	
		Mean±SD (Min-Max) (Median)	**Mean±SD (Min-Max) (Median)**	**Mean±SD (Min-Max) (Median)**	**Mean±SD (Min-Max) (Median)**	**P**
Age (years)		78.2±8.0 65-104 (78)	74.8±6.6 65-94 (75)	81.6±7.6 65-104 (82)	70.0±2.6 65-75 (69.5)	**<0.001**
Sex	Female	141(68.4%)	42 (60.9%)	89 (76.1%)	10 (50.0%)	**0.017**
	Male	65(31.6%)	27 (39.1%)	28 (23.9%)	10 (50.0%)	
Weight		71.4±13.9 45-130 (70)	73.2±14.1 50-130 (70)	69.7±14.1 45-130 (68)	75.6±11.1 55-98 (77)	**0.037**
BMI		27.0±5.4 16.3-50.8 (26.0)	27.2±5.3 20-50.8 (25.8)	26.8±5.6 16.3-50.8 (26.0)	27.1±4.4 19.2-34.7 (26.9)	0.698
Anesthesia Duration (min)		137.4±47.6 60-300 (130)	145.4±48.0 60-300 (150)	134.3±47.7 0-300 (130)	127.8±43.5 70-210 (130)	0.140
Surgical Duration (min)		119.0±42.8 50-280 (120)	124.9±42.6 50-270 (120)	116.8±43.3 60-280 (110)	111.8±39.8 60-180 (120)	0.266
Bleeding Amount (cc)		315.2±158 4 100-750 (300)	292.1±149 1 100-750 (300)	331.5±167 1 100-700 (300)	340.0±151 7 200-500 (300)	0.509
ICU Stay Duration (days)		2.3±4.1 0-30 (1)	1.9±4.2 0-30 (1)	2.9±4.3 0-26 (2)	0.2±0.7 0-3 (0)	**<0.001**
Hospital Stay Duration (days)		11.2±9.4 3-82 (9)	10.7±9.4 3-60 (9)	12.4±9.8 4-82 (11)	5.3±2.6 4-14(4)	**<0.001**

Chi-square Test, Kruskal-Wallis Test, ICU: Intensive Care Unit

Frail patients were statistically significantly older than pre-frail and non-frail patients (Table 2) (p<0,001). Pre-frail patients were statistically significantly older than non-frail patients (Table 2) (p=0.002).

The groups differed significantly in terms of weight distribution (Table 1) (p=0.037). Frail patients were statistically significantly thinner than non-frail patients (Table 2) (p=0,024). There was a statistically significant difference between the duration of intensive care and hospitalization of the groups (Table 1) (p=0.001). The intensive care unit duration of stay of frail patients was statistically significantly longer than that of pre-frail and non-frail patients (Table 2) (p=0.002, p<0,001). The duration of intensive care hospitalization of pre-frail patients was statistically significantly longer than non-frail patients (Table 2) (p=0,002). The duration of hospitalization of frail and pre-frail patients was statistically significantly longer than that of non-frail patients (Table 1b) (p<0,001).

Comorbid conditions were present in 95.1% of patients, with hypertension being the most common (68.9%). The prevalence of comorbidities was significantly higher in frail and pre-frail groups (p<0.001). Hip surgery represented the leading surgical indication (65%). Hip and knee surgeries were more common in frail and pre-frail patients, while tibial surgeries were more frequent in non-frail patients (p<0.001).

A statistically significant difference was found between the crystalloid consumption of the groups (Table 3) (p=0.019). A statistically significant difference was found between the vasopressor needs of the groups (Table 3) (p=0,012).

A statistically significant difference was found between the incidences of MINS of the groups (Table 3) (p<0,001). The incidence of MINS in the total number of patients was 44.4%, with 23.2% in pre-frail patients, 63.2% in frail patients and 5.3% in non-frail patients. A statistically significant difference was found between the 30-day adverse event frequencies of the groups (Table 3) (p<0,001). The incidence of 30-day adverse events in the total number of patients was 16.1%, with 4.3% in pre-frail patients, 25.6% in frail patients and 0.0% in non-frail patients. A statistically significant difference was found between the 30-day mortality rates of the groups (Table 3) (p=0.001). The rate of 30-day mortality rates in the total number of patients was 9.8%, with 1.4% in pre-frail patients, 16.4% in frail patients and 0.0% in non-frail patients.

A statistically significant difference was found between the groups at 30 and 40 minutes (p=0.038, p=0.026). With the increase in frailty, MAP values

Table 2. Demographic Data, Anesthesia Duration, Surgical Duration, Duration of Hospitalization and Intensive Care Unit Stay, Amount of Bleeding Subgroup Analyses

	Pre-frail vs. Frail	Pre-frail vs. Non-Frail	Frail vs. Non-Frail
	p	p	p
Age	**<0.001**	**0.002**	**<0.001**
Weight	0.094	0.220	**0.024**
BMI	0.626	0.579	0.453
Anesthesia Duration	0.072	0.155	0.668
Surgical Duration	0.148	0.203	0.771
Amount of Bleeding	0.288	0.473	0.810
Duration of ICU Stay	**0.002**	**0.002**	**<0.001**
Duration of Hospitalization	0.032	**<0.001**	**<0.001**

Mann Whitney U Test Bonferroni correction p<0.017, BMI: Body Mass Index, ICU: Intensive Care Unit



decreased. A statistically significant difference was found between the HR distributions of the groups before and after induction at 20.-120 minutes (p=0.002, p=0.045, p=0.036, p=0.004, p=0.020,

Table 3. Anesthesia Method, Crystalloid and Blood Product Use, Vasopressor Requirement, Presence of MINS, 30-Day Adverse Events and Mortality

		Total		Frailty						p
				Pre-frail		Frail		Non-Frail		
		n	%	n	%	n	%	n	%	
Type of Anesthesia	General	77	37.4%	25	36.2%	46	39.3%	6	30.0%	0.708
	Spinal	129	62.6%	44	63.7%	71	60.7%	14	70.0%	
Crystalloid Consumption (cc)		1560.0±1105.3 500-15000 (1500)		1844.9±1732.3 500-15000 (1500)		1411.1±511.5 500-3000 (1500)		1447.5±632.3 750-3500 (1500)		**0.019**
Blood Product Use (n)		47	23.5%	16	23.9%	29	25.7%	2	10.0%	0.312
Vasopressor Requirement (n)		91	44.2%	26	37.7%	61	52.1%	4	20.0%	**0.012**
MINS (n)		91	44.4%	16	23.2%	74	63.2%	1	5.3%	**<0.001**
30-Day Adverse Events (n)		33	16.1%	3	4.3%	30	25.6%	0	0.0%	**<0.001**
30-Day Mortality		20	9.8%	1	1.4%	19	16.4%	0	0.0%	**0.001**

Chi-square test, Kruskal -Wallis test, MINS: Myocardial Injury After Non-Cardiac Surgery

Table 4. Troponin Levels

	Total	Frailty			p
		Pre-frail	Frail	None	
	Mean±SD Min-Max (Median)	Mean±SD Min-Max (Median)	Mean±SD Min-Max (Median)	Mean±SD Min-Max (Median)	
Troponin Monitoring					
Pre-op	17.4±15.0 0.04-153.4 (13.7)	12.1±7.3 3-32.5 (10.74)	22.4±17.4 0.04-153.4 (19.7)	6.5±4.2 2.3-15.6 (4.8)	**<0.001**
Post-op 0.	27.9±50.5 2.3-599 (17.55)	16.1±18.3 2.5-125 (12.27)	38.4±63.6 3.6-599 (26.8)	7.2±4.5 2.3-17.1 (5.45)	**<0.001**
6th hour	28.4±35.3 2.19-341 (19)	18.6±25.8 2.3-195 (13.22)	37.9±39.8 2.2-341 (28.6)	7.1±4.5 2.3-18.1 (4.9)	**<0.001**
12th hour	31.7±37.4 2.45-313 (19.76)	19.5±27.1 2.5-205 (12.7)	43.1±41.5 3.5-313 (33)	7.5±4.4 2.5-16.2 (5.1)	**<0.001**
24th hour	41.0±83.0 2.56-782 (22.15)	30.5±94.2 2.7-782 (13.6)	53.0±81.0 3.6-732 (32.1)	7.6±4.4 2.6-18 (5.9)	**<0.001**
48th hour	49.0±104.1 2.4-971 (20.85)	35.5±119.9 2.4-971 (13.7)	64.0±100.4 3.5-584 (29.1)	7.4±4.3 2.9-18.3 (6.3)	**<0.001**
72nd hour	49.8±136.6 2-1392 (20.56)	30.4±97.5 2-793 (12.5)	68.7±163.1 3.3-1392 (30.4)	6.9±4.1 3-19.1 (5.3)	**<0.001**

Kruskal Wallis Test, Pre-op: Preoperative

Table 5. Subgroup Analysis of Troponin

	Pre-Frail vs.Frail	Pre-Frail vs.None	Frail vs.None
TROPONİN Monitoring	**p**	**p**	**p**
Preop	<0.001	<0.001	<0.001
Postop 0.	<0.001	<0.001	<0.001
6th hour	<0.001	<0.001	<0.001
12th hour	<0.001	<0.001	<0.001
24th hour	<0.001	<0.001	<0.001
48th hour	<0.001	<0.001	<0.001
72th hour	<0.001	<0.001	<0.001

Mann Whitney U Test with Bonferroni correction, p<0.017, Pre-op: Preoperative

p=0.001, p=0.003, p=0.003, p=0.009), p=0.006). HR values increased with the increase in frailty. A statistically significant difference was found between the SPO2 distributions of the groups before induction (p=0,024). SPO 2 values of frail patients before induction were statistically significantly lower than non-frail patients (p=0,013).

A statistically significant difference was found between the Troponin distributions of the groups at Pre-op, post-op 0, 6, 12, 24, 48 and 72 hours (Table 4) (p<0,001).

Troponin values of frail patients were statistically significantly higher than those of pre-frail and non-frail patients (Table 5) (p<0,001). Troponin values of pre-frail patients were statistically significantly higher than those of non-frail patients (Table 5) (p<0,001).

A multivariate logistic regression analysis was performed to identify variables associated with MINS, including age, gender, ASA score, comorbidities (DM, HT, CAD, HF, dementia, COPD, CKD), vasopressor requirement, hypotension, and frailty status. In the ENTER model, ASA score (OR= 3.445; 95% CI: 1.287–9.222; p= 0.014), hypertension (OR= 2.726; 95% CI: 1.108–6.707; p= 0.029), dementia (OR= 4.414; 95% CI: 1.040–18.734; p= 0.044), and frailty (OR= 2.492; 95% CI: 1.019–6.098; p= 0.045) were significantly associated with MINS. No other variables reached statistical significance (Table 6).

Table 6. Logistic Regression Analysis Using ENTER Method to Determine Predictors of MINS

		OR	%95 GA	p
Age		1.038	0.985 – 1.094	0.160
Sex	Male	–	–	–
	Female	1.434	0.632 – 3.254	0.388
ASA		**3.445**	1.287 – 9.222	**0.014**
Comorbidities		0.157	0.014 – 1.760	0.133
DM		1.065	0.490 – 2.313	0.874
HT		**2.726**	1.108 – 6.707	**0.029**
CVD		1.031	0.331 – 3.207	0.959
CAD		0.668	0.300 – 1.488	0.323
HF		3.938	0.858 – 18.065	0.078
AF		1.914	0.297 – 12.341	0.495
Alzheimer		1.146	0.199 – 6.611	0.878
Dementia		**4.414**	1.040 – 18.734	**0.044**
Asthma		3.391	0.629 – 18.291	0.156
COPD		0.753	0.177 – 3.195	0.700
CKD		1.197	0.159 – 9.007	0.861
Hypothyroidism		0.773	0.201 – 2.976	0.708
Malignancy		0.424	0.058 – 3.071	0.395
Vasopressor requirement		1.488	0.675 – 3.280	0.324
Hypotension		1.101	0.486 – 2.494	0.818
Frailty status Pre-Frail		–	–	–
Frail		**2.492**	1.019 – 6.098	**0.045**
Non-Frail		0.386	0.039 – 3.859	0.418

OR= Odds ratio; CI= Confidence interval; ASA= American Society of Anesthesiologists; DM= Diabetes mellitus; HT= Hypertension; CVD= Cerebrovascular disease; CAD= Coronary artery disease; HF= Heart failure; AF= Atrial fibrillation; COPD= Chronic obstructive pulmonary disease; CKD= Chronic kidney disease. p<0.05

In the final Backward LR model, ASA score (OR= 2.892; 95% CI: 1.234–6.779; p= 0.015) and frailty (OR= 2.720; 95% CI: 1.215–6.090; p= 0.015) remained independently associated with MINS (Table 7).



Table 7. Multivariable Logistic Regression Model for Predictors of MINS (Backward LR Method)

	OR	%95 GA	p
Age	1.044	0.996 – 1.095	0.072
ASA	2.892	1.234 – 6.779	0.015
HT	1.990	0.918 – 4.318	0.081
HF	3.505	0.843 – 14.567	0.084
Dementia	3.563	0.922 – 13.773	0.065
Frailty	1.000	–	–
Frail	2.720	1.215 – 6.090	0.015
Non-Frail	0.514	0.058 – 4.539	0.549

OR= Odds ratio; CI= Confidence interval; ASA= American Society of Anesthesiologists; HT= Hypertension; HF= Heart failure. p<0.05

DISCUSSION

In this prospective cohort study evaluating the association between frailty and postoperative myocardial injury in elderly patients undergoing orthopedic surgery, we found that the incidence of MINS significantly increased with higher frailty levels. Frail patients were predominantly older, of female sex, and had a greater burden of comorbidities. Moreover, increased frailty was associated with longer hospitalization and ICU stays, as well as higher 30-day morbidity and mortality.

Previous research has reported frailty rates of approximately 23% among patients undergoing orthopedic surgery, while studies focusing on hip fracture surgery have demonstrated rates as high as 53% (6,7). In our study, the prevalence of frailty and pre-frailty was higher—56.7% and 33.5%, respectively. This may be explained by the inclusion of patients aged 65 years and above, combined with the high proportion of hip fracture cases (65%). Hip fractures often require urgent surgical intervention in elderly individuals with multiple comorbidities, which likely contributed to the higher frailty prevalence in our sample.

Frailty has consistently been shown to increase postoperative morbidity, prolong hospital stays, and worsen functional outcomes (8, 9). In line with these findings, our results demonstrated that frail patients required longer ICU and hospital care compared to their pre-frail and non-frail counterparts. The mean hospital stay was 12.4 days in frail patients, 10.7 days in pre-frail patients, and 5.3 days in non-frail patients, while ICU stays averaged 2.9, 1.9, and 0.2 days, respectively.

Thirty-day outcomes were also adversely affected by frailty. We observed a 30-day complication rate of 25.6% in frail patients compared to 4.3% in pre-frail patients, with no adverse events in the non-frail group. Similarly, 30-day mortality was 16.4% in frail patients and 1.4% in pre-frail patients, while no deaths occurred among non-frail patients. These findings are consistent with prior evidence showing increased short- and long-term mortality in frail surgical patients, independent of frailty measurement tools or type of surgery (3, 4, 8, 9).

When the risk factors associated with frailty are examined, it is pointed out that there are many environmental, epigenetic and biological factors, and especially, that frailty increases with age. Our study also found that frailty increased with age. Epidemiological data consistently demonstrate that frailty is more prevalent among women than men, highlighting a critical sex-specific vulnerability. (10,11). In our study, female gender was more common with a rate of 68.4%. It was also observed

that female gender was more common in frail (76.9%) and pre-frail patients (60.1%).

Although frailty has been widely recognized as a critical determinant of surgical outcomes, no universally accepted standard exists for its measurement. Several assessment tools have been proposed, yet none have been universally adopted for routine clinical practice. The FRAIL questionnaire, which evaluates fatigue, resistance, ambulation, illnesses, and weight loss, offers a simple and practical method, especially in immobile patients, and has been validated in Turkish populations (12-14). This tool allowed us to categorize patients effectively into frail, pre-frail, and non-frail groups.

Cardiovascular dysfunction is a major concern in frail populations. Subclinical structural and functional changes in the heart, combined with the presence of comorbidities, increase susceptibility to perioperative cardiovascular events (15, 16). In our study, nearly all frail patients (99.1%) and most pre-frail patients (94.2%) had additional systemic illnesses, supporting this association.

Although MINS is asymptomatic, it is distinguished from other cardiac pathologies by its significant contribution to postoperative morbidity and mortality. Existing literature predominantly addresses the development of MINS, as well as its incidence and associated risk factors, primarily in adult populations aged 45 years and older (17). However, there is a notable absence of studies specifically investigating clinical characteristics, predisposing factors, and 30-day outcomes of MINS in frail geriatric patients.

In the VISION study, 15103 patients over the age of 45 who underwent non-cardiac surgery were evaluated, of whom 3092 underwent orthopedic procedures. The incidence of MINS in this orthopedic subgroup was reported as 11.9%, which is notably higher than in non-orthopedic surgeries. These findings highlight the importance of postoperative troponin surveillance in patients with risk factors for MINS (17, 18).

In our study, the overall incidence of MINS was 44.4%. Notably, this rate increased substantially with frailty status: MINS was observed in 63.2% of frail patients, 23.2% of pre-frail patients, and only 5.3% of non-frail patients. The higher incidence of MINS compared to the VISION study may be attributed to our study population consisting exclusively of patients aged 65 years and older. However, the markedly elevated rate of MINS among frail individuals underscores the need to reassess existing risk models and incorporate frailty as a significant and independent predictor of MINS.

Even after adjusting for potential confounding factors such as age, sex, ASA classification, comorbidity burden, vasopressor use, and intraoperative hypotension, frailty remained an independent predictor of MINS in our cohort. Frail patients had more than a twofold higher likelihood of developing MINS compared with pre-frail individuals. These findings demonstrate that the association between frailty and myocardial injury cannot be attributed solely to chronological aging or comorbidity clustering, but rather reflects a distinct physiological vulnerability inherent to frailty itself. Given that both ASA classification and frailty consistently emerged as significant predictors across all models, incorporating systematic frailty assessment into perioperative risk stratification frameworks may enhance clinical decision-making for geriatric orthopedic patients.

The VISION Study Group defined a high-sensitivity troponin value between 20 and 65ng/L and an absolute change of at least 5ng/L, or an absolute change of 65ng/L or more as MINS (19). Therefore, we accepted the reference values of this study as the diagnosis of MINS in our study.

Severe hypotension or anemia, both recognized causes of oxygen supply-demand imbalance, have been associated with 72% of perioperative myocardial ischemic events. The primary risk factor for MINS is perioperative and postoperative



hypotension. Within a subgroup analysis of the VISION Study, tachycardia and systolic hypotension were identified as significant predictors of increased MINS risk (17).

In our study, mean arterial pressure (MAP) was found to be statistically significantly lower in frail patients only at 30 and 40 minutes intraoperatively. However, given that the overall intraoperative vasopressor requirement was 52.1% in frail patients compared to 37.7% in pre-frail patients, it is plausible that the actual incidence of intraoperative hypotension is substantially higher among the frail population. Despite efforts to mitigate the most critical known risk factor for MINS by maintaining target heart rate (HR) and MAP, the incidence of MINS remained notably high in frail patients.

The impact of anesthesia technique on outcomes in frail patients remains unclear. The 2020 guideline for the management of hip fractures reported no significant differences between general and regional anesthesia, emphasizing that optimal perioperative care is paramount (20). In our study, the choice of anesthesia technique was made by the anesthesiologist independently of the study protocol. Spinal anesthesia was administered in 60.7% of frail patients, 63.7% of pre-frail patients, and 70% of non-frail patients. Although no statistically significant differences were detected among the groups regarding anesthesia technique, the reduced preference for spinal anesthesia in frail patients was primarily attributed to concerns over hypotension and the prevalent use of oral anticoagulants in this population.

Our study is limited by a smaller sample size compared to similar research and exclusion of MINS events after 72 hours. Nevertheless, we found that MINS incidence increases in frail geriatric patients undergoing orthopedic surgery.

Conflict of Interest: The authors report no conflicts of interest.

REFERENCES

1. Panayi AC, Orkaby AR, Sakthivel D, et al. Impact of frailty on outcomes in surgical patients: A systematic review and meta-analysis. Am J Surg 2019;218(2):393-400. doi: 10.1016/j.amjsurg.2018.11.020.
2. Lin HS, Watts JN, Peel NM, Hubbard RE. Frailty and post-operative outcomes in older surgical patients: A systematic review. BMC Geriatr 2016;16(1):157. doi:10.1186/s12877-016-0329-8.
3. Chan S, Wong EKC, Ward SE, Kuan D, Wong CL. The predictive value of the Clinical Frailty Scale on discharge destination and complications in older hip fracture patients. J Orthop Trauma 2019;33(10):497-502. doi:10.1097/BOT.0000000000001518.
4. Pizzonia M, Giannotti C, Carmisciano L, et al. Frailty assessment, hip fracture and long-term clinical outcomes in older adults. Eur J Clin Invest 2021;51(4): e13445. doi:10.1111/eci.13445.
5. Ruetzler K, Khanna AK, Sessler DI. Myocardial Injury After Noncardiac Surgery: Preoperative, Intraoperative, and Postoperative Aspects, Implications, and Directions. Anesth Analg 2020;131(1):173-86. doi:10.1213/ANE.0000000000004567.
6. van de Ree CLP, Landers MJF, Kruithof N, et al. Effect of frailty on quality of life in elderly patients after hip fracture: a longitudinal study. BMJ Open 2019;9(7): e025941. doi:10.1136/bmjopen-2018-025941.
7. Johnson RL, Abdel MP, Frank RD, et al. Impact of Frailty on Outcomes After Primary and Revision Total Hip Arthroplasty. J Arthroplasty 2019;34(1):56-64.e5. doi: 10.1016/j.arth.2018.09.078.
8. Beggs T, Sepehri A, Szwajcer A, Tangri N, Arora RC. Frailty and perioperative outcomes: a narrative review. Canadian Journal of Anesthesia/Journal Canadien d'anesthésie 2015;62(2):143-57. doi:10.1007/s12630-014-0273-z.
9. Lin H-S, McBride R, Hubbard R. Frailty and anesthesia – risks during and post-surgery. Local Reg Anesth 2018; 11:61-73. doi:10.2147/LRA.S142996.
10. O'Caoimh R, Sezgin D, O'Donovan MR, et al. Prevalence of frailty in 62 countries across the world: a systematic review and meta-analysis of population-level studies. Age Ageing 2021;50(1):96-104. doi:10.1093/ageing/afaa219.
11. Park C, Ko FC. The Science of Frailty. Clin Geriatr Med 2021;37(4):625-38. doi:10.1016/j.cger.2021.05.008.

12. Gleason LJ, Benton EA, Alvarez-Nebreda ML,et al. FRAIL Questionnaire Screening Tool and Short-Term Outcomes in Geriatric Fracture Patients. J Am Med Dir Assoc 2017;18(12):1082-6. doi:10.1016/j.jamda.2017.07.005.

13. Kitamura K, van Hooff M, Jacobs W, Watanabe K, de Kleuver M. Which frailty scales for patients with adult spinal deformity are feasible and adequate? A systematic review. Spine Journal 2022;22 (7):1191-204. doi:10.1016/j.spinee.2022.01.017.

14. Hymabaccus BAB, Dogrul RT, Balcı C, et al. An effective and practical tool to assess physical frailty in older adults: Turkish validation of the FRAIL Scale. Marmara Medical Journal 2023;36(2):149-56. doi:10.5472/marumj.1297696.

15. Kusunose K, Okushi Y, Yamada H, et al. Prognostic Value of Frailty and Diastolic Dysfunction in Elderly Patients. Circulation Journal 2018;82(8):2103-10. doi:10.1253/circj. CJ-18- 0017.

16. Singh M, Stewart R, White H. Importance of frailty in patients with cardiovascular disease. Eur Heart J 2014;35(26):1726-31. doi:10.1093/eurheartj/ehu197.

17. Abbott TEF, Pearse RM, Archbold RA, et al. A Prospective International Multicentre Cohort Study of Intraoperative Heart Rate and Systolic Blood Pressure and Myocardial Injury After Noncardiac Surgery: Results of the VISION Study. Anesth Analg 2018;126(6):1936-45. doi:10.1213/ANE.0000000000002560.

18. Thomas S, Borges F, Bhandari M, et al. Association between myocardial injury and cardiovascular outcomes of orthopaedic surgery: A vascular events in noncardiac surgery patients cohort evaluation (VISION) substudy. J Bone Joint Surg Am 2020;102(10):880-8. doi: 10.2106/JBJS.18.01305.

19. Devereaux PJ, Biccard BM, Sigamani A, et al. Association of Postoperative High-Sensitivity Troponin Levels With Myocardial Injury and 30-Day Mortality Among Patients Undergoing Noncardiac Surgery. JAMA 2017;317(16):1642-51. doi:10.1001/jama.2017.4360.

20. Griffiths R, Babu S, Dixon P, et al. Guideline for the management of hip fractures 2020. Anaesthesia 2021;76(2):225-37. doi:10.1111/anae.15291.

ORIGINAL ARTICLE

THE RELATIONSHIP BETWEEN OBSTRUCTIVE SLEEP APNEA SYNDROME, CHRONIC DISEASES AND QUALITY OF LIFE IN GERIATRIC PATIENTS ATTENDING THE SLEEP UNIT

Turkish Journal of Geriatrics
2025; 28(4):545–553

DOI: 10.29400/tjgeri.2025.471

Hasan TÜLE
Elçin BALCI

Erciyes University, Department of Public Health, Faculty of Medicine, Kayseri, Türkiye

Abstract

Introduction: The primary aim of our study was to determine the frequency of chronic diseases and quality of life in elderly patients admitted to a sleep unit.

Materials and Method: The study was conducted with participants over 65 years of age who applied to the sleep unit with complaints such as sleep disorders, snoring, suffocation during sleep, somnolence, daytime sleepiness. Data were obtained by using Personal Information Form, Quality of Life Scale and polysomnography reports. Cronbach Alpha reliability analysis, Chi-Square, Independent groups t-test, One-way ANOVA Analysis of Variance, Pearson Correlation Analysis and Linear Regression Analysis were used to evaluate the data.

Results: It was determined that 66.3% of the participants had a diagnosis of chronic disease, most frequently diabetes mellitus, hypertension, asthma, chronic obstructive pulmonary disease and heart diseases. 89% of the participants had obstructive sleep apnea syndrome. Quality of life levels were determined to be at a good level. It was determined that there was a negative correlation between the apnea hypopnea index value of the participants and the sort form-12 total score, and a one-unit increase in apnea hypopnea index values significantly decreased the quality of life of the patients by 0.174 times.

Conclusion: It was determined that most of the participants were diagnosed with chronic diseases and obstructive sleep apnea syndrome and that the quality of life levelswere at a good level, however, the increase in apnea hypopnea index value significantly decreased the quality of life.

Keywords: Sleep Apnea, Obstructive; Chronic Disease; Quality of Life.

Correspondence

Hasan TÜLE
Phone : +905558699828
e-mail : htule66@gmail.com

Received : Oct 24, 2025
Accepted: Dec 15, 2025

Cite this article as:
Tüle H, Balcı E. The Relationship Between Obstructive Sleep Apnea Syndrome, Chronic Diseases and Quality of Life in Geriatric Patients Attending the Sleep Unit. Turkish Journal of Geriatrics 2025; 28(4):545–553.doi:10.29400/tjgeri.2025.471

The content of this journal is licensed under the Creative Commons Attribution-NonCommercial 4.0 International License.

INTRODUCTION

Sleep is defined as the process of temporary, partial and periodic loss of the organism's communication with the environment in a reversible manner with stimuli of varying intensity. At the same time, it is the rest period in which the human body rests physically and mentally, cells are renewed, memory functions are controlled, learning is maintained, and preparation for new experiences begins (1). During the sleep cycle, vital systems such as respiratory, circulatory and nervous systems as well as disorders in musculoskeletal systems are repaired. Disruption of the sleep-wake cycle leads to a decrease in sleep quality and this leads to negative effects on human health (2).

Obstructive sleep apnea syndrome (OSAS), characterized by recurrent complete (apnea) or partial (hypopnea) obstruction of the upper airways, is a disease associated with sleep desaturation and recurrent awakenings (arousal) (3). The prevalence of this disease is comparable to other important chronic diseases such as chronic obstructive pulmonary disease (COPD), diabetes mellitus (DM), coronary artery disease (CAD) and asthma. OSAS can occur in any age group and the incidence of the disease in men of all ages is twice that of women (4).

Chronic diseases are defined as long-standing and slowly progressing diseases. Chronic diseases are diseases that require long- term medical care and treatment and cause irreversible changes (5).

The concept of quality of life, which is expressed as the subjective satisfaction and happiness of the individual in his/her life, is defined as how the person sees his/her situation, expectations, standards, goals and experiences in line with his/her own interests (6). OSAS, which has become an important public health problem today, causes individuals to become easily irritable and to experience problems in their relationships with others (7).

Variables such as male gender, obesity, advanced age, smoking and alcohol consumption have an important role in OSAS. Especially respiratory diseases, cardiovascular diseases, DM, metabolic diseases and other systemic diseases may increase the incidence of OSAS, and the presence of diseases may also affect the progression of OSAS. (3)

The aim of this study is to determine the relationship between OSAS, chronic diseases and quality of life.

MATERIALS AND METHOD

Prior to commencing the study, approval was obtained from the Kayseri City Education and Research Hospital Clinical Research Ethics Committee with decision number 555 dated May 18, 2022. Individuals who agreed to participate in the study were informed about the data collection tools and their consent was obtained.

The study was conducted with 363 patients over the age of 65 between January 2022 and August 2023. The sample size was determined using the G*Power program (version 3.1.9.4), with an effect size of d=0.3, a type error of 0.05, N2/N1=1, and α=0.05, based on previous studies. The minimum sample size was 322 patients. Patients who did not have communication problems or psychiatric issues and who agreed to participate in the study were selected using simple random sampling. According to the calculation using G*Power (version 3.1.9.4), the power of the test was found to be P=1.0000000 (100.0%). The data were transferred to a computer and analyzed using SPSS (version 23.0). Using Chi-square analysis and descriptive statistics tests on the data obtained from the Sociodemographic Information Form, the frequency, distribution, mean, standard deviation, and maximum and minimum values of the disease frequency and disease diagnosis characteristics of the patients participating in the study were calculated. The normality of the distribution of the data obtained from the scale was determined using the Kolmogorov-Smirnov test. The mean score, standard deviation, median, range, maximum, and minimum values of the scale and its components were determined from the obtained data. The



internal consistency coefficient of the scale and its components was calculated using Cronbach's alpha coefficient through reliability analysis. To compare the differences between means in independent groups, the Independent Samples t-test was used for two groups with normally distributed data, and ANOVA (Analysis of Variance) was used for more than two groups. In groups where a significant difference was found in the ANOVA, the difference between groups was examined using Tukey and Tamhane's T2 tests. The homogeneity of the groups was determined using the Levene Test. Pearson Correlation Coefficient analysis was applied to variables with a normal distribution to determine the relationship between dependent and independent variables. Linear regression analysis was used to determine whether the AHI level (severity of OSAS) of patients has an effect on their quality of life. A significance level of $p<0.05$ was accepted for the evaluation of the data.

RESULTS

Table 1. shows the distribution of the patients who participated in the study according to the frequency of chronic diseases and disease diagnoses.

It was found that 66.3% of the patients who participated in the study had a diagnosis of chronic disease. HT in 43.0% (n=156), DM in 31.4% (n=114), asthma in 22.5% (n=82), COPD in 5.6% (n=20), stroke in 0.2% (n=1), MI in 0.8% (n=3), CHF in 11.6% (n=42), heart rhythm disorder in 1.4% (n=5), 4.5% had thyroid diseases (n=17), 6.0% had osteoporosis (n=22), 0.5% had cancer (n=2) and 12.0% had depression (n=44). It was found that the most common diagnoses were HT and DM, and the least common diagnoses were stroke and cancer (Table 1).

Table 2. shows the distribution of OSAS status and OSAS level according to AHI values of the patients participating in the study.

When the OSAS level was analyzed according to the AHI of the patients participating in the study,

Table 1. Distribution of Patients According to Frequency of Chronic Diseases and Disease Diagnoses (n=363)

Disease Characteristics	Number	%
Diagnosis of chronic disease		
There is	241	66.3
None	122	33.7
DM		
There is	114	31.4
None	249	68.6
Hypertension (HT)		
There is	156	43.0
None	207	57.0
Asthma		
There is	82	22.5
None	281	77.5
COPD		
There is	20	5.6
None	343	94.4
Stroke		
There is	1	0.2
None	362	99.8
Myocardial Infarction (MI)		
There is	3	0.8
None	360	99.2
Chronic Heart Failure (CHF)		
There is	42	11.6
None	321	88.4
Heart Rhythm Disorder		
There is	5	1.4
None	358	98.6
Thyroid Diseases		
There is	17	4.5
None	346	95.5
Osteoporosis		
There is	22	6.0
None	341	94.0
Cancer		
There is	2	0.5
None	361	99.5
Depression		
There is	44	12.0
None	319	88.0
Total	363	100.0

Table 2. Distribution of Obstructive Sleep Apnea Syndrome Level According to Apnea-Hypopnea Index Values of Patients (n=363)

OSAS Level	Number	%
Mild Snoring-No OSA (AHI<5)	40	11.0
Mild OSAS (5≤AHI<15)	32	8.9
Moderate OSAS (15≤AHI<30)	96	26.4
Severe OSAS (AHI≥30)	195	53.7
Total	363	100.0

it was found that 53.7% had severe OSAS (AHI≥30), 26.4% had moderate OSAS (15≤AHI<30), 8.9% had mild OSAS (5≤AHI<15) and 11.0% had mild snoring (no OSAS) (AHI<5) (Table 2).

Table 3 shows the comparison of Quality of Life Scale, Physical Component Summary (PCS-12) and Mental Component Summary (MCS-12) scores according to the frequency of chronic diseases and disease diagnoses.

When Table 3 was analyzed, it was found that SF-12 total score, PCS-12 total score and MCS-12 total score of the patients differed significantly

Table 3. Comparison of Quality of Life Scale, Physical Component Summary and Mental Component Summary Scores of Patients According to Frequency of Chronic Disease and Disease Diagnosis

Chronic Disease Prevalence and Disease Diagnosis	n	Quality of Life Scale and its Components		
		SF-12 Total	PCS-12 Total	MCS-12 Total
		$\bar{x}$ ± SD	$\bar{x}$ ± SD	$\bar{x}$ ± SD
Diagnosis of chronic disease				
There is	241	65.38 ± 21.82	67.89 ± 18.98	65.38 ± 21.82
None	122	84.29 ± 15.52	84.32 ± 11.67	84.29 ± 15.52
Test value		t= -11.882	t= -10.987	t= -11.733
Significance level		p=0.000*	p=0.000*	p=0.000*
DM				
There is	114	62.33 ± 20.42	61.18 ± 22.96	63.49 ± 19.53
None	249	77.28 ± 17.08	76.59 ± 19.49	77.97 ± 16.22
Test value		t= -7.854	t= -7.173	t= -7.969
Significance level		p=0.000*	p=0.000*	p=0.000*
HT				
There is	156	64.87 ± 20.28	63.54 ± 22.31	66.19 ± 19.68
None	207	78.40 ± 16.61	77.93 ± 19.30	78.87 ± 15.64
Test value		t= -7.845	t= -7.437	t= -7.650
Significance level		p=0.000*	p=0.000*	p=0.000*
Asthma				
There is	82	61.93 ± 19.70	59.91 ± 22.02	63.96 ± 19.59
None	281	75.68 ± 18.27	75.19 ± 20.55	76.17 ± 17.34
Test value		t= -6.790	t= -6.723	t= -6.277
Significance level		p=0.000*	p=0.000*	p=0.000*
COPD				
There is	20	49.93 ± 21.97	46.29 ± 24.74	53.58 ± 21.07
None	343	73.92 ± 18.47	73.25 ± 20.71	74.60 ± 17.75
Test value		t= -5.559	t= -6.497	t= -5.078
Significance level		p=0.000*	p=0.000*	p=0.000*
Stroke				
There is	1	33.75 ± 0.00.	33.33 ± 0.00.	34.16 ± 0.00.
None	362	72.67 ±19.39	71.83 ± 21.78	73.50 ± 18.50
Test value		t= -2.005	t= 1.766	t= -2.124
Significance level		p=0.046*	p=0.078	p=0.034*



Table 3. Continued...

Chronic Disease Prevalence and Disease Diagnosis	n	Quality of Life Scale and its Components		
		SF-12 Total	PCS-12 Total	MCS-12 Total
		$\bar{x}$ ± SD	$\bar{x}$ ± SD	$\bar{x}$ ± SD
MI				
There is	3	50.83 ± 28.34	48.95 ± 33.05	50.83 ± 28.34
None	360	72.77 ± 19.30	71.94 ± 21.66	72.77 ± 19.30
Test value		t= -2.255	t= -2.105	t= -2.250
Significance level		p=0.025*	p=0.036*	p=0.025*
CHF				
There is	42	55.86± 19.14	54.48 ± 21.62	57.24 ± 18.44
None	321	74.77± 18.42	74.01 ± 20.84	75.54 ± 17.53
Test value		t= -7.191	t= --6.564	t= -7.298
Significance level		p=0.000*	p=0.000*	p=0.000*
Heart Rhythm Disorder				
There is	5	67.85± 16.53	63.09 ± 16.39	72.61 ± 17.35
None	358	72.66± 19.50	71.88 ± 21.88	73.43 ± 18.60
Test value		t= -0.648	t= -1.057	t= -0.116
Significance level		p=0.517	p=0.291	p=0.908
Thyroid Diseases				
There is	17	57.25± 22.78	55.49 ± 25.56	59.01 ± 21.59
None	346	73.32± 19.00	72.52 ± 21.36	74.11 ± 18.16
Test value		t= -3.838	t= -3.621	t= -3.776
Significance level		p=0.000*	p=0.000*	p=0.000*
Osteoporosis				
There is	22	54.02± 17.42	51.72 ± 18.81	56.32 ± 18.11
None	341	73.77± 18.98	73.03 ± 21.39	74.51 ± 18.07
Test value		t= -5.456	t= -5.234	t= -5.254
Significance level		p=0.000*	p=0.000*	p=0.000*
Cancer				
There is	2	51.04± 18.56	52.08 ± 20.62	50.00 ± 16.49
None	361	72.68± 19.42	71.83 ± 21.81	73.52 ± 18.53
Test value		t= -1.572	t= -1.278	t= -1.792
Significance level		p=0.117	p=0.202	p=0.074
Depression				
There is	44	60.36± 21.53	59.12 ± 24.98	61.60 ± 19.97
None	319	74.25± 18.56	73.47 ± 20.81	75.03 ± 17.80
Test value		t= -4.681	t= -4.182	t= -5.309
Significance level		p=0.000*	p=0.000*	p=0.000*

$\bar{X}$: Mean, SD: Standard Deviation, F: ANOVA Analysis of Variance value, t: Independent groups t test value,*p<0.05, **Tamhane's T2 Test.

Table 4. Comparison of Disease Frequency of Patients According to Obstructive Sleep Apnea Syndrome Level

Variables	OSAS Level								
	OSAS None		Mild OSAS		Moderate OSAS		Severe OSAS		Test value and p
	n	%	n	%	N	%	n	%	
Diagnosis of chronic disease									
There is	16	6.5	21	8.7	62	25.9	142	58.9	χ^2=21.792
None	24	19.6	11	9.2	34	27.6	53	43.6	p=0.000*
DM									
There is	2	2.0	6	5.3	31	27.0	75	65.8	χ^2=25.610
None	38	15.1	26	10.5	65	26.2	120	48.2	p=0.000*
HT									
There is	6	3.8	11	7.2	38	24.0	101	64.9	χ^2=27.254
None	33	16.3	21	10.1	59	28.3	94	45.3	p=0.000*
Asthma									
There is	6	7.3	7	8.3	20	24.8	49	59.6	χ^2=2.803
None	34	12	25	9.1	77	26.9	145	52.0	p=0.423
COPD									
There is	1	7.4	2	11.1	3	14.8	14	66.7	χ^2=2.843
None	38	11.2	30	8.8	93	27.1	182	53.0	p=0.417
Stroke									
There is	-	0.0	-	0.0	-	0.0	1	100.0	χ^2=0.863
None	40	11.0	32	8.9	96	26.5	194	53.6	p=0.938
MI									
There is	-	0.0	1	33.3	-	0.0	2	66.7	χ^2=3.027
None	40	11	32	8.8	96	26.7	192	53.5	p=0.387
CHF									
There is	1	1.8	3	7.1	14	33.9	24	57.1	χ^2=6.552
None	39	12.1	29	9.1	81	25.4	172	53.4	p=0.088
Heart Rhythm Disorder									
There is	-	0.0	1	20.0	3	60.0	1	20.0	χ^2=4.378
None	40	11.1	32	8.8	93	26	193	54.1	p=0.223
Thyroid Diseases									
There is	-	0.0	1	5.8	5	29.4	11	64.7	χ^2=3.916
None	40	11.5	31	9.1	91	26.4	184	53.0	p=0.271
Osteoporosis									
There is	-	0.0	2	6.9	7	31.0	13	62.1	χ^2=4.161
None	40	11.6	30	9.0	89	26.2	182	53.2	p=0.245
Cancer									
There is	1	50.0	-	0.0	-	0.0	1	50.0	χ^2=3.511
None	40	10.8	32	8.9	95	26.6	194	53.7	p=0.319
Depression									
There is	5	10.3	3	6.9	12	27.6	24	55.2	χ^2=0.373
None	34	11.0	30	9.2	84	26.3	171	53.5	p=0.946

χ^2: Chi-Square Test value, *p<0.05



according to the presence of a diagnosis of chronic disease, and the SF-12, PCS-12 and MCS-12 scores of patients with a diagnosis of chronic disease were significantly lower than those of patients without a diagnosis of chronic disease ($p<0.05$) (Table 3).

In the study, SF-12 total score, PCS-12 total score and MCS-12 total score differed significantly according to the presence of DM, HT, asthma, COPD, stroke, MI, CHF, thyroid diseases, osteoporosis and depression; SF-12, PCS-12 and MCS-12 scores of patients with a diagnosis of

DM, HT, asthma, COPD, stroke, MI, CHF, thyroid diseases, osteoporosis and depression were significantly lower than those of patients without a diagnosis of DM, HT, asthma, COPD, stroke, MI, CHF, thyroid diseases, osteoporosis and depression ($p<0.05$) (Table 3).

In the study, it was determined that the SF-12, PCS-12 scores of patients without a diagnosis of heart rhythm disorder and cancer were higher than those of patients with a diagnosis of heart rhythm disorder and cancer, but the scores of quality of life and its components did not differ significantly according to the diagnosis of heart rhythm disorder and cancer ($p>0.05$) (Table 3).

Table 4 shows the comparison of the disease frequencies of the patients according to the level of OSAS.

When Table 4 was analyzed, it was found that 8.7% of the patients with chronic diagnosis had mild OSAS, 25.9% had moderate OSAS and 58.9% had severe OSAS. Among the patients with severe OSAS, 65.8% had DM, 64.9% had HT, 59.6% had asthma, 66.7% had COPD, 66.7% had MI, 57.1% had CHF, 20.0% had cardiac arrhythmia, 64.8% had thyroid diseases, 62.1% had osteoporosis, 50.0% had cancer and 55.2% had depression. In the study, it was determined that there was a significant relationship between the diagnosis of chronic disease status, DM diagnosis and HT disease diagnosis and OSAS level ($p<0.05$); however, there was no significant relationship between asthma, COPD, stroke, MI, CHF, thyroid diseases, osteoporosis and depression and OSAS level ($p>0.05$) (Table 4)

DISCUSSION

In our study, 66.3% of the patients had a diagnosis of chronic disease. HT was diagnosed in 43.0%, DM in 31.4%, asthma in 22.5%, COPD in 5.6%, CHF in 11.6%, cardiac arrhythmia in1.4%, thyroid diseases in 4.5%, osteoporosis in 6.0%, cancer in 0.4% and depression in 12.0%. It was found that HT and DM were the most common diagnoses and stroke and cancer were the least common diagnoses in the patients who participated in the study. In similar studies conducted on patients who applied to sleep units in our country, it was reported that 27.0%-45.0% of the patients had HT, 11.4%-37.8% had DM, 8.8%-17.2% had CHF, and 4.1%-9.9% had asthma/COPD. Furthermore, in studies conducted in patients with OSAS, it was found that 41.0-51.7% had HT, 21.3-24.3% had DM, 2.0-5.2% had CHF, and 19.7% had COPD (1, 8). Insimilar studies conducted in various countries, it was found that 22.6-47.0% of the patients had HT, 9.3-26.9% had DM, 16.7-22.7% had COPD, and 8.6% had CVD, and the results were compatible with our study and the studies conducted in our country (9, 10). In addition, mild OSAS was found in 8.7%, moderate OSAS in 25.9% and severe OSAS in 58.9% of patients with a diagnosis of chronic disease in our study. In other words, it was observed that as the level of OSAS increased, chronic diseases and depression level increased.

In our study, OSAS was detected in 89.0% of the patients according to the AHI value; 53.7% of them had severe OSAS, 26.4% had moderate OSAS, and 8.9% had mild OSAS. In some studies, conducted in patients presenting to sleep units, the frequency of OSAS was reported to be 74.4% and 75.9% (8). In studies conducted in patients who applied to sleep units in different countries, OSAS level was reported to be between 62.0% and 88.0% (10). In studies conducted both in our country and abroad,

it was found that the level of OSAS was high in patients applying to sleep units. When these results are considered, it can be said that the results of our study and other studies are similar.

It was determined that the quality of life scores of the participants decreased significantly as the age range increased. There are many studies examining the relationship between the age factor and quality of life and therefore, it shows that there is a close relationship between these two concepts (11). Health problems, role losses, losses of family members, decrease in cognitive functions and similar conditions that develop with age affect the quality of life of the individual (12). We observe similar results to our research results in the studies conducted.

In our study, 58.9% of patients with a chronic diagnosis had severe OSAS and a significant relationship was found between the diagnosis of chronic disease and OSAS level. Among thepatients with severe OSAS, 65.8% had DM, 64.9% had HT, 59.6% had asthma, 66.7% had COPD, 75.0% had MI, 57.1% had CHF, 28.6% had cardiac arrhythmia, 68.2% had thyroid diseases, 62.1% had osteoporosis, 50.0% had cancer and 55.2% had depression. In our study, a significant relationship was found between the diagnosis of DM and HT disease and OSAS level, whereas no significant relationship was found between asthma, COPD, stroke, MI, CHF, thyroid diseases, osteoporosis and depression and OSAS level. In our study, the incidence of OSAS was found to be significantly higher in patients with HT and DM. In some studies, conducted abroad, depression was found in 14.0-14.8% of OSAS patients and the results were consistent with our study (12.0%). In a study conducted in China, hepatopathy was found in 44.6% of patients (9,10). Depression, hypochondriasis and conversion reactions are observed in OSAS. A significant proportion of OSAS patients experience social adaptation problems, family problems, decreased school or work performance, and their quality of life decreases significantly (7). Untreated OSAS leads to an increase in HT, coronary and cerebrovascular diseases, poorer neurocognitive performance, mental problems and all these lead to a decrease in the quality of life of patients (13).

In our study, it was determined that there was a significant relationship between the AHI variable and the quality of life level of the patients. The AHI values of the patients at the end of polysomnography(PSG) show that 10.3% of the patients' quality of life level is significantly affected. It was determined that the AHI values of the patients at the end of PSG significantly decreased the quality of life by 0.174 times. The results of some studies in the literature indicate that quality of life is related with AHI values and the determinants of OSAS severity (14). In a study conducted by Lopes et al. (2008) on 1892 patients to evaluate the quality of life in severe OSAS, it was reported that the quality of life decreased depending on the severity of the disease and the quality of life decreased significantly with increasing OSAS severity. In the same study, it was determined that quality of life parameters including social functionality and emotional role difficulty regressed in patients with an AHI value greater than 30 (15). In Hanazay's (2014) study evaluating the level of quality of life, frequency of depressive symptoms and the effect of PAP treatment in patients with OSAS, it was reported that a positive correlation was found between the increase in AHI value and deterioration in quality of life level (13). These resultscan be said to be important in terms of showing the presence of correlation between quality of life and OSAS severity.

REFERENCES

1. Akerstedt T, Wright K. Sleep loss and fatigue in shift work and shift work disorder. Sleep Medicine Clinics 2009;4(2):257-271.doi:10.1016/j.jsmc.2009.03.001
2. Al-Terki A, Abu-Farha M, AlKhairi I, et al. Increased level of angiopoietin like proteins 4 and 8 in people with sleep apnea. Front Endocrinol (Lausanne), 2018 Novomber;9:651. doi: 10.3389/fendo.2018.00651



3. Appleton S, Gill TK, Lang CJ, et al. Prevalence and comorbidity of sleep conditions in Australian adults: 2016 Sleep Health Foundation national survey. Sleep Health 2018;4(1):13-19.doi:10.1016/j.sleh.2017.10.006
4. Asghari A, Mohammadi F, Kamrava SK, et al. Evaluation of quality of life in patients with obstructive sleep apnea. European Archives of Oto-Rhino-Laryngology 2013;270:1131-1136. doi:10.1007/s00405-012-2122-y
5. Ayyildiz Y, Demirli Y. Public opinions on obesity tax: A field research in Turkey. Business and Economics Research Journal 2015;6(2):59-75.ISSN: 1309-2448
6. Demir S. Relationship between oxygen desaturation and Beck Depression Index in patients with obstructive sleep apnea syndrome. Journal of Turkish Sleep Medicine 2016;3(1):1-5.doi:10.5578/ttj.30506
7. Güven S, Şener A. Factors affecting life satisfaction in old age. Turkish Journal of Geriatrics 2010; 14(2):179-186
8. Hasanefendioğlu E, Sezgin M, Sungur MA, et al. Health related quality of life in patients with chronic low back pain: The effect of pain, clinical and functional status on quality of life. Journal of Physical Medicine & Rehabilitation Sciences 2012;15(3):94-98. doi:10.4274/tftr.72324
9. Latner JD, Durso LE, Mond JM. Health and health-related quality of life among treatment-seeking overweight and obese adults: Associations with internalized weight bias. Journal of Eating Disorders 2013;1(3). doi:10.1186/2050-2974-1-3
10. Lopes C, Esteves AM, Bittencourt LRA, et al. Relationship between the quality of life and the severity of obstructive sleep apnea syndrome. Brazilian Journal of Medical and Biological Research 2008;41(10):908-913. doi:10.1590/S0100-879X2008001000011
11. ÖktemAyık S, Akhan G, Peker Ş. Obesity frequency and comorbidities in patients with obstructive sleep apnea syndrome (OSAS). Turkish Thoracic Journal 2011;12(3):105-110.doi:10.5152/ttd.2011.24
12. Öztop H, Şener A, Güven S, et al. Influences of intergenerational support on life satisfaction of the elderly: The Turkish sample. Social Behavior and Personality: An International Journal 2009;37(7):957-970. doi:10.2224/sbp.2009.37.7.957
13. Ward BW, Black LI. State and regional prevalence of diagnosed multiple chronic conditions among adults aged ≥18 years-United States 2014. Morbidity and Mortality Weekly Report 2016;65(29):735-738. doi:10.15585/mmwr.mm6529a3
14. Yılmaz T. Sleep Respiratory Arrest and Snoring, In: Önerci M (Ed). Oversleeping Disorders. 1st edition, Öncü Printing House, Ankara 2003, pp. 213-26
15. Young T, Palta M, Dempsey J, et al. The occurrence of sleep-disordered breathing among middle-aged adults. New England Journal of Medicine 1993;328(17):1230-1235. doi:10.1056/NEJM199304293281704

Turkish Journal of Geriatrics
2025; 28(4):554–566

DOI: 10.29400/tjgeri.2025.472

Nuray ARI[1]
Ayşe SAĞMAK TARTAR[2]
Sümeyra KAYALI[1]
Serhat DAYAN[2]
Bahar TANIK ŞİMŞEK[2]
Hatice Handan AKBULUT[3]

[1] Fırat University, Faculty of Medicine, Department of Medical Microbiology, Elazığ, Türkiye

[2] Fırat University, Faculty of Medicine, Department of Infectious Diseases and Clinical Microbiology, Elazığ, Türkiye

[3] Fırat University, Faculty of Medicine, Department of Immunology, Elazığ, Türkiye

Correspondence

Nuray ARI
Phone : +905059264662
e-mail : nari@firat.edu.tr

Received : Oct 10, 2025
Accepted: Dec 26, 2025

Cite this article as:
Arı N, Sağmak Tartar A, Kayalı S. et al. Microbiological Profiles and Clinical Outcomes of Bloodstream Infections in Geriatric Patients Admitted to Intensive Care Units: A Single-Center Experience. Turkish Journal of Geriatrics 2025; 28(4):554–566.doi:10.29400/tjgeri.2025.472

ORIGINAL ARTICLE

MICROBIOLOGICAL PROFILES AND CLINICAL OUTCOMES OF BLOODSTREAM INFECTIONS IN GERIATRIC PATIENTS ADMITTED TO INTENSIVE CARE UNITS: A SINGLE-CENTER EXPERIENCE

Abstract

Introduction: Bloodstream infections are associated with high mortality in older adults due to immunosenescence and comorbidities. This study aimed to investigate pathogen distribution, antimicrobial resistance patterns, and predictors of early and late mortality in intensive care unit patients aged ≥65 years.

Materials and Method: Between September 2022 and September 2024, blood culture results of intensive care unitpatients aged ≥65 years at Fırat University Hospital were evaluated. The first clinically significant isolates were analyzed; identification and susceptibility were performed by automated systems and confirmed by conventional methods when necessary. Statistical analyses were conducted.

Results: Among 469 patients, the most frequent pathogens were *Klebsiella spp.* (18.6%), *Enterococcus spp.* (16.8%), and Escherichia coli(12.6%). Extended-spectrum β-lactamase positivity was 77.0% in *Klebsiella spp.* 50.8% in *Escherichia coli*. In *Klebsiella spp.*, imipenem and meropenem susceptibilities were 37.3% and 35.3%, respectively, and amikacin susceptibility was 84.9%. *Acinetobacter spp.* showed 94.7% susceptibility to colistin, while Staphylococcus aureus was 100% susceptible to vancomycin. Approximately 40–50% of *Candida* isolates demonstrated azole resistance. Secondary bloodstream infections occurred in 62.5%, with higher C-reactive protein levels (p=0.034). In multivariable analysis, only serum albumin was independently associated with early mortality.

Conclusion: In geriatric intensive care unit patients, bloodstream infections were mostly secondary, predominantly caused by Klebsiellaspeciesand Escherichia coli.High Extended-spectrum β-lactamase rates and marked carbapenem resistance complicate treatment.Low serum albumin independently predicted early mortality. Our findings highlight the need for close monitoring of infection burden and resistance patterns.

Keywords: Aged; Intensive Care Units; Sepsis; Bacteremia; Drug Resistance.

The content of this journal is licensed under the Creative Commons Attribution-NonCommercial 4.0 International License.

INTRODUCTION

Bloodstream infections (BSIs), ranging from bacteremia to sepsis and septic shock, are serious clinical conditions that result in high morbidity and mortality among older adults. Advanced age, immunosenescence, and the presence of multiple comorbidities increase susceptibility to infections and contribute to a more severe and rapid disease course. In addition, BSIs in the elderly often present with atypical symptoms, leading to diagnostic and therapeutic delays that are recognized as major contributors to mortality (1,2). Previous studies have reported that individuals aged ≥65 years are significantly more likely to be diagnosed with sepsis compared to younger adults, imposing a growing burden on healthcare systems (3,4).

BSIs are particularly frequent among geriatric patients admitted to intensive care units (ICUs), where they often require urgent management. Knowledge of the clinical course and antimicrobial resistance patterns of BSIs in this population is therefore critical for guiding appropriate therapeutic decisions (3).

Colonization with multidrug-resistant organisms is more common in older adults who require long-term care, complicating treatment and adversely affecting quality of life. Gram-negative bacteria account for 40–60% of BSIs in this age group and are associated with higher rates of antimicrobial resistance (5,6).

Population-based studies indicate a rising incidence of BSIs in the elderly. However, data regarding pathogen distribution, resistance patterns, and clinical predictors of mortality in this vulnerable group remain limited (7).

This study aimed to evaluate the distribution of microorganisms and antimicrobial resistance patterns isolated from blood cultures of patients aged ≥65 years admitted to Level I, Level II, and Level III intensive care units (ICUs), and to investigate the association of clinical and laboratory parameters with early (≤7 days) and late (7–30 days) mortality.

MATERIALS AND METHOD

Study Design, Setting, and Participants

Between September 2022 and September 2024, blood culture results of patients aged ≥65 years admitted to intensive care units of Fırat University Hospital were retrospectively evaluated. Based on their clinical capabilities and available organ-support modalities, ICUs were categorized into Level I, Level II, and Level III. Internal Medicine, Anesthesiology, Infectious Diseases, and Nephrology ICUs were classified as Level III; Gastroenterology, Surgical, Oncology, Hematology, and mixed ICUs as Level II; and the Cardiology ICU as Level I. The first clinically significant isolates were included in the analysis. A clinically significant isolate was defined as the first microorganism considered a true pathogen based on compatible clinical features, growth in ≥1 blood culture set, presence of systemic inflammatory response, and confirmation by an infectious diseases specialist. Identification and antimicrobial susceptibility testing were performed by automated systems and confirmed with conventional methods when necessary. Patients were classified as primary and secondary BSIs; in addition to clinical findings, key laboratory parameters such as C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), procalcitonin, creatinine, and albumin were analyzed in relation to pathogen distribution and resistance patterns; independent risk factors for mortality were determined using multivariable analyses. Associations with early (≤7 days) and late (7–30 days) mortality were also evaluated.

Inclusion and Exclusion Criteria

Only bloodstream infections that occurred after ICU admission were included; patients with pre-existing infections or positive cultures before ICU admission were excluded. Among multiple blood culture samples from the same patient, only the first clinically significant isolate was included. Isolates considered to be contaminants and repeated growths within 10 days were excluded.

Definitions

Bloodstream Infection (BSI): Defined as the detection of a viable microorganism in a blood culture.

Blood Culture Contamination: Growth of one or more microorganisms belonging to the skin flora in only a single blood culture set (e.g., in one or more bottles of a single set, or in only one of two or three sets) without clinical or microbiological evidence supporting true infection with that organism (8).

This group typically includes organisms such as coagulase-negative *Staphylococci*, *Corynebacterium spp.*, *Bacillus spp.* (non-anthracis), and *Micrococcus spp.*

Primary BSI: Infections originating directly from endovascular sources (e.g., infective endocarditis) (8).

Secondary BSI: Infections resulting from hematogenous spread from a secondary focus such as the urinary tract, lungs, or catheters (8).

Lung-derived Secondary BSI: Secondary bloodstream infection of pulmonary origin was defined when radiologically confirmed pneumonia was present, a pathogenic microorganism was isolated from a lower respiratory tract sample (endotracheal aspirate or bronchoalveolar lavage), and the same microorganism with identical species identification was isolated from the blood culture within the same infectious episode.

Data Collection and Clinical Assessment

Electronic records obtained from hospital and laboratory information systems were retrospectively reviewed. Recorded data included demographic and clinical characteristics such as age, sex, and comorbidities; ward of admission, source of infection, recent antibiotic use (within the last three months), and prior hospitalization history. In addition, isolated micro organisms and their anti microbial susceptibility profiles from blood cultures were documented. Patients were classified under two main groups based on the infection source: primary BSIs and secondary BSIs. Laboratory parameters, including CRP, ESR, procalcitonin, leukocyte count, neutrophil and lymphocyte percentages, lactate, AST, ALT, urea, creatinine, total protein, and albumin, were evaluated. Differences between early (≤7 days) and late (7–30 days) mortality were also analyzed. Due to missing data in some laboratory parameters, analyses were performed on the available subsample for each parameter.All biochemical and hematological measurements were taken from blood samples drawn at the time of blood culture collection.

Microbiological Studies

Blood cultures were incubated using an automated system (BD BACTEC™, USA). For cultures yielding growth signals, subcultures were performed after Gram staining onto 5% sheep blood agar and EMB media. Identification and antimicrobial susceptibility testing were carried out using a semi-automated system (BD Phoenix™, Becton, Dickinson and Company, Sparks, MD, USA), disk diffusion (Bioanalyse, Ankara, Türkiye), and broth microdilution (Sensititre™, Thermo Fisher Scientific Inc., Waltham, MA, USA). Potential contaminants were excluded from the analysis. Antimicrobial susceptibility results were interpreted according to the criteria of the European Committee on Antimicrobial Susceptibility Testing (EUCAST v2023) and the recommendations of the Turkish Society of Microbiology ADTS (Standardization of Antimicrobial Susceptibility Testing) working group.

Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics v22.0 (IBM Corp., Armonk, NY, USA). The distribution of continuous variables was assessed using the Shapiro–Wilk test. For normally distributed variables, the independent samples t-test was applied, while the Mann–Whitney U test was used for non-normally distributed variables.

Categorical variables were presented as counts and percentages, and continuous variables as mean ± standard deviation or median (min–max). Associations between variables were examined using Spearman correlation analysis. Multivariable logistic regression was applied to identify predictors of early and late mortality among patients with known outcomes. Variables included in the multivariable logistic regression model were age, sex, infection source (primary/secondary), ICU level, major comorbidities, initial vital signs (temperature, systolic and diastolic blood pressure, heart rate, respiratory rate), inflammatory markers (CRP, ESR, procalcitonin), WBC, neutrophil and lymphocyte percentages, lactate, renal and liver function tests (urea, creatinine, AST, ALT), total protein, and albumin levels.A p-value <0.05 was considered statistically significant.

Ethics approval

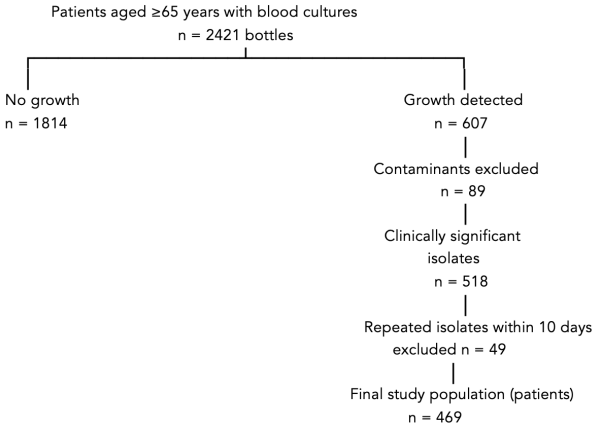
The study was conducted in accordance with the Declaration of Helsinki and approved by the Fırat University Non-Interventional Research Ethics Committee (Approval No: 2025/03-35, Date: 19.02.2025). Informed consent was waived due to the retrospective design.Data extraction and analyses were performed after ethics approval had been obtained.

RESULTS

Cohort flow and baseline characteristics

During the study period, a total of 2421 blood culture bottles from patients aged ≥65 years were screened through the hospital information system. Among these, 1814 bottles (74.9%) showed no growth, while 607 bottles (25.1%) yielded microbial growth. All reported results are based on the 469 patients included in the final analysis.

Of the 607 positive blood culture samples obtained during the study period, 89 (14.7%) were considered contaminants and excluded from the analysis. Only the first clinically significant isolate from each patient was included, resulting in a total of 469 geriatric patients (200 women, 42.6%; 269 men, 57.4%) analyzed.



Due to missing data in some laboratory parameters, comparisons were performed on the available subsamples. The mean age was 75.4 ± 7.9 years for women and 76.9 ± 8.5 years for men. In accordance with standard clinical practice, at least two blood culture sets were obtained from each patient during the diagnostic evaluation. In most cases, 2 to 3 sets (4–6 bottles) were collected.

Among the 469 geriatric ICU patients included in the study, multimorbidity was highly prevalent. The median number of chronic comorbidities per patient was 3 (IQR: 2–5), and 74% of the cohort had three or more chronic conditions. The most common comorbidities were hypertension (63.5%), diabetes mellitus (51.5%), ischemic heart disease (38.0%), chronic kidney disease (26.0%), heart failure (24.0%), and chronic obstructive pulmonary disease (19.4%). Cerebrovascular disease was present in 14.3% of patients, while 13–14% had an active malignancy (solid or hematologic). In addition, neurological disorders such as dementia, Parkinson's disease, and a history of stroke were frequent, contributing to reduced airway protection and increased aspiration risk. Overall, the patient population exhibited substantial frailty and physiologic vulnerability consistent with advanced age and multiple chronic diseases.

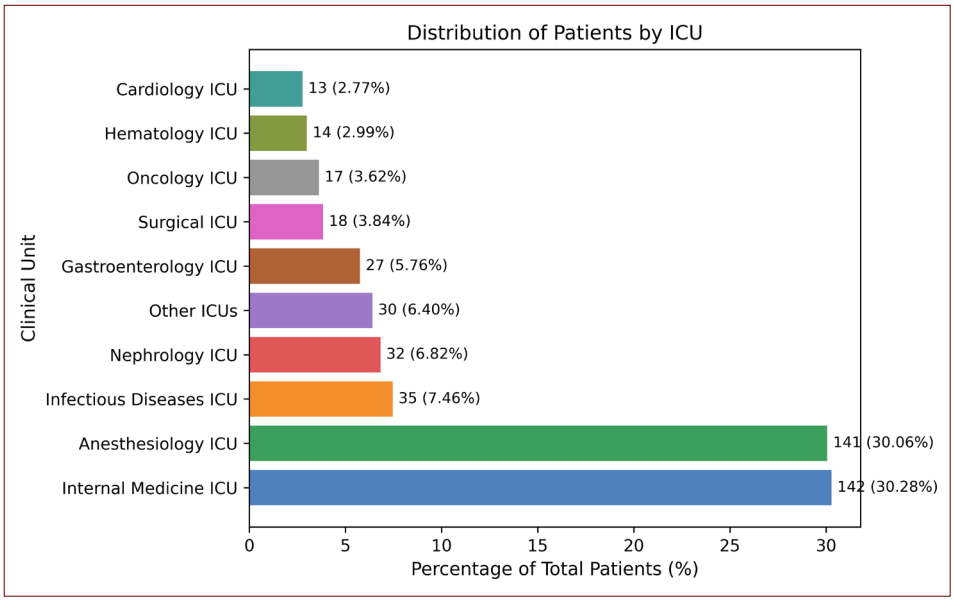


Figure 1. Distribution of geriatric patients with bloodstream infections by intensive care unit (n=469).

The most frequent admissions were to the Internal Medicine ICU (n=142, 30.3%) and the Anesthesiology ICU (n=141, 30.1%) (Figure 1). Among 469 patients with BSI, 350 (74.6%) were monitored in Level III ICUs, 106 (22.6%) in Level II ICUs, and 13 (2.8%) in Level I ICUs. The mean time from ICU admission to the first BSI episode was 6.4 ± 4.7 days.

Distribution of pathogens

Among the microorganisms isolated from blood cultures, *Klebsiella spp.* was the most frequent (n=87, 18.6%), followed by *Enterococcus spp.* (n=79, 16.8%), *Escherichia coli (E. coli)* (n=59, 12.6%), *Acinetobacter spp.* (n=57, 12.1%), and *Staphylococcus aureus* (n=51, 10.9%). Other isolates included *Pseudomonas spp.* (n=28, 6.0%), *Stenotrophomonas maltophilia* (n=20, 4.3%), and *Streptococcus spp.* (n=12, 2.6%). In addition, of 41 isolates (8.7%), 34 (7.2%) were other *Enterobacterales* (e.g., *Enterobacter aerogenes, Morganella morganii, Proteus mirabilis*), and 7 (1.5%) were other Gram-negative bacteria (e.g., *Achromobacter spp., Moraxella spp.*).

Fungal pathogens were isolated in 7.5% (n=35) of positive cultures, including 20 *Candida albicans* isolates (4.3%) and 15 *non-albicans Candida* species (3.2%) such as *C. glabrata, C. parapsilosis, C. tropicalis, C. kefyr, C. dubliniensis,* and *C. haemulonii*

Antimicrobial and antifungal susceptibility patterns

Extended-Spectrum Beta-Lactamase (ESBL) production was detected in 59.9% of Enterobacterales isolates. ESBL positivity was 77.0% in *Klebsiella spp.*, 50.8% in *E. coli,* and 23.1% in other *Enterobacterales.*

Carbapenem resistance was high in Klebsiella spp. (imipenem 60.2%, meropenem 64.7%, ertapenem 68.2%) and Acinetobacter spp. (88.9% for both imipenem and meropenem). In contrast, E. coli showed markedly lower resistance (imipenem 5.3%, meropenem 7.1%, ertapenem 26.4%). Pseudomonas spp. exhibited moderate resistance (16–25%), while other Enterobacterales demonstrated heterogeneous resistance ranging from 25% to 50%.



Table 1 summarizes the susceptibility profiles of *Klebsiella spp.*, *Escherichia coli*, and other *Enterobacteriaceae* isolates. Table 2 presents the susceptibility distributions of non-fermentative

Table 1. Susceptibility profiles of Klebsiella spp.,Escherichia coli, and other Enterobacteriaceae isolates to commonly used antibiotics.

	Enterobacteriaceae											
	Klebsiella				***Escherichia coli***				**Other *Enterobacteriaceae***			
Antibiotic	**S (n, %)**	**I (n, %)**	**R (n, %)**	**Total**	**S (n, %)**	**I (n, %)**	**R (n, %)**	**Total**	**S (n, %)**	**I (n, %)**	**R (n, %)**	**Total**
Ampicillin	–	–	86, 100%	86	11, 20.0%	–	44, 80.0%	55	–	–	–	–
Amoxicillin–Clavulanate	15, 18.3%	–	67, 81.7%	82	19, 40.4%	–	28, 59.6%	47	5, 14.3%	–	30, 85.7%	35
Ampicillin–Sulbactam	16, 22.2%	–	56, 77.8%	72	19, 40.4%	–	28, 59.6%	47	–	–	–	–
Ceftazidime	15, 17.7%	1, 1.2%	69, 81.2%	85	22, 38.6%	3, 5.3%	32, 56.1%	57	10, 32.3%	–	21, 67.7%	31
Cefazolin	–	11, 12.9%	74, 87.1%	85	–	16, 28.6%	40, 71.4%	56	–	–	–	–
Ceftazidime–Avibactam	38, 82.6%	–	8, 17.4%	46	9, 81.8%	–	2, 18.2%	11	5, 41.7%	–	7, 58.3%	12
Ceftriaxone	17, 19.4%	–	70, 80.5%	87	23, 39.0%	–	36, 61.0%	59	12, 36.4%	–	21, 63.6%	33
Cefepime	17, 20.2%	–	67, 79.8%	84	27, 49.1%	–	28, 50.9%	55	10, 29.4%	3, 8.8%	21, 61.8%	34
Cefuroxime	–	10, 11.9%	74, 88.1%	84	–	19, 34.5%	36, 65.5%	55	–	2, 15.4%	11, 84.6%	13
Imipenem	31, 37.4%	2, 2.4%	50, 60.2%	83	51, 91.1%	2, 3.6%	3, 5.4%	56	18, 64.3%	3, 10.7%	7, 25.0%	28
Meropenem	30, 35.3%	–	55, 64.7%	85	52, 92.9%	–	4, 7.1%	56	21, 70.0%	–	9, 30.0%	30
Ertapenem	27, 31.8%	–	58, 68.4%	85	39, 73.6%	–	14, 26.4%	53	14, 50.0%	–	14, 50.0%	28
Gentamicin	69, 79.3%	–	18, 20.7%	87	47, 79.7%	–	12, 20.3%	59	17, 50.0%	–	17, 50.0%	34
Amikacin	73, 84.9%	2, 2.3%	12, 13.9%	86	55, 96.5%	–	2, 3.5%	57	25, 64.1%	–	14, 35.9%	39
Ciprofloxacin	19, 21.8%	1, 1.2%	67, 77.0%	87	24, 40.7%	3, 5.1%	32, 54.2%	59	17, 41.5%	3, 7.3%	21, 51.2%	41
Levofloxacin	18, 20.9%	1, 1.2%	67, 77.9%	86	24, 42.1%	1, 1.8%	32, 56.1%	57	19, 48.7%	4, 10.3%)	16, 41.0%	39
Piperacillin–Tazobactam	24, 27.9%	–	62, 72.1%	86	42, 72.4%	–	16, 27.6%	58	20, 54.1%	2, 5.4%	15, 40.5%	37
Trimethoprim–Sulfamethoxazole	39, 44.8%	1, 1.2%	47, 54.0%	87	26, 44.1%	–	33, 55.9%	59	24, 68.6%	–	11, 31.4%	35
Colistin	15, 34.1%	–	29, 65.9%	44	21, 100%	–	–	21	4, 26.7%	–	11, 73.3%	15

Results are expressed as the number and percentage of isolates classified as susceptible (S), intermediate (I), or resistant (R) according to EUCAST breakpoints

Table 2. Susceptibility profiles of *Acinetobacter spp.* and *Pseudomonas spp.* isolates to commonly used antibiotics.

	Non-fermentative Bacteria							
	Acinetobacter				***Pseudomonas spp.***			
Antibiotic	**S (n, %)**	**I (n, %)**	**R (n, %)**	**Total**	**S (n, %)**	**I (n, %)**	**R (n, %)**	**Total**
Ceftazidime	–	–	–	–	–	21, 77.8%	6, 22.2%	27
Ceftazidime–Avibactam	–	–	–	–	11, 78.6%	–	3, 21.4%	14
Cefepime	–	–	–	–	–	21, 84.0%	4, 16.0%	25
Imipenem	6, 11.1%	–	48, 88.9%	54	–	21, 75.0%	7, 25.0%	28
Meropenem	5, 9.3%	1, 1.9%	48, 88.9%	54	19, 76.0%	2, 8.0%	4, 16.0%	25
Gentamicin	7, 12.5%	–	49, 87.5%	56		–	–	–
Amikacin	7, 12.7%	–	48, 87.3%	55	26, 92.9%	–	2, 7.1%	28
Ciprofloxacin	–	6, 10.7%	50, 89.3%	56	–	21, 80.8%	5, 19.2%	26
Levofloxacin	6, 11.1%		48, 88.9%	54	–	23, 82.1%	5, 17.9%	28
Piperacillin–Tazobactam	–	–	–	–	–	24, 85.7%	4, 14.3%	28
Trimethoprim–Sulfamethoxazole	14, 26.4%	1, 1.9%	38, 71.7%	53	–	–	–	–
Colistin	18, 94.7%	–	1, 5.3%	19	–	–	–	–

Results are expressed as the number and percentage of isolates classified as susceptible (S), intermediate (I), or resistant (R) according to EUCAST breakpoints.

Gram-negative bacilli (*Acinetobacter spp.* and *Pseudomonas spp.*). Table 3 displays susceptibility results for Gram-positive organisms, including *Staphylococcus aureus*, *Streptococcus spp.*,*Enterococcus faecalis*, and *Enterococcus faecium*. Table 4 shows antifungal susceptibility patterns for *Candida albicans* and non-albicans Candida species.

Primary versus secondary BSIs and mortality

Among the 469 geriatric patients included, 176 (37.5%) had primary BSIs and 293 (62.5%) had secondary BSIs. Chi-square analysis showed that secondary BSIs were significantly more frequent in males compared to females ($\chi^2 = 6.37$, $p = 0.012$). The most common source of secondary infection was the lungs (n = 117, 39.9%), followed by the urinary

Table 3. Susceptibility profiles of Gram-positive bacteria, including *Staphylococcus aureus*, *Streptococcus spp.*, *Enterococcus faecalis*, and *Enterococcus faecium*.

	Gram-positive Bacteria							
	Staphylococcus aureus				***Streptococcus spp.***			
Antibiyotic	**S (n, %)**	**I (n, %)**	**R (n, %)**	**Total**	**S (n, %)**	**I (n, %)**	**R (n, %)**	**Total**
Penicillin G	5, 10.9%	–	41, 89.1%	46	7, 58.3%	5, 41.7%	–	12
Cefoxitin	11, 47.8%	–	12, 52.2%	23	–	–	–	–
Erythromycin	39, 76.5%	–	12, 23.5%	51	–	–	–	–
Clindamycin	36, 75.0%	1, 2.1%	11, 22.9%	48	–	–	–	–
Cefuroxime	–	–	–	–	5, 71.4%	–	2, 28.6%	7
Cefotaxime/Ceftriaxone	–	–	–	–	6, 85.7%	–	1, 14.3%	7
Cefepime	–	–	–	–	4, 57.1%	–	3, 42.9%	7
Trimethoprim–Sulfamethoxazole	47, 92.2%	2, 3.9%	2, 3.9%	51	–	–	–	–
	38, 77.6%	–	11, 22.4%	49	–	–	–	–
Levofloxacin	0, 0%	44, 88.0%	6, 12.0%	50	–	–	–	–
Gentamicin	50, 98.0%	–	1, 2.0%	51	9, 100%	–	0, 0%	9
Fusidic Acid	41, 82.0%	–	9, 18.0%	50	–	–	–	–
Teicoplanin	46, 100%	–	0, 0%	46	–	–	–	–
Vancomycin	46, 100%	–	0, 0%	46	11, 91.7%	–	1, 8.3%	12
Linezolid	46, 95.8%	2, 4.2%	–	48	–	–	–	–
Meropenem	–	–	–	–	7, 100%	–	–	7
	E. fecalis				***E. faecium***			
	S (n, %)	**I (n, %)**	**R (n, %)**	**Total**	**S (n, %)**	**I (n, %)**	**R (n, %)**	**Total**
Ampicillin	34, 91.9%	1, 2.7%	2, 5.4%	37	6, 15.8%	1, 2.6%	31, 81.6%	38
Streptomycin-Syn	22, 59.5%	–	15, 40.5%	37	6, 16.2%	–	31, 83.8%	37
Gentamicin	28, 75.7%	–	9, 24.3%	37	12, 32.4%	–	25, 67.6%	37
Teicoplanin	34, 94.4%	–	2, 5.6%	36	30, 81.1%	–	7, 18.9%	37
Vancomycin	36, 97.3%	–	1, 2.7%	37	32, 86.5%	–	5, 13.5%	37
Linezolid	34, 97.1%	–	1, 2.9%	35	36, 97.3%	–	1, 2.7%	37

Results are presented as the number and percentage of isolates classified as susceptible (S), intermediate (I), or resistant (R) according to EUCAST clinical breakpoints



Table 4. Antifungal susceptibility profiles of *Candida albicans* and *non-albicans Candida* isolates. Non-albicans species (3.2%) included *C. glabrata*, *C. parapsilosis*, *C. tropicalis*, *C. kefyr*, *C. dubliniensis*, and *C. haemulonii*.

	Candida albicans				***non-albicans Candida***			
Antibiyotic	**S (n, %)**	**I (n, %)**	**R (n, %)**	**Total**	**S (n, %)**	**I (n, %)**	**R (n, %)**	**Total**
Amfoterisin B	16, 84.2%	–	3, 15.8%	19	12, 75.0%	–	4, 25.0%	16
Anidulafungin	14, 73.7%	–	5, 26.3%	19	5, 100%	–	–	5
Fluconazol	11, 57.9%	–	8, 42.1%	19	8, 50.0%	4, 25.0%	4, 25.0%	16
Vorikonazol	8, 47.1%	3, 17.6%	6, 35.3%	17	8, 80.0%	–	2, 20.0%	10
Itrakanazol	8, 50.0%	–	8, 50.0%	16	–	–	–	–
Posakanazol	10, 58.8%	–	7, 41.2%	17	–	–	–	–
Mikofungin	17, 89.5%	–	2, 10.5%	19	10, 71.4%	–	4, 28.6%	14

Results are presented as the number and percentage of isolates classified as susceptible (S), intermediate (I), or resistant (R) according to EUCAST clinical breakpoints.

Table 5. Comparison of biochemical parameters between primary (n=176) and secondary (n=293) bloodstream infection groups.

Parameter	**Primary BSI (n=176)**	**Secondary BSI (n=293)**	**p-value**
CRP (mg/L)	84 (41.5–163.9)	111 (53.3–164.3)	0.034
ESR (mm/h)	62 (31–94.5)	64 (36.5–98.0)	0.399
Procalcitonin (ng/mL)	0.9 (0.3–3.2)	0.85 (0.3–4.7)	0.050
Leukocytes ($\times 10^3/\mu L$)	12.170 (9.100–17.100)	11.430 (8.500–14.400)	0.275
Neutrophils (%)	82 (70.5–90.0)	82 (73.0–89.0)	0.901
Lymphocytes (%)	11 (6–15)	7 (4–14)	0.267
Lactate (mmol/L)	1.8 (1.1–2.7)	2.3 (1.3–3.9)	0.205
AST (U/L)	38 (26–66.5)	37.5 (24–64)	0.958
ALT (U/L)	30 (18–60.5)	21 (14–41.8)	0.243
Urea (mg/dL)	95 (58–138)	90.5 (60–112)	0.331
Creatinine (mg/dL)	1.2 (0.9–2.2)	1.3 (0.9–2.1)	0.201
Total protein (g/dL)	5.8 (5.2–6.5)	5.95 (5.1–6.4)	0.861
Albumin (g/dL)	3.07 ± 0.62	3.09 ± 0.69	0.773

(Note: The n values for each parameter represent available data; therefore, effective sample size varies by parameter).

tract (n = 92, 31.4%) and catheter-related infections (n = 30, 10.2%). Other sources included wound, intra-abdominal, biliary, and joint fluid infections (n = 54, 18.4%). Regarding mortality, in the primary BSI group, early mortality (≤7 days) was 16.5% (n = 29) and late mortality (7–30 days) was 18.8% (n = 33); while in the secondary BSI group, early mortality was 17.1% (n = 50) and late mortality 21.2% (n = 62). The difference between groups was not statistically significant ($p = 0.853$). When biochemical parameters were compared, CRP levels were significantly higher in the secondary BSI group ($p = 0.034$). Procalcitonin levels were also higher in the secondary group, but only showed borderline significance ($p = 0.050$). No other parameters differed significantly between groups (all $p > 0.05$) (Table 5).

Multivariable analysis

In multivariable logistic regression analysis, only serum albumin level was independently associated with early mortality (OR = 0.57, 95% CI: 0.38–0.85, p = 0.009). Each 1 g/dL increase in albumin was associated with an approximately 43% reduction in the risk of early mortality. Model fit was confirmed by the Hosmer–Lemeshow test (p = 0.395). The explanatory power was moderate (Cox & Snell R^2 = 0.098, Nagelkerke R^2 = 0.131), and the model correctly classified 63.6% of cases.

DISCUSSION

In our cohort of elderly ICU patients, bloodstream infections were associated with substantial comorbidity burden and high mortality, consistent with previous studies reporting increased susceptibility in geriatric populations (1). This makes BSIs one of the leading causes of morbidity and mortality in this population. Previous studies have reported an increasing frequency of BSIs in geriatric patients, with Gram-negative bacteria as the predominant pathogens and widespread ESBL production among *Enterobacterales* (9–11). These resistance patterns highlight the growing antimicrobial resistance burden in the elderly and further complicate appropriate therapeutic choices in life-threatening conditions such as sepsis. Inappropriate empirical therapy has been shown to markedly reduce survival in septic shock (12).

In older adults, urinary tract infections, pneumonia, and catheter-related bacteremias have been reported as the most common secondary sources. Chandroulis et al. reported that secondary BSIs significantly increased mortality, while Rodriguez-Mañas emphasized that urinary infections are particularly prominent as causes of geriatric sepsis (10, 13). In an epidemiological study by Sante et al., the incidence of secondary BSIs in ICU settings was found to be substantial; 69% of patients had central venous catheters, 68% had urinary catheters, and overall mortality was reported at approximately 29% (14). In our study, the rate of secondary BSIs in geriatric patients was 62.5%, which is consistent with previous reports. Furthermore, unlike some other studies, our findings identified the lungs, urinary tract, catheters, and other sources (wound, intra-abdominal, biliary, joint fluid, etc.) as the leading foci of secondary infections in descending order. Although Gram-negative bacteria frequently colonize the gastrointestinal and urinary tracts in elderly individuals, respiratory tract infections are a leading source of secondary bacteremia in ICU settings. Advanced age, impaired swallowing reflexes, and high aspiration risk contribute to the development of pneumonia. In addition, mechanical ventilation, prolonged intubation, tracheostomy, and impaired airway clearance significantly increase the incidence of ventilator-associated and hospital-acquired pneumonia. Therefore, the predominance of lung-derived secondary BSIs in our cohort is consistent with the pathophysiology of critical illness and aligns with previous studies reporting the respiratory tract as a major origin of secondary bacteremia in ICU patients.

The higher rate of secondary BSIs observed in male patients suggests that sex may represent an independent risk factor for infection development in the geriatric population. Previous studies have indicated that male sex, particularly in combination with advanced age, may increase susceptibility to urinary and catheter-related infections (10). Consistently, chi-square analysis in our study also demonstrated that secondary BSIs were significantly more frequent in males than in females.

In bacteriological analysis, the majority of isolates were Gram-negative bacteria, with *Klebsiella spp.* and *E. coli* being the most frequently detected pathogens. This finding parallels previous studies reporting that gastrointestinal and urinary tract-related secondary bacteremias are common in the elderly, and that Gram-negative pathogens play a dominant role in geriatric sepsis (5, 6, 9).



Klebsiella spp., E. coli, and *Acinetobacter spp.* isolates exhibited high resistance rates to β-lactam antibiotics, with particularly low susceptibility to ampicillin, cephalosporins, and fluoroquinolones. Moreover, the high prevalence of ESBL production among our isolates is consistent with the findings of Ilmavirta et al., who highlighted increasing ESBL rates in *E. coli* bacteremias in recent years (11). Carbapenems showed limited activity against Klebsiella and *E. coli*, while *Acinetobacter spp.* isolates demonstrated marked resistance to carbapenems; in such cases, only colistin retained significant effectiveness. In Pseudomonas spp. isolates, the aminoglycoside antibiotic amikacin showed the highest activity. Similarly, previous studies have emphasized the widespread prevalence of ESBL-positive *Enterobacterales* and the rising rates of carbapenem resistance in elderly ICU patients (11). These findings underscore the necessity of tailoring empirical antibiotic choices to local resistance patterns in elderly ICU patients and highlight the increasing challenges in selecting appropriate therapy.

Among Gram-positive isolates, *S. aureus* and *Enterococcus spp.* were predominant, showing particularly high resistance rates to penicillin G. In contrast, glycopeptide and oxazolidinone antibiotics such as vancomycin, teicoplanin, and linezolid exhibited high levels of susceptibility across all isolates. *E. faecium* isolates showed very low susceptibility to ampicillin and limited activity against agents such as gentamicin and streptomycin. In *Streptococcus spp.* isolates, moderate susceptibility to β-lactams was maintained. These findings indicate that classical β-lactam agents may be insufficient against Gram-positive BSI pathogens, while glycopeptides continue to play a crucial role in empirical therapy. Furthermore, the presence of resistant species such as *E. faecium* has been linked to increased prolonged hospital stays in the geriatric population (15, 16).

The *Candida* species identified in our study also stand out as important causes of sepsis in geriatric patients. Approximately 7.5% of isolates were *Candida albicans* and *non-albicans Candida,* indicating that invasive candidemia represents a considerable pathogen burden in elderly ICU patients. The literature clearly describes risk factors for candidemia in advanced age, including immune senescence, prolonged broad-spectrum antibiotic therapy, central venous catheterization, and extended ICU stays (17). The increasing proportion of *non-albicansCandida* species necessitates careful consideration of changing antifungal resistance profiles (18). This finding underscores the importance of revising antifungal treatment protocols in the elderly population. The antifungal susceptibility profiles of *Candida albicans* and *non-albicans* isolates highlight the need for careful consideration in the treatment of candidemia in elderly patients. In *Candida albicans* isolates, echinocandins and polyenes such as micafungin, amphotericin B, and anidulafungin demonstrated high efficacy, whereas azole antifungals, particularly voriconazole and itraconazole, showed low susceptibility rates. In *non-albicans Candida* species, fluconazole susceptibility remained around 50%, whereas anidulafungin was effective in all tested isolates. This finding supports the growing trend of azole resistance in geriatric patients. The literature has reported a strong association between invasive candidemia and mortality in elderly individuals, recommending echinocandins as the preferred therapy due to increasing azole resistance (18, 19). Our findings emphasize the importance of carefully planning empirical antifungal therapy and integrating antifungal susceptibility testing into treatment strategies for elderly ICU patients.

In this study, CRP and procalcitonin levels were higher in the secondary BSI group, but they did not show an independent association with mortality in multivariable analysis. Similarly, no significant

association was observed for neutrophil-to-lymphocyte ratio. In contrast, only serum albumin level was independently associated with early mortality. The literature has emphasized the role of CRP and procalcitonin in the diagnosis and prognosis of sepsis, reporting their association with mortality particularly in elderly patients (15, 16, 20). Our findings suggest that these biomarkers should be carefully interpreted in elderly patients and highlight the importance of establishing age-specific cutoff values.

Low serum albumin levels may reflect conditions such as malnutrition, high comorbidity burden, and immune deficiency in geriatric patients, and can therefore be associated with poor prognosis. The literature has also demonstrated that hypoalbuminemia increases the risk of mortality in sepsis and critical illness (21, 22). In our multivariable logistic regression analysis, only serum albumin level was independently associated with early mortality within the first 7 days. This finding supports the prognostic importance of albumin and indicates that it may serve as a clinically valuable biomarker. Our results are consistent with the literature reporting early and late mortality rates in elderly patients with sepsis (23). Therefore, individualized supportive treatments based on albumin levels and the implementation of early, multidisciplinary approaches are recommended in geriatric patients.

Strengths and Limitations

The major strength of this study is the analysis of resistance profiles using a large microbiological and clinical dataset in patients aged ≥65 years followed in Level I, Level II, and Level III ICUs. With these features, it represents one of the few comprehensive studies focusing on BSIs in geriatric patients in the literature. On the other hand, its single-center, retrospective design and the presence of missing data for some laboratory parameters limited the analytical power of the study.

Summary of Findings and Clinical Significance

The findings of this study demonstrate that BSIs in elderly ICU patients are largely secondary in origin and predominantly caused by Gram-negative bacteria. The high rates of ESBL production observed particularly in *Klebsiella spp.* and *E. coli* highlight the growing burden of antimicrobial resistance in the geriatric population. In addition, the marked carbapenem resistance observed especially in *Acinetobacter spp.* and some *Enterobacterales* isolates further complicates appropriate treatment planning. Our results are consistent with numerous studies reporting increased infection rates, shifting pathogen distributions, and progressively resistant antimicrobial patterns in elderly individuals (9–11).

Pathophysiological Reasons and Future Recommendations

Immunosenescence associated with aging and the high burden of comorbidities increase susceptibility to infections. Therefore, consideration of local resistance patterns, the use of biomarkers (CRP, procalcitonin, albumin, etc.) as prognostic indicators, and the application of early, appropriate empirical therapy combined with aggressive supportive strategies are crucial. Multicenter, prospective studies evaluating long-term outcomes are needed.

CONCLUSION

Bloodstream infections in geriatric ICU patients are predominantly secondary in origin and largely caused by Gram-negative organisms, particularly *Klebsiella spp.* and *Escherichia coli,* with high rates of ESBL production and substantial carbapenem resistance. Low serum albumin was the only independent predictor of early mortality. These findings highlight the importance of early recognition, appropriate empirical therapy, and close clinical monitoring in elderly ICU populations. Given that pathogen distribution and antimicrobial resistance profiles vary widely across institutions, it



is essential for each center to regularly monitor its own epidemiological and resistance data to guide empirical treatment strategies and strengthen infection control practices.

In addition, strict hand hygiene, meticulous catheter care, regular decubitus pressure–injury monitoring, and early respiratory rehabilitation are essential components of infection prevention bundles in geriatric ICU patients and should be systematically implemented.

Limitations

Patient-level linkage of susceptibility results was not available, which limited pathogen-specific mortality analysis. Because only patients with confirmed BSI were included and ICU-level denominators (total number of patients monitored in each ICU type) were not available, true incidence rates by ICU level could not be calculated and comparisons across ICU types were not possible.

REFERENCES

1. Clifford KM, Dy-Boarman EA, Haase KK, Maxvill K, Pass SE, Alvarez CA. Challenges with diagnosing and managing sepsis in older adults. Expert Rev Anti Infect Ther 2016;14(2):231-41. (DOI:10.1586/14787210.2016.1135052)
2. Pawelec G. Age and immunity: what is "immunosenescence"? Exp Gerontol 2018;105:4-9. (DOI:10.1016/j.exger.2017.10.024)
3. Martin GS, Mannino DM, Moss M. The effect of age on the development and outcome of adult sepsis. Crit Care Med 2006;34(1):15-21. (DOI:10.1097/01.CCM.0000194535.82812.BA)
4. Kaukonen KM, Bailey M, Suzuki S, Pilcher D, Bellomo R. Mortality related to severe sepsis and septic shock among critically ill patients in Australia and New Zealand, 2000-2012. JAMA 2014;311(13):1308-16. (DOI:10.1001/jama.2014.2637)
5. Buetti N, Atkinson A, Marschall J,Kronenberg A. Incidence of bloodstream infections: a nationwide surveillance of acute care hospitals in Switzerland 2008-2014. BMJ Open 2017;7(3):e013665. (DOI:10.1136/bmjopen-2016-013665)
6. Rowe TA, McKoy JM. Sepsis in older adults. Infect Dis Clin North Am 2017;31(4):731-42. (DOI:10.1016/j.idc.2017.07.010)
7. Leibovici-Weissman Y, Tau N, Yahav D. Bloodstream infections in the elderly: what is the real goal? Aging Clin Exp Res 2021;33:1101-12. (DOI:10.1007/s40520-019-01337-w)
8. Association of Clinical Microbiology Specialists (KLIMUD). Laboratory Examination of Bloodstream Specimens. Revised 2nd ed. Ankara: KLIMUD; 2022. [Internet]. Available from: https://www.klimud.org/uploads/content/KLIMUD%20Rehberleri_Kan%20Dolasimi_ver02.pdf. Accessed: 10.09.2025. ISBN: 978-605-84108-7-9. (in Turkish)
9. Douglas NM, Hennessy JN, Currie BJ, Baird RW. Trends in bacteremia over two decades in the Top End of the Northern Territory, Australia. Open Forum Infect Dis 2020;7(11):ofaa472. (DOI:10.1093/ofid/ofaa472)
10. Rodriguez-Mañas L. Urinary tract infections in the elderly: a review of disease characteristics and current treatment options. Drugs Context 2020;9:2020-4-13. (DOI:10.7573/dic.2020-4-13)
11. Ilmavirta H, Ollgren J, Räisänen K et al. Increasing proportions of extended-spectrum β-lactamase-producing isolates among Escherichia coli from urine and bloodstream infections: results from a nationwide surveillance network, Finland, 2008 to 2019. Euro Surveill 2023;28(43):2200934. (DOI:10.2807/1560-7917.ES.2023.28.43.2200934)
12. Kumar A, Ellis P, Arabi Y, et al. Initiation of inappropriate antimicrobial therapy results in a five-fold reduction of survival in human septic shock. Chest 2009;136(5):1237-48. (DOI:10.1378/chest.09-0087)
13. Chandroulis I, Schinas G, de Lastic AL, et al. Patterns, outcomes, and economic burden of primary vs secondary bloodstream infections: a single-center, cross-sectional study. Pathogens 2024;13(8):677. (DOI:10.3390/pathogens13080677)
14. Sante L, Aguirre-Jaime A, Miguel MA, Ramos MJ, Pedroso Y, Lecuona M. Epidemiological study of secondary bloodstream infections: the forgotten issue. J Infect Public Health 2019;12(1):37-42. (DOI:10.1016/j.jiph.2018.08.011)
15. Pierrakos C, Vincent JL. Sepsis biomarkers: a review. Crit Care 2010;14(1):R15. (DOI:10.1186/cc8872)

16. Reunes S, Rombaut V, Vogelaers D, et al. Risk factors and mortality for nosocomial bloodstream infections in elderly patients. Eur J Intern Med 2011;22(5):e39-e44. (DOI:10.1016/j.ejim.2011.02.004)

17. Pfaller MA, Diekema DJ. Epidemiology of invasive candidiasis: a persistent public health problem. Clin Microbiol Rev 2007;20(1):133-63. (DOI:10.1128/CMR.00029-06)

18. Pappas PG, Kauffman CA, Andes DR, et al. Clinical practice guideline for the management of candidiasis: 2016 update by the Infectious Diseases Society of America. Clin Infect Dis 2016;62(4):e1-50. (DOI:10.1093/cid/civ933)

19. Bassetti M, Giacobbe DR, Vena A, Wolff M. Diagnosis and treatment of candidemia in the intensive care unit. Semin Respir Crit Care Med 2019;40(4):524-39. (DOI:10.1055/s-0039-1693704)

20. Duan N, Sun L, Huang C, Li H, Cheng B. Microbial distribution and antibiotic susceptibility of bloodstream infections in different intensive care units. Front Microbiol 2021;12:792282. (DOI:10.3389/fmicb.2021.792282)

21. Erdogan M, Fındıklı HA. The relationship between hypoalbuminemia and mortality in geriatric patients with sepsis. J Crit Intensive Care 2021;12:80-84. (DOI:10.37678/dcybd.2021.2824)

22. Wu HN, Yuan EY, Li WB, Peng M, Zhang QY, Xie KL. Microbiological and clinical characteristics of bloodstream infections in general intensive care unit: a retrospective study. Front Med 2022;9:876207. (DOI:10.3389/fmed.2022.876207)

23. Laupland KB, Pasquill K, Steele L, Parfitt EC. Burden of bloodstream infection in older persons: a population-based study. BMC Geriatrs 2021;21:31. (DOI:10.1186/s12877-020-01984-z)

Turkish Journal of Geriatrics
2025; 28(4)

FROM THE EDITOR IN CHIEF
Yeşim GÖKÇE KUTSAL

EDITORIAL ARTICLE

GERIATRIC REHABILITATION IN AN AGEING WORLD: CHALLENGES, OPPORTUNITIES, AND THE FUTURE OF PERSON-CENTERED CARE
Yeşim GÖKÇE KUTSAL

ORIGINAL ARTICLES

RISK FACTORS FOR POSTOPERATIVE PULMONARY COMPLICATIONS AFTER MAJOR ABDOMINAL SURGERY IN PATIENTS AGED 65 YEARS AND OLDER: A RETROSPECTIVE OBSERVATIONAL STUDY
Arif TİMUROĞLU, Mustafa Kemal ŞAHİN

THE EFFECT OF OPTIC NERVE SHEATH DIAMETER ON PROGNOSIS AND ITS PERIOPERATIVE EVALUATION IN GERIATRIC ISCHEMIC CEREBROVASCULAR PATIENTS
Barış ASLANOĞLU, Kamuran AYDIN, Sezer Onur GUNARA, Barış ALTUN

EXAMINING PRESCRIPTION DRUG USE AND HEALTH CARE ACCESS AMONG OLDER ADULTS IN RURAL AREAS: A CROSS-SECTIONAL STUDY BASED ON THE HEALTH BELIEF MODEL
Yağmur ÖZKAYA, Büşra DEMİR ÇETİNKAYA, Gülden HAKVERDİ, Eyüp Can POLAT, Gülbin ÖZÇELİKAY

TURKISH CULTURAL ADAPTATION AND VALIDATION OF THE SYMPTOMS OF EARLY DEMENTIA-11 QUESTIONNAIRE
Oğulcan ÇÖME, Nezaket SABIR, Tuğçe YÜKSEL, Gizem LİMNİLİ, Nilgün ÖZÇAKAR

THE ROLE OF FRAILTY INDEX IN PREDICTING POSTOPERATIVE COMPLICATIONS IN GERIATRIC VASCULAR SURGERY PATIENTS
Sercan TAK, Okan YAMAN, Erkan İRİZ, Mustafa Hakan ZOR, Abdullah ÖZER, Gürsel Levent OKTAR, Başak KOÇAK, Fatih ÖNCÜ

FRAILTY AND ASA SCORE AS INDEPENDENT PREDICTORS OF EARLY POSTOPERATIVE COGNITIVE DYSFUNCTION IN OLDER SURGICAL PATIENTS: A PROSPECTIVE COHORT STUDY
Gülistan BARCA ÖNEN, Feray GÜRSOY

BARRIERS AND FACILITATORS TO PHYSICAL ACTIVITY PARTICIPATION IN OLDER ADULTS: A TÜRKİYE–USA COMPARISON
Gülşah ŞAHİN, Hongdao MENG, Debra DOBBS, Ebru YALÇIN

TRENDS AND GLOBAL RESEARCH PATTERNS IN GERIATRIC REHABILITATION: A 10-YEAR BIBLIOMETRIC ANALYSIS
İbrahim ULUDOĞAN, Ayşe Merve ÇIRACIOĞLU

THE RADIOLOGICAL RISK FACTORS AFFECTING MECHANICAL FAILURE IN THE SURGICAL TREATMENT WITH PROXIMAL FEMORAL NAIL OF INTERTROCHANTERIC FRACTURES IN ELDERLY PATIENTS: A RETROSPECTIVE COHORT STUDY
Ahmet AKSOY, Ahmet ASLAN, Hamza Can AKDENİZ

THE EFFECT OF INCREASED FRAILTY ON MYOCARDIAL INJURY AFTER NON-CARDIAC SURGERY (MINS) IN ELDERLY PATIENTS UNDERGOING ORTHOPEDIC SURGERY: A PROSPECTIVE, COHORT STUDY
İsmail DUYMAZ, Hacer Şebnem TÜRK, Pınar SAYIN, Leyla KILINÇ, Mustafa Bilgehan AYIK, Ayşe SURHAN ÇINAR, Sibel OBA

THE RELATIONSHIP BETWEEN OBSTRUCTIVE SLEEP APNEA SYNDROME, CHRONIC DISEASES AND QUALITY OF LIFE IN GERIATRIC PATIENTS ATTENDING THE SLEEP UNIT
Hasan TÜLE, Elçin BALCI

MICROBIOLOGICAL PROFILES AND CLINICAL OUTCOMES OF BLOODSTREAM INFECTIONS IN GERIATRIC PATIENTS ADMITTED TO INTENSIVE CARE UNITS: A SINGLE-CENTER EXPERIENCE
Nuray ARI, Ayşe SAĞMAK TARTAR, Sümeyra KAYALI, Serhat DAYAN, Bahar TANIK ŞİMŞEK, Hatice Handan AKBULUT