

Turkish journal of GERIATRICS

Volume: 29 | Number: 1 | Year: 2026



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: 15 March 2026

Turkish Journal of
GERIATRICS
Volume: 29 • Issue: 1 • Year: 2026

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: 29 • Issue: 1 • Year: 2026

Contents

EDITORIAL

FROM THE EDITOR IN CHIEF IX
Yeşim GÖKÇE KUTSAL

REVIEW ARTICLE

FROM ACUTE RESPIRATORY INFECTION TO FUNCTIONAL DISABILITY: TRAJECTORIES OF POST-ILLNESS FUNCTIONAL DECLINE IN OLDER ADULTS 1
Lale ÖZIŞIK

ORIGINAL ARTICLES

ROLES OF THE C-REACTIVE PROTEIN-ALBUMIN-LYMPHOCYTE INDEX AND PAN-IMMUNE-INFLAMMATION VALUE INDICES AS NEW INDICATORS OF DEMENTIA SEVERITY 14
Emel SABAZ KARAKEÇİ, Nesibe AYDOĞDU, Serpil DOĞAN

INFLAMMATORY AND NUTRITIONAL BIOMARKERS FOR PREDICTING MORTALITY IN ELDERLY PATIENTS WITH COMMUNITY-ACQUIRED PNEUMONIA 25
Gülhan AYHAN ALBAYRAK, Mustafa İlteriş BARDAKÇI

ANALYSIS OF RISK FACTORS FOR PREOPERATIVE DELIRIUM FOLLOWING GERIATRIC HIP FRACTURE AND ITS RELATIONSHIP WITH MORTALITY: A RETROSPECTIVE COHORT STUDY 34
Murat EREM, Savaş YILDIRIM, Eşref SELÇUK, Mehmet Tuğrul ALVER, Sinem EREM

CLINICAL OUTCOMES OF SUPRASCAPULAR NERVE PULSED RADIOFREQUENCY IN ELDERLY PATIENTS WITH ADHESIVE CAPSULITIS: A RETROSPECTIVE COHORT STUDY 47
Salim Taner GÖZÜKIZIL, Halil İbrahim ALTUN

THE EFFECT OF BLOOD PARAMETERS AND SURGICAL TREATMENT METHODS ON MORTALITY IN GERIATRIC HIP FRACTURES: CAN PREOPERATIVE ALBUMIN AND LYMPHOCYTE LEVELS PREDICT MORTALITY 56
Ömer Levent KARADAMAR, Ali Murat BAŞAK, Anıl ÖZGÜR, Ali AYDİLEK, Uğur YÜZÜGÜLDÜ, Enes KELEŞ, Mustafa KARA

COMPARISON OF PERIOPERATIVE OUTCOMES IN YOUNG AND GERIATRIC LIVING KIDNEY DONORS: A SINGLE-CENTER RETROSPECTIVE COHORT STUDY 67
Emrah ŞAHİN, Ender ANILIR, Adem TUNCER, Abuzer DİRİCAN, Bülent ÜNAL

ACUTE ABDOMEN IN THE OLDEST-OLD: ETIOLOGIES AND MORTALITY OUTCOMES IN NONAGENARIANS 74
Ahmet Gürkan ERDEMİR, Ayşenur BOLUKÇU, Esra AKÇİÇEK, Gökhan KAHRAMAN, Ali BATUR, İlkay Sedakat İDİLMAN, Mehmet Ruhi ONUR, Erhan AKPINAR

ASSESSMENT OF THE RELATIONSHIP BETWEEN HOPELESSNESS LEVEL AND DEATH ANXIETY IN GERIATRIC INDIVIDUALS 86
Meltem ÇAPAR ÇİFTÇİ, Funda KAVAK BUDAK

ATTITUDES OF THORACIC SURGEONS AND RESIDENTS TOWARD THORACIC SURGERY IN ELDERLY PATIENTS 98
Atilla CAN, Hüseyin YILDIRAN

EVALUATION OF COGNITIVE IMPAIRMENTS IN GLAUCOMA SUBTYPES: PRIMARY OPEN-ANGLE GLAUCOMA, PSEUDOEXFOLIATION SYNDROME, AND PSEUDOEXFOLIATION GLAUCOMA 110
Nur Ebru BARÇIN, Hatice Deniz İLHAN, Ali ÜNAL

IMPACT OF AGE ON EARLY MORTALITY AND CLINICAL OUTCOMES A FTER EMERGENCY HIP ARTHROPLASTY IN ELDERLY PATIENTS 116
Furkan TONTU, Abdurrahman Engin BAYDEMİR, Payam RAHİMİ, Sinan AŞAR, Bilal Faruk KARADOĞAN, Funda GÜMÜŞ ÖZCAN

www.turkgeriatri.org

From The Editor In Chief

www.turkgeriatri.org

The integrity and quality of scientific publishing rest fundamentally on the commitment, expertise, and intellectual generosity of peer reviewers. As editors of this journal, we express our profound appreciation for the time and effort that referees devote to the careful evaluation of manuscripts, frequently undertaken alongside demanding clinical, academic, and administrative responsibilities.

In 2025, the journal received an impressive number of submissions encompassing a broad spectrum of disciplines, study designs, and methodological approaches. Assessing these manuscripts for originality, methodological rigor, clinical and scientific relevance, and clarity of presentation is an exacting and highly responsible task. It is through the discerning judgment, critical insight, and constructive recommendations of our referees that we are able to maintain the high scholarly standards expected by our authors, readers, and the wider scientific community.

Peer review is, in essence, a selfless scholarly service that often remains unrecognized despite its central role in the advancement of knowledge. By ensuring that published work is accurate, transparent, and impactful, reviewers safeguard the credibility of the scientific record. Their thoughtful critiques not only strengthen individual manuscripts but also contribute meaningfully to the cumulative progress of science and the dissemination of reliable evidence to clinicians, researchers, and policymakers.

On behalf of the Editorial Board, we extend our sincere gratitude to all the below scientific referees who have supported the journal with their expertise and dedication.

Prof. Özlem ERDEN AKİ, Assoc. Prof. Aysun ANKAY YILBAŞ, Prof. Sadık ARDIÇ, Assoc. Prof. Didem ARSLANTAŞ, Prof. Ali ATAN, Assoc. Prof. Yalım ATEŞ, Prof. Vildan AVKAN OĞUZ, Prof. Saime AY, Assoc. Prof. Kaniye AYDIN, Prof. Tolga Reşat AYDOS, Prof. Mehmet Murad BAŞAR, Prof. Terken BAYDAR, Prof. Ertan BATİSLAM, Assoc. Prof. Derya SOY BUĞDAYCI, Prof. Banu CANGÖZ, Prof. Ahmet COŞAR, Prof. Banu ÇAKIR, Prof. Burcu DUYUR ÇAKIT, Prof. Bülent ÇİFTÇİ, Prof. Aslı DÖNMEZ, Prof. Ayşe GELAL, Prof. Zafer GÜNENDİ, Prof. Özlem GÜLBAHAR,

Prof. Gloria GUTMAN, Prof. Gülşen HASÇELİK, Prof. Kenan HIZEL, Prof. Jale İRDESEL, Assoc. Prof. Sevilay KARAHAN, Prof. Suzan KARA ÖZER, Prof. Fuat KALYONCU, Prof. Pembe KESKİNOĞLU, Prof. Semih KESKİL, Assoc. Prof. Gülce KİRAZLI, Prof. Murat KOÇ, Prof. Ali KUTSAL, Gökçe KUTSAL MSc, Prof. Erhan ESER, Assist Prof. Mahir KUNT, Assoc Prof. Serpil ÖCAL, Prof. Demet OFLUOĞLU, Prof. Kutay ORDU GÖKKAYA, Prof. Bahar ÖZÇELİK, Prof. Oya ÜNAL ÖZDEMİR, Prof. Şerefnur ÖZTÜRK, Assoc. Prof. Selçuk ÖZTÜRK, Assoc. Prof. Ebru ÖZTÜRK, Sercan ÖZYURT MD, Prof. Nurdan PAKER, Assoc. Prof. Reyhan POLAT, Prof. Neslişah RAKICIOĞLU, Prof. İskender SAYEK, Assoc. Prof. Sercan TAK, Assoc. Prof. Bahar TAK, Prof. Mehmet Ali TAŞKAYNATAN, Assist. Prof. Perihan TEKELİ, Assoc. Prof. Tugan TEZCANER, Assoc. Prof. Zahide TUNÇBİLEK, Prof. Ali Rıza TÜMER, Prof. Canan ULUOĞLU, Prof. Songül VAİZOĞLU and Prof. İrfan YORULMAZ.

As we enter a new year of publishing, we remain committed to acknowledging and valuing their indispensable contributions. We also encourage authors, readers, and academic institutions to join us in recognizing the vital role that reviewers play in the scientific enterprise. Together, we can continue to foster a culture of rigor, integrity, collegiality, and collaboration that underpins excellence in research and scholarly communication.

Yeşim GÖKÇE KUTSAL

REVIEW

FROM ACUTE RESPIRATORY INFECTION TO FUNCTIONAL DISABILITY: TRAJECTORIES OF POST-ILLNESS FUNCTIONAL DECLINE IN OLDER ADULTS

Turkish Journal of Geriatrics
2026; 29(1):1–13

DOI: 10.29400/tjgeri.2026.473

Lale ÖZIŞIK

Hacettepe University Faculty Of Medicine,
Department of Internal Medicine, Ankara, Türkiye

Abstract

Acute respiratory infections are a leading cause of hospitalization and mortality among older adults, yet their long-term functional consequences remain underrecognized. As survival improves in aging populations, functional decline has emerged as a critical outcome that extends beyond the acute phase of illness.

This review introduces a novel host-centric, trajectory-based framework derived from disablement models that conceptualizes acute respiratory infections as biological stressors interacting with baseline vulnerability. Within this framework, the "trajectory concept" is employed to map heterogeneous recovery patterns in which frailty, multimorbidity, and pre-existing functional impairment outweigh pathogen-specific effects in determining long-term disability.

Drawing on evidence from pneumococcal disease, influenza, respiratory syncytial virus, and COVID-19 in adults aged ≥65 years, we identify key biological and clinical mediators, including immunosenescence, inflammaging, acute sarcopenia, delirium, and hospitalization-associated disability that link acute illness to sustained functional loss. Trajectory analyses reveal patterns ranging from rapid recovery to persistent or progressive disability and identify the early post-discharge period as a critical and potentially modifiable window.

Reframing acute respiratory infections as systemic triggers of functional decline shifts clinical priorities from survival to disability prevention. Integrated care models, centered on vaccination, geriatric-informed acute care, comprehensive geriatric assessment, and structured rehabilitation, are essential to preserve independence in ageing populations.

Keywords: Respiratory Tract Infections; Disability Evaluation; Frailty; Functional Status; Aged; Subacute Care.

Correspondence

Lale ÖZIŞIK
Phone : +903123053029
e-mail : lale.ozisik@hacettepe.edu.tr

Received : Feb 16, 2026
Accepted: Feb 20, 2026

Cite this article as:
Özışık L. From Acute Respiratory Infection to Functional Disability: Trajectories of Post-Illness Functional Decline in Older Adults. Turkish Journal of Geriatrics 2026; 29(1):1–13. doi: 10.29400/tjgeri.2026.473

INTRODUCTION

The global demographic shift toward an aging population represents a significant public health challenge in the twenty-first century. By 2050, the global population of adults aged 65 years and older is projected to reach 2.1 billion, with the fastest growth in middle-income countries such as Turkey (1). As this shift occurs, population ageing is rapidly reshaping the clinical consequences of acute illnesses. Biological aging leads to a decline in physiological reserves, known as homeostenosis, and increases vulnerability to acute stressors, including acute respiratory infections (ARIs) (2, 3). Among older adults, ARIs are associated with substantially higher rates of hospitalization, complications, and mortality than in younger individuals. Furthermore, advances in acute care and vaccination have shifted focus to outcomes beyond the acute phase of illness (3, 4).

Traditional evaluations of ARIs have primarily focused on short-term outcomes, including in-hospital mortality, intensive care unit (ICU) admission, and length of stay. Although these outcomes are important, they fail to capture the health domains that are particularly significant to older adults. For many patients, survival following an acute infection marks the beginning of a new phase characterized by a trajectory of functional decline, cognitive impairment, and a loss of independence. Functional status has emerged as a critical outcome, frequently providing a more accurate prediction of long-term prognosis, institutionalization, and mortality than disease-specific severity indices (3, 5, 6).

Post-illness recovery trajectories in older adults are heterogeneous, ranging from a transient decline with gradual functional recovery to sustained or progressive functional and cognitive impairments (5). Recent evidence indicates that these outcomes are predominantly influenced by host-related vulnerabilities, including frailty, multimorbidity, and baseline health status, rather than by the specific pathogen involved (3).

Functional impairment is a strong predictor of rehospitalization, long-term care (LTC) placement, and mortality, and it imposes a substantial burden on caregivers and healthcare systems in aging populations (6). Framing ARIs as potential triggers of functional decline aligns infectious disease management with geriatric priorities that focus on preserving independence and quality of life.

This review synthesizes current evidence on the trajectories of post-illness functional decline in adults aged 65 years and older following influenza, respiratory syncytial virus (RSV), pneumococcal disease, and coronavirus disease 2019 (COVID-19). It examines the epidemiological burden, underlying mechanisms, and physical, cognitive, and psychosocial consequences, and discusses implications for clinical practice, geriatric rehabilitation, and preventive strategies.

ACUTE RESPIRATORY INFECTIONS IN OLDER ADULTS: SCOPE AND BURDEN

Streptococcus pneumoniae, influenza virus, RSV, and SARS-CoV-2 are the primary causes of acute respiratory infections (ARIs) that are associated with severe outcomes in older adults, highlighting the significant disease burden within this population (Table 1) (3, 7-14).

Pneumococcal Disease and Community-Acquired Pneumonia

Pneumococcal disease, which most frequently manifests as community-acquired pneumonia, remains a major cause of hospitalization among older adults and is the leading contributor to disability-adjusted life years (DALYs) attributable to lower respiratory infections (LRIs) globally (15). In 2023, LRIs were responsible for approximately 1.2 million deaths among adults aged 70 years and older worldwide (8). Recent studies indicate that limitations in activities of daily living (ADL) at discharge are independently associated with increased risks of rehospitalization and mortality among older pneumonia survivors (16).

Table 1. Epidemiological Burden and Post-Acute Functional Decline Associated with Major Respiratory Pathogens in Older Adults.

Pathogen	Global Mortality / Burden-Older Adults	Post-Acute Functional Decline	Key Clinical Insight
S. pneumoniae (8, 9)	25.3% of LRI deaths globally	30–60% poor recovery over 6 months.	Leading contributor to DALYs in older populations.
Influenza (3, 10)	70–85% of flu deaths in high-income nations	18–23% persistent decline within 1 month	Frailty is a strong risk modifier for catastrophic decline.
COVID-19 (11)	80% of deaths are in older adults	40–50% experience decline at 3 months	Higher post-acute health loss compared to seasonal influenza.
RSV (12–14)	74,000 in-hospital deaths	1/3 fail to return to baseline at 6 months	Frailty, diabetes, or pre-existing impairment are strong risk modifiers

COVID-19, coronavirus disease 2019; RSV, respiratory syncytial virus; LRI, lower respiratory tract; DALY, disability-adjusted life years

Influenza

Globally, influenza causes up to 650,000 respiratory deaths annually (17). Hospitalization rates increase with advancing age, particularly after 75 years. Influenza-associated morbidity extends beyond acute episodes, contributing to health loss across multiple organ systems, including the pulmonary, cardiovascular, hematological, metabolic, and neurological systems, as well as long-term loss of independence (18). It is increasingly recognized as a trigger of functional decline (3).

COVID-19

The COVID-19 pandemic has highlighted the increased vulnerability of older adults to respiratory infections. COVID-19 is a multisystem disease that affects nearly all organ systems (19). Recent evidence indicates that SARS-CoV-2 infection results in a greater burden of health loss during the post-acute phase than during the acute phase. Furthermore, SARS-CoV-2 is associated with higher health losses than seasonal influenza in both phases of the illness (18). One year post-hospitalization, symptomatic older COVID-19 survivors, developed 1.27 more functional disabilities on a 15-point scale than at baseline (20).

RSV

RSV infections in older adults are projected to reach 800,000 annual hospitalizations in high-income countries by 2025 (12). RSV infection in older adults is often associated with longer hospital stays and higher ICU admission rates than influenza B, while overall hospitalization and mortality rates among adults aged 60 years and older are comparable to those observed with influenza (12, 13). Clinical cohort studies indicate that RSV infection in hospitalized older adults is associated with an acute decline in both ADLs and instrumental activities of daily living (IADLs) (14). These findings highlight that RSV is an under-recognized contributor to post-infectious disabilities in later life.

Across all major respiratory infections, hospitalization is a critical inflection point in the pathway toward disability in older adults. As survival improves in aging populations, post-infectious functional impairment is expected to constitute an increasing proportion of the overall disease burden (6).

CONCEPTUAL FRAMEWORK OF POST-ILLNESS FUNCTIONAL DECLINE

Post-illness functional decline in older adults can be conceptualized as a dynamic process in which an acute respiratory infection serves as a health stressor initiating a cascade of impairments that may lead to persistent disabilities. Figure 1 illustrates a proposed conceptual framework connecting acute respiratory infection, baseline vulnerability, hospitalization-related stressors, and subsequent functional and societal outcomes in older adults.

The Disablement Process (Nagi–Verbrugge–Jette Model)

The disablement process provides a foundational framework for understanding how ARIs lead to functional disabilities in older adults. Originally, this model described a dynamic progression from pathology to impairment, functional limitation, and ultimately disability (21). Within this framework, ARIs function as pathological triggers that accelerate the disablement process, rather than merely as transient health insults.

In older adults, infection-related impairments, such as hypoxemia, systemic inflammation, and neuromuscular dysfunction, frequently progress to functional limitations, including mobility, difficulty with transfers, and impaired self-care. When the compensatory capacity is exceeded, these limitations manifest as overt disabilities, which are typically measured by declines in ADLs and IADLs. The model emphasizes that disability is not an inevitable consequence of aging but rather the result of interactions between acute stressors and baseline vulnerability.

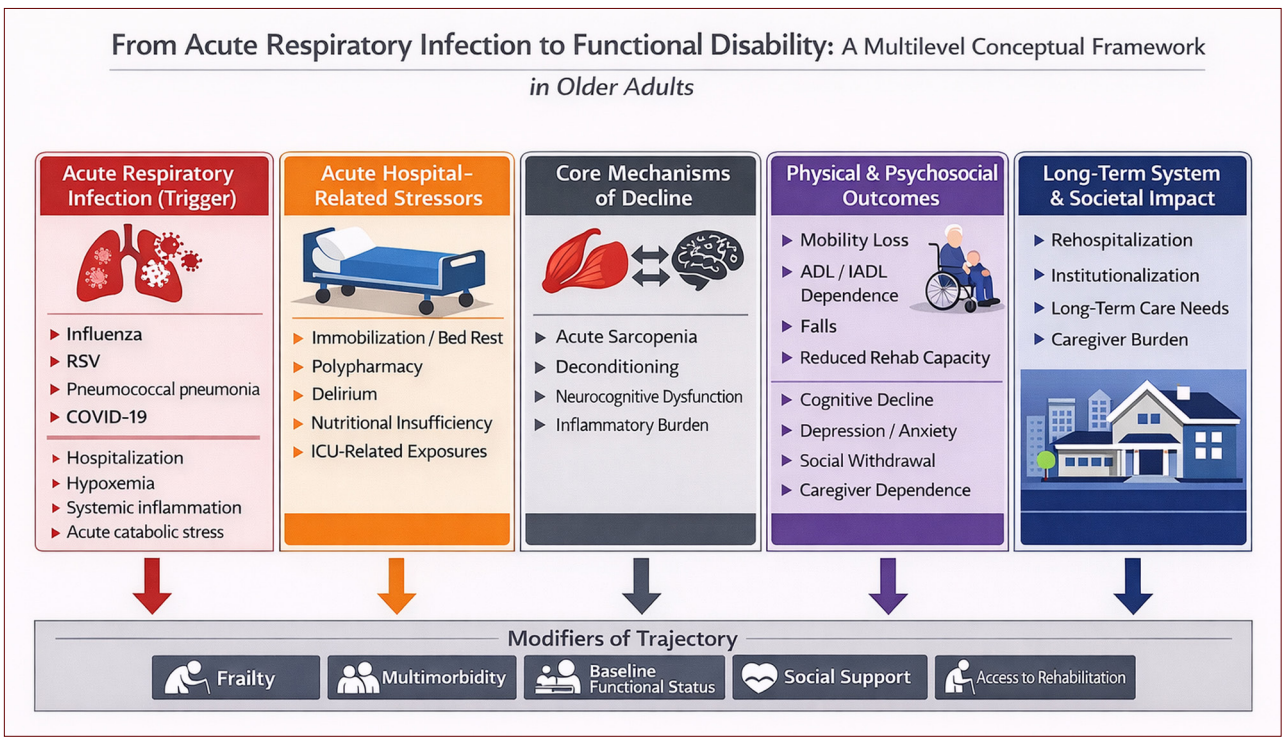


Figure 1. From Acute Respiratory Infection to Functional Disability: A Multilevel Conceptual Framework in Older Adults

ADL, activities of daily living; IADL, instrumental activities of daily living; RSV, respiratory syncytial virus; ICU, intensive care unit; COVID-19, coronavirus disease 2019



Baseline Vulnerability and Functional Reserve

Baseline vulnerability is a key determinant of post-illness functional outcomes in older adults. Frailty, multimorbidity, cognitive impairment, and pre-existing functional limitations reduce physiological and functional reserves, limiting the capacity to tolerate and recover from acute stressors. Among these factors, frailty represents the most integrative construct, capturing cumulative deficits across biological, functional, and social domains (2, 22).

Frailty plays a central role in the disablement framework as a trajectory modifier that limits recovery and amplifies post-infectious functional decline (2). It interacts bidirectionally with multimorbidity to synergistically deplete physiological reserves, explaining why similar ARIs precipitate catastrophic or persistent disability, while others do not (23). Additionally, ARIs frequently exacerbate chronic conditions such as heart failure, diabetes, or chronic obstructive pulmonary disease (COPD), accelerating decline through mechanisms of inflammation and organ dysfunction (2, 16, 24). As an effect modifier, frailty substantially strengthens the association between multimorbidity and disability (2, 23).

Individuals with preserved reserves may recover functional independence despite substantial physiological stress, whereas those with limited reserves may transition to dependency after relatively moderate insults. This vulnerability gradient explains the pronounced heterogeneity in functional outcomes observed after ARIs (6, 22).

Hospitalization-Associated Disability

Hospitalization is a pivotal stage in the disablement process and serves as an independent risk factor for functional decline. Approximately one-third of older adults acquire new limitations in their daily living activities during hospitalization, a phenomenon known as hospitalization-associated disability (HAD) (22). HAD arises from the combined effects of reduced mobility, prolonged bed rest, acute systemic inflammation, delirium, nutritional deficits, and iatrogenic factors including polypharmacy, excessive sedation, and indwelling devices. These stressors disproportionately affect individuals with limited baseline physiological reserves, thereby intensifying functional decline during acute care.

Older adults who develop delirium during hospitalization face an increased risk of persistent disability and loss of independence for months after discharge, irrespective of the underlying infection (25). In this conceptual framework, delirium serves as both an indicator of vulnerability and a contributor to subsequent impairment.

Functional Decline as a Clinical and Prognostic Endpoint

Functional decline should be recognized as a primary clinical and prognostic endpoint, rather than a secondary outcome. Reductions in ADLs and mobility are strongly associated with rehospitalization, LTC placement, and mortality among older adults with respiratory infections (10, 20).

This integrative framework provides a foundation for examining the biological mechanisms underlying functional decline and heterogeneous recovery trajectories observed after ARIs in older adults.

BIOLOGICAL AND PHYSIOLOGICAL MECHANISMS DRIVING FUNCTIONAL DECLINE

Immunosenescence, Inflammaging, and Metabolic Dysregulation

Age-related immune dysregulation, defined by immunosenescence and chronic low-grade inflammation (inflammaging), establishes a biological environment in which acute infections provoke exaggerated and sustained inflammatory responses (24, 26). During ARIs, acute cytokine surges superimposed on this pro-inflammatory

baseline resemble a senescence-associated secretory phenotype (SASP), which contributes to multisystem dysfunction and delayed recovery. Additionally, the interaction between pre-existing inflammaging and infection-induced dysregulation of the tryptophan–kynurenine pathway, mediated by indoleamine 2,3-dioxygenase, may exacerbate mitochondrial dysfunction and neurotoxicity, thereby accelerating the transition from acute illness to prolonged functional disability. This pathway has been implicated in post-acute infection syndromes, providing a mechanistic link between acute inflammation, muscle fatigue, and persistent functional impairment (27).

Acute Sarcopenia, Immobility, and Catabolic Stress

Hospitalization due to ARIs is frequently associated with acute sarcopenia, driven by systemic inflammation, endocrine catabolism, nutritional deficits, and muscle disuse (28-30). Even short periods of bed rest can result in significant declines in muscle strength and aerobic capacity among older adults, often reducing them below critical functional thresholds (28, 29). In this population, an increased inflammatory burden and poor nutritional markers are correlated with diminished functional recovery (28, 30). In the context of ARIs, symptoms such as dyspnea, hypoxemia, and fatigue further restrict activity, perpetuating a cycle of inactivity, weakness, and dependency.

In addition to peripheral muscle loss, ARIs negatively affect respiratory muscle function, including diaphragmatic strength and coordination. Age-related reductions in the respiratory reserve, known as presbypnea, increase susceptibility to prolonged dyspnea, and impair cough effectiveness and secretion retention. These factors limit physical activity and contribute to ongoing deconditioning during recovery (31).

Sarcopenic dysphagia constitutes an additional pathway through which infection leads to adverse outcomes, including recurrent aspiration and increased mortality (32). Furthermore, gut dysbiosis exacerbates systemic inflammation and muscle catabolism, reinforcing the gut–muscle axis, which may further hinder recovery in older adults (33).

Moreover, patients with severe ARIs may require intensive care, where the risk of ICU-acquired weakness (ICU-AW) is high and has major consequences for physical recovery. ICU-AW is characterized by symmetric neuromuscular dysfunction associated with critical illness and its management, which leads to persistent functional impairment after discharge (34). In addition to muscle weakness, many ICU survivors develop post–intensive care syndrome (PICS), which encompasses physical, cognitive, and mental health impairments that are closely linked to long-term prognosis (35). These mechanisms are particularly pronounced in patients requiring intensive care, where ICU-AW and PICS contribute substantially to prolonged physical, cognitive, and psychological impairments (34, 35).

PHYSICAL FUNCTIONAL DECLINE

Physical functional decline is one of the most common and clinically significant sequelae of ARIs in older adults. Importantly, physical decline seldom occurs in isolation and is closely linked to cognitive vulnerability, mood disturbances, and social determinants, which collectively shape recovery trajectories.

Decline in Mobility, Activities of Daily Living, Instrumental Activities, and Falls

ARIs often lead to a significant decline in physical function among older adults, most notably affecting ADLs, IADLs, mobility, and balance. Loss of independence in ADLs and IADLs is a primary indicator of post-illness disability. Studies of hospitalized older adults with pneumonia, influenza, RSV, or COVID-19 report that 30–60% experience new or worsened limitations in ADLs or IADLs at discharge or during early follow-up, with many



failing to achieve full recovery (3, 10, 18, 20, 36). Even minor reductions in mobility or self-care capacity are associated with an increased risk of rehospitalization, LTC placement, and mortality (6, 10).

Additionally, factors such as acute illness–related weakness, deconditioning, orthostatic hypotension, polypharmacy, and impaired balance increase fall risk during and after hospitalization. These factors frequently result in a shift from independent ambulation to the need for assisted mobility (18, 29).

Rehabilitation Needs and Recovery Trajectories

Consequently, ARIs markedly increase the demand for post-acute rehabilitation and supportive services. Trajectory analyses of cohorts with pneumonia and COVID-19 indicate that baseline frailty, the extent of mobility loss, and access to rehabilitation are critical determinants of recovery patterns (18, 20). Many older adults require inpatient or home-based rehabilitation following discharge, and a subset transition to long-term care when their baseline physical function is not fully regained (6, 20).

Geriatric rehabilitation programs incorporating progressive resistance training, balance exercises, and task-oriented ADL training result in significant improvements in mobility and independence compared with standard care (37). Notably, patients with delirium or mild cognitive impairment can achieve substantial functional recovery through individualized, interdisciplinary rehabilitation, demonstrating that cognitive vulnerability does not necessarily limit rehabilitation benefits (38).

COGNITIVE AND PSYCHOSOCIAL SEQUELAE

Delirium, Post-Illness Cognitive Decline, and Mood Disorders

In addition to physical impairments, ARIs are associated with significant cognitive and psychosocial sequelae. Post-infectious cognitive decline occurs frequently, particularly in patients who experience delirium, hypoxemia, or critical illness during hospitalization. Delirium is a strong predictor of long-term functional and cognitive decline following ARIs and is consistently associated with sustained cognitive impairment and functional dependence for months after discharge, regardless of the type of infection. Acute brain dysfunction reflects the convergence of neuroinflammation, hypoxemia, metabolic disturbances, and sleep disruptions (25, 39). Older adults who develop delirium are at increased risk of requiring institutional care after discharge (6).

Depression and anxiety commonly develop after hospitalization for ARIs, often resulting from prolonged symptoms, loss of independence, and social withdrawal (20, 40). Reduced mobility and increased functional dependence further exacerbate social isolation, worsen mental health outcomes, and impede recovery trajectories (41).

Loss of Social Functioning and Caregiver Burden

Social isolation is both a consequence and a driver of post-illness decline (42). Older adults recovering from respiratory infections often have decreased social engagement due to physical limitations, cognitive impairment, fear of contagion, or diminished confidence. During the COVID-19 pandemic, infection control measures and extended isolation intensified these effects, resulting in a measurable decline in social participation and functional status among older adults (43).

Functional decline after ARIs often extends beyond the patient and imposes a substantial burden on caregivers. Increased caregiving demands are associated with emotional distress, reduced caregiver health, and a higher likelihood of patient institutionalization (40).

Cognitive impairment, mood disorders, social isolation, and caregiver burden interact with physical

decline to influence the likelihood of recovery or the persistence of disability.

TRAJECTORIES OF FUNCTIONAL DECLINE AND RECOVERY IN OLDER ADULTS

Functional outcomes after ARIs in older adults are most accurately conceptualized as trajectory-based processes that reflect the timing, rate, and persistence of functional change rather than binary states of recovery or non-recovery. Trajectory-based analyses offer a more clinically meaningful framework by capturing longitudinal patterns of changes in function, cognition, and independence (44, 45).

The literature describes two complementary yet conceptually distinct frameworks: one addresses the initiation of disability (disability onset trajectories), and the other examines the evolution of function after discharge (recovery trajectories). Integrating these approaches provides a more complete understanding of post-ARI functional outcomes (Table 2) (18, 45).

Disability Onset After ARI

Using monthly assessments of community-dwelling older adults, Gill et al. identified two primary subtypes of disability onset, catastrophic and progressive, and two additional patterns, accelerated and persistently severe disability (45). Hospitalization is a major precipitant of catastrophic and accelerated disability, supporting the hypothesis that acute medical events, including ARIs, are significant triggers of functional collapse in vulnerable individuals (45).

Post-Discharge Recovery Trajectories

Disability onset patterns are conceptually distinct from the post-acute recovery trajectories that describe the evolution of function after discharge. Trajectory analyses of older adults hospitalized with pneumonia consistently identify three primary pathways: rapid recovery, partial recovery, and persistent disability.

Comparable trajectories have also been reported for ARIs. Approximately 20% of older adults hospitalized with influenza or other acute respiratory illnesses experience persistent or catastrophic functional decline shortly after discharge (3). In COVID-19 cohorts, sustained functional impairment and worsening frailty at 3 months closely resemble the outcomes seen after non-COVID pneumonia when accounting for baseline vulnerability (20).

Prospective trajectory analyses of older adults hospitalized for pneumonia, influenza, RSV, or

Table 2. Disability onset patterns and recovery trajectories in older adults following acute illness

Dimension	Pattern	Key features
Disability onset	Catastrophic	Sudden functional decline (<1 month)
	Progressive	Gradual functional decline (over months)
Recovery trajectory	Rapid recovery	Return to baseline function
	Partial recovery	Recovery of basic ADL, persistent IADL dependence
	Persistent disability	Sustained ADL dependence, LTC risk
Key modifiers	—	Frailty, baseline function, delirium, hospitalization-related exposures, multimorbidity, polypharmacy, rehab access

ADL, activities of daily living; IADL, instrumental activities of daily living; LTC, long-term care



COVID-19 indicate that only a minority achieved full functional recovery within 6 months. Instead, a substantial proportion of patients experience poor recovery trajectories marked by sustained impairment in ADLs or progressive disability (3, 17, 18, 20).

These findings support a host-centric framework, suggesting that ARIs act as prototypical stress tests rather than primary determinants of the recovery trajectory. Baseline frailty, pre-existing functional limitations, and in-hospital delirium were among the strongest predictors of unfavorable outcomes (6). A trajectory-based perspective identifies a potentially modifiable vulnerable period within the first 30–90 days after discharge, during which targeted geriatric interventions may improve long-term functional outcomes (18).

HEALTH SYSTEM AND SOCIETAL IMPLICATIONS

Persistent post-illness functional decline leads to increased health system utilization, greater demand for long-term care, and higher societal costs. As the population ages and survival rates from severe infections improve, these downstream effects increasingly contribute to the overall disease burden.

Rehospitalization, Healthcare Utilization, Long-Term Care, and Institutionalization

Functional decline following ARIs has significant consequences for patients, healthcare systems, and society. Functional impairment is a strong predictor of rehospitalization among older adults. Evidence has consistently shown that new or worsening ADL limitations at discharge independently increase the risk of 30-day and 6-month readmissions after hospitalization for pneumonia, influenza, RSV, and COVID-19 (3, 10, 17, 20). Rehospitalization further accelerates functional decline, resulting in a cycle of recurrent admissions and sustained use of healthcare services, including rehabilitation and mental health services (6, 45).

A major system-level consequence of post-ARI disabilities is the transition to LTC. Older adults who do not recover their baseline functions after pneumonia or COVID-19 experience high rates of institutionalization. For example, 10–20% of older European COVID-19 patients require higher levels of care at discharge (20). Similar transitions toward dependency have been observed following severe influenza and RSV hospitalization (3, 17, 41).

Economic Burden and Health Inequities

The economic burden of post-infectious disability is substantial (7). Functional decline increases healthcare expenditures by lengthening inpatient stays, increasing the use of rehabilitation services, expanding home care needs, and increasing the frequency of LTC placement. Cost analyses show that disability-related expenses often surpass those of the acute infectious episode, particularly when long-term care is necessary (4, 7). As populations age, disabilities related to ARIs are expected to become a major driver of healthcare spending.

However, these impacts are not equally distributed. Globally, approximately 46% of individuals aged 60 and older experience functional disability (1). Older adults in lower socioeconomic regions are more likely to face delayed recovery, institutionalization, and unmet care needs after ARIs, reinforcing existing health inequalities (9). Therefore, addressing post-infection functional decline is both a clinical priority and a matter of health equity.

PREVENTION AND MITIGATION STRATEGIES

Vaccination as Disability Prevention

Vaccination against influenza, pneumococcal disease, RSV, and COVID-19 is increasingly recognized as a strategy to prevent not only mortality but also post-infectious disability. Vaccines

indirectly protect the functional status of older adults by reducing the incidence and severity of infections and hospitalization rates (4, 8, 15, 46). Observational studies have indicated that vaccination is associated with a lower risk of severe disease, ICU admission, prolonged hospitalization, and subsequent functional decline in older adults (3, 8, 12). Positioning vaccination as a means of disability prevention aligns infectious disease prevention with the geriatric goal of preserving independence.

In-Hospital and Transitional Interventions

Hospital-based interventions are essential to mitigate functional decline. Early mobilization programs decrease hospitalization-associated disability, enhance mobility at discharge, and reduce length of stay (22). Delirium prevention protocols, including orientation, sleep promotion, vision and hearing optimization, and medication review, significantly lower the incidence of delirium and subsequent cognitive and functional impairments (25). Optimizing nutrition, avoiding unnecessary fasting, and initiating early protein supplementation can prevent acute sarcopenia and facilitate recovery (28). Additionally, minimizing polypharmacy, especially the use of sedatives, anticholinergics, and medications associated with orthostatic hypotension, reduces the risk of delirium, falls, and mobility impairment (23, 39).

The implementation of Comprehensive Geriatric Assessment during or shortly after discharge improves functional outcomes and reduces preventable readmissions by identifying medical, cognitive, and social needs (23). Systematic functional assessments at discharge are critical for guiding post-acute care and preventing unrecognized disabilities (10, 22).

Post-Acute and Technology-Assisted Rehabilitation

Post-acute rehabilitation is essential for functional recovery after ARIs. The complexity of geriatric patients necessitates individualized, interdisciplinary rehabilitation approaches that integrate medical stabilization with functional recovery, particularly in resource-constrained settings (47). Comprehensive geriatric rehabilitation improves mobility, ADL performance, and the likelihood of returning home (37). Emerging technologies, including tele-rehabilitation, virtual reality–assisted exercise, and inspiratory muscle training, show promise in extending access to rehabilitation and sustaining gains after discharge, particularly for patients with mobility or geographic barriers (18, 28). These approaches may be especially valuable in aging societies with constrained rehabilitation capacity.

FUTURE DIRECTIONS AND CLINICAL IMPLICATIONS

Future research should incorporate functional endpoints alongside traditional outcomes such as mortality and length of stay. Declines in ADLs, mobility loss, and transitions in frailty are patient-centered outcomes that more accurately reflect long-term prognosis in older adults (5, 6). Trajectory-based longitudinal studies are necessary to characterize heterogeneous recovery patterns and to identify modifiable inflection points (18).

Integrated care models that connect acute care, rehabilitation, primary care, and social services are essential. Incorporating comprehensive geriatric assessment into infectious disease pathways may mitigate disability, reduce rehospitalization, and improve equity in outcomes in aging populations (4, 23).

CONCLUSION

Acute respiratory infections often represent turning points in the functional health of older adults. For many individuals, survival from pneumonia, influenza, RSV, or COVID-19 marks the beginning of a trajectory toward disability.

This review demonstrates that within the geriatric population, functional status is a stronger predictor of survival and quality of life than multimorbidity

alone. Recognizing ARIs as triggers of functional decline supports a "functional-first" clinical approach in which the preservation of mobility, independence, and cognitive function is prioritized alongside survival. Vaccination, geriatric-informed hospital care, and timely rehabilitation are essential strategies to interrupt pathways that lead to disability.

For clinicians, researchers, and policymakers, these findings highlight that preventing and mitigating post-infectious functional decline is essential for broadening the focus of care beyond survival alone toward the preservation of autonomy, thereby sustaining healthy aging and resilient healthcare systems in the context of demographic transition.

REFERENCES

1. World Health Organization. Ageing and health [Internet]. Geneva: WHO; 2025. Available from: https://www.who.int/news-room/fact-sheets/detail/ageing-and-health. Accessed: 26.01.2026.
2. Fried LP, Cohen AA, Xue Q-L, et al. The physical frailty syndrome as a transition from homeostatic symphony to cacophony. Nature Aging. 2021;1(1):36-46. doi:10.1038/s43587-020-00017-z.
3. Andrew MK, MacDonald S, Godin J, et al. Persistent Functional Decline Following Hospitalization with Influenza or Acute Respiratory Illness. J Am Geriatr Soc. 2021;69(3):696-703. doi:10.1111/jgs.16950.
4. Hanage WP, Schaffner W. Burden of Acute Respiratory Infections Caused by Influenza Virus, Respiratory Syncytial Virus, and SARS-CoV-2 with Consideration of Older Adults: A Narrative Review. Infectious Diseases and Therapy. 2025;14(1):5-37. doi:10.1007/s40121-024-01080-4.
5. Ferrante LE, Pisani MA, Murphy TE, et al. Functional Trajectories Among Older Persons Before and After Critical Illness. JAMA Internal Medicine. 2015;175(4):523-9. doi:10.1001/jamainternmed.2014.7889.
6. Covinsky KE, Palmer RM, Fortinsky RH, et al. Loss of Independence in Activities of Daily Living in Older Adults Hospitalized with Medical Illnesses: Increased Vulnerability with Age. Journal of the American Geriatrics Society. 2003;51(4):451-8. doi:10.1046/j.1532-5415.2003.51152.x.
7. Zhang S, Wahi-Singh P, Wahi-Singh B, et al. Costs of management of acute respiratory infections in older adults: A systematic review and meta-analysis. J Glob Health. 2022;12:04096. doi:10.7189/jogh.12.04096.
8. Infections GBDLR, Antimicrobial Resistance C. Global burden of lower respiratory infections and aetiologies, 1990-2023: a systematic analysis for the Global Burden of Disease Study 2023. Lancet Infect Dis. 2025. doi:10.1016/S1473-3099(25)00689-9.
9. Park CM, Dhawan R, Lie JJ, et al. Functional status recovery trajectories in hospitalised older adults with pneumonia. BMJ Open Respir Res. 2022;9(1). doi:10.1136/bmjresp-2022-001233.
10. Centers for Disease Control and Prevention (CDC). Flu and People 65 Years and Older [Internet]. Atlanta: CDC; 2024. Available from: https://www.cdc.gov/flu/highrisk/65over.htm Accessed: 26.01.2026.
11. Prampart S, Le Gentil S, Bureau ML, et al. Functional decline, long term symptoms and course of frailty at 3-months follow-up in COVID-19 older survivors, a prospective observational cohort study. BMC Geriatr. 2022;22(1):542. doi:10.1186/s12877-022-03197-y.
12. Tanriover MD, Azap A, Cakir Edis E, et al. Respiratory syncytial virus (RSV) infections in adults: Current trends and recommendations for prevention - a global challenge from a local perspective. Hum Vaccin Immunother. 2025;21(1):2514357. doi:10.1080/21645515.2025.2514357.
13. Maggi S, Veronese N, Burgio M, et al. Rate of Hospitalizations and Mortality of Respiratory Syncytial Virus Infection Compared to Influenza in Older People: A Systematic Review and Meta-Analysis. Vaccines. 2022;10(12):2092. doi:10.3390/vaccines10122092.
14. Branche AR, Saiman L, Walsh EE, et al. Change in functional status associated with respiratory syncytial virus infection in hospitalized older adults. Influenza Other Respir Viruses. 2022;16(6):1151-60. doi:10.1111/irv.13043.
15. Ozisik L. The New Era of Pneumococcal Vaccination in Adults: What Is Next? Vaccines (Basel). 2025;13(5):498. doi:10.3390/vaccines13050498.
16. Yamada K, Iwata K, Yoshimura Y, et al. Activities of daily living limitation and functional decline during hospitalization predict 180-day readmission and mortality in older patients with pneumonia: A single-center, retrospective cohort study. Respir Med. 2024;234:107830. doi:10.1016/j.rmed.2024.107830.

17. World Health Organization. Influenza (Seasonal) [Internet]. Geneva: World Health Organization; 2024. Available from: https://www.who.int/news-room/fact-sheets/detail/influenza-(seasonal. Accessed: 26.01.2026.
18. Xie Y, Choi T, Al-Aly Z. Long-term outcomes following hospital admission for COVID-19 versus seasonal influenza: a cohort study. Lancet Infect Dis. 2024;24(3):239-55. doi:10.1016/S1473-3099(23)00684-9.
19. Kawai K, Muhere CF, Lemos EV, et al. Viral Infections and Risk of Cardiovascular Disease: Systematic Review and Meta - Analysis. Journal of the American Heart Association. 2025;14(21):e042670. doi:10.1161/JAHA.125.042670.
20. Dias MB, Avelino-Silva TJ, Ferriolli E, et al. Post-Discharge COVID-19 Symptoms Predict 1-Year Functional Decline, Falls, and Emergency Department Visits: A Cohort Study. J Am Geriatr Soc. 2025;73(6):1722-32. doi:10.1111/jgs.19490.
21. Verbrugge LM, Jette AM. The disablement process. Soc Sci Med. 1994;38(1):1-14. doi:10.1016/0277-9536(94)90294-1.
22. 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.
23. Clegg A, Young J, Iliffe S, Rikkert MO, Rockwood K. Frailty in elderly people. Lancet. 2013;381(9868):752-62. doi:10.1016/s0140-6736(12)62167-9.
24. Franceschi C, Garagnani P, Parini P, Giuliani C, Santoro A. Inflammaging: a new immune–metabolic viewpoint for age-related diseases. Nature Reviews Endocrinology. 2018;14(10):576-90. doi:10.1038/s41574-018-0059-4.
25. Kaushik R, McAvay GJ, Murphy TE, et al. In-Hospital Delirium and Disability and Cognitive Impairment After COVID-19 Hospitalization. JAMA Network Open. 2024;7(7):e2419640. doi:10.1001/jamanetworkopen.2024.19640.
26. Aw D, Silva AB, Palmer DB. Immunosenescence: emerging challenges for an ageing population. Immunology. 2007;120(4):435-46. doi:10.1111/j.1365-2567.2007.02555.x.
27. Chilosi M, Doglioni C, Ravaglia C, et al. Unbalanced IDO1/IDO2 Endothelial Expression and Skewed Keynurenine Pathway in the Pathogenesis of COVID-19 and Post-COVID-19 Pneumonia. Biomedicines. 2022;10(6):1332. doi:10.3390/biomedicines10061332.
28. Welch C, Z KH-S, C AG, J ML, T AJ. Acute Sarcopenia Secondary to Hospitalisation - An Emerging Condition Affecting Older Adults. Aging Dis. 2018;9(1):151-64. doi:10.14336/ad.2017.0315.
29. Kortebein P, Symons TB, Ferrando A, et al. Functional impact of 10 days of bed rest in healthy older adults. J Gerontol A Biol Sci Med Sci. 2008;63(10):1076-81. doi:10.1093/gerona/63.10.1076.
30. Liu JYJ, Reijnierse EM, van Ancum JM, et al. Acute inflammation is associated with lower muscle strength, muscle mass and functional dependency in male hospitalised older patients. PLoS One. 2019;14(4):e0215097. doi:10.1371/journal.pone.0215097.
31. Janssens JP, Pache JC, Nicod LP. Physiological changes in respiratory function associated with ageing. Eur Respir J. 1999;13(1):197-205. doi:10.1034/j.1399-3003.1999.13a36.x.
32. Maeda K, Akagi J. Sarcopenia is an independent risk factor of dysphagia in hospitalized older people. Geriatr Gerontol Int. 2016;16(4):515-21. doi:10.1111/ggi.12486.
33. Lustgarten MS. The Role of the Gut Microbiome on Skeletal Muscle Mass and Physical Function: 2019 Update. Frontiers in Physiology. 2019;10:1435. doi:10.3389/fphys.2019.01435.
34. Gonzalez A, Abrigo J, Achiardi O, Simon F, Cabello-Verrugio C. Intensive care unit-acquired weakness: A review from molecular mechanisms to its impact in COVID-19. Eur J Transl Myol. 2022;32(3):10511. doi:10.4081/ejtm.2022.10511.
35. Inoue S, Nakanishi N, Amaya F, et al. Post-intensive care syndrome: Recent advances and future directions. Acute Med Surg. 2024;11(1):e929. doi:10.1002/ams2.929.
36. Gokce-Kutsal Y, Ordu-Gokkaya N, Karahan S, et al. What Awaits Us After Covid-19? Musculoskeletal System Involvement in The Elderly Population in Türkiye And Its Aftermath. Turkish Journal of Geriatrics. 2024;27(1):88-97. doi:10.29400/tjgeri.2024.382.
37. Liu CJ, Latham NK. Progressive resistance strength training for improving physical function in older adults. Cochrane Database Syst Rev. 2009;2009(3):Cd002759. doi:10.1002/14651858.CD002759.pub2.
38. Muir SW, Yohannes AM. The impact of cognitive impairment on rehabilitation outcomes in elderly patients admitted with a femoral neck fracture: a systematic review. J Geriatr Phys Ther. 2009;32(1):24-32. doi:10.1519/00139143-200932010-00006.

39. Inouye SK, Westendorp RG, Saczynski JS. Delirium in elderly people. Lancet. 2014;383(9920):911-22. doi:10.1016/s0140-6736(13)60688-1.

40. Adelman RD, Tmanova LL, Delgado D, Dion S, Lachs MS. Caregiver burden: a clinical review. Jama. 2014;311(10):1052-60. doi:10.1001/jama.2014.304.

41. Davydow DS, Hough CL, Levine DA, Langa KM, Iwashyna TJ. Functional disability, cognitive impairment, and depression after hospitalization for pneumonia. Am J Med. 2013;126(7):615-24.e5. doi:10.1016/j.amjmed.2012.12.006.

42. Shankar A, Hamer M, McMunn A, Steptoe A. Social isolation and loneliness: relationships with cognitive function during 4 years of follow-up in the English Longitudinal Study of Ageing. Psychosom Med. 2013;75(2):161-70. doi:10.1097/PSY.0b013e31827f09cd.

43. Torralba Estelles J, Velert Belenguer J, Martinez Mendoza E, Ferrer Torregrosa J. Impact of the COVID-19 Pandemic on Functionality and Fall Risk in Institutionalized Geriatric Patients: A Longitudinal Observational Study. Life. 2025;15(7):1130. doi:10.3390/life15071130.

44. Gill TM. Disentangling the disabling process: insights from the precipitating events project. Gerontologist. 2014;54(4):533-49. doi:10.1093/geront/gnu067.

45. Gill TM, Gahbauer EA, Han L, Allore HG. The role of intervening hospital admissions on trajectories of disability in the last year of life: prospective cohort study of older people. BMJ. 2015;350:h2361. doi:10.1136/bmj.h2361.

46. Ozisik L, Tanriover MD, Rigby S, Unal S, European Federation of Internal Medicine AWG. ADVICE for a healthier life: Adult Vaccination Campaign in Europe. Eur J Intern Med. 2016;33:14-20. doi:10.1016/j.ejim.2016.04.021.

47. Kutsal YG. Geriatric Rehabilitation in an Ageing World: Challenges, Opportunities, and the Future of Person-Centered Care. Turkish Journal of Geriatrics. 2025;28(4):433-8. doi:10.29400/tjgeri.2025.460

ORIGINAL ARTICLE

ROLES OF THE C-REACTIVE PROTEIN-ALBUMIN-LYMPHOCYTE INDEX AND PAN-IMMUNE-INFLAMMATION VALUE INDICES AS NEW INDICATORS OF DEMENTIA SEVERITY

Turkish Journal of Geriatrics
2026; 29(1):14–24

DOI: 10.29400/tjgeri.2026.474

Emel SABAZ KARAKEÇİ[1]
Nesibe AYDOĞDU[2]
Serpil DOĞAN[3]

[1] Health Sciences University Fethi Sekin City Hospital, Department of Physical medicine and rehabilitation, Elazig, Türkiye

[2] Health Sciences University Fethi Sekin City Hospital, Department of Internal medicines, Elazig, Türkiye

[3] Health Sciences University Fethi Sekin City Hospital, Department of Neurology, Elazig, Türkiye

Correspondence

Emel Sabaz Karakeçi
Phone : +904246066000
e-mail : emelsabaz@gmail.com

Received : Dec 29, 2025
Accepted: Feb 15, 2026

Cite this article as:
Sabaz Karakeçi E, Aydoğdu N, Doğan S. Roles of the C-Reactive Protein-Albumin-Lymphocyte Index and Pan-Immune-Inflammation Value Indices as New Indicators of Dementia Severity . Turkish Journal of Geriatrics 2026; 29(1):14–24. doi: 10.29400/tjgeri.2026.474

Abstract

Introduction: Alzheimer's disease is a common condition that can be challenging to diagnose, primarily due to the high costs and limited availability of specific tests. This study aimed to explore the relationship between peripheral inflammation markers, such as pan-immune-inflammation-value and the C-reactive protein -albumin-lymphocyte and their ability to predict the severity of the disease.

Materials and Method: A total of 232 patients diagnosed with Alzheimer's-type dementia and 52 healthy individuals with no history of the disease were retrospectively included in the study conducted between January 2024 and November 2025. The patients were classified into five groups based on the Clinical Dementia Rating Scale. After a 10-12 hour fast, venous blood samples were collected from all participants, and demographic and clinical data were obtained from the hospital information system. The analysis included complete blood count parameters (leukocytes, neutrophils, lymphocytes, monocytes, and platelets), C-reactive protein levels, serum albumin levels, and routine biochemical parameters from the blood samples.

Results: Although there was no significant difference in pan-immune-inflammation values between the study groups ($p = 0.721$), the C-reactive protein-albumin-lymphocyte index showed a significant decrease as the severity of dementia increased. Similarly, Albumin-Lymphocyte Ratio, Systemic Inflammatory Index, Neutrophil-Lymphocyte Ratio, and Platelet-Lymphocyte Ratio also showed significant differences between the groups ($p < 0.05$).

Conclusion: The findings of this study highlight the attractiveness of the C-reactive protein-albumin-lymphocyte index and the albumin/lymphocyte ratio as potential screening tools for dementia risk assessment in clinical settings.

Keywords: Biomarkers; C-Reactive Protein; Lymphocytes; Prognosis; Dementia; Inflammation; Retrospective Studies.

INTRODUCTION

Alzheimer's disease (AD) is among the most common and most devastating forms of dementia. It has become an increasingly pressing public health issue due to the ageing global population, with its prevalence projected to double in Europe and to triple worldwide by 2050 (1, 2). Clinically, AD is characterised by memory loss, language difficulties (aphasia), problems with recognising objects (agnosia), impaired visual-spatial skills, challenges with abstract thinking and problem-solving, and changes in personality and behaviour. Therefore, this disease significantly diminishes the quality of life of affected individuals and places a heavy burden on caregivers (3).

The primary neuropathological features of AD are amyloid-β deposition, intraneuronal neurofibrillary tangles and synaptic loss. However, the biological mechanisms that trigger the onset and progression of the disease have yet to be fully understood (4). Multiple pathological processes – including vascular abnormalities, mitochondrial dysfunction, oxidative stress, reduced glucose metabolism and neuroinflammation – contribute to the complex nature of the disease (5). Recent research has intensely focused on the hypothesis that chronic inflammatory processes lead to cognitive decline by disrupting neuroglial cell signalling.

In this context, various biomarkers of systemic inflammation have been linked to AD. Among these, the neutrophil-to-lymphocyte ratio (NLR), monocyte-to-lymphocyte ratio (MLR), platelet-to-lymphocyte ratio (PLR) and Systemic Inflammation Index are convenient, low-cost and widely utilised indicators of peripheral systemic inflammation. Multiple investigations have shown that elevations in these ratios may signal cognitive impairment and/or progression towards dementia in patients with AD (6). Additional parameters associated with inflammation and/or immunity have been introduced as potential predictors of dementia risk, such as the Pan-Immune-Inflammation Value (PIV). PIV incorporates the initial aspects of both NLR and PLR, together with parameters from neutrophils, platelets, lymphocytes and monocytes, thereby enabling more comprehensive assessment of inflammatory and immune status than with the NLR and MLR (7). PIV has demonstrated prognostic potential in inflammatory and/or autoimmune disorders such as vasculitis and ischaemic stroke (8). Similarly, the C-reactive protein (CRP)-albumin-lymphocyte (CALLY) index, which incorporates multiple inflammatory markers, provides a more complete and reliable measure of systemic inflammatory, nutritional and immune status than previously described inflammation index (9). It has shown prognostic value in cancer, but its potential role in AD diagnosis has not yet been investigated (9, 10).

Diagnosing AD remains a major challenge, as the limited availability and high cost of definitive tests often leads to delays. Therefore, this study aimed to investigate the association between traditional blood markers – particularly neutrophils – and peripheral inflammatory markers. Specifically, it examined correlations between PIV and CALLY index levels and the increased severity of classic clinical features of AD to determine whether these blood markers are linked to further cognitive deficits or impairments in patients diagnosed with AD.

MATERIALS AND METHOD

This study was approved by the Non-Interventional Research Ethics Committee of Elazig Fethi Sekin City Hospital (Ethics Committee Decision No. 2025/5-13).

Participant Recruitment

A total of 232 patients with AD-type dementia, classified according to the criteria of the National Institute on Aging and Alzheimer's Association (NIA-AA), participated between January 2024 and November 2025. All patients were enrolled in the rehabilitation programme of Elazig Fethi Sekin

City Hospital via its neurology outpatient clinic and palliative care service. The inclusion criteria were age over 65 years, a diagnosis of AD-type dementia according to the NIA-AA criteria and receipt of care at a neurology outpatient clinic (11). Exclusion criteria included a history or presence of malignancy (cancer); decompensated renal, hepatic, or chronic heart failure; acute infection, decubitus ulcer, or major surgery within the past month; acute or chronic inflammatory disease; hematological disease; and any significant endocrine disorder requiring treatment; or use of corticosteroids or immunosuppressive drugs.

In addition, 52 healthy individuals – with no history of dementia or major neurological or psychiatric disorders and matched to the patients by age and sex – were recruited from the same outpatient clinic.

Thus, this study included 284 participants, divided into five groups according to the participants' Clinical Dementia Rating Scale (CDRS) scores (12). Group 1, with mild dementia (n = 64); Group 2, with mild moderate dementia (n = 62); Group 3, with moderate dementia (n = 49); Group 4, with severe dementia (n = 57); and Group 5, without dementia (control, n = 52). Written informed consent was obtained from each participant or their caregiver.

Data Collection

Demographic and clinical data were obtained from the Hospital Information System. Venous blood samples were collected following a 10–12 h fast. The blood samples were analyzed via complete blood count using a SYS/MAX 8000 Automated Hematology Analyzer (Sysmex Corporation, Kobe, Japan) which provides total leukocyte and leukocyte differential counts as well as counts for neutrophils, lymphocytes and monocytes. CRP and serum albumin levels were also measured, together with routine biochemical assays for Aspartate aminotransferase, Alanine aminotransferase, glucose, urea, creatinine and vitamin B12. CRP and serum albumin levels were quantified using a Roche Cobas 8000 Biochemistry Analyzer (Roche Diagnostics, Basel, Switzerland). The reference ranges for albumin, lymphocytes and CRP in our laboratory are 3.5–5.2 g/dL, 1000–4000 cells/μL and 0–5 mg/L, respectively.

To assess inflammatory status, the PIV and CALLY indices were calculated using data from the complete blood count, CRP and albumin levels, according to the following equations:

PIV = (Neutrophil × Monocyte × Platelet) / Lymphocyte

CALLY index = (Lymphocyte count [cells/μL] × Albumin [g/dL]) / (CRP [mg/L] × 10^4)

SII (Systemic Inflammatory Index) = (Platelet x Neutrophil)/ Lymphocyte

NLR (Neutrophil Lymphocyte ratio) = Neutrophil/ Lymphocyte

PLR (Platelet Lymphocyte ratio) = Platelet/ Lymphocyte

Dementia severity was determined by the same experts based on the participants' clinical histories, neurological examinations and standardised cognitive tests, particularly the Mini-Mental State Examination (MMSE) and the Montreal Cognitive Assessment.

Statistical Analysis

IBM SPSS Statistics (version 22) and G*Power (version 3.1) were used for data analysis. In the descriptive analysis, categorical variables were reported as counts and percentages, while non-parametric continuous variables were expressed as medians and ranges (minimum to maximum). Spearman's correlation was applied to assess the relationship between the CALLY index values and MMSE scores. For the comparison of non-parametric continuous variables across groups, the Kruskal-Wallis test was employed. Where global significance was observed, post-hoc pairwise comparisons were performed using the Mann-Whitney U test with Bonferroni correction for multiple testing. Pair-



wise comparisons were performed with *p*-values adjusted for multiple testing. To examine the independent association between the CALLY index values and dementia severity, as measured by MMSE, a multivariate ordinal regression model was constructed, adjusting for confounding variables including age, sex, and comorbidities. The diagnostic performance of the inflammatory indices and their ability to discriminate dementia severity were evaluated using Receiver Operating Characteristic (ROC) curve analysis. The Comparison of the Area Under the Curves (AUC) was performed using the DeLong method, and the Z statistic was utilized to determine the significance of the differences between the AUC values of the CALLY index and other markers (NLR, PLR, Albumin, etc.). The optimal cut-off values for achieving the highest diagnostic accuracy of each analytical parameter were established using the Youden index formula: "sensitivity + specificity − 1.Statistical significance was set at $p < 0.05$. To reduce the risk of Type II errors, all analyses were powered at > 80%.

RESULTS

The study included a total of 284 participants, stratified into five groups based on Clinical Dementia Rating Scale (CDRS) scores. No dementia (control, n = 52), mild dementia (n = 64), mild to moderate dementia (n = 62), moderate dementia (n = 49), and severe dementia (n = 57). No statistically significant differences were found between the groups regarding gender, total white blood cell (WBC), platelet, Neutrophil count, glucose, AST or vitamin B12 levels. However, significant differences were observed in urea (p=0.008), creatinine (p=0.009), and ALT (p=0.003) levels across the groups. CRP levels showed a significant and notable increase from the control group to the severe dementia group. In contrast, serum albumin levels displayed a significant decreasing trend as dementia severity progressed. Regarding white blood cell parameters, Lymphocyte and Monocyte counts also showed a significant differences. The Lymphocyte and Monocyte percentage considerably decreased with worsening dementia, indicating a shift in the immune cell profile.

No significant difference was noted in PIV values between the study groups (p= 0.721). However, the CALLY index showed a significant decline with increasing dementia severity. This indicates a strong inverse relationship with dementia stages. Similarly, the Albumin-to-Lymphocyte Ratio decreased significantly between the groups ($p < 0.001$). On the other hand, it was found that SII, NLR, and PLR values increased statistically significantly in correlation with the severity of dementia. (Table 1).

The analyses revealed significant differences in CALLY index values among patients grouped according to their CDR scores. In particular, patients in the severe dementia stage had significantly lower CALLY index scores than all groups included in the study. (Figure 1).

In the comparative analysis of dementia groups, the CALLY and ALB/LYM indices were identified as the parameters with the highest statistical significance in distinguishing the severe dementia group from all other groups. (Table 2).

A multivariate logistic regression model was applied to identify independent determinants associated with severe dementia. The results revealed that CALLY, ALB/LYM ratio, Albumin, and CRP were significant independent factors. The diagnostic efficacy of these indices, including threshold values, sensitivity, specificity, AUC, and 95% confidence intervals, is shown in Table 3 via ROC analysis.

Analysis of the diagnostic performance of the CALLY index, comparing it to various inflammatory markers along with other indices to assess its effectiveness in discriminating dementia severity, showed that the CALLY index had significantly higher diagnostic accuracy compared to NLR, PLR, and Albumin levels. Although the CALLY index

Table 1. Demographic and laboratory findings of patients

Variables	Normal	Mild Dementia	Mild-Moderate Dementia	Moderate Dementia	Severe Dementia	P
Mean Age (years) ±SD (Min-Max)	73±7.34 (59-95)	81.5±8.29 (63-107)	81.9±7.0 (67-100)	81.4±7.62 (67-100)	83.5±6.02 (69-95)	<0.001
Gender	Male:26 Female:26	Male:22 Female:42	Male:22 Female:40	Male:25 Female:24	Male:16 Female:41	0.174
Comorbid Diseases	HT:37 DM:23 IHD:18 COLD:18 Others:31	HT:50 DM:27 IHD:27 COLD:8 Others:35	HT:42 DM:19 IHD:26 COLD:16 Others:37	HT:32 DM:13 IHD:9 COLD:13 Others:33	HT:38 DM:22 IHD:13 COLD:9 Others:37	
WBCx103/µL ±SD (Min-Max)	7.7±2.29 (4.3-14.7)	7.1±2.53 (2.6-18.0)	7.9±4.40 (3.1-31.0)	7.8±3.35 (2.50-20.0)	7.8±3.10 (3.40-17.20)	0.357
PLTx103/µL±SD (Min-Max)	261.4±90.04 (133-620)	251.5±104.8 (14.1-690.0)	267.5±130.8 (94-792)	228.5±86.93 (14-522)	269.2±112.5 (23-593)	0.178
NEU(103/µL)±SD (Min-Max)	5.0±2.15 (1.89-12.90)	4.7±2.16 (1.57-13.0)	5.1±3.09 (1.73-24.0)	5.2±2.97 (1.12-17.0)	5.7±3.12 (1.76-15.0)	0.430
LYM103/µL ±SD (Min-Max)	1.90±0.90 (0.89-5.28)	1.60±0.76 (0.33-4.10)	1.90±2.70 (0.35-22.0)	1.80±0.79 (0.66-3.99)	1.40±0.77 (0.06-4.54)	0.027
MONOCYTE103/µL ±SD (Min-Max)	0.79±0.95 (0.20-7.37)	0.59±0.24 (0.20-1.36)	0.73±1.11 (0.22-8.95)	0.82±1.24 (0.15-8.95)	0.48±0.48 (0.02-0.81)	<0.001
CRP (mg/L) ±SD (Min-Max)	18.9±36.37 (0.70-236)	28.3±30.39 (0.30-386)	20.4±30.86 (0.44-179)	24.6±40.79 (1.0-181)	69.1±99.91 (2.07-456)	<0.001
Glucose (mg/dL) ±SD (Min-Max)	145.1±86.75 (65-400)	136.2±71.06 (57-499)	130.9±58.51 (62-340)	118.3±71.19 (46-536)	131.9±58.61 (59-398)	0.320
Urea (mg/dL) ±SD (Min-Max)	46.3±27.72 (11-163)	49.2±28.02 (2.6-210)	45.97±22.68 (17-152)	50±41.60 (15-307)	73.58±50.52 (21-208)	0.008
Creatinine (mg/dL±SD (Min-Max)	0.9±0.36 (0.30-2.20)	0.9±0.66 (0.40-5.30)	0.9±0.36 (0.40-2.20)	0.8±0.33 (0.30-2.09)	0.9±0.82 (0.20-5.60)	0.009
Albumin (g/dL) ±SD (Min-Max)	3.8±0.56 (2.0-4.80)	3.6±0.49 (2.4-4.70)	3.4±0.54 (2.2-4.40)	3.5±0.65 (2.0-5.1)	2.9±0.56 (1.70-4.10)	<0.001
AST (U/L) ±SD (Min-Max)	22.8±11.42 (9.0-75.0)	22.1±11.27 (10.0-90.0)	26.1±29.99 (7.0-209.0)	24.4±18.71 (9.0-122.0)	34.0±69.20 (9.0-534.0)	0.727
ALT (U/L) ±SD (Min-Max)	19.3±11.47 (5.0-60.0)	15.3±11.46 (4.0-68.0)	15.1±19.14 (2.0-151.0)	18.4±17.85 (4.0-109.0)	26.4±52.0 (2.0-388.0)	0.003
B12 (pg/mL) ±SD (Min-Max)	241.4±152.82 (57.0-710.0)	315.4±359.46 (64.0-1565.0)	266.50±280.69 (50.0-1500.0)	299.60±364.40 (50.0-1500.0)	233.3±203.57 (50.0-1123.0)	0.691
PIV	612.3±563.17 (54.37-2509.41)	602.80±767.95 (11.52-4469.20)	1004.6±2409.40 (8.78-17697.10)	762.4±1300.05 (4.34-7580.19)	775.0±1063.18 (51.49-6393.60)	0.721
ALB/LYM	7.43±3.75 (1.78-21.41)	5.78±3.01 (0.89-16.81)	6.73±10.87 (0.84-88.00)	6.25±3.22 (1.47-15.01)	4.2±2.89 (0.13-17.71)	P<0.001
CALLY	2.38±3.41 (0.01-15.84)	2.72±6.43 (0.00-37.80)	1.60±2.72 (0.01-16.77)	1.41±1.61 (0.01-6.51)	0.52±0.83 (0.00-3.68)	P<0.001
SII	826.72±610.67 (93.76-2884.38)	894.48±672.66 (22.59-3464.50)	1131.70±1128.88 (21.96-6554.48)	814.54±782.59 (28.99-3228.99)	1793.40±2677.41 (234.08-15984.00)	0.017
NLR	3.16±2.31 (0.39-14.49)	3.71±2.82 (0.85-13.98)	3.98±2.96 (0.15-15.17)	3.73±3.83 (0.60-24.29)	7.92±12.17 (1.04-65.00)	0.019
PLR	162.32±85.13 (36.95-412.60)	187.83±99.27 (5.44-495.12)	196.08±105.31 (6.86-454.26)	152.35±88.80 (16.11-456.72)	266.12±220.04 (61.23-1110.00)	0.003

WBC: White blood cells, PLT: Platelet, NEU: Neutrophil, LYM: Lymphocyte, CRP: C-reactive protein, AST: Aspartate aminotransferase, ALT: Alanine transaminase, PIV: Pan-immune-inflammation-value, CALLY: C-reactive protein-albumin-lymphocyte, ALB: Albumin, HT: Hypertension, DM: Diabetes mellitus, IHD: Ischemic heart disease, COLD: Chronic obstructive lung disease, SII: Systemic Inflammatory Index, NLR: Neutrophil Lymphocyte ratio, PLR: Platelet Lymphocyte ratio

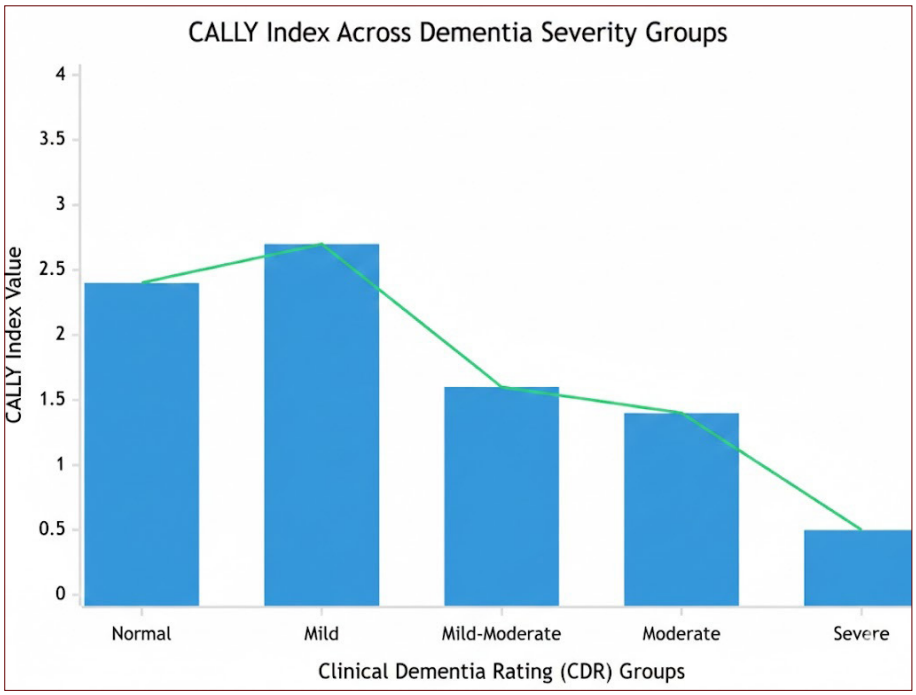


Figure 1. The CALLY index shows a significant decreasing trend with increasing dementia severity.

Table 2. Comparison of inflammatory indices between groups

Intergroup Comparison: PIV, ALB/LYM, CALLY, SII, PLR, NLR	Normal	Mild Dementia	Mild-Moderate Dementia	Moderate Dementia	Severe Dementia
Normal	-	0.418 0.010 0.454 0.545 0.170 0.310	0,868 0.001 0.159 0.333 0.101 0.098	0.274 0.146 0.240 0.459 0.598 0.659	0.865 p<0.001 p<0.001 0.007 0.004 0.002
Mild Dementia	-	-	0.539 0.638 0.485 0.636 0.626 0.581	0.715 0.438 0.677 0.163 0.033 0.487	0.364 p<0.001 p<0.001 0.029 0.113 0.025
Mild-Moderate Dementia	-	-	-	0.412 0.222 0.831 0.130 0.019 0.252	0.768 0.004 p<0.001 0.132 0.205 0.118
Moderate Dementia	-	-	-	-	0.255 p<0.001 p<0.001 0.002 p<0.001 0.009
Severe Dementia					

PIV: Pan-immune-inflammation-value, CALLY: C-reactive protein-albumin-lymphocyte, ALB: Albumin, LYM: Lymphocyte, SII: Systemic Inflamatory Index, NLR: Neutrophil Lymphocyte ratio, PLR: Platelet Lymphocyte ratio

Table 3. AUC, sensitivity, specificity, confidence intervals of the cut-off values for predicting dementia severity based on ROC analysis.

Criteria*,**	Sensitivity	Specificity	AUC	95% Confidence interval		P value
				Lower	Upper	
CALLY ≤0.355	73.68	70.48	0.736	0.680	0.786	p<0.001
ALB/LYM≤3.41	45.61	84.14	0.702	0.645	0.755	p<0.001
NLR>3.88	50.88	74.01	0.626	0.567	0.683	0.003
PLR>125	82.46	38.33	0.621	0.562	0.678	0.004
CRP>11.68	70.18	66.08	0.713	0.657	0.765	p<0.001
Albumin≤3.3	78.95	78.95	0.800	0.749	0.845	p<0.001

*The cut-off levels of were calculated based on ROC-AUC analysis and the Youden index

** Cut-off values were calculated for the data that were identified as significant in the logistic regression analysis.

OR: odds ratio, CALLY: C-reactive protein-albumin-lymphocyte, ALB: Albumin, LYM: Lymphocyte, CRP: C-reactive protein, NLR: Neutrophil Lymphocyte ratio, PLR: Platelet Lymphocyte ratio.

performed numerically better than the ALB/LYM ratio and CRP, the differences were not statistically significant (Table 4).

Table 4. Pairwise comparison of Receiver Operating Characteristic (ROC) curves

Compared indices	Z	P
CALLY vs. NLR	2.673	0.007
CALLY vs. PLR	2.640	0.008
CALLY vs. Albumin	2.166	0.030
CALLY vs. ALB/LYM	1.140	0.254
CALLY vs. CRP	1.617	0.106
ALB/LYM vs. NLR	2.292	0.022
ALB/LYM vs. PLR	2.301	0.021
NLR vs. Albumin	3.970	<0.001
PLR vs. Albumin	4.054	<0.001
CRP vs. Albumin	2.474	0.013
NLR vs. PLR	0.136	0.891

CALLY: C-reactive protein-albumin-lymphocyte, ALB: Albumin, LYM: Lymphocyte, CRP: C-reactive protein, NLR: Neutrophil Lymphocyte ratio, PLR: Platelet Lymphocyte ratio.

DISCUSSION

This study explored the relationship between dementia severity and systemic inflammatory markers, specifically PIV and the CALLY index. To our knowledge, this is the first study to directly associate the CALLY index with dementia severity. Our key finding is a significant decrease in the CALLY index with increasing dementia severity, whereas no comparable relationship was observed with PIV.

There is growing evidence that inflammation contributes substantially to the development of dementia. Neuroinflammation can be triggered when microglia, the cells responsible for protecting the central nervous system from infections by clearing dysfunctional neurons, structural components and plaques, release inflammatory substances under pathological conditions (13). In the acute phase, microglial neuron loss due to inflammatory mediators leads to synaptic dysfunction, and in later stages, to cognitive decline (14). Animal studies have also demonstrated that peripheral cytokines can initiate neuroinflammation in the central nervous system when inflammatory mediators cross regions where the blood–brain barrier is compromised (15).

Alongside neuroinflammation, systemic inflammation is believed to play a major role in disease progression (16). Geng et al. (17) suggested that systemic inflammation indices, such as the Systemic Inflammation Index and PIV, can predict cognitive decline. Tondo et al. (18) reported that high



neutrophil counts, reflecting chronic inflammation, and low lymphocyte counts, indicating reduced responsive to foreign pathogens, can serve as neuroinflammatory markers in early dementia screening. They also noted that changes in these parameters might be associated with a rapid decline in cognitive function. The observation of elevated CRP levels in moderate to severe dementia further suggests that systemic inflammation increases with disease progression.

Understanding the inflammatory burden in patients with dementia, including AD, may help identify those who would benefit most from anti-inflammatory treatments. Long-term use of nonsteroidal anti-inflammatory drugs has been associated with reduced dementia risk, supporting the potential role of anti-inflammatory therapies in alleviating dementia-related neuroinflammation, improving certain pathological features and even treating the disease (16).

Largescale studies corroborate these findings. A study conducted in the United Kingdom, which included approximately 500,000 participants, found an inverse relationship between CRP – a biomarker of inflammation measured using WBC counts – and cognitive function (19). The study revealed particularly high CRP levels in groups with moderate and severe dementia, indicating that systemic inflammation increases as the disease progresses. This suggests that the elevated CRP levels observed in the severe dementia patients in the present study may play a role in the development of dementia. Borda et al. (20) reported that patients newly diagnosed with dementia who had higher CRP levels experienced greater functional deterioration over five years. Our findings of elevated CRP in severe dementia align with these reports, suggesting that severe infections (sepsis) significantly influence disease progression and functional decline in dementia (21).

However, some studies have found no direct correlation between CRP or interleukin-6 and dementia. To assist in addressing these discrepancies, composite indices have been explored (22, 23). The CALLY index is unique because it integrates multiple physiological pathways – CRP (inflammation), albumin (nutritional status) and lymphocytes (immune regulation) – thereby providing a more comprehensive and accurate measure of the relationship between inflammatory markers and dementia than single-parameter markers can.

The present study revealed a reverse relationship between CALLY index values and dementia severity. The severe dementia group exhibited markedly reduced CALLY index values with decreased albumin and increased CRP. We interpret this finding as further evidence that systemic inflammatory catabolism and malnutrition accompany late-stage dementia. It highlights that a peripheral index such as CALLY can provide a deeper explanation of the complex pathophysiology of dementia than CRP or albumin alone.

Platelets, while central to clotting, also mediate inflammation through their interactions with WBCs. Evidence suggests that they may serve as systemic biomarkers for neurodegenerative disorders (24). By evaluating the use of platelets as a multiplier, we can predict the inflammatory potential of diseases based on their PIV value (8). However, Algul et al. found a strong positive correlation between dementia severity and NLR but not PLR, possibly due to the lack of other prognostic markers associated with platelet counts (25). Consistent with this, the present study found no significant differences in PIV across the groups, suggesting that PIV is a more specific indicator of acute-phase responses or oncohaematological pathologies than the chronic neurodegenerative inflammation associated with dementia.

This study found that the PLR showed a significant association with the severity of dementia, whereas the PIV did not reach statistical significance. This discrepancy may stem from the multi-parametric nature of PIV, which incorporates neutrophil, monocyte, and platelet counts simultaneously.

While this comprehensive structure allows PIV to effectively reflect acute-phase systemic responses, it may be less sensitive to the chronic, low-grade neuroinflammation characteristic of Alzheimer's type dementia. In contrast, PLR more specifically highlights the role of platelet-mediated inflammatory pathways in neurodegeneration, suggesting it as a more focused marker for monitoring disease progression in this population. We observed significant differences among the dementia groups in the basic haematological and biochemical indices – albumin, CRP, and monocyte and lymphocyte counts – underscoring the importance of the biological factors of nutrition and systemic inflammation in the development of dementia. Furthermore, because lymphocytes and monocytes can cross the blood–brain barrier and interact with glia, their relative concentrations in blood may more accurately reflect ongoing neuroinflammation than assay-validated serum markers.

Platelet counts, as measured by PIV, are likely poor indicators of dementia pathology, as they are influenced by multiple physiological stressors and therefore cannot be directly correlated to dementia-related pathologies. Other systemic inflammatory markers – monocytes, lymphocytes and neutrophils – may exert greater influence on composite indices.

This study has several limitations. First, its cross-sectional design prevents the establishment of causality between dementia and systemic inflammation. Second, while peripheral blood markers indicate systemic inflammation, they may not directly reflect central nervous system inflammation. Third, the single centre design, limited sample size and absence of comparisons with other inflammatory markers restrict the generalisability of the findings. A notable limitation of our study is the statistically significant difference in mean age between the control group and the dementia groups. Although we aimed to match participants by age and sex, the higher average age in the severe dementia group reflects the clinical reality of disease progression. Since inflammatory markers can be influenced by the aging process itself, this age disparity should be considered when interpreting the systemic inflammation indices. Finally, it is important to note that inflammatory parameters can be influenced by multiple factors, including infections, metabolic disorders and even ageing.

CONCLUSION

This study provides valuable insights into the predictive value of inflammatory markers in dementia by comparing their levels across patients with varying levels of dementia severity and healthy controls. The main finding is that the CALLY index is strongly linked to the severity of AD, whereas PIV does not appear to be an independent marker of dementia risk. Our results suggest that the CALLY index may provide better diagnostic utility than other inflammatory indices because it is clinically more comprehensive; it assesses the overall immuno-nutritional status of the patient rather than simply focusing on an isolated inflammatory response.

These results suggest that the CALLY index and albumin-to-lymphocyte measurements are promising screening tools for dementia risk in clinical practice. Both are widely available, simple to calculate, inexpensive, and derived from routine laboratory parameters.

To further clarify the causal relationship between these markers and dementia risk, prospective longitudinal cohort studies and validation studies with larger sample sizes are needed. Additionally, the prognostic performance of the CALLY index should be compared with that of other commonly used indices, such as NLR.

Acknowledgements: The authors have no acknowledgements to declare.

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

Funding Sources: The authors received no financialsupport for the present study.



REFERENCES

1. Crous-Bou M, Minguillon C, Gramunt N, Molinuevo JL. Alzheimer's disease prevention: from risk factors to early intervention. Neurology 1984;34(7):939-44. (Doi: 10.1212/wnl.34.7.939)
2. Wang C, Zong S, Cui X, et al. The effects of microglia-associated neuroinflammation on Alzheimer's disease. Front Immunol 2023;14:1117172. (Doi: 10.3389/fimmu.2023.1117172)
3. McKhann G, Drachman D, Folstein M, Katzman R, Price D, Stadlan EM. Clinical diagnosis of Alzheimer's disease: report of the NINCDS-ADRDA Work Group under the auspices of Department of Health and Human Services Task Force on Alzheimer's Disease. Neurology 1984;34(7):939-44. (Doi: 10.1212/wnl.34.7.939)
4. Long JM, Holtzman DM. Alzheimer Disease: An Update on Pathobiology and Treatment Strategies. Cell 2019;179(2):312-339. (Doi: 10.1016/j.cell.2019.09.001)
5. Rostagno AA. Pathogenesis of Alzheimer's Disease. Int J Mol Sci 2022;24(1):107. (Doi: 10.3390/ijms24010107)
6. Dong X, Nao J, Shi J, Zheng D. Predictive Value of Routine Peripheral Blood Biomarkers in Alzheimer's Disease. Front Aging Neurosci 2019;11:332. (Doi: 10.3389/fnagi.2019.00332)
7. Ligorio F, Fuca G, Zattarin E, et al. The Pan-Immune-Inflammation-Value Predicts the Survival of Patients with Human Epidermal Growth Factor Receptor 2 (HER2)-Positive Advanced Breast Cancer Treated with First-Line Taxane-Trastuzumab-Pertuzumab. Cancers (Basel) 2021;13(8):1964. (Doi: 10.3390/cancers13081964)
8. Wang S, Zhang L, Qi H, Zhang F L, Fang Q, Qiu L. Pan-Immune-Inflammatory Value Predicts the 3 Months Outcome in Acute Ischemic Stroke Patients after Intravenous Thrombolysis. Curr Neurovasc Res 2023;20(4):464-471. (Doi: 10.2174/0115672026276427231024045957)
9. Iida H, Tani M, Komeda K, et al. Superiority of CRP-albumin-lymphocyte index (CALLY index) as a non-invasive prognostic biomarker after hepatectomy for hepatocellular carcinoma. HPB (Oxford) 2022;24(1):101-115. (Doi: 10.1016/j.hpb.2021.06.414)
10. Liu XY, Zhang X, Zhang Q, et al. The value of CRP-albumin-lymphocyte index (CALLY index) as a prognostic biomarker in patients with non-small cell lung cancer. Support Care Cancer 2023;31(9):533. (Doi: 10.1007/s00520-023-07997-9)
11. McKhann GM, Knopman DS, Chertkow H, et al. The diagnosis of dementia due to Alzheimer's disease: recommendations from the National Institute on Aging-Alzheimer's Association work groups on diagnostic guidelines for Alzheimer's disease. Alzheimers Dement 2011;7(3):263-9. (Doi: 10.1016/j.jalz.2011.03.005)
12. Morris JC. The Clinical Dementia Rating (CDR): current version and scoring rules. Neurology 1993;43(11):2412-4. (Doi: 10.1212/wnl.43.11.2412-a)
13. Khan MA, Khan ZA, Shoeb F, Fatima G, Khan RH, Khan MM. Role of de novo lipogenesis in inflammation and insulin resistance in Alzheimer's disease. Int J Biol Macromol 2023;242(Pt 2):124859. (Doi: 10.1016/j.ijbiomac.2023.124859)
14. Jia S, Yang H, Huang F, Fan W. Systemic inflammation, neuroinflammation and perioperative neurocognitive disorders. Inflamm Res 2023;72(9):1895-1907. (Doi: 10.1007/s00011-023-01792-2)
15. Wang RP, Ho YS, Leung WK, Goto T, Chang RC. Systemic inflammation linking chronic periodontitis to cognitive decline. Brain Behav Immun 2019;81:63-73. (Doi: 10.1016/j.bbi.2019.07.002)
16. Fakhoury M. Inflammation in Alzheimer's disease. Curr. Alzheimer Res 2020;17:959–961. (Doi: 10.2174/1567205017112101011051 3)
17. Geng C, Chen C. Association between elevated systemic inflammatory markers and the risk of cognitive decline progression: a longitudinal study. Neurol Sci 2024;45(11):5253-5259. (Doi: 10.1007/s10072-024-07654-x)
18. Tondo G, Aprile D, De Marchi F, et al. Investigating the Prognostic Role of Peripheral Inflammatory Markers in Mild Cognitive Impairment. J Clin Med 2023;12(13):4298. (Doi: 10.3390/jcm12134298)
19. Mekli K, Lophatananon A, Maharani A, Nazroo JY, Muir KR. Association between an inflammatory biomarker score and future dementia diagnosis in the population-based UK Biobank cohort of 500,000 people. PLoS One 2023;18(7):e0288045. (Doi: 10.1371/journal.pone.0288045)
20. Borda MG, Cederholm T, Salazar-Londono S, et al. C-reactive protein predicts functional decline in older adults newly diagnosed with dementia: A 5-year follow-up study. Rev Esp Geriatr Gerontol 2025;60(6):101722. (Doi: 10.1016/j.regg.2025.101722)

21. Sun M, Li F, Wang Y, et al. Sepsis on dementia risk: A population-based cohort study with dose-dependent analysis. J Crit Care 2025;89:155100. (Doi: 10.1016/j.jcrc.2025.155100)

22. Ozben T, Ozben S. Neuro-inflammation and anti-inflammatory treatment options for Alzheimer's disease. Clin Biochem 2019;72:87-89. (Doi: 10.1016/j.clinbiochem.2019.04.001)

23. Su C, Zhao K, Xia H, Xu Y. Peripheral inflammatory biomarkers in Alzheimer's disease and mild cognitive impairment: a systematic review and meta-analysis. Psychogeriatrics 2019;19(4):300-309. (Doi: 10.1111/psyg.12403)

24. Blennow K, Zetterberg H. Biomarkers for Alzheimer's disease: current status and prospects for the future. J Intern Med 2018;284(6):643-663. (Doi: 10.1111/joim.12816)

25. Algul FE, Kaplan Y. Increased Systemic Immune-Inflammation Index as a Novel Indicator of Alzheimer's Disease Severity. J Geriatr Psychiatry Neurol 2025;38(3):214-222. (Doi: 10.1177/08919887241280880)

Turkish Journal of Geriatrics
2026; 29(1):25–33

DOI: 10.29400/tjgeri.2026.475

Gülhan AYHAN ALBAYRAK
Mustafa İlteriş BARDAKÇI

[1] Şişli Hamidiye Etfal Training and Research Hospital , Chest diseases, İstanbul, Türkiye

ORIGINAL ARTICLE

INFLAMMATORY AND NUTRITIONAL BIOMARKERS FOR PREDICTING MORTALITY IN ELDERLY PATIENTS WITH COMMUNITY- ACQUIRED PNEUMONIA

Abstract

Introduction: Community-acquired pneumonia remains a leading cause of morbidity and mortality among older adults. Although conventional scoring systems, such as CURB-65 and pneumonia severity indexes, provide prognostic guidance, novel inflammation- and nutrition-based biomarkers may offer enhanced predictive accuracy. This study evaluated and compared the prognostic performance of six novel biomarkers; neutrophil-to-lymphocyte ratio, systemic immune-inflammation index, prognostic nutritional index, lymphocyte-to-monocyte ratio, C-reactive protein-to-albumin ratio, and modified Glasgow prognostic score in comparison with conventional scoring systems in elderly patients hospitalized with community-acquired pneumonia.

Materials and Method: A total of 105 patients aged ≥65 years who were hospitalized with community-acquired pneumonia between 2020 and 2025 were included in this retrospective cohort study, and their clinical, laboratory, and demographic data were collected. Prognostic performance for 30-day mortality was assessed using receiver-operating characteristic curves, Area Under the Receiver Operating Characteristic Curve and Kaplan–Meier survival analyses.

Results: C-reactive protein-to-albumin ratio demonstrated the highest discriminatory ability, followed by prognostic nutritional index and neutrophil-to-lymhocyte ratio. Although elevated platelet lymphocyte ratio was associated with reduced survival rates (p=0.038), none of the novel biomarkers remained independent predictors in multivariate Cox regression analyses.

Conclusion: C-reactive protein-to-albumin ratio is a simple, cost-effective, and highly predictive biomarker for in-hospital mortality in elderly patients with community-acquired pneumonia, outperforming other indices and complementing conventional scores. Estimation of C-reactive protein-to-albumin ratio may facilitate early risk stratification and guide interventions in this population.

Keywords: Community-Acquired Pneumonia; Inflammation Mediators; Biomarkers; Prognosis; Aged.

Correspondence

Gülhan AYHAN ALBAYRAK
Phone : +905355416672
e-mail : gulhanayhanalbayrak@gmail.com

Received : Jan 14, 2026
Accepted: Feb 15, 2026

Cite this article as:
Ayhan Albayrak G, Bardakçı Mİ. Inflammatory and Nutritional Biomarkers for Predicting Mortality in Elderly Patients with Community- Acquired Pneumonia. Turkish Journal of Geriatrics 2026; 29(1):25–33. doi: 10.29400/tjgeri.2026.475

INTRODUCTION

Community-acquired pneumonia (CAP) is a major cause of hospitalization and mortality, particularly affecting the elderly and those with chronic comorbidities globally (1,2). In older adults, immunosenescence and frailty compromise host responses, leading to atypical presentations, such as confusion or falls instead of classic symptoms which complicate early diagnosis and prognostication (3).

Traditional severity scores, such as PSI and CURB-65, provide useful prognostic information; however, their predictive accuracy is often limited in the geriatric population because of atypical presentations and dynamic inflammatory responses (4). Consequently, simple, objective, and readily available biomarkers that reflect systemic inflammation and nutritional status are needed.

Recent studies suggests neutrophil-to-lymphocyte ratio (NLR), systemic immune-inflammation index (SII), prognostic nutritional index (PNI), lymphocyte-to-monocyte ratio (LMR), C-reactive protein-to-albumin ratio (CAR), and modified Glasgow prognostic score (mGPS) as potential prognostic markers in CAP (5,6).

In elderly adults, CAP frequently presents with atypical or nonspecific features, complicating timely diagnosis and limiting the performance of established scoring systems (7). These limitations underscore the need for objective, easily applicable biomarkers that can enhance early prognostic assessment in this population. Accordingly, this study evaluated the prognostic performance of NLR, SII, PNI, LMR, CAR, and mGPS for predicting 30-day mortality among hospitalized elderly patients with CAP and compared their predictive accuracy with that of conventional scoring systems.

MATERIALS AND METHOD

Study Design

This retrospective cohort study was conducted at Şişli Etfal Training and Research Hospital, Istanbul, Turkey. The study adhered to the principles of the WMA of Helsinki – Ethical Principles for Medical Research Involving Human Participants and was approved by the Institutional Ethics Committee (Approval No: 3193/28.10.2025). The retrospective design allowed for the evaluation of clinical and laboratory data extracted from previously recorded patient files over a defined study period.

Electronic medical records for patients with CAP at Şişli Hamidiye Etfal Training and Research Hospital between January 1, 2020 and January 1, 2025 were retrospecitvely reviewed. Diagnosis of CAP was established according to the Turkish Thoracic Society Pneumonia Guidelines, which require the presence of new pulmonary infiltrates on chest imagings together with compatible clinical symptoms, such as fever, cough, sputum production, or dyspnea.

Demographic characteristics (age, sex, and comorbidities), clinical outcomes (requirements for hospitalizations and 30-day all-cause mortality), and laboratory parameters, including white blood cell, neutrophil, lymphocyte, monocyte, and platelet counts, and C-reactive protein and albumin levels were systematically extracted from the electronic medical records for analysis.

Study Participants

Eligible patients were aged ≥18 years, received a diagnosis of CAP confirmed according to ICD-10 codes, and had complete blood count and basic biochemical analyses were already performed upon admission. Patients who had hospital-acquired or ventilator-associated pneumonia, hematologic malignancies, active tuberculosis and received chemotherapy or immunosuppressive therapy within the preceding three months, , or those with missing laboratory data were excluded and remaining 105 patients were included in the study. Data about demographic characteristics, clinical outcomes, and laboratory parameters,including



white blood cell, neutrophil, lymphocyte, monocyte, and platelet counts, and C-reactive protein and albumin levels were systematically extracted from the electronic medical records for analysis.

Calculation of Prognostic Scores

Conventional prognostic scoring systems (CURB-65 and PSI) and novel biomarker-based indices were calculated for each patient using demographic, clinical, and admission laboratory values. The novel scores, derived from routine blood tests, included the NLR = Neutrophil Count / Lymphocyte Count, PLR = Platelet Count / Lymphocyte Count, LMR = Lymphocyte Count / Monocyte Count, SII = Platelet Count X Neutrophil Count / Lymphocyte Count), PNI = (Albumin (g/dL)X 10) + (0.005 X Lymphocyte Count), and the CAR = CRP (mg/L) / Albumin (g/L). Additionally, the mGPS was categorized into 0, 1, or 2 points based on CRP and Albumin levels, while the PSI was calculated using its complex, established system incorporating age, sex, comorbidities, and various clinical/laboratory parameters (8).

Statistical Analysis

Statistical analyses were performed with IBM SPSS Statistics for macOS, version 30.0 (IBM Corp.). Categorical variables were summarized as numbers and percentages, and continuous variables as means with standard deviations or medians with ranges. The distribution of continuous variables was evaluated using the Shapiro–Wilk test. Group comparisons were conducted using the Mann–Whitney U test for non-normally distributed continuous variables and chi-square or Fisher's exact test for categorical variables. The discriminatory ability of NLR, SII, PNI, LMR, CAR, mGPS, and PSI for in-hospital mortality was assessed with receiver operating characteristic (ROC) curve analysis; area under the ROC curve values with 95% confidence intervals and optimal cut-off values were calculated. Subsequently, patients were categorized into high- and low-risk groups according to these cut-off values. In-hospital survival, defined as the interval from admission to death or discharge, was analyzed with Kaplan–Meier methods, and between-group differences were tested with the log-rank test. Hazard ratios with 95% confidence intervals were reported. Statistical significance was set at $P<0.05$.

RESULTS

The analysis included 105 geriatric patients (mean age; 73 years, 33.3% women). Comorbid conditions were present in 37.4% of the cohort (Table 1). According to the CURB-65 scores, approximately 50% of the patients were classified as having low-to-moderate risk. Contrastingly, approximately 25% of them were categorized in the high or very high risk groups according to pneumonia severity indices (PSI), indicating considerable variation in baseline severity of CAP. Notably, 42.9% of the patients had an elevated mGPS, consistent with substantial systemic inflammation and highlighting the prognostic relevance of inflammation–nutrition biomarkers in this population.

The baseline demographic and clinical characteristics of survivors and non-survivors are presented (Table 2). Comorbidities were significantly more frequent among patients who died during hospitalization ($P<0.001$). All non-survivors were classified in the intermediate-risk CURB-65 category, and mortality increased markedly across higher PSI classes ($P<0.001$). Whereas most survivors fell into the low-to-moderate PSI groups, all deaths occurred in the very high-risk category. Higher modified Glasgow Prognostic Scores (mGPS scores) were more common among non-survivors ($P<0.001$). Length of hospital stay was significantly longer in patients who did not survive ($P<0.001$).

Laboratory findings and biomarker distributions according to survival status are shown (Table 3). Non-survivors had higher glucose, ALT, AST, CRP levels, leukocyte, and neutrophil counts ($P<0.05$), accompanied by lower lymphocyte and albumin

Table 1. Distribution of Demographic and Clinical Characteristics in Elderly Patients With Community-Acquired Pneumonia

Variables (N=105)	n (%)	Mean±SD	Median (Min-Max)
Age (years)		73±6.2	72 (65-92)
Sex			
Female	35 (33.3)		
Male	70 (66.7)		
Comorbidities, n (%)	37 (37.4)		
Smoking status			
Smoker	32 (30.5)		
Non-smoker	50 (47.6)		
Ex-smoker	23 (21.9)		
Laboratory parameters			
Fasting blood glucose (mg/dL)		129.5±57.3	113 (69-357)
BUN (mg/dL)		36.6±17.5	33 (14-141)
CR (mg/dL)		1±0.6	0.9 (0.3-5.6)
ALT (IU/L)		28.5±20.3	22 (7-110)
AST (IU/L)		35.4±26.4	27 (11-177)
Procalcitonin (ng/mL)		0.3±0.6	0.1 (0-3.8)
CRP (mg/dL)		49.5±59.2	23.4 (0.9-303)
WBC (× 10^9/L)		9.6±3.3	9.1 (3.4-19.9)
Neutrophil (× 10^9/L)		7.4±3.2	6.9 (1.9-18.9)
Lymphocyte (× 10^9/L)		1.4±0.7	1.3 (0.3-3.6)
Platelet (× 10^9/L)		222±95.7	197 (61-586)
Ferritin (µg/L)		287.3±281.3	189 (14-1983)
Monocyte (× 10^9/L)		0.6±0.3	0.5 (0.1-2.8)
Albumin (g/dL)		34.4±8.5	36.6 (18.9-54.9)
Biomarkers			
NLR		7.3±6.4	4.8 (1.1-33.7)
PLR		191.7±130.7	155 (58.2-857.1)
LMR		3.2±2.1	2.8 (0.4-10.9)
SII		1574±1875.8	1199.3 (143.5-16165.7)
PNI		41.3±10	43.9 (23.3-68.6)
CAR		1.7±2.2	0.7 (0-11.5)
CURB-65			
Low risk	56 (53.3)		
Moderate risk	49 (46.7)		
PSI			
Class II (Low)	57 (54.3)		
Class III (Moderate)	19 (18.1)		
Class IV (High)	4 (3.8)		
Class V (Very high)	25 (23.8)		
mGPS			
Systemic inflammation-none	30 (28.6)		
Moderately severe inflammation	30 (28.6)		
Marked inflammation	45 (42.9)		
Hospital stay (days)		16.7±5.6	15 (9-30)
Patient's current medical condition			
Survived	80 (76.2)		
Exited	25 (23.8)		

ALT:Alanine aminotransferase; AST: Aspartate aminotransferase; BUN: Blood urea nitrogen; CAR: C-reactive protein-to-albumin ratio; CR: Creatinine; CRP: C-reactive protein:; CURB-65 severity index: (confusion, uremia, respiratory rate, BP, age ≥ 65 years); LMR: lymphocyte-to-monocyte ratio; mGPS:modified Glasgow Prognostic Score; NLR:Neutophil-to-lymphocyte ratio; PLR: Platelet-to-lymphocyte ratio; PNI:Prognostic Nutritional Index; PSI: Pneumonia severity index; SII:Systemic Immune-Inflammation Index; WBC: White blood cell



Table 2. Comparision of demographic and clinical characteristics between survival and non-survival patients

Variables (N=105)	Survived (n=80)	Non-survived (n=25)	p-value
	n (%) or Median (Min-Max)	n (%) or Median (Min-Max)	
Age (years)	72 (65-92)	72 (65-89)	0.431
Sex			1.000
Female	27 (33,8)	8 (32)	
Male	53 (66,3)	17 (68)	
Presence of concomitant disease(s)	18 (24,3)	19 (76)	<0.001
Smoking status			0.612
Smoker	24 (30)	8 (32)	
Non-smoker	40 (50)	10 (40)	
Quitter	16 (20)	7 (28)	
CURB-65			<0.001
Low risk	56 (70)	0 (0)	
Moderate risk	24 (30)	25 (100)	
PSI			<0.001
Class II (Low)	57 (71,3)	0 (0)	
Class III (Moderate)	19 (23,8)	0 (0)	
Class IV (High)	4 (5)	0 (0)	
Class V (Very high)	0 (0)	25 (100)	
mGPS			<0.001
Systemic inflammation-none	30 (37,5)	0 (0)	
Moderately severe inflammation	27 (33,8)	3 (12)	
Marked inflammation	23 (28,8)	22 (88)	
Hospital stay (days)	13 (9-24)	25 (18-30)	<0.001

CURB-65 severity index: (confusion, uremia, respiratory rate, BP, age ≥ 65 years); mGPS:modified Glasgow Prognostic Score; PSI: Pneumonia severity index

Table 3. Distribution of Patients' Biomarkers and Laboratory Parameters according to survival and non-survival patients

Variables (N=105)	Survived (n=80)	Exitus (n=25)	p-value
	Median (Min-Max)	Median (Min-Max)	
Laboratory parameters			
Fasting blood glucose, (mg/dL)	108.5 (73-357)	126 (69-336)	0.007
BUN(mg/dL)	33 (15-141)	30 (14-55)	0.535
CR (mg/dL)	0.9 (0.3-2.8)	0.9 (0.5-5.6)	0.795
ALT (IU/L)	19.5 (7-110)	29 (10-92)	0.006
AST (IU/L)	25.5 (11-163)	35 (15-177)	0.016
Procalcitonin (ng/mL)	0 (0-3.8)	0.2 (0-3.8)	<0.001
CRP (mg/dL)	14.2 (0.9-128)	92 (53-303)	<0.001
WBC (× 10^9/L)	8.8 (3.4-19.6)	11.5 (5.7-19.9)	<0.001
Neutrophil (× 10^9/L)	6.2 (1.9-18.9)	9.1 (4.1-16.7)	<0.001
Lymphocyte (× 10^9/L)	1.4 (0.4-3.6)	0.9 (0.3-2.2)	0.002
Platelet (× 10^9/L)	216 (61-586)	179 (101-425)	0.172
Ferritin µg/L	155.5 (14-1983)	367 (17-937)	0.021
Monocyte (× 10^9/L)	0.5 (0.1-2.8)	0.5 (0.1-1.2)	0.721
Albumin (g/dL)	38.1 (21.2-54.9)	23.7 (18.9-47)	<0.001
Biomarkers			
NLR	4 (1.1-33.7)	10.2 (2.2-22.8)	<0.001
PLR	146.8 (58.2-857.1)	177 (73.9-652.3)	0.031
LMR	3 (0.4-10.5)	1.7 (0.7-10.9)	0.015
SII	950.4 (143.5-16165.7)	1784.5 (302.4-7000.4)	<0.001
PNI	45.3 (26.4-68.6)	28.1 (23.3-52.6)	<0.001
CAR	0.4 (0-4.8)	4 (2-11.5)	<0.001

ALT:Alanine aminotransferase; AST: Aspartate aminotransferase; BUN: Blood urea nitrogen; CAR: C-reactive protein-to-albumin ratio; CR: Creatinine; CRP: C-reactive protein;LMR: lymphocyte-to-monocyte ratio; mGPS:modified Glasgow Prognostic Score; NLR:Neutophil-to-lymphocyte ratio; PLR: Platelet-to-lymphocyte ratio; PNI:Prognostic Nutritional Index; PSI: Pneumonia severity index; SII:Systemic Immune-Inflammation Index; WBC: White blood cell

concentrations, indicating greater inflammatory burden and diminished nutritional reserve. NLR, PLR, LMR, SII, PNI, and CAR were all associated with mortality (P<0.05).

ROC curve analysis demonstrated that NLR, SII, and CAR had meaningful discriminative power for predicting in-hospital mortality (Table 4). CAR showed the highest accuracy rates with 100% sensitivity and 85% specificity. PLR and LMR yielded more limited predictive performance. Kaplan–Meier analyses showed shorter in-hospital survival among patients with elevated NLR, PLR, SII, and CAR values. High PLR was associated with significantly reduced survival (24.5±0.5 vs. 27.0±1.2 days, P=0.038). No deaths occurred in the low-CAR group. Though not statistically significant survival was shorter in patients with low LMR and PNI (Figure 1).

Table 4. Results of ROC Analysis of Laboratory Parameters Predicting Mortality

Risk factors	AUC (95% CI)	Cut-off value	p-value	Sensitivity (%)	Specificity (%)
NLR	0.813 (0.720-0.905)	>5.2	<0.001	88.0	70.0
PLR	0.643 (0.518-0.768)	>150	0.025	76.0	55.0
LMR	0.662 (0.534-0.790)	≤1.7	0.013	52.0	83.8
SII	0.767 (0.666-0.868)	>997.7	<0.001	92.0	57.5
PNI	0.851 (0.751-0.951)	≤36.1	<0.001	84.0	83.8
CAR	0.964 (0.933-0.995)	>1.9	<0.001	100.0	85.0

CAR: C-reactive protein-to-albumin ratio; LMR: lymphocyte-to-monocyte ratio; NLR:Neutophil-to-lymphocyte ratio; PLR: Platelet-to-lymphocyte ratio; PNI:Prognostic Nutritional Index; ROC: Receiver operating characteristic curve analysis;SII:Systemic Immune-Inflammation Index

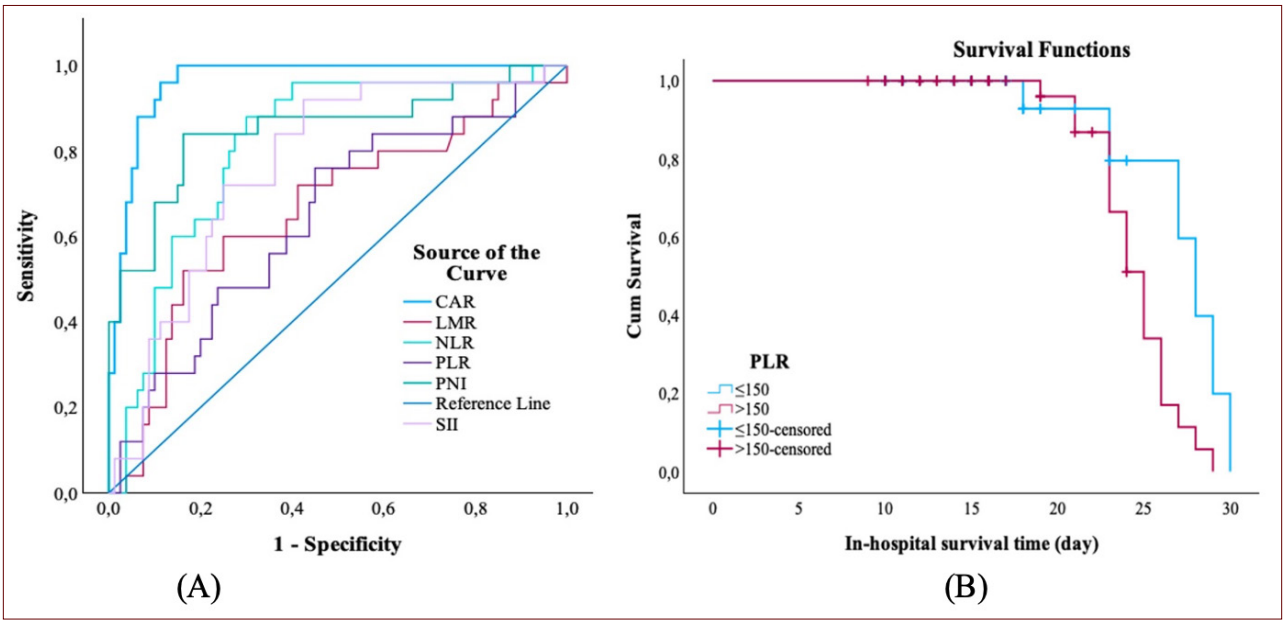


Figure 1. A) Results of ROC Analysis of Laboratory Parameters Predicting Mortality. B) In-hospital survival (Kaplan–Meier) curve according to groups with high and low PLR indices

CAR: C-reactive protein-to-albumin ratio; LMR: lymphocyte-to-monocyte ratio; NLR:Neutophil-to-lymphocyte ratio; PLR: Platelet-to-lymphocyte ratio; PNI:Prognostic Nutritional Index; SII:Systemic Immune-Inflammation Index

DISCUSSION

CAP is a major cause of morbidity and mortality in older adults, owing to age-related physiological decline, multimorbidity, and immunosenescence. In this geriatric cohort, we demonstrated that traditional clinical severity scores (CURB-65 and PSI) and inflammation-nutrition-based biomarkers were strongly associated with in-hospital mortality. These findings reinforce the multifactorial determinants of prognosis in elderly CAP and highlight the need for risk-stratification tools that capture infectious burden, host resilience, and systemic inflammatory imbalance (7).

A central finding of our study is the superior prognostic accuracy of the CAR, which outperformed all other biomarkers and displayed greater discriminative ability than the PSI score. This observation aligns with the increasing evidence supporting CAR as a sensitive marker reflecting the dual impact of acute inflammation and nutritional compromise on prognosis of pneumonia (8). Because CRP rises rapidly in response to systemic inflammation while albumin declines with inflammatory stress and reduced physiologic reserve, CAR integrates both dimensions into a single metric, making it biologically plausible and clinically practical for early mortality prediction in vulnerable older adults (9).

The prognostic utility of NLR has been widely documented in CAP. Previous studies reported that high NLR values strongly correlate with short-term mortality and may perform comparably, or in some cases, superior, to conventional scoring systems (10-12). In a study focusing on elderly patients with CAP, NLR demonstrated a clear dose-response relationship, with mortality rates increasing sharply beyond a threshold value (11). Additional large-scale cohort data support a non-linear association, showing that mortality risk rises steeply with increasing NLR values, whereas incorporating NLR into PSI and CURB-65 improves model performance modestly (12). In this study, NLR showed significant univariate predictive capacity; however, its effect was attenuated after adjustment for other biomarkers and clinical severity indices. This pattern mirrors recent literature data suggesting that although NLR is a sensitive indicator of systemic inflammation, its independent predictive power may diminish in biomarker-rich multivariate models (13).

Similarly, the SII, incorporating neutrophil, lymphocyte, and platelet counts, is a promising prognostic marker in pneumonia and other infectious diseases. Elevated SII values reflect amplified inflammatory responses and are associated with increased mortality, prolonged hospitalization, and ICU admission (14). In severe CAP, an "SII-PNI score," was shown to independently predict 28-day mortality, highlighting the synergistic prognostic value of inflammatory intensity and nutritional reserve (15). Although SII demonstrated significant associations with mortality in our univariate analyses, it did not remain independently predictive in multivariate modeling, possibly owing to the stronger performance of CAR, which captures similar pathophysiological pathways more robustly.

The mGPS, another inflammation-nutrition–based index, showed strong prognostic value in this elderly population. The performance of mGPS was comparable to that of the PSI, despite requiring fewer parameters and relying only on CRP and albumin levels. Previous research supports the prognostic value of mGPS in respiratory infections and inflammatory states, suggesting its potential as a practical alternative if complex scoring systems may not be feasible (16). The similar predictive ability of mGPS and PSI in our elderly cohort further underscores the importance of inflammatory-nutritional status in determining outcomes in CAP.

Furthermore, recent studies have examined combined indices to enhance prognostic precision. Evidence suggests that pairing inflammation-based scores with radiological severity assessments, nutritional markers, or comorbidity indices improves early identification of high-risk patients (17). For

instance, integrating computed tomography-based severity metrics with fibrinogen-albumin ratios or inflammation-nutrition indices has shown added value in predicting mortality and need for intensive care (18). Our findings complement this line of research by demonstrating that CAR, a simple and readily accessible biomarker, can offer prognostic performance equal to or greater than more complex multifactorial tools, especially in elderly populations in which reliability, speed, and practicality are essential.

Parameters used in this study including NLR, PLR, and SII across the broader spectrum of infectious disease, particularly in cases of pneumosepsis had firmly correlated with disease severity.and mortality reflecting the hyperinflammatory state characteristic of advanced infection (19). Interestingly, our cohort comprised elderly patients with CAP without advanced sepsis; however, inflammation-related biomarkers still showed robust predictive value. This finding suggests that these indices may detect early inflammatory trajectories that precede clinical deterioration, providing an opportunity for timely intervention in older adults (20).

Limitations

The study has several key limitations, primarily its retrospective design and the small sample size (n=105). These limitations restrict the generalizability of our findings. Further validation is warranted to enable the integration of these results into clinical guidelines and confirm the robustness of the prognostic superiority of CAR scores. Such studies are essential to solidify the prognostic value of CAR score as a definitive and widely accepted tool for accurate risk prediction in this population.

CONCLUSION

In this geriatric cohort with CAP, particularly CAR demonstrated strong prognostic value and outperformed several widely used hematologic indices and traditional severity scores. CAR showed superior discriminative accuracy and exhibited prognostic performance comparable to or greater than the PSI score, underscoring its clinical relevance as a simple, reliable, and readily accessible indicator of early risk of mortality. Along with the mGPS, CAR highlights the central role of systemic inflammation and nutritional reserve in determining short-term outcomes in older adults with CAP. Incorporating these biomarkers alongside established scoring systems may enhance early risk stratification, support timely therapeutic decision-making, and improve clinical management in vulnerable geriatric populations. Future multicenter prospective studies are warranted to validate these findings and explore biomarker-integrated prognostic models specifically tailored to the physiological characteristics of elderly patients.

Statement of ethics: This study was approved by the Şişli Hamidiye Etfal Training and Research Hospital, Istanbul, Türkiye (Approval No: 3193/28.10.2025).

Conflict of interest statement: The authors declare no competing interests.

Funding sources: The author(s) received no financial support for this work, authorship, and/or publication.

REFERENCES

1. Metlay JP, Waterer GW, Long AC, et al. Diagnosis and treatment of adults with community-acquired pneumonia. Am J Respir Crit Care Med 2019;200(7):e45–e67. doi:10.1164/rccm.201908-1581ST.
2. Wu M, Li Z, Zheng W, et al. Association between anticholinergic medication use and the risk of pneumonia in elderly adults: A systematic review and meta-analysis. Ann Med 2023;55(1):2209736. doi :10.1080/07853890.2023.2209736.
3. Respiratory Branch of Chinese Geriatrics Society. Chinese expert consensus on the diagnosis and treatment of pneumonia in the elderly (2024 edition). Chin J Tuberc Respir Dis 2025;48(1):18–34 (in Chinese). doi:10.3760/cma.j.cn112147-20240611-00328.



4. Lim WS, Baudouin SV, George RC, et al. BTS guidelines for the management of community-acquired pneumonia in adults: Update 2009. Thorax 2009;64(Suppl 3):iii1–iii55. doi:10.1136/thx.2009.121434.

5. Zhao L, Bao J, Shang Y, et al. Prognostic value of serum albumin levels and respiratory rate for community-acquired pneumonia. PLoS One 2021;16(3):e0248002. doi:10.1371/journal.pone.0248002.

6. Islam MM, Satici MO, Eroglu SE. Clinical significance and prognostic value of systemic inflammatory indices: An extensive literature review. Turk J Emerg Med 2024;24(1):8–19. doi:10.4103/tjem.tjem_198_23.

7. Chen JH, Chang SS, Liu JJ, et al. Comparison of pneumonia severity index and CURB-65 among different age groups. Thorax 2010;65(11):971–977. doi:10.1136/thx.2009.129627.

8. Guliyev M, Alan O, Safarov S, et al. Prognostic significance of inflammatory and nutritional biomarkers in metastatic gastric cancer. J Oncol Sci 2025;11(1):14–21. doi:10.37047/jos.galenos.2025.2024.106668.

9. Cataudella E, Giraffa CM, Di Marca S, et al. Neutrophil-to-lymphocyte ratio as a predictor of prognosis in elderly patients with community-acquired pneumonia. J Am Geriatr Soc 2017;65(8):1796–1801. doi:10.1111/jgs.14894.

10. Huang L, Weng B, Wang M, et al. Neutrophil-to-lymphocyte ratio improves mortality prediction in older adults with community-acquired pneumonia. BMC Geriatr 2025;25(1):485. doi:10.1186/s12877-025-06121-2.

11. Sharma Y, Thompson C, Zinellu A, et al. Neutrophil-to-lymphocyte ratio in predicting outcomes of community-acquired pneumonia. Clin Med 2025;25(1):100278. doi:10.1016/j.clinme.2024.100278.

12. Ustaalioğlu I, Kibici O. C-reactive protein to albumin ratio as a prognostic marker in community-acquired pneumonia mortality. Turk J Clin Lab 2025;1:180–185 (in Turkish).

13. Chen X, Hao L, Zhou Y, et al. Combined systemic immune-inflammation index and prognostic nutritional index score in severe community-acquired pneumonia. J Inflamm Res 2025;18:7105–7114. doi:10.2147/JIR.S521440.

14. Unal Cetin E, Kurtkulagi O, Kamis F, et al. ICU mortality prediction in community-acquired pneumonia using inflammation-based scores and CT severity. Biomol Biomed 2025;25(9):2083–2091. doi:10.17305/bb.2025.12127.

15. Calis AG, Karaboga B, Uzer F, et al. Correlation of pneumonia severity scores with inflammatory indices in community-acquired pneumonia. J Clin Med 2025;14(3):728. doi:10.3390/jcm14030728.

16. Ceylan M, Akman C, Aksoy M, et al. Comparison of CRP/albumin ratio with CURB-65 and PSI in predicting mortality in community-acquired pneumonia. Clin Respir J 2020;14(7):633–638. doi:10.1111/crj.13188.

17. Fukumoto T, Sato S, Shoji H, et al. Prognostic role of the modified Glasgow prognostic score in community-acquired pneumonia. Int J Infect Dis 2020;93:102–109. doi:10.1016/j.ijid.2020.01.024.

18. Ranzani OT, Zampieri FG, Forte DN, et al. C-reactive protein/albumin ratio and modified Glasgow prognostic score as predictors of mortality in community-acquired pneumonia. Clin Infect Dis 2013;57(9):1292–1299.

19. Uluc K, Turan H. Prognostic value of systemic immune-inflammation index in pneumosepsis patients. Harran Univ J Med Fac 2024;21(3):490–495 (in Turkish).

20. Eksioglu M, Azapoglu Kaymak B, Unal Akoglu E, et al. Comparative prognostic accuracy of inflammation- and nutrition-based scores in older adults with community-acquired pneumonia. Int J Gen Med 2025;18:4811–4824. doi:10.2147/IJGM.S540730.

Turkish Journal of Geriatrics
2026; 29(1):34–46

DOI: 10.29400/tjgeri.2026.476

Murat EREM[1]
Savaş YILDIRIM[1]
Eşref SELÇUK[1]
Mehmet Tuğrul ALVER[2]
Sinem EREM[3]

[1]Trakya University School of Medicine, Department of Orthopedics and Traumatology, Edirne, Türkiye

[2]Sultan 1. Murat State Hospital, Department of Orthopedics and Traumatology, Edirne, Türkiye

[3]Trakya University Faculty of Health Sciences, Department of Nutrition and Dietetics, Edirne, Türkiye

Correspondence

Murat EREM
Phone : +902842234210
e-mail : muraterem@trakya.edu.tr

Received : Dec 24, 2025
Accepted: Feb 11, 2026

Cite this article as:
Erem M, Yıldırım S, Selçuk E et al. Analysis of Risk Factors for Preoperative Delirium Following Geriatric Hip Fracture and Its Relationship with Mortality: A Retrospective Cohort Study. Turkish Journal of Geriatrics 2026;29(1):34–46. doi: 10.29400/tjgeri.2026.476

ORIGINAL ARTICLE

ANALYSIS OF RISK FACTORS FOR PREOPERATIVE DELIRIUM FOLLOWING GERIATRIC HIP FRACTURE AND ITS RELATIONSHIP WITH MORTALITY: A RETROSPECTIVE COHORT STUDY

Abstract

Introduction: Although postoperative delirium in patients with hip fractures has been extensively studied, preoperative delirium has rarely been examined. We investigated the risk factors for developing preoperative delirium in patients with hip fracture and their relation to mortality.

Materials and Method: We retrospectively reviewed the records of 316 patients who underwent hip fracture surgery. Preoperative delirium was defined according to the Diagnostic and Statistical Manual-5 criteria, and the time of onset of delirium (0-24 hours) was recorded. We evaluated patient demographics, medical conditions, laboratory results, movement patterns, and death rates.

Results: Preoperative delirium occurred in 16.5% of the patients. Most patients who experienced delirium developed symptoms during the first six hours of hospitalization. The preoperative delirium group showed lower serum albumin levels (3.2±0.5 vs 3.6±0.6 g/dL, $p<0.001$), lower prognostic nutritional index values (31.2±6.8 vs 36.1±7.5, $p<0.001$) and elevated creatine kinase levels (168 vs 92 U/L, $p<0.001$). Alzheimer's/dementia (odds ratio: 5.43), creatine kinase levels above 100 U/L (odds ratio: 3.65), albumin levels below 3.5 g/dL (odds ratio: 3.12), prognostic nutritional index values under 35 (odds ratio: 2.78) and dependent mobilization (odds ratio: 2.18) were independent risk factors. The multivariate logistic regression model showed suitable discrimination power through its area under curve value of 0.687 which fell within a 95% confidence interval of 0.599 to 0.774 while achieving sensitivity at 65.8% and specificity at 61.2% and accuracy at 61.7%. The preoperative delirium group experienced a 36.5% one-year mortality rate, which was significantly higher than the 18.2% mortality rate in the non-delirium group ($p=0.001$).

Conclusion: The risk factors for preoperative delirium include low albumin levels, low prognostic nutritional index values, elevated creatine kinase, dependent mobilization, and neurocognitive impairment. The presence of preoperative delirium leads to an extended postoperative delirium duration and elevated patient mortality rates. The research results require analysis based on the study design which used a single center to collect retrospective data and the difficulties of detecting delirium through medical records analysis.

Keywords: Delirium; Hip Fractures; Mortality; Creatine Kinase; Nutrition Assessment.



INTRODUCTION

Hip fractures are the leading and most dangerous musculoskeletal injuries in the elderly population. The aging population worldwide has led to a fast-growing number of hip fracture cases and it is predicted that the 1.7 million cases in 1990 will become 6.3 million by 2050 (1). Most hip fractures (95%) occur in people aged sixty and above and 90% stem from falls (2,3). The death rate of patients with hip fracture is between 15% and 30% during the first year of recovery, and most patients fail to regain their previous level of functionality (4). Loss of independent walking ability affects 40% of the patients, while 60% require assistance with their daily tasks (5).

Delirium is the most prevalent postoperative complication among elderly patients. The development of postoperative delirium affects 20-50% of older patients with hip fracture, leading to longer hospital stays, elevated healthcare expenses and higher death rates (6, 7). Postoperative delirium has received extensive attention, but preoperative delirium has been investigated less so. Preoperative delirium creates challenges for surgical readiness and produces poor results during postoperative care.

The literature has identified elements which affect recovery, but how these impact preoperative delirium development is not clear (3). Meta-analyses of patients across all age groups have failed to identify distinct risk factors which affect preoperative delirium in elderly patients undergoing surgery (1). Research on how nutritional status, laboratory results (including enzymes indicating muscle damage), and mobilization abilities affect the development of preoperative delirium is lacking.

We investigated how preoperative nutritional status, laboratory results, and mobilization abilities determine preoperative delirium in elderly patients with hip fracture, while studying how preoperative delirium affects postoperative delirium duration and survival rates during the first year. Our research aimed to detect early warning signs of preoperative delirium in patients with hip fractures aged above sixty-five years, establish the predictive value of markers, and determine preoperative delirium timing effects on surgical results and one-year survival rates.

MATERIALS AND METHOD

Study Design and Population

We analyzed 316 elderly patients who underwent hip fracture surgery at our orthopedics and trauma clinic between January 2020 and December 2023. This study aimed to identify preoperative delirium risk indicators and study their relationships with death rates.

The study included patients who met four specific criteria: (1) age > 65 years; (2) hip fracture diagnosis limited to femoral neck or intertrochanteric fractures; (3) surgical intervention; and (4) at least 12 months of follow-up. Patients with pathological fractures, multiple trauma, acetabular fractures, previous hip surgery, or incomplete data were excluded.

Definition and Assessment of Preoperative Delirium

Preoperative delirium was defined as an acute state of confusion that developed after hospital admission and prior to surgery. Diagnoses were made according to the Diagnostic and Statistical Manual (DSM)-5 criteria with psychiatric consultation and confirmed using the Confusion Assessment Method (CAM). Preoperative delirium developed in 52 patients (16.5%). The time of onset of delirium was the time elapsed until the development of post-fracture delirium and was categorized into five groups: (1) 0-6 h (n=28, 53.8%), (2) 6-12 h (n=15, 28.8%), (3) 12-24 h (n=9, 17.3%), (4) 24-48 h (n=0, 0%), and (5) >48 h (n=0, 0%).

Postoperative delirium was defined as delirium that began within the first 72 h after surgery or continued from preoperative delirium.

Postoperative delirium was detected in 40 patients (12.7%); 32 of these developed in patients with preoperative delirium (61.5%), and eight developed in patients without preoperative delirium (3.0%).

Clinical Assessment Parameters

Patient information was collected through demographic and clinical assessments, including age, sex, fracture location, American Society of Anesthesiologists (ASA) score, and pretrauma mobility level. Patient mobility was categorized as independent walking without help, assisted walking with a cane or walker, or wheelchair-dependent or bedridden status.

Patient comorbidities including hypertension, diabetes mellitus, coronary artery disease, heart failure, Alzheimer's disease (AD), dementia, chronic obstructive pulmonary disease, and chronic renal failure were documented. The diagnosis of AD and dementia was verified through consultations with neurology and psychiatry specialists. The total disease count was equal to the sum of all recorded comorbidities.

Laboratory test results from the first 24 h before surgery were documented, including hemoglobin, albumin, total protein, urea, creatinine, lymphocyte count, creatine kinase (CK), and fasting blood glucose (FBG). The prognostic nutritional index (PNI) calculation used the formula [serum albumin (g/dL) × 10 + total lymphocyte count (/mm^3) × 0.005]. CK levels were evaluated for the first time in relation to preoperative delirium, and a threshold value of 100 U/L, determined by receiver operating characteristic (ROC) analysis, was used.

Surgical and Hospital Parameters

The time to surgery (days), type of anesthesia (general/spinal), duration of surgery (min), intraoperative blood loss (mL), transfusion requirement (none/1-2 units/>2 units of red blood cell suspension), intensive care unit (ICU) stay duration, and total hospital stay duration were recorded. Surgery duration was categorized using a threshold value of 70 min. Intraoperative blood loss was categorized using a threshold value of 90 mL.

Follow-up and Mortality Assessment

Patients were evaluated at four time points after discharge: 1, 3, 6, and 12 months. Patients who did not attend outpatient clinic follow-ups were contacted via phone. Researchers confirmed patient deaths by checking hospital records and the national death reporting system.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics (version 27.0; IBM Corp., Armonk, NY, USA). Normal distribution was assessed using the Kolmogorov–Smirnov test. Mean ± standard deviation was used for normally distributed data, median [25th-75th percentile] for non-normally distributed data, and number (%) for categorical data.

Independent samples t-tests or Mann–Whitney U tests were used to compare continuous variables between patients with and without preoperative delirium, while chi-square tests or Fisher's exact tests were used to analyze categorical variables. For the analysis of the time of onset of preoperative delirium, comparisons were made between five time groups (0–6 h, 6–12 h, 12–24 h, 24–48 h, >48 h). The Kruskal–Wallis test and analysis of variance used for continuous variable intergroup analyses, whereas the chi-square test was used to analyze categorical variables. Due to the absence of patients in the 24–48 h and >48 h groups, these groups were represented by a "0" value in the statistical analysis.

Univariate and multivariate logistic regression analyses were performed to determine the independent risk factors that contributed to preoperative delirium. Variables with $p<0.20$ in the univariate analysis were included in the multivariate



model. A backward-stepwise method was used. Model fit was assessed using Nagelkerke R^2 and the Hosmer–Lemeshow test. The final model achieved discriminative results through calculations of sensitivity and specificity and accuracy and PPV and NPV and AUC with 95% confidence intervals. Cut-off values were established through ROC analysis and existing medical literature by using age ≥80 y, albumin <3.5 g/dL, PNI <35, CK >100 U/L, pre-trauma dependent mobilization, surgery duration >70 min, and intraoperative blood loss >90 mL.

The effect of preoperative delirium on postoperative delirium persistence was evaluated using the chi-square test. Patients who developed delirium after 24 h were not included in the analysis.

The preoperative delirium effect on mortality was determined using risk ratio (RR) calculations. Fisher's exact test was used to evaluate differences in mortality rates between the study groups. The research used a $p<0.05$ threshold to determine statistical significance for all data analyses.

Ethical Approval

This study was approved by the Ethics Committee of Trakya University Faculty of Medicine. (Approval Date: 22/09/2025, Number: 2025/396). Patient consent was not required owing to the retrospective design of the study. The data were analyzed anonymously. This study was conducted in accordance with the principles of the Declaration of Helsinki.

RESULTS

Study Population Characteristics

The study involved 316 elderly patients with hip fractures, with an average age of 81.5 y, 68.4% females, and with 56.3% of the participants aged ≥80 years. Intertrochanteric fractures occurred twice as often as femoral neck fractures (65.2% vs. 34.8%). Most patients needed help in walking before their injury (55.4%), 29.7% had maintained their ability to walk independently, and 14.9% required complete care (Table 1).

Incidence and Risk Factors of Pre-operative Delirium

Pre-operative delirium affected 52 patients (16.5 %). The patients who developed delirium were older than those without delirium (84.2 y vs 81.0 y) and made up 71.2% of patients aged 80 and above ($p=0.012$). The delirium group showed higher ASA scores than the non-delirium group ($p=0.008$); however, no sex differences were observed between the groups. The delirium group had twice as many patients with ASA score 4 as the

non-delirium group (30.8% vs. 17.0%). The pre-trauma mobility assessment showed that dependent patients had a significantly higher risk of developing delirium, whereas independent walkers had lower delirium rates (Table 1).

Comorbidity Profile

Neurocognitive disorders were strongly linked to preoperative delirium development. Alzheimer's disease or dementia was found 46.2% of patients in the delirium group, and only 10.6% of the non-delirium group ($p<0.001$). The delirium group had a significantly higher total disease burden than the non-delirium group (2.8 vs 2.1, $p=0.008$) (Table 1).

Laboratory Parameters

Patients with delirium had lower hemoglobin, albumin, total protein, and lymphocyte levels. The PNI results were significantly lower in those with delirium compared to those without (31.2 vs 36.1, $p<0.001$), indicating that malnutrition is a factor in the development of delirium. The delirium group showed elevated urea and creatinine levels, and CK levels were twice those in the non-delirium group (168 vs. 92 U/L, $p<0.001$). The FBG levels in patients with delirium were higher than in those without (178.5 mg/dL vs. 148.3 mg/dL, $p=0.007$) (Table 1).

Table 1. Patient Characteristics, Laboratory Parameters, and Preoperative Delirium Relationship

Parameter	All Patients (n=316)	Pre-op Delirium (+) (n=52)	Pre-op Delirium (–) (n=264)	p-value
DEMOGRAPHIC AND CLINICAL CHARACTERISTICS				
Age (years)	81.5 ± 7.2	84.2 ± 6.8	81.0 ± 7.2	0.003[b]
Age groups				0.012[c]
<80 years	138 (43.7%)	15 (28.8%)	123 (46.6%)	
≥80 years	178 (56.3%)	37 (71.2%)	141 (53.4%)	
Gender				0.485[c]
Male	100 (31.6%)	18 (34.6%)	82 (31.1%)	
Female	216 (68.4%)	34 (65.4%)	182 (68.9%)	
Fracture Type				0.627[c]
Femoral neck	110 (34.8%)	17 (32.7%)	93 (35.2%)	
Intertrochanteric	206 (65.2%)	35 (67.3%)	171 (64.8%)	
ASA Score				0.008[c]
ASA 2	123 (38.9%)	12 (23.1%)	111 (42.0%)	
ASA 3	132 (41.8%)	24 (46.2%)	108 (40.9%)	
ASA 4	61 (19.3%)	16 (30.8%)	45 (17.0%)	
Pre-Trauma Mobilization				<0.001[c]
Independent	94 (29.7%)	8 (15.4%)	86 (32.6%)	
Supported	175 (55.4%)	30 (57.7%)	145 (54.9%)	
Dependent	47 (14.9%)	14 (26.9%)	33 (12.5%)	
Comorbidities				
Hypertension	181 (57.3%)	33 (63.5%)	148 (56.1%)	0.320[c]
Diabetes	111 (35.1%)	21 (40.4%)	90 (34.1%)	0.382[c]
Coronary Artery Disease	73 (23.1%)	15 (28.8%)	58 (22.0%)	0.278[c]
Heart Failure	57 (18.0%)	13 (25.0%)	44 (16.7%)	0.151[c]
Alzheimer's	28 (8.9%)	12 (23.1%)	16 (6.1%)	<0.001[e]
Dementia	31 (9.8%)	14 (26.9%)	17 (6.4%)	<0.001[e]
Alzheimer's or Dementia	52 (16.5%)	24 (46.2%)	28 (10.6%)	<0.001[c]
COPD	51 (16.1%)	11 (21.2%)	40 (15.2%)	0.277[c]
Chronic Kidney Disease	41 (13.0%)	10 (19.2%)	31 (11.7%)	0.137[c]
Total Number of Diseases[a]	2.2 ± 1.8	2.8 ± 1.9	2.1 ± 1.7	0.008[b]
LABORATORY PARAMETERS				
Hemoglobin (g/dL)[a]	11.5 ± 1.9	11.0 ± 1.8	11.6 ± 1.9	0.038[b]
Albumin (g/dL)[a]	3.5 ± 0.6	3.2 ± 0.5	3.6 ± 0.6	<0.001[b]
Total Protein (g/dL)[a]	6.3 ± 0.8	6.0 ± 0.7	6.4 ± 0.8	0.001[b]
Urea (mg/dL)[f]	47.0 [37–62]	56.0 [43–72]	45.0 [36–59]	0.002[d]
Creatinine (mg/dL)[f]	0.9 [0.8–1.2]	1.1 [0.9–1.4]	0.9 [0.7–1.1]	0.008[d]
Lymphocytes (10^3/μL)[a]	1.4 ± 0.7	1.2 ± 0.6	1.5 ± 0.7	0.004[b]
PNI[a]	35.3 ± 7.6	31.2 ± 6.8	36.1 ± 7.5	<0.001[b]
CK (U/L)*[f]	101 [62–178]	168 [112–284]	92 [58–156]	<0.001[d]
FBG (mg/dL)[a]	153.3 ± 74.3	178.5 ± 82.4	148.3 ± 71.8	0.007[b]

*[a] Mean ± Standard Deviation; [b] Independent samples t-test; [c] Chi-square test; [d] Mann-Whitney U test; [e] Fisher's exact test; [f] Median [25th–75th percentile]. Novel finding in literature. PNI: Prognostic Nutritional Index; CK: Creatine Kinase; FBG: Fasting Blood Glucose; COPD: Chronic Obstructive Pulmonary Disease; ASA: American Society of Anesthesiologists.

Table 2. Preoperative Delirium Onset Time Analysis

Time of Delirium Onset	n (%)	Median Age	ASA ≥3 (%)	Albumin (g/dL)[a]	Alzheimer/Dementia (%)	12-month Mortality (%)
0-6 hours	28 (53.8%)	85.2	23 (82.1%)	3.1 ± 0.5	15 (53.6%)	12 (42.9%)
6-12 hours	15 (28.8%)	83.8	11 (73.3%)	3.3 ± 0.4	6 (40.0%)	5 (33.3%)
12-24 hours	9 (17.3%)	82.4	6 (66.7%)	3.4 ± 0.5	3 (33.3%)	2 (22.2%)
24-48 hours	0 (0.0%)	-	-	-	-	-
>48 hours	0 (0.0%)	-	-	-	-	-
p-value	-	0.238[g]	0.412[c]	0.084[g]	0.382[c]	0.287[c]

[a] Mean ± Standard Deviation; [c] Chi-square test; [g] ANOVA test (Kruskal-Wallis test for median age). Note: Analysis of the time of onset of post-fracture delirium in 52 patients who developed preoperative delirium

Temporal Patterns of Delirium Onset

All 52 patients who developed preoperative delirium presented with symptoms within the first 24 h following their fracture. The majority of patients (53.8%) developed delirium during the first 6 h after fracture, followed by 28.8% between 6–12 h, and 17.3% between 12–24 h. No patients developed delirium after 24 h (Table 2). The median age of the patients showed a non-significant decrease as delirium onset was delayed (p=0.238). Patients who experienced delirium earlier in their hospital stay had higher ASA scores, lower albumin levels, and higher incidence of AD and dementia, although the differences were not statistically significant. The 12-month mortality rates demonstrated a non-significant pattern of increased risk for patients who developed delirium in the first 6 h compared with those who developed delirium between 12–24 h (42.9% vs. 22.2%) (p=0.287) (Table 2).

Postoperative Delirium Continuity

Forty patients (12.7%) developed postoperative delirium, with most continuing from pre-operative delirium. A majority (61.5%) of patients with preoperative delirium maintained their condition after surgery, but only 3.0% of patients without preoperative delirium developed postoperative delirium (p<0.001). Analysis of duration showed that patients with preoperative delirium maintained their condition longer and experienced more frequent postoperative delirium episodes. Patients who developed delirium within the first 6 h of preoperative care had a 71.4% chance of showing postoperative delirium, whereas patients who developed delirium between 6-12 h had a 53.3% chance, and those who developed it between 12-24 h had a 44.4% chance (p=0.048). The absence of patients who developed preoperative delirium after 24 h demonstrates that the first 24 h post-fracture plays a vital role in the development of delirium (Table 3).

Surgical and Hospital Parameters

Patients who showed preoperative delirium needed to wait longer for their surgery compared to those without delirium (median, 6 days vs. 4 days, p<0.001). The delirium group received blood transfusions at a higher rate (69.2% vs. 55.7%, p=0.028), and required twice as many blood transfusions exceeding two units compared (23.1% vs. 13.3%). The delirium group spent longer periods in the ICU and had longer hospital stays (Table 4).

Mortality Analysis

The presence of preoperative delirium was associated with elevated mortality rates during all observation periods. The delirium group

Table 3. Relationship Between Preoperative and Postoperative Delirium and Temporal Analysis

A. Relationship Between Pre-Operative and Post-Operative Delirium			
	Pre-Operative Delirium (+) (n=52)	**Pre-Operative Delirium (–) (n=264)**	**p value**
Post-op Delirium Development			<0.001[c]
Present	32 (61.5%)	8 (3.0%)	
Absent	20 (38.5%)	256 (97.0%)	
Post-Operative Delirium Total	40 patients (12.7%)		
Post-Operative Delirium Duration			<0.001[c]
No Post-Operative Delirium	20 (38.5%)	256 (97.0%)	
1–3 days	10 (19.2%)	5 (1.9%)	
4–7 days	15 (28.8%)	2 (0.8%)	
>7 days	7 (13.5%)	1 (0.4%)	
B. Temporal Relationship Between Pre-Operative Delirium Duration and Post-Operative Delirium Persistence			
Pre-Operative Delirium Duration	**Total (n)**	**Post-Operative Delirium Persisting n (%)**	**Post-Operative Delirium Not Persisting n (%)**
0–6 hours	28	20 (71.4%)	8 (28.6%)
6–12 hours	15	8 (53.3%)	7 (46.7%)
12–24 hours	9	4 (44.4%)	5 (55.6%)
24–48 hours	0	0 (0.0%)	0 (0.0%)
>48 hours	0	0 (0.0%)	0 (0.0%)
Total	52	32 (61.5%)	20 (38.5%)

[c] Chi-square test. [a] Post-Operative delirium developed in a total of 40 patients (32 patients with pre-operative delirium continued to have it + 8 patients without pre-operative delirium developed it newly).

Table 4. Surgical and Hospital Parameters

Parameter	**Pre-Operative Delirium (+) (n=52)**	**Pre-Operative Delirium (–) (n=264)**	**p value**
Time Until Surgery (days)[f]	6.0 [4-9]	4.0 [3-6]	<0.001[d]
Type of Anesthesia			0.834[c]
General	44 (84.6%)	225 (85.2%)	
Spinal	8 (15.4%)	39 (14.8%)	
Transfusion Requirement			0.028[c]
None	16 (30.8%)	117 (44.3%)	
1-2 Units	24 (46.2%)	112 (42.4%)	
>2 Units	12 (23.1%)	35 (13.3%)	
ICU Length of Stay (days)[f]	2.0 [1-4]	1.0 [0-2]	<0.001[d]
Total Hospital Stay (days)[f]	15.0 [12-20]	10.0 [8-13]	<0.001[d]

[c] Chi-square test; [d] Mann-Whitney U test; [f] Median [25th-75th percentile]

experienced first-month mortality at a rate that exceeded that of the non-delirium group by more than four times. The risk ratio for death decreased with time but remained higher than twice that of the non-delirium group rate throughout the 12-month study. The delirium group had a 36.5% mortality rate at the end of 12 months, whereas the non-delirium group had an 18.2% mortality rate.

Independent Risk Factors

The multivariate logistic regression model revealed distinct factors that independently predicted preoperative delirium development. The presence of AD or dementia was the most significant risk factor, increasing the risk of delirium by 5.43 times (OR: 5.43, 95% CI: 2.61-11.29). The second most important independent risk factor for delirium was elevated CK levels, with values above 100 U/L increasing the risk by 3.6 times. Low albumin levels and reduced PNI values also contributed to an increased delirium risk. The risk of delirium doubled when patients had dependent mobility before their trauma. Age and ASA score maintained their significance in the univariate analysis but lost significance in the multivariate analysis. The risk factors used in the model accounted for 35% of the total variance in delirium, as shown in Figure 1.

The final multivariate logistic regression model showed it could predict preoperative delirium with

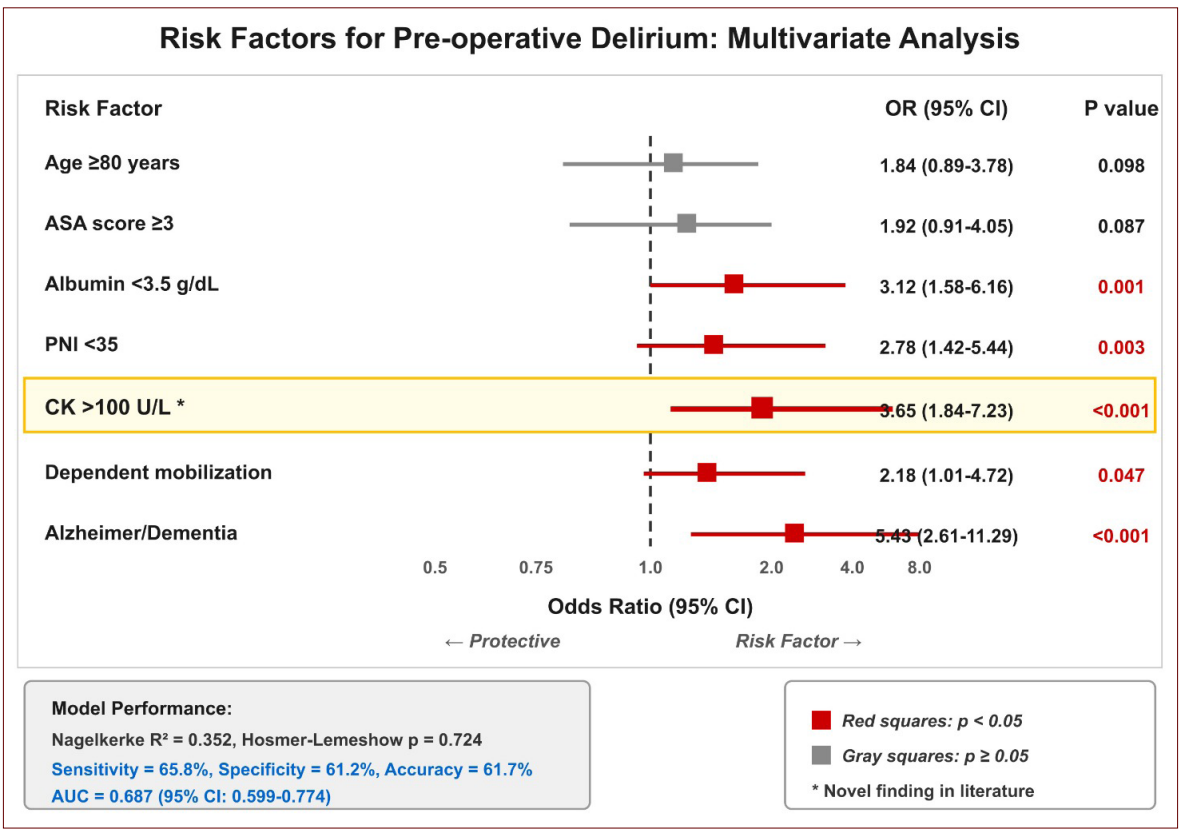


Figure 1. Forest plot of risk factors for preoperative delirium. Multivariate logistic regression analysis showing odds ratios with 95% confidence intervals. CK: creatine kinase, PNI: Prognostic Nutritional Index, ASA: American Society of Anesthesiologists, CI: confidence interval, OR: odds ratio.

a moderate level of accuracy. The model produced results which included 65.8% sensitivity and 61.2% specificity and 61.7% overall accuracy. The model achieved a 18.8% positive predictive value (PPV) and a 92.9% negative predictive value (NPV) which showed its strong ability to predict patients who would not develop delirium. The receiver operating characteristic curve area under the curve (AUC) measured 0.687 with a 95% confidence interval ranging from 0.599 to 0.774 which shows the model achieved acceptable discrimination ability. Model fit was adequate with Nagelkerke R^2 = 0.352 and Hosmer-Lemeshow goodness-of-fit test p = 0.724 (Table 5, Figure 1, Figure 2).

Table 5. Performance Measures of the Multivariate Logistic Regression Model for Preoperative Delirium Prediction

Performance Measure	Value	95% CI
Sensitivity	65.8%	56.2 – 75.4%
Specificity	61.2%	55.3 – 67.1%
Accuracy	61.7%	56.3 – 67.1%
Positive Predictive Value (PPV)	18.8%	12.4 – 25.2%
Negative Predictive Value (NPV)	92.9%	89.2 – 96.6%
Area Under ROC Curve (AUC)	0.687	0.599 – 0.774
Nagelkerke R^2	0.352	–
Hosmer-Lemeshow p-value	0.724	–

ROC: Receiver Operating Characteristic; CI: Confidence Interval; PPV: Positive Predictive Value; NPV: Negative Predictive Value.

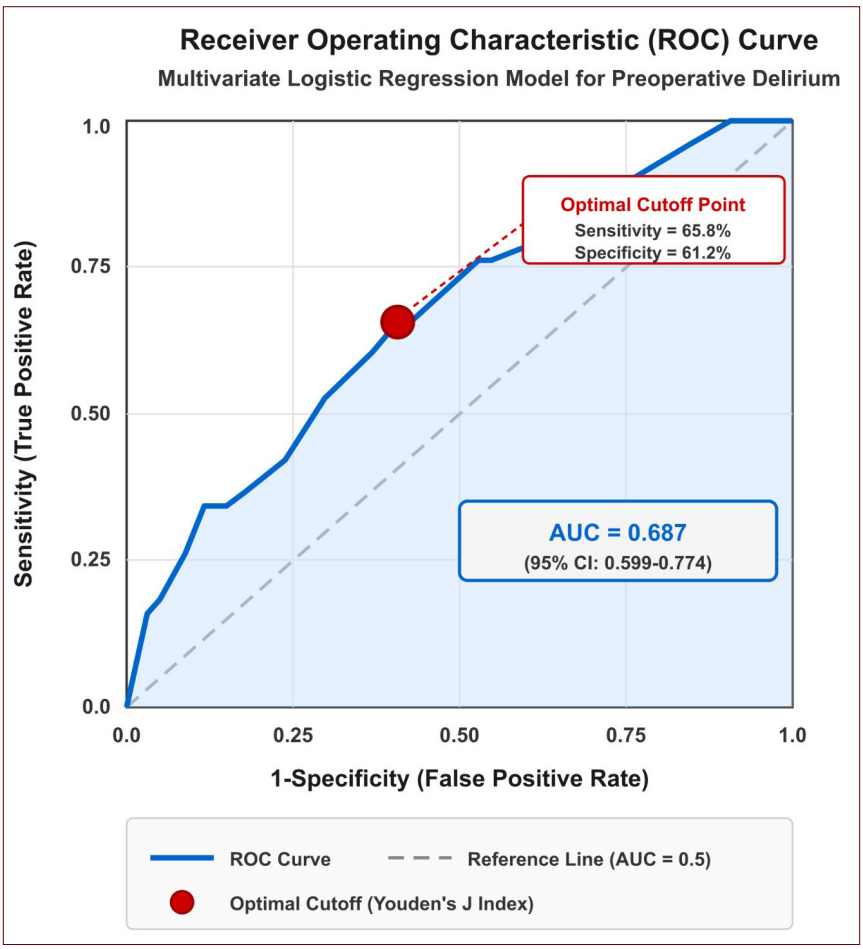


Figure 2. Receiver Operating Characteristic (ROC) curve for the multivariate logistic regression model predicting preoperative delirium. The diagonal dashed line represents the performance of a random classifier (AUC = 0.5). The red dot indicates the optimal cutoff point determined by Youden's J index (sensitivity = 65.8%, specificity = 61.2%). The area under the curve (AUC) was 0.687 (95% CI: 0.599-0.774), indicating acceptable discriminative performance

DISCUSSION

This study examined the factors that increase the risk of preoperative delirium and their impact on survival rates among elderly patients with hip fractures. There has been extensive research on postoperative delirium, whereas preoperative delirium remains poorly understood. The research revealed that preoperative delirium occurred in 16.5% of the patients. The most significant risk factors for preoperative delirium included AD/dementia (odds ratio [OR]: 5.43), elevated CK level (OR: 3.65), low albumin level (OR: 3.12), low PNI (OR: 2.78), and dependent mobilization (OR: 2.18). The one-year mortality rate of the patients who experienced preoperative delirium was 36.5%; however, the mortality rate of the control group was 18.2%.

Our study found for the first time that elevated CK levels were associated with preoperative delirium. A CK level >100 U/L increased the risk of delirium by 3.65 times. The preoperative delirium patients showed a median CK value of 168 U/L, whereas the non-delirium group had a median CK value of 92 U/L. The significant difference between these values indicates that muscle damage and post-fracture immobilization may be responsible for the development of delirium. Muscle breakdown, indicated by elevated CK levels, results in systemic inflammation and metabolic disturbances. The breakdown of muscle tissue produces myoglobin and other substances that affect the blood-brain barrier and create neuroinflammatory conditions. Pain and discomfort due to muscle injuries create conditions that increase the risk of delirium. The results suggest that CK measurement should become a standard procedure during the initial treatment period of hip fracture because patients with elevated values require intensive observation.

Preoperative delirium development occurred during the first 24 h of hospital stay, according to our study results. The first 6 h after the fracture resulted in preoperative delirium development in 53.8% of the 52 patients who experienced this condition. The postoperative delirium persistence rate was 71.4% among patients who experienced early delirium (within 6 h) but decreased to 44.4% among those who developed delirium between 12–24 h. Patients who experienced early delirium had poorer treatment outcomes. Patients with hip fractures experience the highest risk of developing delirium during the first day after surgery, followed by a gradual decrease in risk throughout the subsequent days (8). The patients who developed early delirium showed three distinct risk factors: they were older (85.2 y vs. 82.4 y), had more severe ASA scores (82.1% vs. 66.7%) and showed higher rates of AD/dementia (53.6% vs. 33.3%). Patients who experienced early delirium showed higher mortality rates at the twelve-month mark (42.9% vs. 22.2%). The initial period following a fracture represents a crucial time for patient observation because patients who experience delirium during this time require enhanced monitoring.

Our study demonstrated the direct impact of nutritional factors on preoperative delirium development. The PNI value was 31.2±6.8 in the preoperative delirium group and 36.1±7.5 in the non-delirium group ($p<0.001$). The fact that PNI <35 increases the risk of delirium by 2.78 times is consistent with a previous report (9). Xu and Luo's finding of a threshold value of PNI <45.45 in patients with femoral neck fractures may reflect population differences (10). Our lower threshold value can be explained by the advanced age and high comorbidity burden in our patient group. Dong et al. demonstrated that preoperative malnutrition elevates delirium risk by 3.04 times during non-cardiac surgical procedures, which aligns with the high-risk nature of hip fracture surgery (11).

This study supports the established connection between low albumin levels and higher preoperative delirium risk. Albumin levels below 3.5 g/dL in our study resulted in a 3.12 times higher risk of

preoperative delirium which exceeded the 2.99 times risk increase found by Wang et al. (12). Wang et al. demonstrated that a albumin level decrease of 1 g/L increases delirium risk by 11%, showing a direct relationship between albumin levels and delirium risk. Our research verifies the established relationship between albumin levels and delirium risk, while confirming that albumin serves as a vital threshold indicator. The patients with preoperative delirium had an average albumin level of 3.2±0.5 g/dL while the non-delirium group had an average of 3.6±0.6 g/dL. The difference in albumin levels indicates that this protein serves as both a nutritional marker and an indicator of metabolic stress and inflammation. Research has shown that patients with body mass index values below 18.5 kg/m2 have a 1.686 times higher risk of mortality (13). Chen et al. established that hemoglobin levels (OR=1.95) function as independent factors that increase delirium risk (8).

Patients with ASA scores above 3 had 2.38 times more risk of developing preoperative delirium according to univariate analysis however, this association became non-significant in multivariate analysis. The study by Arshi et al. established ASA score as a risk factor for postoperative delirium with an OR of 1.20; our higher OR might stem from our focus on preoperative delirium (14). A study found that patients with ASA scores ≥3 experienced a 2.01 times higher risk of developing delirium during major orthopedic surgeries (15), and 54.6% of patients with dementia developed delirium (16). In our study, the presence of AD/dementia increased the risk of preoperative delirium 5.43 times indicating that neurocognitive disorders are a leading cause of preoperative delirium. Visual and auditory impairments also strongly contribute to delirium development (8).

The duration of postoperative delirium exceeded 7 d in 13.5% of the patients who had preoperative delirium, but only 0.4% of the patients without preoperative delirium experienced this outcome. The results demonstrated that preoperative delirium led to both extended postoperative delirium and more severe delirium symptoms.

The median time to surgery was 6 d in the preoperative delirium group and 4 d in the non-delirium groups, respectively ($p<0.001$). Delays in surgical procedures may stem from the challenges faced by healthcare providers when identifying and treating preoperative delirium. A study showed that surgical timing did not affect 30-d mortality; however, our research established that extended preoperative delays lead to preoperative delirium (17). The survival outcomes of patients who underwent surgery within 2 d after injury were superior to those who required > 2d (13). The preoperative delirium group required blood transfusions at a higher rate than did the non-delirium group (69.2% vs. 55.7%, $p=0.028$). Lee et al. demonstrated that blood transfusions increased the risk of developing postoperative delirium by 2.53 times (18).

This study examined how preoperative delirium affects patient survival at different time points. The delirium group experienced a 9.6% mortality rate during the first month, compared to only 2.3% in the non-delirium group (RR: 4.23). Mortality rates were 36.5% and 18.2%, respectively, when tracked for 12 months (RR: 2.11). A Turkish study reported a one-year overall mortality rate of 29.49%, which exceeds the 22% rate observed in our study (19). Gottschalk et al. found no significant link between postoperative delirium and mortality, but our study established a strong connection between preoperative delirium and mortality. Preoperative delirium appears to be a more dangerous clinical condition than postoperative delirium based on these findings.

The final multivariate logistic regression model showed average discrimination power through its ability to predict preoperative delirium with 65.8% sensitivity and 61.2% specificity and 61.7% overall accuracy. The ROC curve area reached 0.687 (95%



CI: 0.599-0.774) which showed that the model had acceptable ability to distinguish between groups. This research has some limitations. This was a retrospective, single center study, which may limit generalizability of the findings.

Our findings indicate that standard tests for CK, albumin, and PNI should be performed during preoperative assessments. The risk level for patients increased when their CK levels exceeded 100 U/L, albumin levels were below 3.5 g/dL or PNI levels were below 35. The monitoring of patients with a history of AD or dementia and need-assisted mobilization should be intensified. The development of delirium during the first 6 h after a fracture makes patients more likely to experience ongoing postoperative delirium. Future research should study CK as a potential cause of delirium through prospective investigation. Preoperative nutritional strategies should be evaluated to establish their effectiveness in reducing the occurrence of delirium.

CONCLUSION

Preoperative delirium is a significant complication affecting 16.5% of elderly hip fracture patients, with all cases developing within the first 24 hours post-fracture. Elevated CK levels >100 U/L (OR: 3.65), AD/dementia (OR: 5.43), low albumin <3.5 g/dL (OR: 3.12), PNI <35 (OR: 2.78), and dependent mobilization (OR: 2.18) were independent risk factors. Preoperative delirium was associated with persistent postoperative delirium (61.5%) and increased one-year mortality (36.5% vs. 18.2%). The prediction model demonstrated acceptable discriminative ability (AUC: 0.687, 95% CI: 0.599-0.774).

This study has limitations inherent to its retrospective, single-center observational design, which restrict causal inference and external validity. Preoperative delirium was identified through medical record review using DSM-5 criteria rather than prospective standardized screening, increasing the risk of misclassification, particularly of hypoactive delirium. Although multivariable analyses were performed, residual confounding is likely, as key factors such as frailty, pain severity, medication exposure, inflammatory markers, fracture complexity, and environmental contributors were not systematically captured. Laboratory-based nutritional indices and creatine kinase levels may have reflected acute physiological stress rather than baseline status. While preoperative delirium was associated with increased one-year mortality, the observational design precludes conclusions regarding causality.

Future multicenter, prospective studies using validated delirium assessment tools and comprehensive geriatric variables are needed to clarify mechanisms and to evaluate whether targeted prevention strategies can improve outcomes and survival in older adults with hip fractures.

Acknowledgements: We would like to thank Editage (www.editage.com) for English language editing.

Conflicts of interest: The authors declare that they have no conflict of interest to disclose.

REFERENCES

1. Qi YM, Li YJ, Zou JH, Qiu XD, Sun J, Rui YF. Risk factors for postoperative delirium in geriatric patients with hip fracture: A systematic review and meta-analysis. Front Aging Neurosci. 2022;14:960364. doi:10.3389/fnagi.2022.960364.
2. Chen DX, Yang L, Ding L, Li SY, Qi YN, Li Q. Perioperative outcomes in geriatric patients undergoing hip fracture surgery with different anesthesia techniques: A systematic review and meta-analysis. Medicine (Baltimore). 2019;98(49):e18220. doi:10.1097/MD.0000000000018220.
3. Araiza-Nava B, Méndez-Sánchez L, Clark P, et al. Short- and long-term prognostic factors associated with functional recovery in elderly patients with hip fracture: A systematic review. Osteoporos Int. 2022;33(3):497-514. doi:10.1007/s00198-022-06346-6.

4. Andaloro S, Cacciatore S, Risoli A, et al. Hip Fracture as a Systemic Disease in Older Adults: A Narrative Review on Multisystem Implications and Management. Med Sci. 2025;13(89). doi:10.3390/medsci13030089.
5. Xu B, Yan S, Low LL, Vasanwala FF, Low SG. Predictors of poor functional outcomes and mortality in patients with hip fracture: a systematic review. BMC Musculoskelet Disord. 2019;20:568. doi:10.1186/s12891-019-2950-0.
6. Lee SJ, Jung SH, Lee SU, Lim JY, Yoon KS, Lee SY. Postoperative delirium after hip surgery is a potential risk factor for incident dementia: A systematic review and meta-analysis of prospective studies. Arch Gerontol Geriatr. 2020;87:103977. doi:10.1016/j.archger.2019.103977.
7. de Jong L, van Rijckevorsel VAJM, Raats JW, Klem TMA, Kuijper TM, Roukema GR. Delirium following hip hemiarthroplasty for proximal femoral fractures in elderly patients: risk factors and clinical outcomes. Clin Interv Aging. 2019;14:427-435. doi:10.2147/CIA.S189760.
8. Chen X, Huang Y, Chen F, Jiang X, Lin D, Lin F. The incidence and risk factors of perioperative delirium in elderly patients with hip fracture under the Unaccompanied-Care model. Journal of Orthopaedic Surgery and Research. 2025;20:693. doi:10.1186/s13018-025-06114-2.
9. Mi X, Jia Y, Song Y, et al. Preoperative prognostic nutritional index value as a predictive factor for postoperative delirium in older adult patients with hip fractures: a secondary analysis. BMC Geriatrics. 2024;24:21. doi:10.1186/s12877-023-04629-z.
10. Xu Y, Luo Y. Preoperative Prognostic Nutritional Index Is a Predictive Factor for Postoperative Delirium in Elderly Patients with Femoral Neck Fracture. Clinical Interventions in Aging. 2025;20:941-950. doi:10.2147/CIA.S518366.
11. Dong B, Wang J, Li P, Li J, Liu M, Zhang H. The impact of preoperative malnutrition on postoperative delirium: a systematic review and meta-analysis. Perioperative Medicine. 2023;12:55. doi:10.1186/s13741-023-00345-9.
12. Wang W, Yao W, Tang W, Li Y, Lv Q, Ding W. Association between preoperative albumin levels and postoperative delirium in geriatric hip fracture patients. Frontiers in Medicine. 2024;11:1344904. doi:10.3389/fmed.2024.1344904.
13. Han X, Han L, Chu F, et al. Predictors for 1-year mortality in geriatric patients following fragile intertrochanteric fracture surgery. Journal of Orthopaedic Surgery and Research. 2024;19:701. doi:10.1186/s13018-024-05219-4.
14. Arshi A, Lai WC, Chen JB, Bukata SV, Stavrakis AI, Zeegen EN. Predictors and sequelae of postoperative delirium in geriatric hip fracture patients. Geriatric Orthopaedic Surgery & Rehabilitation. 2018;9:1-8. doi:10.1177/2151459318814823.
15. Urban MK, Sasaki M, Schmucker AM, Magid SK. Postoperative delirium after major orthopedic surgery. World Journal of Orthopedics. 2020;11(2):90-106. doi:10.5312/wjo.v11.i2.90.
16. Callan KT, Donnelly M, Lung B, et al. Risk factors for postoperative delirium in orthopedic hip surgery patients: a database review. BMC Musculoskeletal Disorders. 2024;25:71. doi:10.1186/s12891-024-07174-x.
17. van Rijckevorsel VAJM, de Jong L, Verhofstad MHJ, Roukema GR. Influence of time to surgery on clinical outcomes in elderly hip fracture patients: an assessment of surgical postponement due to non-medical reasons. Bone & Joint Journal. 2022;104-B(12):1369-1378. doi:10.1302/0301-620X.104B12.BJJ-2022-0172.R2.
18. Lee S-S, Kim J-H, Lee J-J, Kwon Y-S, Seo E-M. The impact of blood transfusion in developing postoperative delirium in patients with hip fracture surgery. Journal of Clinical Medicine. 2023;12(14):4696. doi:10.3390/jcm12144696.
19. Menekse S, Arslanoglu F, Zora H. Mortality rates and forensic causes after hip fracture: a retrospective observational study. Archives of Bone and Joint Surgery. 2024;12(11):789-797. doi:10.22038/ABJS.2024.77489.3580.

ORIGINAL ARTICLE

CLINICAL OUTCOMES OF SUPRASCAPULAR NERVE PULSED RADIOFREQUENCY IN ELDERLY PATIENTS WITH ADHESIVE CAPSULITIS: A RETROSPECTIVE COHORT STUDY

Turkish Journal of Geriatrics
2026; 29(1):47–55

DOI: 10.29400/tjgeri.2026.477

Salim Taner GÖZÜKIZIL[1]
Halil İbrahim ALTUN[2]

[1] Prof. Dr. Cemil Taşcıoğlu City Hospital, Pain Medicine Clinic, İstanbul, Türkiye

[2] Kanuni Sultan Süleyman Training and Research Hospital, Pain Medicine Clinic, İstanbul, Türkiye

Abstract

Introduction: Adhesive capsulitis causes severe pain and limited movement, particularly in older adults. Treating this condition in elderly patients is difficult because standard therapies can carry risks due to age-related health issues and multiple medications. Suprascapular nerve pulsed radiofrequency provides a potentially safer, minimally invasive option. This study assessed the effectiveness and safety of this method in patients aged 65 and older.

Materials and Method: Thirty-two patients with adhesive capsulitis received ultrasound-guided suprascapular nerve pulsed radiofrequency. The primary outcome was the Shoulder Pain and Disability Index; secondary outcomes included Numeric Rating Scale scores for activity and rest pain. Assessments occurred at baseline, 4, and 12 weeks.

Results: Post-procedure assessments at 4 and 12 weeks demonstrated statistically significant reductions in Shoulder Pain and Disability Index scores and Numeric Rating Scale scores compared to baseline. While Shoulder Pain and Disability Index pain scores stayed consistent between weeks 4 and 12, a small but statistically significant rise in resting pain was observed at week 12 compared to week 4; however, pain levels remained significantly lower than pre-treatment levels. No serious procedure-related adverse events were reported.

Conclusion: Ultrasound-guided Suprascapular nerve pulsed radiofrequency seems to be an effective and safe treatment for chronic shoulder pain in elderly patients with adhesive capsulitis. Besides pain relief, long-lasting functional improvements may help reduce the social and psychological challenges linked to the condition. Due to its good safety profile, this method offers a valuable option for vulnerable patients with few other treatment choices.

Keywords: Pulsed Radiofrequency Treatment; Shoulder Pain; Aged; Ultrasonography; Bursitis.

Correspondence

Salim Taner GÖZÜKIZIL
Phone : +902123145555
e-mail : salimtaner@hotmail.com

Received : Dec 22, 2025
Accepted: Feb 11, 2026

Cite this article as:
Gözükızıl ST, Altun HE. Clinical Outcomes of Suprascapular Nerve Pulsed Radiofrequency in Elderly Patients with Adhesive Capsulitis: A Retrospective Cohort Study. Turkish Journal of Geriatrics 2026; 29(1):47–55. doi: 10.29400/tjgeri.2026.477

INTRODUCTION

Adhesive capsulitis (AC), commonly referred to as frozen shoulder (FS), is a disabling condition characterized by pain and stiffness of the shoulder joint. Although its exact cause is not fully understood, AC has been linked to prolonged immobilization, trauma, and systemic conditions such as diabetes and thyroid disorders (1). It affects approximately 2% to 5% of the general population (2) and typically presents with marked shoulder pain, often worsening at night, together with substantial limitations in both active and passive ranges of motion (ROM) (3,4). The disorder generally follows a characteristic course, progressing through painful (freezing), stiff (frozen), and recovery (thawing) phases, with spontaneous resolution occurring within one to two years in many cases (5).

AC most commonly occurs in individuals in their fifth and sixth decades of life, with peak incidence in the mid-50s, while onset before 40 years of age is rare. Women are affected more frequently than men, and involvement of the nondominant shoulder is slightly more common. The contralateral shoulder may become affected in 6% to 17% of patients within five years (6). Current evidence indicates that the disease likely begins with inflammation involving the axillary fold, anterosuperior joint capsule, coracohumeral ligament, and rotator cuff interval (7), followed by synovial adhesion formation and progressive fibrosis (8). These changes lead to capsular thickening, contraction, and a reduction in glenohumeral joint volume.

Although AC is often regarded as a self-limiting condition, complete functional recovery is not achieved in a considerable proportion of patients. Evidence guiding optimal treatment remains limited, and no single management strategy has been universally accepted (9). Current treatment options include oral or intra-articular corticosteroids, physiotherapy, hydrodistension, manipulation under anesthesia, and surgical approaches such as arthroscopic or open capsular release (10). Suprascapular nerve block (SSNB) has emerged as an alternative method for pain control by targeting the suprascapular nerve, which supplies nearly 70% of the sensory innervation to the shoulder and acromioclavicular joints (11). When the duration of analgesia provided by local anesthetics is inadequate, pulsed radiofrequency (PRF) lesioning may be used to extend pain relief, with encouraging results reported in the literature (12).

The impact of AC extends beyond physical limitations. Ongoing pain and restricted shoulder function can interfere with daily routines and social participation, often leading to fear of movement, activity avoidance, and increased pain-related distress (13). Dependence on others for routine activities may result in frustration and feelings of guilt, while symptoms that are underestimated in the workplace can contribute to reduced confidence and withdrawal from professional roles (14).

In older adults, these physical and psychosocial consequences may be particularly pronounced, given the additional challenges associated with aging. Despite growing interest in suprascapular nerve pulsed radiofrequency (SSN-PRF) as a treatment option for adhesive capsulitis, evidence focusing specifically on patients aged 65 years and older remains limited. Therefore, the present study aimed to evaluate the efficacy and safety of SSN-PRF in elderly patients with adhesive capsulitis.

MATERIALS AND METHOD

Study Design and Patients

This retrospective observational cohort study was conducted from June 2022 to June 2023 at tertiary training and research hospitals in Istanbul, Turkey. The study was designed and reported following the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines. Ethical approval was obtained from the Istanbul Kanuni Sultan Süleyman Training and Research Hospital Ethics Committee (KAEK/2024.09.192). The study is also registered on ClinicalTrials.

gov (NCT07088562). Research was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki, as revised in 2024. All participants provided written informed consent.

Patients aged 65 years and older diagnosed with adhesive capsulitis (symptom duration over 3 months), who had a Numeric Rating Scale (NRS) score higher than four despite receiving conservative medical and physical therapy, and who provided written informed consent were screened for eligibility. The exclusion criteria included: a history of shoulder surgery; primary shoulder conditions such as shoulder impingement syndrome, osteoarthritis, or other causes of shoulder pain; recent shoulder injections within the last three months; psychosis; cardiac pacemakers or implantable cardioverter-defibrillators (ICDs); decompensated chronic illnesses; bleeding disorders; active malignancy or infection; advanced cervical disc herniation; allergies to medications used; and inability to communicate or refusal to undergo the procedure.

For each included patient, the diagnosis of adhesive capsulitis was established based on clinical criteria, including shoulder pain persisting for at least three months predominantly spontaneous in nature and restriction of both active and passive range of motion, most notably in external rotation. Imaging studies, including MRI, X-ray, and ultrasonography, were used mainly to rule out other shoulder conditions that could mimic adhesive capsulitis, such as rotator cuff tears, neoplasms, bursitis, cervical disc herniation, or inflammatory arthropathies. Although the diagnosis was primarily clinical, MRI findings suggestive of adhesive capsulitis such as thickening of the coracohumeral ligament, obliteration of subcoracoid fat within the rotator interval, and thickening of the axillary recess were regarded as supportive findings.

Procedure

All procedures were performed by a single experienced physician specializing in musculoskeletal procedures, using a Toshiba TUS-A300™ ultrasound (USA) device equipped with an 11L4 linear transducer. A Cosman™ RFG-4 RF generator was used for the radiofrequency (RF) procedures. The procedures were conducted using Unified™ EchoRF™ hybrid needles, which are 100 mm long, 20G gauge, and have a 10 mm active tip (containing an electrode, cannula, and injection tube).

A diagnostic suprascapular nerve block was performed under ultrasound guidance using 5 mL of 0.25% bupivacaine. Pain intensity was reassessed 30 minutes after the injection, and a positive response was defined as a reduction of at least 50% in Numeric Rating Scale (NRS) scores during shoulder movement. Patients who demonstrated a positive response were scheduled for the PRF procedure one week later, allowing sufficient time for the effect of the local anesthetic to subside and baseline pain levels to return before proceeding with the intervention. For the SSN-PRF procedure, patient was seated between the physician and the ultrasound monitor, facing the monitor, with the ipsilateral arm resting on the contralateral shoulder. To visualize the suprascapular notch, the physician placed the ultrasound probe parallel to the scapular spine, superior to the acromion, and slowly adjusted it medially. Once the suprascapular notch was visualized, a 20-G, 3.5-inch hybrid RF needle with a 10 mm active tip was carefully advanced beneath the transverse scapular ligament. The RF electrode was then connected to perform sensory and motor stimulation tests of the target nerve. Sensory stimulation at 50 Hz and 0.3-0.5 V elicited paresthesia in the shoulder; during motor tests at 2 Hz and 0.3-0.5 V, visible contractions of the supraspinatus and infraspinatus shoulder muscles were observed. After confirming the correct needle position and obtaining appropriate responses, pulsed radiofrequency (PRF) was applied to the suprascapular nerve at 42°C and 45 volts for 240 seconds. This was followed by negative aspiration and an injection of 5 mL of 0.25% bupivacaine into the same area to prevent procedural pain (Figure

1). All procedures were performed under sterile conditions, and local skin anesthesia was applied before needle insertion.

One week after the procedure, all patients received an exercise booklet to start a home rehabilitation program. A physiotherapist demonstrated exercises, including self-stretching, range-of-motion activities, and strengthening exercises. Patients were advised to take 500 mg of paracetamol (up to four tablets per day) and/or 200 mg of ibuprofen as needed. They were instructed not to take any analgesics on the day of or the day before follow-up assessments, as these could influence clinical outcome measurements.

Outcome Measures

All patients were evaluated by the researchers for both primary and secondary outcome measures at baseline (before procedure) and at 4- and 12-week post-procedure. The primary outcome was the Shoulder Pain and Disability Index (SPADI) score, while secondary outcome measures included Numeric Rating Scale (NRS-11) scores. All adverse events occurring during the procedure or follow-up visits were documented.

Primary Outcome Measures

The SPADI is a shoulder-specific index consisting of 13 items that evaluate pain and disability across two separate subscales. Each item is scored from 0 to 10, and the total scores for the pain, disability, and overall subscales are converted to a 100-point scale. Higher SPADI scores indicate more shoulder-related pain and disability. A reduction of 18 points or more in the total SPADI score from baseline to week 12 (final follow-up) was considered a sign of treatment success (15). The validity and reliability of the Turkish version of SPADI have been previously confirmed (16).

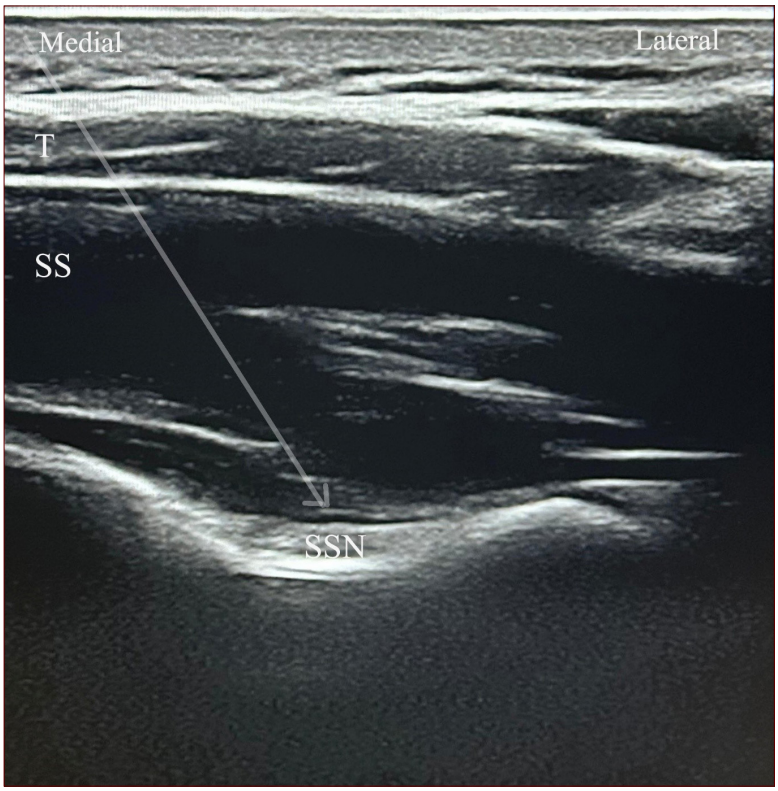


Figure 1. Ultrasound-guided pulsed radiofrequency of the suprascapular nerve via the suprascapular notch using an in-plane approach

T: Trapez muscle, SS: Supraspinatus muscle, SSN: Suprakapuler notch, Arrow: Needle direction

Secondary Outcome Measures

Pain intensity was measured using an 11-point Numeric Rating Scale (NRS), where 0 meant "no pain" and 10 indicated "worst pain imaginable." Separate NRS scores were recorded for pain during activity and rest.

Statistical Analyses

Statistical analyses were conducted using SPSS software (version 22.0, IBM Corp., Chicago, IL, USA). Descriptive statistics were presented as mean ± standard deviation and median (min–max) for continuous variables, and as frequencies and percentages for categorical variables. The Shapiro–Wilk test was employed to evaluate the normality of continuous data. For normally distributed data, comparisons between independent groups were made with the independent samples t-test, while the Mann–Whitney U test was used if the data were not normally distributed. Categorical variables were compared using the chi-square test. Paired comparisons of dependent variables were conducted with the Wilcoxon signed-rank test, and correlations between continuous variables were evaluated using Spearman's rank correlation coefficient. A p-value < 0.05 was considered statistically significant.

RESULTS

A total of 47 patient records were screened for eligibility. After nine patients who met the exclusion criteria were excluded, an additional six patient records were removed because these patients did not continue their follow-up. As a result, 32 patients (n=32) who met the inclusion criteria were enrolled in the study (Figure 2).

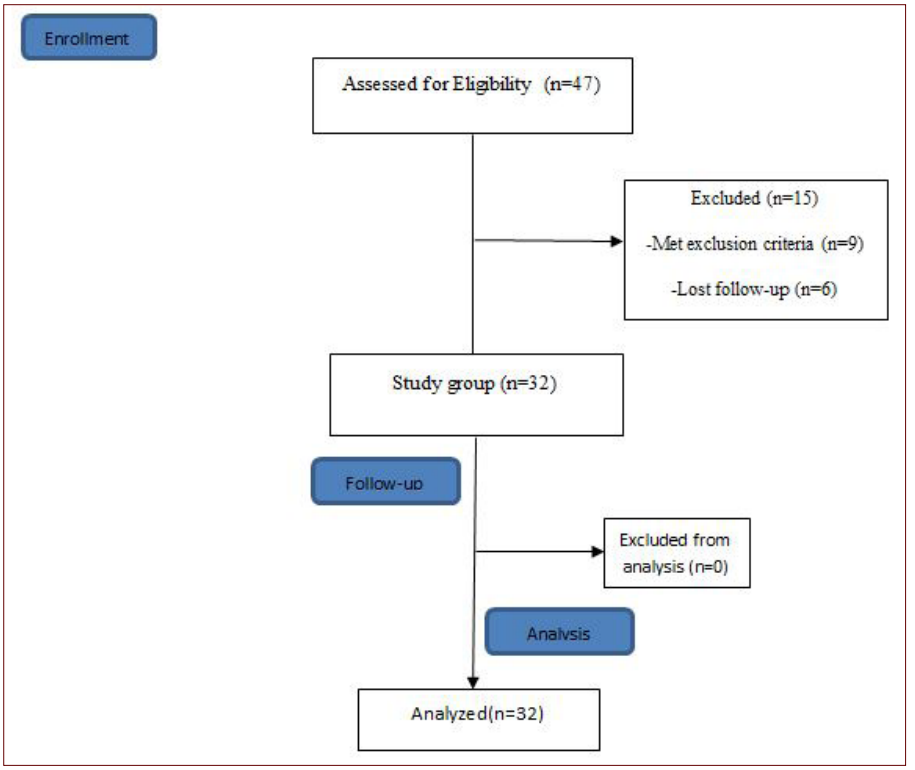


Figure 2. STROBE guideline flow diagram for the study.

STROBE: Strengthening the reporting of observational studies in epidemiology

Table 1. Demographic and clinical characteristics

Sex	**n**	**%**
Man	6	18.8
Woman	26	81.3
Total	32	100.0
Side	**n**	**%**
Left	20	62.5
Right	12	37.5
Total	32	100.0
DM	**n**	**%**
No	22	68.8
Yes	10	31.3
Total	32	100.0

DM: diabetes mellitus

All 32 patients in the study were aged 65 years or older and diagnosed with adhesive capsulitis. Of these, 26 patients (81.3%) were female, 20 patients (62.5%) had left shoulder involvement, and 10 patients (31.3%) had diabetes mellitus (Table 1). No significant correlations were found between age, sex, symptom duration, BMI, affected side, or diabetes mellitus and NRS or SPADI scores.

At both the 4-week and 12-week post-procedure assessments, NRS activity and rest scores were significantly lower than their pre-procedure baseline values ($p<0.05$ for both). While NRS activity levels did not differ substantially between weeks 4 and 12 ($p>0.05$), the NRS rest score at week 12 showed a significant increase compared to week 4 ($p<0.05$) (Table 2).

Table 2. Changes in NRS and SPADI scores at baseline, 4, and 12 weeks post-procedure

		Mean±SD	**Wilcoxon Signed Test**	**p**
NRS(Activity)	T_0-T_1	6.34+1.82	-4.95	0.00
	T_0-T_2	6.59+1.24	-4.99	0.00
	T_1-T_2	0.25+1.43	-0.084	0.39
NRS (Rest)	T_0-T_1	1.75+0.98	-4.77	0.00
	T_0-T_2	0.75+1.29	-2.78	0.00
	T_1-T_2	-1.00+1.16	4.05	0.00
SPADI (Pain)	T_0-T_1	65.45+18.19	-4.93	0.00
	T_0-T_2	65.23+15.46	-4.93	0.00
	T_1-T_2	-0.21+14.21	-0.20	0.83
SPADI (Disability)	T_0-T_1	65.37+17.66	-4.93	0.00
	T_0-T_2	64.90+16.45	-4.93	0.00
	T_1-T_2	-0.46+14.97	-0.30	0.75
SPADI (Total)	T_0-T_1	63.20+19.21	-4.93	0.00
	T_0-T_2	62.80+18.86	-4.93	0.00
	T_1-T_2	-0.39+14.48	-0.35	0.87

Data are shown as mean±SD

T0= Before the procedure, T1= 4th week of the procedure, T2= 12 th week of the procedure

NRS: Numeric Rating Scale; SPADI: Shoulder Pain and Disability Index; SD: Standart Deviation



Pre-procedure SPADI (pain, disability, and total) scores were significantly higher than follow-up scores at both 4 and 12 weeks ($p<0.05$ for each). However, no statistically significant difference was observed between SPADI pain scores at week 4 and week 12 ($p>0.05$) (Table 2).

Adverse events were rare, nonsevere, and transient. Presyncope occurred in only one patient and transient motor block developed in another, with both resolving without intervention.

DISCUSSION

In this retrospective observational cohort study, the effectiveness and safety of ultrasound (US)-guided suprascapular nerve pulsed radiofrequency (SSN-PRF) application at the suprascapular notch level were assessed in patients aged 65 and older with chronic shoulder pain caused by adhesive capsulitis (AC). We hypothesized that SSN-PRF at the suprascapular notch level would effectively reduce pain and disability in this group. Our results showed that SSN-PRF significantly decreased pain and improved function from baseline to week 12 in patients with chronic shoulder pain.

Another significant finding of our study was that patients' resting pain intensity (NRS rest) increased significantly at week 12 compared to week 4. Nevertheless, despite this increase, the resting pain score at week 12 was still substantially lower than the baseline pre-treatment score. This observation might be attributed to a partial decline in the neuromodulatory effect of the applied pulsed radiofrequency (PRF) treatment over time. However, PRF is known for its long-lasting analgesic effect; individual responses and effect duration can vary. Additionally, phase changes in the natural progression of adhesive capsulitis or increased mobility in patients whose pain decreased after treatment could also be contributing factors.

On the other hand, although this increase in the NRS rest score was statistically significant, its clinical significance should be carefully evaluated. Most importantly, pain remained significantly lower than baseline values, and functional outcomes (SPADI) also showed significant improvement at week 12. Furthermore, no significant change in pain during activity (NRS activity) was observed. This indicates that the negative impact of this partial increase in resting pain on patients' quality of life and daily activities is limited, and the long-term effectiveness of SSN-PRF continues.

Another important finding of the study was the generally mild and temporary nature of procedure-related adverse events. Therefore, US-guided SSN-PRF can be considered both effective and safe for this patient group.

In addition to SSNB and SSN-PRF, non-surgical treatments for adhesive capsulitis include oral nonsteroidal anti-inflammatory drugs (NSAIDs), physical therapy, and intra-articular corticosteroid injections (IACSI). Elderly individuals are more at risk for medication-related harm due to multimorbidity, polypharmacy, and physiological changes that affect drug absorption, distribution, metabolism, and excretion (17). As a result, NSAID use in elderly people is significantly limited because of their higher risk of serious cardiovascular, renal, hepatic, and gastrointestinal side effects.

While physical therapy is commonly used in AC treatment, evidence supporting its effectiveness is limited. It is often the first treatment option for patients with early-stage AC. However, because there is limited evidence to support using physical therapy alone, it is usually combined with other treatment methods (18). Some studies indicate that adding SSNB to physical therapy is better than physical therapy alone. Conversely, others suggest that SSNB, combined with both physical therapy and the IACSI, offers additional benefits (19, 20, 21). Although IACSI is considered a good option for AC treatment, comparative studies show that SSNB is more effective for pain relief and improved function (22, 23). Additionally, given the potential local and systemic side effects of the IACSI, especially in

diabetic patients, extra caution is needed when planning the IACSI for elderly patients.

Although there are no specific safety studies directly on SSN-PRF, research and reviews on SSNB have shown that the block procedure is safe. In our study, only one patient experienced presyncope. A study by Shanahan et al. involving 1,005 patients who underwent SSNB reported only six side effects: three cases of transient dizziness, two instances of temporary arm weakness, and one case of facial flushing (24). From the perspective of side effects and complications, SSN-PRF seems to be safer than many other treatment options for AC.

The persistent severity of symptoms in AC patients results in impaired social relationships, activity avoidance, and psychological distress. This greatly limits daily, recreational, and work activities by increasing perceived pain and disability. Difficulties within the family and insecurity at work weaken patients' independence and reduce their quality of life. In older adults, the additional challenge of adhesive capsulitis and the need for effective treatment are even more critical. The reductions in pain and improvements in function shown in our study have significant potential to alleviate the social and psychological impacts of adhesive capsulitis.

To date, the available literature addressing suprascapular nerve pulsed radiofrequency (SSN-PRF) specifically for adhesive capsulitis in patients aged 65 years and older remains limited. In this context, the present study adds to the emerging evidence in this area. Unlike neurolytic techniques, PRF exerts its effect through neuromodulation, allowing sustained pain relief without structural nerve injury (12). Given the potential risks associated with corticosteroid use and surgical interventions in older adults, SSN-PRF may represent a well-tolerated therapeutic option in this population. Nevertheless, several limitations should be acknowledged, including the retrospective design of the study, the relatively small sample size, and the absence of a control group. Further prospective studies with larger patient cohorts are warranted to confirm and expand upon these findings.

CONCLUSION

This study indicates that ultrasound (US)-guided suprascapular nerve pulsed radiofrequency (SSN-PRF), applied at the suprascapular notch, may be an effective and safe option for elderly patients (65 years and older) with chronic shoulder pain caused by adhesive capsulitis. Procedure-related adverse events were typically mild and temporary. These results suggest that SSN-PRF is a safe alternative, especially for elderly patients with comorbidities where other treatments might be limited. Since adhesive capsulitis greatly impacts daily activities and quality of life in older adults, our findings imply that SSN-PRF could be an important part of managing this condition in this patient population.

Acknowledgement: The authors have no acknowledgements to declare.

Conflict of Interest: The authors declare that they have no conflict of interest.

REFERENCES

1. Carette S, Moffet H, Tardif J, et al. Intraarticular corticosteroids, supervised physiotherapy, or a combination of the two in the treatment of adhesive capsulitis of the shoulder: a placebo-controlled trial. Arthritis Rheum. 2003;48(3):829-38. doi: 10.1002/art.10954
2. Leafblad N, Mizels J, Tashjian R, Chalmers P. Adhesive capsulitis. Phys Med Rehabil Clin N Am. 2023;34(2):453-68. doi: 10.1016/j.pmr.2022.12.009
3. Kelley MJ, Shaffer MA, Kuhn JE, et al. Shoulder pain and mobility deficits: adhesive capsulitis. J Orthop Sports Phys Ther. 2013;43(5):A1-A31. doi: 10.2519/jospt.2013.0302
4. Cucchi D, Di Giacomo G, Compagnoni R, et al. A high level of scientific evidence is available to guide treatment of primary shoulder stiffness: the SIAGASCOT consensus. Knee Surg Sports Traumatol Arthrosc. 2024;32(1):37-46. doi: 10.1002/ksa.12017

5. Wise SR, Seales P, Houser AP, Weber CB. Frozen shoulder: diagnosis and management. Curr Sports Med Rep. 2023;22(9):307-12. doi: 10.1249/JSR.0000000000001097
6. Rizk TE, Pinals RS. Frozen shoulder. Semin Arthritis Rheum. 1982;11(4):440-52. doi: 10.1016/0049-0172(82)90030-0
7. Ozaki J, Nakagawa Y, Sakurai G, Tamai S. Recalcitrant chronic adhesive capsulitis of the shoulder: role of contracture of the coracohumeral ligament and rotator interval in pathogenesis and treatment. J Bone Joint Surg Am. 1989;71(10):1511-5.
8. Neviaser TJ. Adhesive capsulitis. Orthop Clin North Am. 1987;18(3):439-43.
9. Maund E, Craig D, Suekarran S, et al. Management of frozen shoulder: a systematic review and cost-effectiveness analysis. Health Technol Assess. 2012;16(11):1-264. doi: 10.3310/hta16110
10. Cho CH, Bae KC, Kim DH. Treatment strategy for frozen shoulder. Clin Orthop Surg. 2019;11(3):249-57. doi: 10.4055/cios.2019.11.3.249
11. Ritchie ED, Tong D, Chung F, Norris AM, Miniaci A, Vairavanathan SD. Suprascapular nerve block for postoperative pain relief in arthroscopic shoulder surgery: a new modality? Anesth Analg. 1997;84(6):1306-12. doi: 10.1097/00000539-199706000-00024
12. Liliang PC, Lu K, Liang CL, Tsai YD, Hsieh CH, Chen HJ. Pulsed radiofrequency lesioning of the suprascapular nerve for chronic shoulder pain: a preliminary report. Pain Med. 2009;10(1):70-5. doi: 10.1111/j.1526-4637.2008.00543.x
13. Bilsborough Smith C, Nadesan K, Cairns M, Chester R, Lewis J. Living with frozen shoulder: 'here are the risks. I want the injection': an interpretative phenomenological analysis. Musculoskelet Sci Pract. 2023;65:102755. doi: 10.1016/j.msksp.2023.102755
14. Lyne SA, Goldblatt FM, Shanahan EM. Living with a frozen shoulder - a phenomenological inquiry. BMC Musculoskelet Disord. 2022;23(1):318. doi: 10.1186/s12891-022-05251-7
15. Roy JS, MacDermid JC, Woodhouse LJ. Measuring shoulder function: a systematic review of four questionnaires. Arthritis Rheum. 2009;61(5):623-32. doi: 10.1002/art.24396
16. Bumin G, Tuzun EH, Tonga E. The Shoulder Pain and Disability Index (SPADI): cross-cultural adaptation, reliability, and validity of the Turkish version. J Back Musculoskelet Rehabil. 2008;21(1):57-62.
17. Stevenson JM, Williams JL, Burnham TG, et al. Predicting adverse drug reactions in older adults: a systematic review of the risk prediction models. Clin Interv Aging. 2014;9:1581-93. doi: 10.2147/CIA.S65475
18. Green S, Buchbinder R, Hetrick S. Physiotherapy interventions for shoulder pain. Cochrane Database Syst Rev. 2003;2003(2):CD004258. doi: 10.1002/14651858.CD004258
19. Gunes S, Karacay BC, Diracoglu D. Effect of suprascapular nerve block in addition to physical therapy in patient with adhesive capsulitis. J Int Acad Phys Ther Res. 2022;13(1):2522-30. doi: 10.20540/JIAPTR.2022.13.1.2522
20. Mardani-Kivi M, Nabi BN, Mousavi MH, et al. Role of suprascapular nerve block in idiopathic frozen shoulder treatment: a clinical trial survey. Clin Shoulder Elb. 2022;25(2):129-39. doi: 10.5397/cise.2021.00661
21. Shanahan EM, Gill TK, Briggs E, et al. Suprascapular nerve block for the treatment of adhesive capsulitis: a randomised double-blind placebo-controlled trial. RMD Open. 2022;8(2):e002648. doi: 10.1136/rmdopen-2022-002648
22. Nazim ZK, Farhat MF, Abbasi S. Comparison between intra-articular steroid injection and supra-scapular nerve block in the management of frozen shoulder. Pak J Med Sci. 2024;40(7):1415-9. doi: 10.12669/pjms.40.7.8531
23. Harley JD, Austin CN, Harrison AK, et al. Intra-articular corticosteroid injection vs. suprascapular nerve block for adhesive capsulitis: a systematic review and meta-analysis of level I randomized controlled trials. J Shoulder Elbow Surg. 2025 Jul 16 [Epub ahead of print]. doi: 10.1016/j.jse.2025.05.037
24. Shanahan EM, Shanahan KR, Hill CL, et al. Safety and acceptability of suprascapular nerve block in rheumatology patients. Clin Rheumatol. 2012;31(1):145-9. doi: 10.1007/s10067-011-1813-3

Turkish Journal of Geriatrics
2026; 29(1):56–66

DOI: 10.29400/tjgeri.2026.478

Ömer Levent KARADAMAR[1]
Ali Murat BAŞAK[2]
Anıl ÖZGÜR[3]
Ali AYDİLEK[2]
Uğur YÜZÜGÜLDÜ[4]
Enes KELEŞ[2]
Mustafa KARA[2]

[1] Döşemealtı State Hospital, Department of Orthopedics and Traumatology, Antalya, Türkiye

[2] Gulhane Training and Research Hospital, Department of Orthopedics and Traumatology, Ankara, Türkiye

[3] Defne State Hospital, Department of Orthopedics and Traumatology, Hatay, Türkiye

[4] Balıkesir Atatürk City Hospital, Department of Orthopedics and Traumatology, Balıkesir, Türkiye

Correspondence

Ömer Levent KARADAMAR
Phone : +902424555450
e-mail : leventkaradamar@gmail.com

Received : Dec 29, 2025
Accepted: Feb 21, 2026

Cite this article as:
Karadamar ÖL, Başak AM, Özgür A et al. The Effect of Blood Parameters and Surgical Treatment Methods on Mortality in Geriatric Hip Fractures: Can Preoperative Albumin and Lymphocyte Levels Predict Mortality. Turkish Journal of Geriatrics 2026; 29(1):56–66. doi: 10.29400/tjgeri.2026.478

ORIGINAL ARTICLE

THE EFFECT OF BLOOD PARAMETERS AND SURGICAL TREATMENT METHODS ON MORTALITY IN GERIATRIC HIP FRACTURES: CAN PREOPERATIVE ALBUMIN AND LYMPHOCYTE LEVELS PREDICT MORTALITY

Abstract

Introduction: Geriatric hip fractures are associated with high morbidity and mortality. Identifying reliable preoperative biomarkers may help predict postoperative mortality and improve perioperative management.

Materials and Method: This retrospective study included 913 patients aged 65 years and older who underwent surgery for hip fractures between January 2017 and January 2024. Demographic characteristics, comorbidities, fracture type, surgical and anesthesia methods, ASA score, and preoperative hemoglobin, albumin, and lymphocyte levels were recorded. Mortality status was evaluated, and the diagnostic performance of albumin and lymphocyte levels in predicting mortality was assessed using receiver operating characteristic (ROC) curve analysis.

Results: The mean age of the patients was 79.6 ± 9.7 years, and the postoperative mortality rate was 51.6%. Mortality was significantly associated with lower preoperative albumin and lymphocyte levels ($p<0.001$). A preoperative albumin level <3.5 g/dL demonstrated excellent predictive performance for mortality, with a sensitivity of 99.8% and specificity of 99.5% (AUC: 0.997). The predictive accuracy of lymphocyte count was lower (AUC: 0.622). Mortality rates were also significantly higher in patients with an ASA score ≥4 and in those who received blood transfusions.

Conclusions: Preoperative serum albumin is a highly accurate biomarker for predicting mortality in geriatric patients undergoing hip fracture surgery. Low albumin levels may reflect malnutrition and reduced physiological reserve, contributing to poorer postoperative outcomes. Routine assessment of albumin may facilitate early identification of high-risk patients and support individualized perioperative management strategies.

Keywords: Geriatrics; Hip Fractures; Albumins; Lymphocytes; Mortality.

INTRODUCTION

Hip fractures are among the important public health problems worldwide (1). It is the most common type of fracture, especially in osteoporotic elderly individuals, and surgical treatment is generally the standard approach in this patient group and is often applied after hospitalization (2,3). Factors such as age, chronic diseases, cognitive status, and malnutrition play a role in the development of hip fractures (4). Particularly, osteoporosis is one of the most important risk factors for hip fractures in the elderly population (4).

Elderly individuals represent the fastest-growing age group in the global population. Therefore, a substantial rise in the incidence of hip fractures is anticipated in the coming years (5). Approximately 1.5 million people are hospitalized every year due to hip fractures, and this number is predicted to be more than 4.5 million in 2050 (2). It has been reported that more than 80% of patients with hip fractures are aged 65 years or older (6). The risk of mortality increases significantly, especially in the first year following fracture, and increases further with advanced age (5,7). There is strong evidence that performing surgery within 24-48 hours significantly reduces mortality (8).

Among hip fractures, intertrochanteric and femoral neck fractures have distinct etiologies, treatment strategies, and prognoses. Short- and long-term mortality rates of femoral neck fractures are lower compared to intertrochanteric fractures. However, in terms of surgical approach, hip arthroplasty has been reported to be associated with higher mortality rates compared to internal fixation (6). However, certain studies suggest that there is no significant difference in long-term functional outcomes and mortality between the two types of fractures (9).

Serum albumin level is a commonly used marker for assessing malnutrition (10). Preoperative serum albumin levels were significantly associated with mortality and ICU requirement in elderly patients undergoing hip fracture surgery (1). Similarly, studies from developing countries have highlighted the prognostic value of low preoperative albumin and hematologic parameters. Espinosa et al. reported that reduced preoperative serum markers reflect impaired functional reserve and a higher risk of mortality in elderly populations (2). Within this context, evaluating preoperative albumin and lymphocyte levels may offer practical and effective tools for surgical risk assessment (2).

In addition to albumin, lymphocyte count was evaluated as a potential prognostic parameter because it reflects both nutritional and immunological status. In elderly patients, immune senescence, chronic inflammation, and malnutrition frequently coexist and may negatively influence postoperative recovery (11). Total lymphocyte count has been incorporated into composite prognostic indices such as the Prognostic Nutritional Index (PNI) and the HALP score, which have demonstrated associations with mortality and postoperative complications in geriatric orthopedic populations (12). Furthermore, lymphocyte count is routinely measured, cost-effective, and readily available in daily clinical practice, making it a practical parameter for perioperative risk assessment.

The objective of this study was to evaluate the predictive value of preoperative albumin and lymphocyte levels on postoperative mortality in patients undergoing surgery due to geriatric hip fractures. Moreover, the relationship between mortality and clinical variables such as different surgical techniques, anesthesia methods, ASA score, and blood transfusion was investigated. With the findings of the study, it was aimed to contribute to patient management by identifying biochemical parameters that can predict mortality.

MATERIALS AND METHOD

Study Population

In our study, patients aged 65 years and older who underwent surgical treatment for hip fractures and presented to our clinic between January 2017 and January 2024 were retrospectively included. Patients

under the age of 65, patients with a deteriorated general condition during hospitalization, patients who underwent surgical treatment due to pathological fractures, patients with bilateral hip fractures, patients who had revision surgery for a previous hip fracture on the same side, and patients for whom sufficient data could not be obtained during and after hospitalization were excluded from the study (Figure 1). The study protocol was approved by the Gulhane Clinical Research Ethics Committee of the University of Health Sciences (Decision No: 2024/536, Date: 10/12/2024), and the study was conducted in accordance with the principles of the Helsinki Declaration.

Data Collection

Patients aged 65 years and older who underwent surgical treatment for hip fractures were retrospectively screened through the hospital automation system. Age, gender, and comorbidities (such as coronary artery disease, previous cerebrovascular events, chronic kidney failure, asthma, hypertension, diabetes mellitus, etc.) were recorded. Patients with clinical conditions known to directly affect serum albumin levels such as chronic liver disease, nephrotic syndrome, active malignancy, or systemic inflammatory disorders were excluded from the study. The type of hip fracture at the time of admission was evaluated by using the PACS system. Hip fractures were classified into three groups: femoral neck fractures, intertrochanteric fractures, and subtrochanteric fractures. Femoral neck fractures were evaluated as fractures occurring within the intracapsular region of the hip joint and the area beneath the fibrous capsule. Intertrochanteric fractures were evaluated as fractures occurring in the region between the femoral neck and the lesser trochanter. The region extending from the lesser trochanter to up to 5 cm distally was evaluated as the subtrochanteric fractures.

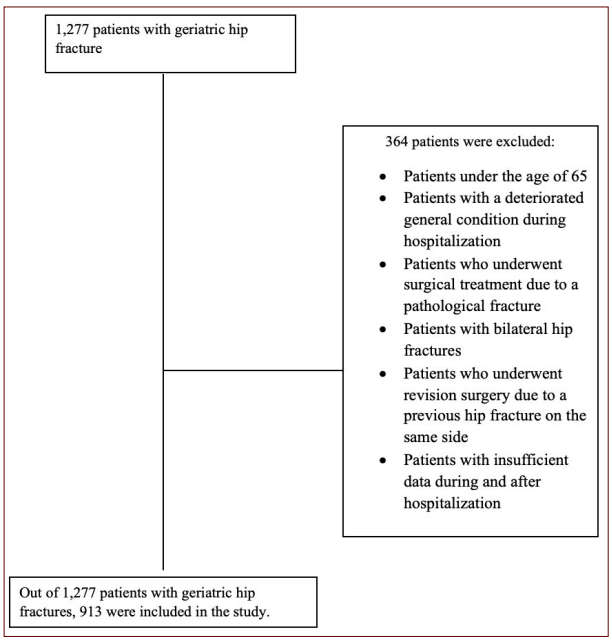


Figure 1. Flow Diagram of the Study

Postoperative control X-ray images taken in the operating room following the surgery were evaluated, and the surgical treatments applied to the patients were categorized into three groups: partial hip arthroplasty, proximal femoral nail, and long proximal femoral nail. Operative notes were reviewed to determine the length of the nails used. The nails over 260 mm were evaluated as long proximal femoral nails, and shorter nails were evaluated as proximal femoral nails. The ASA score (I, II, III, IV) routinely recorded in the surgical notes of the patients, the type of anesthesia administered (categorized into general, spinal, and regional), and the duration of surgery were recorded. Preoperative hemoglobin, albumin, and lymphocyte levels were obtained from the initial blood samples collected at the time of hospital admission. Laboratory data of the patients were reviewed, and the most recent preoperative values were recorded, including hemoglobin, albumin, and lymphocyte levels. Preoperative hospital stay duration, the number of erythrocyte and platelet suspensions administered before and after surgery, and the patients who died postoperatively were also recorded. Mortality data were obtained through the hospital information management system (FONET) and the national electronic health record system



(e-Nabız). Since the exact date or timing of death could not be accessed, mortality was assessed based solely on the presence or absence of a death record. It was not possible to determine whether death occurred during hospitalization or after discharge.

Statistical Analysis

Descriptive statistics for continuous variables were presented as mean, standard deviation, median, minimum, and maximum values, while categorical variables were presented as frequencies and percentages. Power analysis was performed using G*Power (version 3.1.9.7) to assess minimum sample size adequacy for comparing two independent groups. Assuming a medium effect size (Cohen's d=0.50), α=0.05 and power (1−β)=0.95, and equal group allocation, the required minimum sample size was 210 patients (105 per group). As our cohort included 913 patients, the available sample size was considered sufficient to detect at least a medium between-group difference in key laboratory parameters. The Shapiro–Wilk test was used to assess the normality of data distribution. The Mann–Whitney U test was used to compare continuous variables between the patients who survived and the patients who died. For comparisons of nominal variables between groups (in cross tables), the Chi-Square test or Fisher's Exact test was used. The diagnostic performance of preoperative albumin and lymphocyte levels in predicting mortality was evaluated by using the area under the ROC curve (AUC). The best cut-off point was calculated by using Youden's Index. Preoperative albumin and preoperative lymphocyte values were evaluated by using diagnostic accuracy criteria (sensitivity, specificity, positive predictive, and negative predictive). In assessments, IBM SPSS for Windows 20.0 (SPSS Inc. Chicago, IL) program was used, and p<0.05 was accepted as the statistical significance limit.

RESULTS

913 patients, who were operated on due to hip fracture, were included in the study. The mean age of the patients was 79.63 ± 9.74 years, with a minimum of 65 and a maximum of 98 years. The mean preoperative hospital stay was 3.65 ± 2.28 days, and the mean duration of surgery was 2.14 ± 0.65 hours. Of the patients, 67% were female and 33% were male. An ASA score of "3" was recorded in 54.8% of the patients, 60.4% had an intertrochanteric fracture (ICF), and spinal anesthesia was administered in 74.5% of the cases. It was determined that 64% of the patients underwent PFN surgery, and 45.8% received blood replacement. It was reported that 51.6% of the patients died.

A difference was found between the ages of the surviving patients and the deceased patients (p<0.001). The ages of the deceased patients were found to be higher. There was no difference between the preoperative hospitalization periods of the surviving and the non-surviving patients (p>0.05). A difference was found between the operation times of the surviving patients and the deceased patients (p<0.01). The operation times of the deceased patients were found to be shorter. There was no difference between the gender distributions of the surviving patients and the deceased patients (p>0.05). It was observed that the deceased patients had a higher rate of ASA score of 4. No significant differences were found between surviving and deceased patients in terms of gender distribution, fracture types, or comorbidity rates (p>0.05). There was no difference between the anesthesia techniques of the surviving and the deceased patients (p>0.05). A difference was found between the blood replacement numbers of the surviving and the deceased patients (p<0.05). The blood replacement numbers of the deceased patients were found to be higher. There was no difference between the surgical types of both patient groups (p>0.05). A difference was found between the rates of receiving blood replacement in surviving and non-surviving patients (p<0.05). The rate of blood replacement was found to be higher in deceased patients (Table 1).

Table 1. Comparison of demographic characteristics and attributes of surviving and deceased patients

	Surviving (n=442,%48.4)		Deceased (n=471,(%51.6)		p
	Mean ± SD Median (Min-Max)		Mean ± SD Median (Min-Max)		
Age (years)	77.08±10.52 79 (65-96)		82.03±8.26 84 (69-98)		<0.001 [b]
Preoperative length of stay (days)	3.57±1.96 3 (0-13)		3.73±2.54 3 (0-29)		0.713 [b]
Operation duration (hours)	2.20±0.61 2 (1-6)		2.09±0.69 2 (0.53-9.0)		0.003 [b]
Blood replacement number (Units)	0.74±1.17 0 (0-8)		0.99±1.55 0 (0-11)		0.019 [b]
	n	%	n	%	
Gender					
Female	294	66.5	318	67.5	0.748 [c]
Male	148	33.5	153	32.5	
ASA					
1/2	130	29.4	82	17.4	<0.001[c]
3	241	54.5	259	55.0	
4	41	16.1	130	27.6	
Fracture type					
Femoral neck	165	37.3	158	33.5	0.082 [c]
ICF	253	57.2	298	63.3	
Subtrochanteric	24	5.4	15	3.2	
Anesthesia technique					
General	88	20.0	73	15.5	0.349 [c]
Spinal	316	71.7	363	77.1	
Regional	1	0.2	2	0.4	
Spinal+Regional	0	0	1	0.2	
Combined	28	6.3	24	5.1	
LMA	8	1.8	8	1.7	
Comorbidity					
No	66	14.9	70	14.9	0.976 [c]
Yes	376	85.1	401	85.1	
Surgery type					
PFN	271	61.3	313	66.5	0.211 [c]
Long PFN	8	1.8	5	1.1	
PHP	163	36.9	153	32.5	
Blood Replacement					
No	255	57.7	240	51.0	0.041 [c]
Yes	187	42.3	231	49.0	

ASA: American Society of Anesthesiologists, b: Mann-Whitney U Test, c: Chi -Square test/Fisher's Exact test, ICF: Intertrochanteric Fracture, LMA: Laryngeal Mask Airway, PFN: Proximal Femoral Nail, PHP: Partial Hip Prosthesis

Table 2. Comparison of laboratory values of surviving and non-surviving patients

	Surviving (n=442)	Deceased (n=471)	p
	Mean ± SD Median (Min-Max)	Mean ± SD Median (Min-Max)	
Preoperative Hemoglobin	11.75±1.71 11.7 (7.3-18.0)	11.54±1.88 11.3 (6.5-17.9)	0.050 [b]
Preoperative Albumin	4.01±0.29 3.9 (2.9-4.7)	2.59±0.46 2.6 (1.8-7.7)	<0.001 [b]
Preoperative Lymphocyte	1.58±0.81 1.4 (0.3-4.6)	1.24±0.56 1.1 (0.2-4.1)	<0.001 [b]

b: Mann-Whitney U Test

Table 3. Diagnostic performance of Preoperative Albumin and Preoperative Lymphocyte values in distinguishing mortality

	AUC 95% CI	p	Cutoff	Sensitivity 95% CI	Specificity 95% CI	PPV	NPV
Preoperative Albumin	0.997 (0.993-1.000)	<0.001	<3.5	99.8 % (98.8-99.9)	99.5 % (98.4-99.9)	99.6 % (98.8-99.9)	99.8 % (99.1-99.9)
Preoperative Lymphocyte	0.622 0.586-0.659	<0.001	<1.42	79.2 % (75.3-82.6)	47.5 % (42.9-52.1)	61.6 % (58.4-64.8)	68.2 % (65.0-71.2)

AUC: Area Under the Curve , PPV: Positive Predictive Value, NPV: Negative Predictive Value

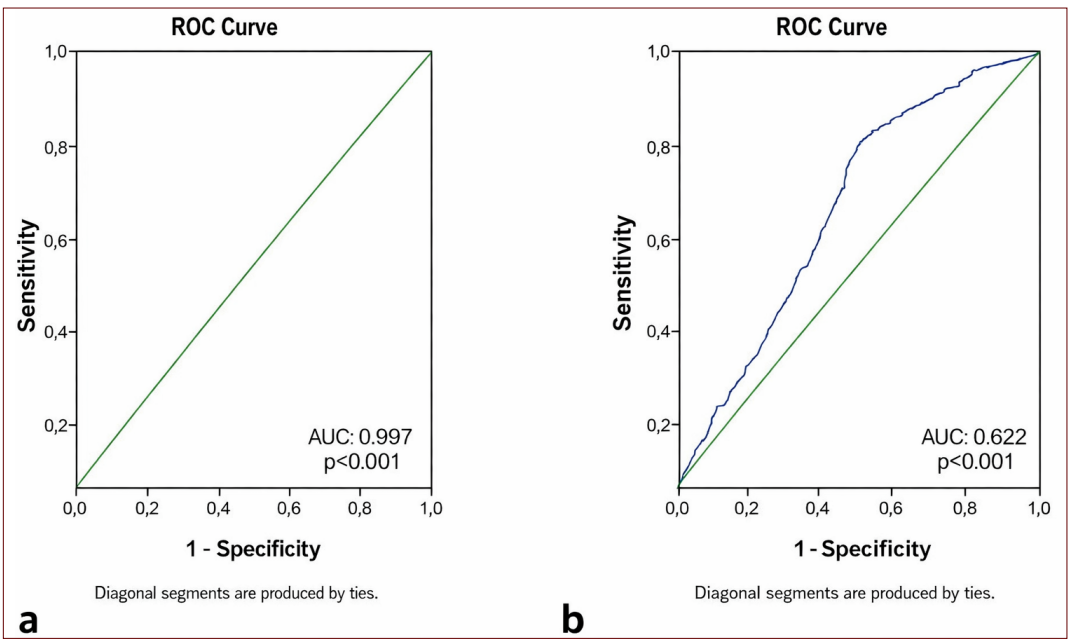


Figure 2. Receiver operating characteristic (ROC) curves showing the predictive value of preoperative laboratory parameters for mortality: (a) albumin and (b) lymphocyte levels.

A significant difference was found between the preoperative hemoglobin values of the surviving and the non-surviving patients (p=0.05). The preoperative hemoglobin values of the deceased patients were found to be lower. There was a difference between the preoperative albumin values of the surviving and the non-surviving patients (p<0.001). Preoperative albumin values of the deceased patients were found to be lower (Table 2).

AUC calculated for preoperative albumin was found to be significant in predicting mortality in patients with hip fractures (p<0.001). The best cut-off point was determined to be <3.5. AUC calculated for preoperative lymphocyte values was found to be significant in predicting mortality in patients with hip fractures (Table 3).

The best cut-off point was determined to be <1.42 (p<0.001). (Figure 2)

DISCUSSION

Mortality rates remain high among geriatric patients with hip fractures, and identifying preventable risk factors through large-scale studies is of great importance. Although surgical techniques have advanced, it is crucial to evaluate the preoperative, intraoperative, and postoperative processes as a whole in order to reduce mortality. Accordingly, a study was designed with the aim of contributing to the existing literature.

Low hemoglobin is a very common condition in patients with hip fractures. In a study conducted by Smeets et al., it was reported that blood transfusion had no effect on mortality (13). In another study, although blood transfusion was found to have no effect on 1-year mortality, it was revealed that there was an increase in mortality as the number of transfusions increased (14). Our study reveals that the low preoperative hemoglobin level and the mortality rate of patients with blood replacement are significantly higher than other patients.

There is no clear consensus regarding the relationship between hip fractures and the type of anesthesia. There is no standardized method among general anesthesia, regional anesthesia, and spinal anesthesia techniques for geriatric hip fracture patients (15). In the study conducted by Kunutsor et al., no relationship was observed between the type of anesthesia and mortality (15). In our study, results similar to the literature were obtained, and no significant relationship was found between the type of anesthesia and mortality. In a meta-analysis including 53 studies, it was reported that the postoperative mortality rate increased with the increase in the ASA score (16). Our study revealed that patients with an ASA score of 4 had a higher mortality rate.

The effects of hip fractures differed between men and women, with male patients having longer surgery durations, higher readmission rates, and higher mortality rates compared to female patients (17). In our study, no significant relationship was found between gender or length of hospital stay and mortality; however, a significant relationship was observed, indicating that patients with shorter operative times had higher mortality rates. ASA scores of these patients were found to be higher compared to other patients.

In a review study including patients over the age of 70 with hip fractures, the relationship between malnutrition and mortality was evaluated (18). Despite advances in treatment methods, mortality rates were reported to remain high, and it was suggested that the prevention of malnutrition might have a significant effect on reducing postoperative mortality (17). In our study, preoperative albumin and lymphocyte levels were evaluated, and the findings suggested that they might serve as predictive risk factors for postoperative mortality.

Albumin and lymphocyte levels were significantly associated with mortality in elderly patients with hip fractures (11). Our study supports these findings and demonstrates particularly high diagnostic accuracy



for albumin levels, with a sensitivity of 99.8% and a specificity of 99.5%. These rates are higher compared to most studies reported in the literature.

Serum albumin levels might be used as a marker to predict postoperative mortality and complication risk in geriatric patients (19). They emphasized that the significantly higher rates of death, sepsis, and intubation in patients with hypoalbuminemia highlighted the importance of albumin as a critical parameter reflecting systemic condition (20). Another study reported that elevated preoperative and postoperative neutrophil-to-lymphocyte ratio (NLR) levels in patients undergoing surgery for geriatric hip fractures were significantly associated with long-term mortality, suggesting that this rate might serve as a prognostic marker (20). This finding highlighted the effect of systemic inflammation on long-term surgical outcomes, and it was suggested that it should be considered in the preoperative assessment (20). However, no significant relationship with short-term mortality was found in their study, and it was suggested that the prognostic value of the parameter might vary depending on timing. In our study, the prognostic value of preoperative albumin and lymphocyte levels in predicting mortality was investigated in patients undergoing surgery for geriatric hip fractures. Our findings indicated that low preoperative albumin levels (<3.5 g/dL) were significantly associated with higher mortality, and that their diagnostic accuracy was remarkably high (AUC: 0.997). Although the lymphocyte level was found to be associated with mortality, it displayed lower diagnostic performance (AUC: 0.622).

The overall mortality rate of 51.6% observed in this study is higher than rates reported in previous literature. However, this finding may be attributed to the advanced mean age of the cohort (79.6 years), the high proportion of patients with ASA scores ≥3 (76.8%), and the substantial prevalence of comorbidities (85.1%). Smith et al. demonstrated through a systematic review that advanced age, high ASA scores, and the presence of comorbid conditions are significantly associated with increased postoperative mortality following hip fracture surgery (16). Similarly, Kannegaard et al. reported a markedly elevated early mortality rate in elderly patients with hip fractures and emphasized that greater comorbidity burden further exacerbates this risk (21).

In previous studies, serum albumin has been identified as a strong predictor of overall mortality in older adults (22). Although this study focused on the prognostic value of individual biomarkers such as albumin and lymphocyte counts, there has been growing interest in composite indices that reflect both nutritional and inflammatory status in geriatric hip fracture patients (12). For instance, the HALP score, which combines hemoglobin, albumin, lymphocyte, and platelet counts, has shown promising results in predicting mortality in elderly populations (12). Inflammation-based prognostic scoring systems have been associated with mortality following hip fractures (23). Future research may explore the applicability of such multidimensional scoring systems to develop more comprehensive risk assessment models.

Although several studies have investigated the association between serum albumin and mortality in geriatric hip fracture patients, the present study contributes to the literature in several aspects. First, it includes a relatively large single-center cohort (n=913), enhancing statistical robustness. Second, it evaluates biochemical parameters alongside surgical and clinical variables within the same population, providing a more comprehensive clinical context. Third, ROC-based cut-off values were determined for albumin and lymphocyte levels, offering practical thresholds for potential risk stratification. Finally, mortality data were obtained from national registry systems, reflecting real-world outcomes in a tertiary referral center population. Geriatric hip fracture is a major public health concern associated with significant morbidity and mortality, yet it is largely preventable. Although surgical

intervention is often inevitable in such cases, the ability to predict postoperative mortality risk during the preoperative period plays a critical role in care planning and clinical decision-making. Low serum albumin levels may reflect not only malnutrition but also underlying inflammatory processes, hepatic dysfunction, and reduced physiological reserve. Similarly, decreased lymphocyte counts may indicate immune suppression and systemic stress. These factors collectively impair the body's ability to tolerate surgical trauma and recover postoperatively. Therefore, biomarkers such as albumin and lymphocyte levels are instrumental in preoperative risk stratification and may also inform preventive strategies. Incorporating such assessments into routine preoperative evaluation allows for tailored interventions based on individualized mortality risk. Mortality in geriatric hip fracture patients is inherently multifactorial and influenced by numerous clinical, functional, and socioeconomic factors. Therefore, it would be inappropriate to attribute mortality solely to a single laboratory parameter such as serum albumin. The present study was designed to evaluate statistical associations and discriminative performance rather than establish causality. Consequently, the findings should be interpreted within a broader clinical context and not as evidence of a direct etiological relationship.

The retrospective and single-center nature of the study are primary factors limiting the generalizability of the results. This situation complicates the assessment of the effect of institutional differences in patient management on the outcomes. Furthermore, the measurement of albumin and lymphocyte levels at different time points may have an effect on the results due to biological variability and differences in laboratory conditions. The lack of assessment of these parameters within a standardized time frame creates limitations in terms of accuracy and comparability. One of the major limitations of the study is the unavailability of specific data regarding the timing of death. Although death records were accessible via FONET and e-Nabız systems, it was not possible to determine whether the deaths occurred during hospitalization or after discharge. This limitation may affect the interpretation of the reported mortality rates. Although the AUC value of 0.997 for albumin indicates excellent discriminative performance, such an unusually high value may raise concerns about potential overfitting or imbalance in the data distribution between mortality and albumin levels. Therefore, validation through prospective, multicenter studies is essential to assess the clinical applicability of this finding. Additionally, although several variables were found to be statistically associated with mortality in univariate analyses, multivariable regression modeling was not performed. Therefore, the independent prognostic contribution of albumin and other clinical parameters could not be definitively established. The findings should thus be interpreted as associations rather than independent predictive effects.

CONCLUSIONS

In this large-scale retrospective study, preoperative serum albumin demonstrated very high discriminative performance and was strongly associated with mortality in geriatric patients undergoing hip fracture surgery (AUC: 0.997). While lymphocyte count was also associated with mortality, its diagnostic performance was comparatively limited. These findings suggest that low albumin levels may reflect not only malnutrition but also systemic inflammation and diminished physiological reserve. However, due to the absence of multivariable modeling, the independent prognostic contribution of albumin cannot be definitively established. Therefore, the results should be interpreted cautiously and considered hypothesis-generating.Future prospective, multicenter studies incorporating multivariable analyses are necessary to validate these findings

and to determine the independent clinical utility of albumin in mortality risk stratification.

Funding Statement: No external funding was received for this study.

Conflict of Interest Statement: The authors declare no conflicts of interest related to this work.

REFERENCES

1. Arslan, K., Celik, S., Arslan, H. C., Sahin, A. S., Genc, Y., & Erturk, C. Predictive value of prognostic nutritional index on postoperative intensive care requirement and mortality in geriatric hip fracture patients. Northern Clinics of Istanbul. 2024; 11(3), 249. doi: 10.14744/nci.2024.60430.
2. Espinosa, K. A., Gélvez, A. G., Torres, L. P., García, M. F., & Peña, O. R. Pre-operative factors associated with increased mortality in elderly patients with a hip fracture: a cohort study in a developing country. Injury. 2018; 49(6), 1162-1168. doi: 10.1016/j.injury.2018.04.007.
3. Darwich, A., Assaf, E., Klein, R., Gravius, S., Wölfl, C. G., & Jawhar, A. Einflussfaktoren auf die Mortalität bei Patienten mit hüftgelenknahen Frakturen an einem regionalen Traumazentrum. Zeitschrift fur Gerontologie und Geriatrie. 2021; 54(6), 561. doi: 10.1007/s00391-021-01869-9.
4. Vasu, B. K., Ramamurthi, K. P., Rajan, S., & George, M. Geriatric patients with hip fracture: frailty and other risk factors affecting the outcome. Anesthesia Essays and Researches. 2018; 12(2), 546-551. doi: 10.4103/aer.aer_61_18.
5. Kesmezacar, H., Ayhan, E., Unlu, M. C., Seker, A., & Karaca, S. Predictors of mortality in elderly patients with an intertrochanteric or a femoral neck fracture. Journal of Trauma and Acute Care Surgery. 2010; 68(1), 153-158. doi: 10.1097/ta.0b013e31819adc50.
6. Hopkins R. B., Pullenayegum, E., Goeree, et al. Estimation of the lifetime risk of hip fracture for women and men in Canada. Osteoporosis international. 2012;23, 921-927. doi: 10.1007/s00198-011-1652-8.
7. Roche, J. J. W., Wenn, R. T., Sahota, O., & Moran, C. G. Effect of comorbidities and postoperative complications on mortality after hip fracture in elderly people: prospective observational cohort study. Bmj, 2005;331(7529), 1374. doi:10.1136/bmj.38643.663843.55.
8. Joseph, E. G., Serotte, J., Haider, M. N., Pavlesen, S., & Anders, M. Delay to surgical treatment in geriatric hip fracture patients. Geriatric Orthopaedic Surgery & Rehabilitation. 2023;14, 21514593231204760. doi: 10.1177/21514593231204760.
9. Haentjens, P., Autier, P., Barette, M., Venken, K., Vanderschueren, D., & Boonen, S. Survival and functional outcome according to hip fracture type: A one-year prospective cohort study in elderly women with an intertrochanteric or femoral neck fracture. Bone. 2007;41(6), 958-964. doi: 10.1016/j.bone.2007.08.026.
10. Russell, M., McAdams, M., Matarese, L., & Gottschlich, M. Contemporary nutrition support practice: a clinical guide. Philadelphia: WB Sanders. 1998; 47-63.
11. Li, S., Zhang, J., Zheng, H., Wang, X., Liu, Z., & Sun, T. Prognostic role of serum albumin, total lymphocyte count, and mini nutritional assessment on outcomes after geriatric hip fracture surgery: a meta-analysis and systematic review. The Journal of arthroplasty. 2019;34(6), 1287-1296. doi: 10.1016/j.arth.2019.02.003.
12. Vural, A., Dolanbay, T., & Yagar, H. Hemoglobin, albumin, lymphocyte and platelet (HALP) score for predicting early and late mortality in elderly patients with proximal femur fractures. PLoS One. 2025; 20(1), e0313842. doi: 10.1371/journal.pone.0313842.
13. Smeets SJM, Verbruggen J, Poeze M. Effect of blood transfusion on survival after hip fracture surgery. Eur J Orthop Surg Traumatol. 2018;28(7):1297–1303. doi: 10.1007/s00590-018-2205-z.
14. Han, X., Han, L., Chu, F. et al. Predictors for 1-year mortality in geriatric patients following fragile intertrochanteric fracture surgery. Journal of Orthopaedic Surgery and Research. 2024;19(1), 701. doi: 10.1186/s13018-024-05219-4.
15. Tomassini S, Yeung J, Whitehouse MR, Matharu GS. Clinical effectiveness and safety of spinal anaesthesia compared with general anaesthesia in patients undergoing hip fracture surgery using a consensus-based core outcome set and patient-and public-informed outcomes: a systematic review and meta-analysis of randomised controlled trials. Br J Anaesth. 2022; 129: 788-800. doi: 10.1016/j.bja.2022.07.031.
16. Smith T, Pelpola K, Ball M, Ong A, Myint PK. Pre-operative indicators for mortality following hip fracture surgery: a systematic review and meta-analysis. Age Ageing. 2014; 43: 464-471. doi: 10.1093/ageing/afu065.

17. Doxey, S. A., Kibble, K., Kleinsmith, R. M., Huyke-Hernández, F. A., Switzer, J. A., & Cunningham, B. P. Hip Fracture Patterns, Hospital Course, and Mortality Differ Between Males and Females. Geriatric Orthopaedic Surgery & Rehabilitation. 2024; 15, 21514593241294048.. doi: 10.1177/21514593241294048.

18. Malafarina, V., Reginster, J. Y., Cabrerizo, S., et al. Nutritional status and nutritional treatment are related to outcomes and mortality in older adults with hip fracture. Nutrients. 2018;10(5), 555. doi: 10.3390/nu10050555.

19. Bohl, D. D., Shen, M. R., Hannon, C. P., Fillingham, Y. A., Darrith, B., & Della Valle, C. J. Serum albumin predicts survival and postoperative course following surgery for geriatric hip fracture. JBJS. 2017;99(24), 2110-2118. doi: 10.2106/jbjs.16.01620.

20. Chen, Y. H., Chou, C. H., Su, et al. Correlation between neutrophil-to-lymphocyte ratio and postoperative mortality in elderly patients with hip fracture: a meta-analysis. J Orthop Surg Res. 2021;16, 1-9 doi: 10.1186/s13018-021-02831-6.

21. Kannegaard, P. N., van der Mark, S., Eiken, P., & Abrahamsen, B. O. Excess mortality in men compared with women following a hip fracture. National analysis of comedications, comorbidity and survival. Age and ageing, 2010;39(2), 203-209. doi: 10.1093/ageing/afp221.

22. Zhang, Y. W., Lu, P. P., Li, Y. et al. Prevalence, characteristics, and associated risk factors of the elderly with hip fractures: a cross-sectional analysis of NHANES 2005–2010. Clinical interventions in aging. 2021; 177-185. doi:10.2147/cia.s291071.

23. Gao, Y. C., Zhang, Y. W., Shi, L., et al. What are risk factors of postoperative pneumonia in geriatric individuals after hip fracture surgery: a systematic review and meta-analysis. Orthopaedic surgery. 2023; 15.1: 38-52. doi: 10.1111/os.13631.

ORIGINAL ARTICLE

COMPARISON OF PERIOPERATIVE OUTCOMES IN YOUNG AND GERIATRIC LIVING KIDNEY DONORS: A SINGLE-CENTER RETROSPECTIVE COHORT STUDY

Turkish Journal of Geriatrics
2026; 29(1):67–73

DOI: 10.29400/tjgeri.2026.479

Emrah ŞAHİN
Ender ANILIR
Adem TUNCER
Abuzer DİRİCAN
Bülent ÜNAL

Istanbul Aydin University, General Surgery and Transplantation Unit, Istanbul, Türkiye

Abstract

Introduction: Expanding the living kidney donor pool has increased interest in evaluating geriatric individuals (≥60 years) as potential donors. Concerns regarding age-related comorbidities and perioperative risks have historically limited the use of older donors. This study aimed to compare perioperative outcomes between geriatric and young living kidney donors.

Materials and Method: Data from donors who underwent laparoscopic living donor nephrectomy at a single tertiary center between June 2018 and December 2024 were retrospectively reviewed. Donors were divided into two groups according to age: a Geriatric Group (≥60 years, n=29) and a Young Group (≤40 years, n=100). Donors aged 41–59 years were excluded by design to maximize between-group contrast. Demographic characteristics, comorbidities, perioperative morbidity parameters, length of hospital stay, and recipient outcomes were compared. Missing BMI data (32.5%) were handled by multiple imputation using Rubin's rules.

Results: The mean age was 65.4±5.5 years in the geriatric group and 29.9±5.5 years in the young group (p<0.001). Hypertension was more prevalent among geriatric donors (31.0% vs. 1.0%; p<0.001), and surgical drains were used more frequently (58.6% vs. 23.0%; p=0.001). After multiple imputation, BMI was significantly higher in geriatric donors (28.4±5.1 vs. 25.4±5.6; p=0.029). Length of hospital stay was longer in the geriatric group (4.62±1.08 vs. 4.11±0.85 days; p=0.013). No significant differences were found in postoperative infection, bleeding, or creatinine levels. No graft loss or mortality occurred.

Conclusion: With careful selection, geriatric living kidney donors demonstrate acceptable perioperative outcomes comparable to younger donors. Chronological age alone should not be an exclusion criterion for living kidney donation.

Keywords: Kidney Transplantation; Living Donor; Aged; Nephrectomy; Perioperative Care.

Correspondence

Emrah ŞAHİN
Phone : +905349526940
e-mail : dr.emrahsahin@gmail.com

Received : Jan 13, 2026
Accepted: Mar 02, 2026

Cite this article as:
Şahin E, Anılır E, Tuncer A et al. Comparison of Perioperative Outcomes in Young and Geriatric Living Kidney Donors:A Single-Center Retrospective Cohort Study. Turkish Journal of Geriatrics 2026; 29(1):67–73. doi: 10.29400/tjgeri.2026.479

INTRODUCTION

Kidney transplantation is the most effective treatment for patients with end-stage renal disease, offering a survival advantage and higher quality of life than dialysis (1, 2). However, the greatest obstacle to this "gold standard" treatment is the growing global organ shortage. Although more than 150,000 organ transplants were performed worldwide in 2022, it is far from meeting the demand (3). In Turkey, tens of thousands of patients are waiting for organ transplantation (4). This critical organ deficit extends the time spent on waiting lists, increasing the risk of morbidity and mortality for these patients (5).

One of the most important strategies for overcoming this challenge is the expansion of living donor kidney transplantation (LDKT) programs. LDKT offers significant advantages over deceased donor transplantation such as superior graft and patient survival rates, shorter cold ischemia times, and the possibility of preemptive transplantation (before starting dialysis) (6).

Historically, advanced donor age has been considered a relative contraindication for living donations because of concerns regarding age-related decline in nephron mass, increased prevalence of comorbidities, and potentially lower graft function (7). The increasing demand for organs has led to strategies to expand the donor pool to the forefront; consequently, individuals aged ≥60 years, who are among the expanded criteria donors, have emerged as a significant potential source (8). The paradigm in clinical practice is evolving from an assessment based solely on an individual's chronological age to a holistic evaluation reflecting their "biological age" and overall health status. This approach supports the idea that healthy older individuals can be safe donors (9).

Although the safety of older living kidney donors has been supported by international evidence, the majority of this evidence originates from Western transplant centers. A recent systematic review and meta-analysis by Bellini et al. (10), which analyzed 47 studies, demonstrated that while older donor age was associated with reduced graft function and higher rates of acute rejection and delayed graft function in recipients, no significant difference in 1-year recipient survival was found between recipients of donors aged <60 versus >60 years. Similarly, Yamamoto et al. (11), in a recent Japanese multicenter study of 633 living-donor kidney transplants, showed that kidneys from donors aged ≥70 years provided comparable death-censored graft survival in recipients aged ≥50 years, supporting the concept of donor–recipient age matching. However, data specifically examining perioperative outcomes in geriatric donors from Turkish transplant centers—despite Turkey's prominent role in global living-donor transplantation—remain scarce. Moreover, most comparative studies use a single age cutoff (e.g., 50 or 60 years), including the adjacent intermediate-age group, which may dilute the contrast between the youngest and oldest donors.

This study aimed to compare the basic demographic characteristics and perioperative morbidities of geriatric (≥60 years) and young (≤40 years) living kidney donors using an extreme age-group comparison design to provide a stringent assessment of whether carefully selected geriatric donors can achieve perioperative outcomes comparable to the healthiest young donors.

MATERIALS AND METHOD

Study Design and Patient Population

This single-center, retrospective cohort study included data from consecutive living donor nephrectomies performed at the Organ Transplant Center of Istanbul Aydin University Florya Medical Park Hospital between June 2018 and December 2024. This study was conducted in accordance with Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines. The study protocol was approved by the Non-Interventional Clinical Research Ethics Committee (Approval No: 163/2025, Date: 06 August 2025).



This study was conducted in accordance with the principles of the Declaration of Helsinki.

Inclusion criteria were as follows: (1) all consecutive living kidney donors who underwent laparoscopic donor nephrectomy at our center during the study period; (2) donor age ≤40 years or ≥60 years at the time of donation; and (3) successful completion of our center's standard multidisciplinary donor evaluation protocol, which includes comprehensive medical, surgical, urological, nephrological, psychological, and anesthesiological assessments in accordance with national guidelines.

Exclusion criteria were: (1) donors aged 41–59 years, who were excluded by the a priori study design to maximize the demographic contrast between comparison groups (extreme age-group comparison design); and (2) donors who underwent open donor nephrectomy. The rationale for excluding the intermediate age group was to create two demographically distinct cohorts representing the extremes of the donor age spectrum, thereby providing a more rigorous test of whether geriatric donors can achieve perioperative outcomes comparable to the youngest, healthiest donors. This design is analogous to approaches used in other transplant studies comparing extreme age groups (11).

The living kidney donors included in the study were divided into two main groups based on their age: Group 1 (Geriatric Donors, ≥60 years, n=29) and Group 2 (Young Donors, ≤40 years, n=100).

Data Collection and Variables

Donor variables (age, sex, body mass index [BMI], smoking history, and comorbidities), donor morbidity variables (length of hospital stay, need for a drain, laxative requirement, and complications), and outcome variables (graft and patient survival) were retrospectively collected from the hospital records. Postoperative infections were defined as culture-proven urinary tract infections, surgical site infections according to Centers for Disease Control and Prevention criteria, or infections supported by clinical and radiological findings requiring antibiotic treatment.

Surgical Technique

All donor nephrectomies were performed laparoscopically using a standard transperitoneal approach. For left nephrectomies, the surgical procedure was typically performed using three trocar ports. A fourth lateral trocar was rarely added to ensure optimal graft manipulation. In right nephrectomy cases, a fourth subxiphoid trocar was routinely placed for safe retraction of the liver. In most cases, control of the renal artery and vein was achieved by transecting both vessels together with a single vascular stapler. The graft was extracted through an approximately 5–6 cm horizontal incision, similar to a Pfannenstiel incision. A closed-system drain was sometimes placed at the discretion of the surgeon.

Statistical Analysis

All statistical analyses were performed using SPSS version 28.0 (IBM Corp., Armonk, NY). Statistical significance was set at $p<0.05$. The normality of continuous variables was assessed using the Shapiro–Wilk test. Normally distributed continuous data were compared using Student's t-test, and non-normally distributed data were compared using the Mann–Whitney U test. Pearson's chi-square test or Fisher's exact test were used to compare categorical variables.

Missing BMI data (42/129 donors; 32.5%) were handled using multiple imputation (MI) as the primary analysis. Twenty complete datasets (m=20) were generated using a regression-based imputation model that included age, sex, and group assignment as predictor variables. Each imputed dataset was analyzed independently, and the results were combined using Rubin's rules to obtain pooled point estimates and standard errors. A complete case analysis was also performed as a sensitivity analysis for comparison. A missingness pattern analysis was conducted to evaluate whether

the data were Missing Completely at Random (MCAR) or Missing at Random (MAR).

RESULTS

In total, 129 living kidney donors were included in this study. The baseline characteristics of the two groups are shown in Table 1. As per the study design, the mean age of the geriatric group was 65.4±5.5 years, while the mean age of the younger group was 29.9±5.5 years (p<0.001). The prevalence of hypertension in the geriatric group (31.0%) was significantly higher than that in the younger group (1.0%) (p<0.001). Coronary artery disease was observed in 2 geriatric donors (6.9%) and none of the young donors (p=0.049). There were no statistically significant differences between groups in terms of sex or smoking status.

After multiple imputation, BMI was significantly higher in the geriatric group (28.4±5.1 kg/m²) compared with the young group (25.4±5.6 kg/m²; Rubin's pooled p=0.029). This finding was not detected in the complete case analysis (25.4±5.7 vs. 28.2±4.9; p=0.064), likely due to reduced statistical power from the 32.5% missing data rate. The missingness pattern analysis showed that the rate of missing BMI data was similar between groups (Young: 43.0% vs. Geriatric: 34.5%; p=0.544), and the mean age did not differ between donors with available and missing BMI data within either group (all p>0.05), supporting a Missing at Random (MAR) assumption.

The perioperative morbidity outcomes for the donors are summarized in Table 2. The length of hospital stay for donors in the geriatric group

Table 1. Demographic and clinical data of young and geriatric donor groups

Variable	Young Group (n=100)	Geriatric Group (n=29)	p-value
Age (years), mean±SD	29.9±5.5	65.4±5.5	<0.001[a]
Female, n (%)	59 (59.0)	18 (62.1)	0.935[b]
BMI (kg/m²), mean±SD (MI)	25.4±5.6	28.4±5.1	0.029[c]
BMI (kg/m²), mean±SD (CC)	25.4±5.7 (n=57)	28.2±4.9 (n=19)	0.064[a]
Smoking, n (%)	27 (27.0)	6 (20.7)	0.657[b]
Hypertension, n (%)	1 (1.0)	9 (31.0)	<0.001[d]
Diabetes mellitus, n (%)	0 (0.0)	1 (3.4)	0.225[d]
Coronary artery disease, n (%)	0 (0.0)	2 (6.9)	0.049[d]

SD: Standard Deviation; BMI: Body Mass Index; MI: Multiple Imputation; CC: Complete Case. a: Independent Samples t-test. b: Pearson Chi-square test. c: Rubin's pooled estimate from 20 multiply imputed datasets. d: Fisher's Exact Test. BMI complete case analysis excludes 42 donors (32.5%) with missing data.

Table 2. Perioperative outcomes and postoperative complications in donor groups

Variable	Young Group (n=100)	Geriatric Group (n=29)	p-value
Hospital stay (days), mean±SD	4.11±0.85	4.62±1.08	0.013[a]
Drain placement, n (%)	23 (23.0)	17 (58.6)	0.001[b]
Laxative requirement, n (%)	27 (27.0)	12 (41.4)	0.210[b]
Postoperative infection, n (%)	5 (5.0)	1 (3.4)	1.000[c]
Postoperative bleeding, n (%)	0 (0.0)	0 (0.0)	–
Postop max creatinine (mg/dL), mean±SD	1.26±0.31	1.28±0.23	0.522[a]
Graft loss, n (%)	0 (0.0)	0 (0.0)	–
Patient mortality, n (%)	0 (0.0)	0 (0.0)	–

SD: Standard Deviation. a: Mann–Whitney U test. b: Pearson Chi-square test. c: Fisher's Exact Test.



(4.62±1.08 d) was significantly longer than for those in the younger group (4.11±0.85 d) (Mann–Whitney U test, p=0.013). A surgical drain was placed in 58.6% of geriatric donors, whereas this rate was 23.0% in younger donors (p=0.001). No postoperative bleeding complications were observed in either group. The postoperative infection rate was low and similar between the groups (p=1.000).

During the follow-up period, no graft loss or patient death was observed in recipients from either donor group (100% graft and patient survival).

DISCUSSION

This study demonstrated that geriatric living kidney donors, despite a higher comorbidity burden, have manageable perioperative outcomes and provide excellent graft function, comparable to young donors. Our findings, consistent with the "healthy donor effect," underscore that a meticulous selection process can mitigate age-related risks, making chronological age a poor standalone criterion for exclusion.

A key strength of the present study is its extreme age-group comparison design (≥60 vs. ≤40 years), which represents a more stringent test than studies using a single age cutoff. By comparing the oldest donors directly with the youngest—rather than with donors only slightly younger than the geriatric threshold—our design amplifies any potential age-related differences. The fact that perioperative outcomes remained largely comparable despite this maximized contrast strengthens the conclusion that well-selected geriatric donors are suitable candidates. Furthermore, although the safety of older donors is supported by large-scale international evidence, including the systematic review and meta-analysis by Bellini et al. (10) encompassing 47 studies and the recent multicenter study by Yamamoto et al. (11), published data from Turkish transplant centers specifically addressing geriatric living kidney donor outcomes remain scarce, despite Turkey's prominent role in global living-donor transplantation. Our study provides real-world evidence to address this gap.

The higher use of surgical drains in our geriatric cohort likely reflects surgeon-dependent practice variation ("confounding by indication"), where surgeons proactively manage the perceived higher risk associated with age-related vascular fragility and higher rates of hypertension rather than reacting to an actual intraoperative event. This variable is inherently limited by the retrospective design, where surgeon decision-making cannot be standardized or controlled. Future prospective studies with standardized drain placement protocols would be needed to objectively assess whether geriatric donors truly require drainage more frequently.

Although the difference in length of hospital stay was statistically significant (p=0.013), the absolute difference of approximately 0.5 days (4.62 vs. 4.11 days) is unlikely to be clinically meaningful. This modest prolongation likely reflects a more conservative postoperative observation period for older patients—a rational and precautionary clinical decision—rather than an increased burden of complications. Similar findings have been reported in other studies of older donors, where slightly longer hospital stays were not associated with higher complication rates (12, 13).

The finding that geriatric donors had significantly higher BMI after multiple imputation (p=0.029) is consistent with the well-established epidemiological trend of increasing body weight with age. Notably, the meta-analysis by Bellini et al. (10) demonstrated that donor obesity increased the incidence of delayed graft function in recipients (RR=0.72, p=0.002), although it did not affect acute rejection rates. In our study, the absence of significant differences in postoperative complications between groups suggests that the moderately higher BMI in geriatric donors did not translate into adverse perioperative outcomes. The complete case analysis, which excluded 32.5% of donors, failed to detect this difference (p=0.064),

underscoring the importance of appropriate handling of missing data.

Our results align with a growing body of literature supporting the safety and efficacy of using older donors (12, 13). Studies have shown that kidneys from older living donors offer a significant survival advantage over those from the deceased donor waiting list (14). Furthermore, long-term follow-up of older donors has shown stable post-nephrectomy renal function, similar to that of younger counterparts (13, 15). Direct comparison with the meta-analytic findings of Bellini et al. (10) is instructive: while their analysis found that recipients of donors aged <60 had 38% lower risk of acute rejection and 72% lower risk of delayed graft function compared to those from donors aged >60, these findings primarily reflect recipient-side graft outcomes rather than donor perioperative safety. Our study complements this evidence by demonstrating that the donor-side perioperative morbidity profile remains favorable in geriatric donors. Additionally, Yamamoto et al. (11) showed that for recipients aged ≥50 years, graft survival from donors aged ≥70 was comparable to that from younger donors (p=0.743), supporting the concept of donor–recipient age matching. This finding reinforces our conclusion that chronological age alone should not preclude donation and that age-appropriate donor–recipient pairing may optimize long-term outcomes.

The primary implication of our study is the reinforcement of a paradigm shift in donor evaluation from a rigid focus on chronological age to a holistic assessment of "physiological fitness" (16). This approach is crucial for safely expanding the donor pool to combat organ shortages.

Limitations of the Study

This study was limited by its retrospective, single-center design, which may affect the generalizability and introduce selection bias. Single-center practice patterns—particularly surgeon-dependent variables such as drain placement criteria—may not be representative of other institutions with different surgical protocols. The follow-up period was insufficient for long-term outcome analysis. The imbalance in group sizes (29 vs. 100) reflects the real-world distribution of donors and may have reduced statistical power for detecting smaller differences. The exclusion of the intermediate age group (41–59 years), while intentional for the extreme age-group comparison design, limits the generalizability of findings to the full spectrum of living kidney donor ages. The 32.5% missing BMI data represented the most significant data quality limitation. Although multiple imputation was performed as the primary analysis to address this issue, the results should still be interpreted with caution. The missingness pattern analysis supported a MAR assumption, but the possibility of data being Missing Not at Random (MNAR) cannot be entirely excluded. Furthermore, our study focused on perioperative outcomes and did not evaluate long-term recipient graft function or survival, which Bellini et al. (10) and Yamamoto et al. (11) have shown to be influenced by donor age. Future studies with longer follow-up periods are needed to address this gap.

CONCLUSIONS

When subjected to a rigorous multidisciplinary evaluation, living kidney donors aged ≥60 years are a safe and vital resource for expanding the organ pool. Chronological age should not be an absolute barrier to organ donation. Future research, ideally multicenter and prospective, should focus on refining the selection of older donor candidates and potentially integrating novel biomarkers of physiological reserve.

Acknowledgements: We would like to thank Editage (www.editage.com) for English language editing.

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



REFERENCES

1. Tonelli M, Wiebe N, Knoll G, et al. Systematic review: kidney transplantation compared with dialysis in clinically relevant outcomes. Am J Transplant. 2011;11(10):2093–2109. doi: 10.1111/j.1600-6143.2011.03686.x.
2. Lentine KL, Smith JM, Lyden GR, et al. OPTN/SRTR 2022 Annual Data Report: Kidney. Am J Transplant. 2024;24(Suppl 1):S19–S118. doi: 10.1016/j.ajt.2024.01.012.
3. Gürçayır D, Karabulut N. Determination of academic staff' attitudes towards organ donation: Türkiye sample. Curr Res Health Sci. 2024;1(2):62–69. doi: 10.5281/zenodo.12510703.
4. Özşeker FN, Kudsioğlu ŞT. Knowledge, attitudes, and behaviors of patients diagnosed with end-stage kidney disease registered on the kidney transplant waiting list regarding organ transplantation and donation. J Eur Intern Med Prof. 2023;1(3). doi: 10.5281/zenodo.8135520.
5. Wolfe RA, Ashby VB, Milford EL, et al. Comparison of mortality in all patients on dialysis, patients on dialysis awaiting transplantation, and recipients of a first cadaveric transplant. N Engl J Med. 1999;341(23):1725–1730. doi: 10.1056/NEJM199912023412303.
6. Savoye E, Santin G, Legeai C, et al. Comparison of kidney graft function and survival in an emulated trial with living donors and brain-dead donors. Transpl Int. 2024;37:13208. doi: 10.3389/ti.2024.13208.
7. Akoh JA, Thiyagarajan UM. Renal transplantation from elderly living donors. J Transplant. 2013;2013:475964. doi: 10.1155/2013/475964.
8. Metzger RA, Delmonico FL, Feng S, Port FK, Wynn JJ, Merion RM. Expanded criteria donors for kidney transplantation. Am J Transplant. 2003;3(Suppl 4):114–125. doi: 10.1034/j.1600-6143.3.s4.11.x.
9. Segev DL, Muzaale AD, Caffo BS, et al. Perioperative mortality and long-term survival following live kidney donation. JAMA. 2010;303(10):959–966. doi: 10.1001/jama.2010.237.
10. Bellini MI, Nozdrin M, Pengel L, Knight S, Papalois V. How good is a living donor? Systematic review and meta-analysis of the effect of donor demographics on post kidney transplant outcomes. J Nephrol. 2022;35(3):807–820. doi: 10.1007/s40620-021-01231-7.
11. Yamamoto R, Saito M, Matsuura T, et al. Clinical outcomes of living kidney transplantation from donors aged 70 years and older: a Japanese multicenter study. Sci Rep. 2026;16:2694. doi: 10.1038/s41598-025-32558-x.
12. Berardinelli L, Pozzoli E, Beretta C, et al. Long-term outcome of living donors older than 60 years. Transplant Proc. 2010;42(4):1111–1113. doi: 10.1016/j.transproceed.2010.03.124.
13. Patel K, Brotherton A, Chaudhry D, et al. Survival advantage comparing older living donor versus standard criteria donor kidney transplants. Transpl Int. 2024;37:12559. doi: 10.3389/ti.2024.12559.
14. Ferguson R, Grinyó J, Vincenti F, et al. Immunosuppression with belatacept-based, corticosteroid-avoiding regimens in de novo kidney transplant recipients. Am J Transplant. 2011;11(1):66–76. doi: 10.1111/j.1600-6143.2010.03338.x.
15. Mesnard B, Territo A, Campi R, et al. Kidney transplantation from elderly donors (>70 years): a systematic review. World J Urol. 2023;41(3):695–707. doi: 10.1007/s00345-023-04311-4.
16. Ahmadi AR, Lafranca JA, Claessens LA, et al. Shifting paradigms in eligibility criteria for live kidney donation: a systematic review. Kidney Int. 2015;87(1):31–45. doi: 10.1038/ki.2014.118.

ORIGINAL ARTICLE

ACUTE ABDOMEN IN THE OLDEST-OLD: ETIOLOGIES AND MORTALITY OUTCOMES IN NONAGENARIANS

Turkish Journal of Geriatrics
2026; 29(1):74–85

DOI: 10.29400/tjgeri.2026.480

Ahmet Gürkan ERDEMİR[1]
Ayşenur BOLUKÇU[1]
Esra AKÇİÇEK[1]
Gökhan KAHRAMAN[1]
Ali BATUR[2]
İlkay Sedakat İDİLMAN[1]
Mehmet Ruhi ONUR[1]
Erhan AKPINAR[3]

[1] Hacettepe University, Faculty of Medicine, Department of Radiology, Ankara, Türkiye

[2] Hacettepe University, Faculty of Medicine, Emergency Medicine, Ankara, Türkiye

[3] University of Chicago, Department of Radiology, Ankara, Türkiye

Correspondence

Ahmet Gürkan ERDEMİR
Phone : +903123051188
e-mail : a.gurkan.erdemir@gmail.com

Received : Feb 02, 2026
Accepted: Mar 03, 2026

Cite this article as:
Erdemir AG, Bolukçu A, Akçiçek E et al. Acute Abdomen in the Oldest-Old: Etiologies and Mortality Outcomes in Nonagenarians. Turkish Journal of Geriatrics 2026; 29(1):74–85. doi: 10.29400/tjgeri.2026.480

Abstract

Introduction: With nonagenarians (≥90 years) increasingly presenting with non-traumatic acute abdomen, evidence on CT-based etiologies and short-term outcomes remains scarce, underscoring the need for focused data. To evaluate the etiological distribution and short-term mortality in nonagenarians undergoing abdominopelvic CT for non-traumatic acute abdomen.

Materials and Method: This retrospective study included patients aged 90–99 who underwent CT between January 2013 and September 2023. Radiological findings were classified into 12 etiological subgroups. Malignancy status and surgical or image-guided interventions were documented. Mortality was assessed at 24 hours, 7 days, and 30 days. Categorical comparisons used chi-square or Fisher's exact tests ($p<0.05$).

Results: A total of 529 patients (mean age: 92.9 years) were analyzed; 55.4% (n=293) had positive CT findings, most frequently hepatopancreatobiliary (10.8%), vascular (10.4%), and intestinal obstruction/torsion (8.5%). Malignancy-related etiologies comprised 31.7% of positive cases. Surgical or interventional treatment was performed in 10.4% (n=55). Overall mortality was 1.5% at 24 hours, 6.2% at 7 days, and 18.3% at 30 days. One-month mortality was higher in patients with positive CT findings (27.3%) compared to negative (7.2%, $p<0.001$). Among positive cases, malignancy-related etiologies showed significantly increased 30-day mortality (49.5% vs. 17.0%, $p<0.001$). Patients undergoing intervention also had elevated mortality (43.6% vs. 23.5%, $p=0.003$). Mortality varied by etiology, with gastrointestinal bleeding, perforation, and vascular causes carrying the greatest risk ($p<0.001$).

Conclusion: This cohort provides a comprehensive overview of CT-based etiologies and outcomes in nonagenarians with acute abdomen. Malignancy, certain etiologies, and the need for intervention were strongly linked with adverse prognosis.

Keywords: Abdomen, Acute; Emergency Medical Services; Multidetector Computed Tomography; Mortality; Aged, 80 and Over.

INTRODUCTION

Advances in modern medicine, public health infrastructure, and socioeconomic conditions have markedly extended life expectancy, resulting in a steadily growing population of very elderly adults—particularly nonagenarians (≥90 years) (1, 2). This demographic shift is increasingly visible in acute care, where emergency departments are encountering more nonagenarian patients than ever before (3-5). Managing acute abdominal presentations in this age group is uniquely challenging: clinical signs are frequently nonspecific because of blunted inflammatory responses and atypical symptomatology, and decision-making is complicated by multimorbidity and limited physiological reserve (6-9).

Computed tomography (CT) is central to the evaluation of suspected acute abdomen in older adults (10, 11). However, most prior studies aggregate all "geriatric" patients without adequate age stratification, limiting the applicability of their findings to the oldest-old (12, 13). Moreover, in nonagenarians it is common for multiple interacting factors to coexist; thus, CT findings should be interpreted in the context of clinical presentation, laboratory data, past medical history, and medications. Our study therefore provides a CT-anchored etiologic description while explicitly acknowledging the need for clinical integration.

Given these gaps in the literature, there is a pressing need for focused studies that characterize the etiological spectrum of non-traumatic acute abdomen in this advanced age group and evaluate relevant clinical outcomes. Our objectives were twofold: (i) to classify radiologically identifiable etiologies on abdominopelvic CT into 12 predefined subgroups designed pragmatically to reflect emergency decision-making (a blend of organ-system and pathophysiologic categories), and (ii) to evaluate all-cause mortality at three clinically relevant time points—24 hours, 7 days, and 30 days. Because cancer-related processes may transcend organ-based buckets and carry distinct prognostic implications, we additionally flagged malignancy-related etiologies as an orthogonal high-risk subset and examined outcomes by malignancy status and by the need for surgical or image-guided intervention.

MATERIALS AND METHOD

This retrospective study was approved by the Institutional Ethics Committee of our institution (approval number: GO 24/078). All procedures were conducted in accordance with the ethical standards outlined in the Declaration of Helsinki. This retrospective, single-center study was undertaken in the emergency department of a tertiary hospital.

Study Population and Eligibility Criteria

Consecutive nonagenarian patients (age ≥90 years) who underwent emergent abdominopelvic CT for non-traumatic acute abdominal symptoms between January 1, 2013 and September 1, 2023 were identified.

Inclusion: acute onset abdominal pain and/or objective abdominal signs leading to ED-initiated CT; absence of recent trauma (<30 days).

Exclusion: trauma within 30 days; CT performed for non-acute indications; technically non-diagnostic CT; duplicate encounters (only the index ED visit per patient retained). Pre-existing malignancy and recent surgery were not exclusionary and were abstracted as covariates.

Case Definitions & Etiologic Taxonomy (12 Subgroups)

A positive CT was defined a priori as imaging evidence plausibly explaining the presentation. CT-based etiologies were classified into 12 predefined subgroups reflecting pragmatic emergency decision-making:

1. Hepatopancreatobiliary (HPB): acute cholecystitis/cholangitis, biliary obstruction, acute pancreatitis (Revised Atlanta features).
2. Vascular emergencies: aortic/visceral aneurysm or dissection, mesenteric ischemia/infarction, mesenteric venous thrombosis with ischemic sequelae.
3. Intestinal obstruction/torsion: mechanical obstruction with a transition point; volvulus.
4. Gastroenterocolitis: CT signs of infectious/inflammatory enteritis or colitis (mural hyperenhancement/edema with perienteric stranding) without perforation/ischemia.
5. Genitourinary: obstructive uropathy, pyelonephritis, emphysematous infection, complicated cystitis.
6. Newly diagnosed uncomplicated malignancy: incidentally detected intra-abdominal/pelvic malignancy without an acute complication explaining symptoms.
7. Diverticulitis: colonic diverticulitis with pericolic inflammation/abscess (Hinchey staging if applicable).
8. Spontaneous hematoma: intramural bowel, retroperitoneal, rectus sheath, or psoas hematoma not related to trauma/procedure.
9. Gastrointestinal perforation: extraluminal free air with identifiable source or highly suggestive CT signs.
10. Gastrointestinal bleeding: active contrast extravasation or intraluminal high-attenuation material compatible with acute bleeding.
11. Appendicitis: typical CT criteria for acute appendicitis.
12. Miscellaneous: entities such as epiploic appendagitis, panniculitis, falciform ligament torsion, or necrotizing infection not fitting the above categories.

Because malignant processes may traverse organ systems and carry distinct prognostic implications, cases were additionally flagged as malignancy-related etiology when the acute CT finding explaining the presentation was attributable to known or newly identified malignancy (e.g., malignant obstruction, tumor-related perforation, ischemia from tumor/thromboembolism). When feasible, the primary tumor origin (e.g., HPB, GI, GU, gynecologic) was recorded.

Handling of Mixed Etiologies

When more than one acute process coexisted, a single "primary driver"—the lesion judged most responsible for the presentation—was assigned, and additional "secondary" processes were recorded. All CT categorizations were performed "in clinical context", integrating ED history, medication use (e.g., anticoagulants), vital signs, and laboratory data available at the time of imaging.

Interventions

Surgical or image-guided interventions (e.g., laparotomy, bowel resection, ERCP, percutaneous drainage, endovascular therapy) performed after the index CT during the same episode of care were recorded regardless of CT categorization, as treatment decisions were made by clinical teams based on the totality of information. Causal inference regarding the effect of intervention was not attempted; intervention status was treated analytically as a "marker of illness severity" and included as an adjustment variable.

CT Acquisition and Image Interpretation

All examinations were performed on a 64-slice scanner (Somatom Perspective, Siemens Healthineers, Erlangen, Germany) within the emergency radiology unit. Typical parameters included 110–130 kVp; automated tube current modulation; collimation 0.6–2.0 mm; rotation time 0.6–1.0 s; reconstructed slice thickness 2 mm. Intravenous iodinated contrast (300–350 mg I/mL; 90–120 mL at 3–5 mL/s) was administered unless



contraindicated; arterial or portal-venous phase timing (30–60 s delay) was selected according to the clinical question. Oral contrast use followed the contemporaneous ED protocol and was recorded.

CT studies were reviewed in "consensus" by two emergency radiologists (8 and 2 years of experience, A.G.E. and A.B. respectively), with access to clinical and laboratory information available at the time of imaging. Outcome data (mortality and subsequent interventions) were not available to the readers during review.

Outcomes and Data Sources

The primary outcome was all-cause mortality at 30 days from the index CT. Secondary outcomes were mortality within 24 hours and within 7 days. Mortality status and dates were obtained from institutional electronic records and, when available, cross-checked with the national death registry. Patients without recorded death by 30 days were censored alive at day 30.

Statistical Analysis

Analyses were conducted in IBM SPSS v23. Continuous variables were summarized as mean±SD or median (IQR), and categorical variables as counts (percentages). Group comparisons employed χ^2 or Fisher's exact tests, as appropriate. Effect sizes were estimated using odds ratios (ORs) with 95% confidence intervals (CIs). For 30-day mortality, a multivariable logistic regression model was specified a priori including age, sex, positive CT (yes/no), etiologic subgroup indicators, malignancy-related etiology (yes/no), IV contrast use, and intervention (yes/no). Collinearity was assessed (VIF<5). Exploratory time-to-event analyses used Kaplan–Meier curves with log-rank tests to compare survival by (i) positive CT, (ii) malignancy-related etiology, and (iii) intervention. Where multiple subgroup comparisons were performed, Benjamini–Hochberg false discovery rate control was applied in sensitivity analyses. A two-sided $p<0.05$ signified statistical significance.

RESULTS

Baseline Data

A total of 529 patients aged 90 years and above were included in the study cohort. The mean age of the population was 92.90 years (SD: 2.61), with a median age of 92.00 years. The majority of the patients were female (n=332, 62.76%), while males accounted for 37.24% (n=197) of the study group.

In terms of imaging protocols, oral contrast was not administered in most cases (n=393, 74.29%), whereas 25.71% (n=136) of the patients received oral contrast agents. Intravenous contrast was more commonly used, with 76.05% (n=397) of patients undergoing contrast-enhanced CT scans, and 24.95% (n=132) evaluated with non-contrast studies.

An overview of the baseline demographic profile and contrast usage among the study cohort is presented in Figure 1.

Etiologic Spectrum and CT Diagnosis

Radiological findings consistent with a specific cause of acute abdomen were identified in 55.39% of the patients (n=293), while no acute pathological findings were detected in the remaining 44.61% (n=236). Among the patients with positive findings, the most frequently observed etiological categories were hepatopancreatobiliary diseases (n=57, 10.77% of all patients; 19.45% of those with pathological findings) and vascular emergencies (n=55, 10.39%; 18.77%), followed by intestinal obstruction or torsion (n=45, 8.50%; 15.35%). Gastroenterocolitis (n=34, 6.42%; 11.60%) and genitourinary causes (n=35, 6.61%; 11.94%) were also relatively common. Less frequent causes included uncomplicated newly diagnosed malignancy (n=22, 4.15%; 7.50%), diverticulitis (n=11, 2.07%; 3.75%), spontaneous hematoma (n=10, 1.89%; 3.41%), gastrointestinal perforation (n=8, 1.51%; 2.73%), gastrointestinal bleeding (n=7, 1.32%; 2.38%), acute appendicitis (n=4, 0.75%; 1.36%), and miscellaneous conditions (n=5, 0.94%; 1.70%). To elaborate, the "spontaneous hematoma" and "miscellaneous" subgroups comprise the

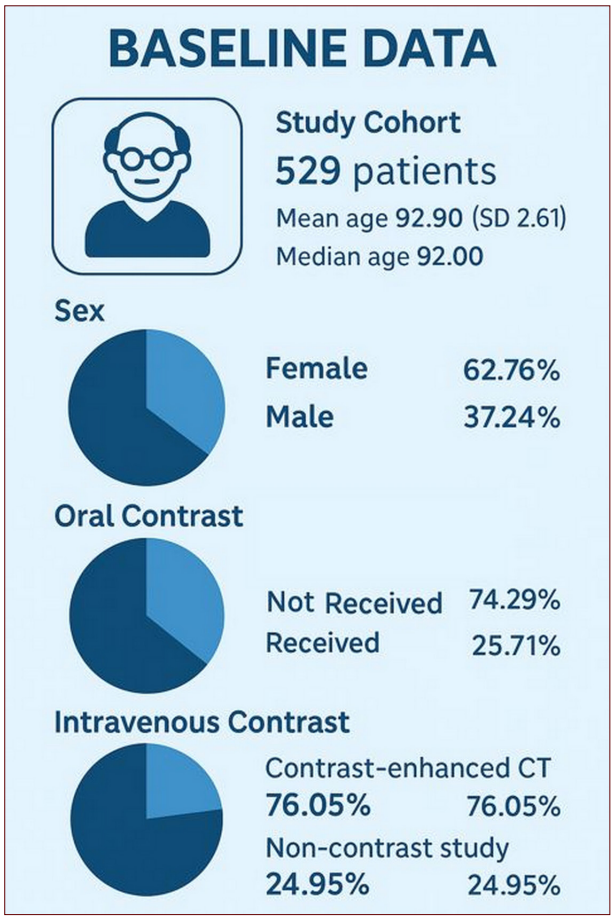


Figure 1. Illustration of baseline data. Demographic and imaging protocol characteristics of the study cohort (n=529). The mean age was 92.90 years (SD: 2.61), with a median age of 92.00 years. The majority of patients were female (62.76%). Oral contrast was not administered in 74.29% of cases, while 76.05% underwent contrast-enhanced CT with intravenous contrast.

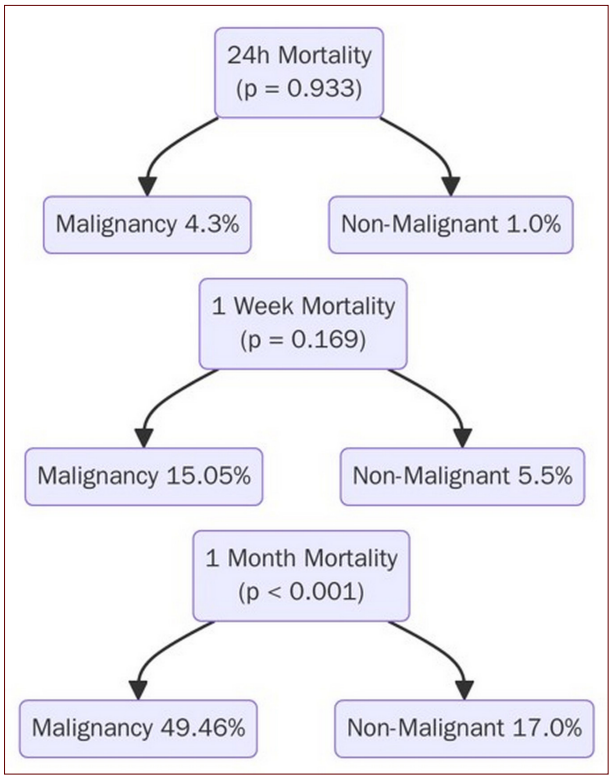


Figure 2. Temporal mortality comparison between malignancy-related and non-malignant causes of acute abdomen. This flowchart demonstrates mortality rates at 24 hours, 1 week, and 1 month among patients with radiologically confirmed pathology, stratified by malignancy association. While early mortality did not differ significantly, one-month mortality was markedly higher in malignancy-related cases (49.46%) compared to non-malignant ones (17.0%) ($p < 0.001$), highlighting malignancy as a key prognostic factor.

following: 7 rectus muscle hematomas, 2 psoas muscle hematomas, and 1 intramural small bowel hematoma; and 2 cases of epiploic appendagitis, 1 case each of panniculitis, torsion of the falciform ligament, and necrotizing fasciitis, respectively.

Outcomes in Malignancy-Related Cases

Among the 293 patients with a radiologically identifiable etiology for acute abdomen, 93 cases (31.74%) were found to be secondary to malignancy, while 68.26% (n=200) were not malignancy-related. Despite the advanced age of the study population, only 18.77% of these patients (n=55) underwent either surgical or image-guided interventional treatment based on CT findings, while the remaining 81.23% (n=238) were managed conservatively.

The stratification of mortality rates based on whether the underlying etiology was malignancy-related or not is illustrated in Figure 2.

Mortality at 24 Hours, 7 Days, and 30 Days

Within the first 24 hours, mortality was observed in 8 patients (1.51% of the entire cohort), with no statistically significant difference between patients with positive CT findings (n=6/293, 2.04%) and those without identifiable pathology (n=2/236, 0.84%) (p=0.261). By day 7, mortality increased to 6.23% (n=33/529), and the difference became statistically significant between patients with positive findings (n=25/293, 8.53%) and those without (n=8/236, 3.38%) (p=0.015). The trend continued at one month, with a total mortality rate of 18.33% (n=97/529). One-month mortality was significantly higher in patients with acute pathological findings on CT (n=80/293, 27.30%) compared to those without any findings (n=17/236, 7.20%) (p<0.001).

The mortality rates at 24 hours, 7 days, and 1 month—stratified by the presence or absence of acute pathological findings on CT—are illustrated in Figure 3.

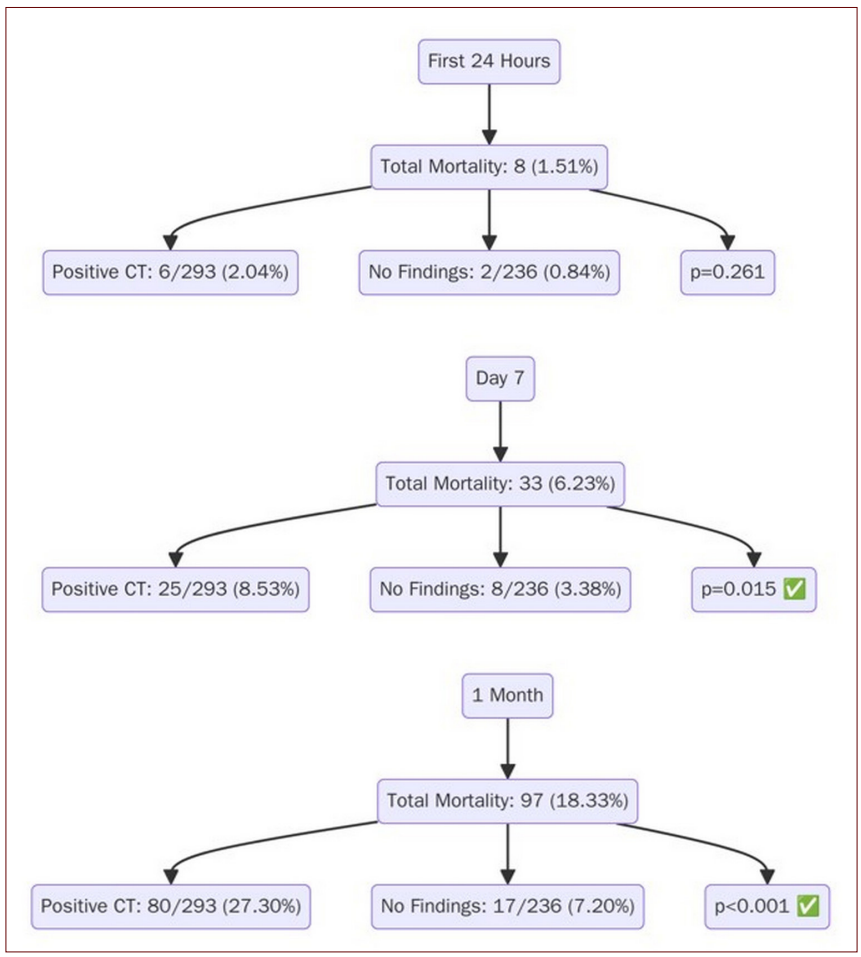


Figure 3. Temporal mortality rates according to the presence or absence of acute radiological findings. This flowchart illustrates mortality at three time points—first 24 hours, day 7, and one month—comparing patients with positive CT findings to those without identifiable pathology. While early mortality (day 1) did not differ significantly between groups (p=0.261), significant differences emerged by day 7 (p=0.015) and were more pronounced at one month (p<0.001), with higher mortality consistently observed among patients with acute radiological findings.

Mortality Across Etiologic Subgroups

Among the 293 patients with radiologically confirmed acute abdominal pathology, mortality was further stratified according to whether the underlying cause was secondary to malignancy (n=93) or not (n=200). Within the first 24 hours, mortality rates were comparable between malignancy-related and non-malignancy-related cases —4.30% (n=4) vs. 1.00% (n=2), respectively— with no statistically significant difference (p=0.933). By the end of the first week, mortality was observed in 15.05% (n=14) of patients with malignancy-associated acute abdomen, compared to 5.50% (n=11) in those without malignancy; however, this difference did not reach statistical significance (p=0.169). At one month, however, malignancy-related cases showed a markedly higher mortality rate of 49.46% (n=46), compared to 17.00% (n=34) in non-malignant cases, and this difference was statistically significant (p<0.001).

Analysis of first-day mortality across the 12 etiological subgroups revealed that early mortality was most pronounced in patients with intestinal perforation (12.50%, 1/8), spontaneous hematoma (10.00%, 1/10), and vascular causes (5.45%, 3/55). Lower rates were noted in patients with intestinal obstruction or torsion (2.22%, 1/45), while no deaths occurred within the first 24 hours in the remaining subgroups, including hepatopancreatobiliary, gastrointestinal bleeding, gastroenterocolitis, genitourinary, newly diagnosed uncomplicated malignancy, appendicitis, diverticulitis, and other miscellaneous conditions. Despite these variations, the differences in first-day mortality among the subgroups were not statistically significant (p=0.214).

One-week mortality rates varied significantly across the 12 etiological subgroups (p=0.002). The highest mortality was observed in patients with intestinal perforation (37.50%, 3/8), followed by vascular causes (20.00%, 11/55) and gastrointestinal bleeding (14.28%, 1/7). Moderate mortality rates were recorded in genitourinary causes (11.42%, 4/35), spontaneous hematoma (10.00%, 1/10), and intestinal obstruction or torsion (8.88%, 4/45). Minimal mortality was noted in patients with gastroenterocolitis (2.94%,

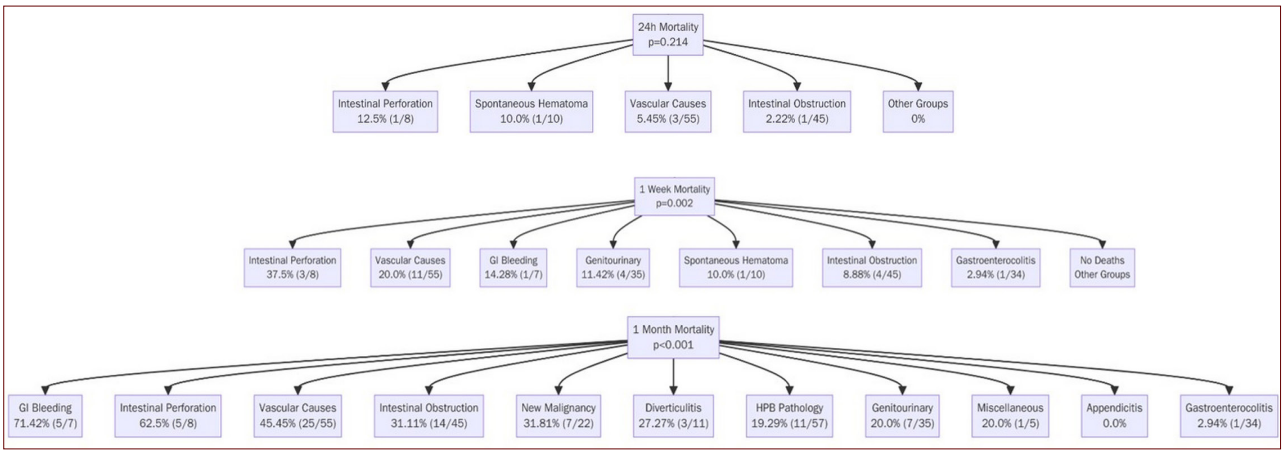


Figure 4. Mortality distribution across 12 etiological subgroups by time points. This diagram illustrates the temporal mortality trends (24 hours, 1 week, and 1 month) among patients with acute abdominal pathology, stratified by 12 distinct etiological categories. The highest early mortality (day 1 and week 1) was observed in intestinal perforation, spontaneous hematoma, and vascular causes. By one month, gastrointestinal bleeding (71.42%) and intestinal perforation (62.5%) had the most pronounced mortality rates, followed by vascular causes, intestinal obstruction, and newly diagnosed malignancy. Gastroenterocolitis and appendicitis were associated with more favorable outcomes.

1/34), while no deaths were recorded within the first week among those with hepatopancreatobiliary pathology, newly diagnosed uncomplicated malignancies, appendicitis, diverticulitis, or other miscellaneous conditions.

At one month, mortality rates demonstrated significant variation across the etiological subgroups ($p<0.001$). The highest one-month mortality was observed in patients with gastrointestinal bleeding (71.42%, 5/7) and intestinal perforation (62.50%, 5/8), followed closely by vascular causes (45.45%, 25/55). Other subgroups with notable one-month mortality included intestinal obstruction or torsion (31.11%, 14/45), newly diagnosed uncomplicated malignancies (31.81%, 7/22), and diverticulitis (27.27%, 3/11). Moderate mortality was recorded in hepatopancreatobiliary (19.29%, 11/57), genitourinary (20.00%, 7/35), and miscellaneous (20.00%, 1/5) conditions. In contrast, patients with appendicitis (0.00%) and most with gastroenterocolitis (2.94%) had more favorable outcomes.

The variation in mortality rates across the twelve etiological subgroups at day 1, day 7, and day 30 is illustrated in Figure 4.

Mortality by Intervention Status

Among the 293 patients with radiologically confirmed acute abdominal pathology, 55 individuals (18.77%) underwent surgical or image-guided interventional treatment. First-day mortality was 5.45% (n=3) in the treated group versus 1.26% (n=3) in those managed conservatively, with no statistically significant difference observed (p=0.082). By the end of the first week, however, mortality was significantly higher in the surgically/interventionally treated group (16.36%, n = 9) compared to the non-treated group (6.72%, n=16) (p=0.021). This trend persisted at one month, where patients who received interventional or surgical management had a mortality rate of 43.63% (n=24), significantly exceeding the 23.52% (n=56) observed in non-intervened patients (p=0.003). These findings suggest that while intervention may be necessary for

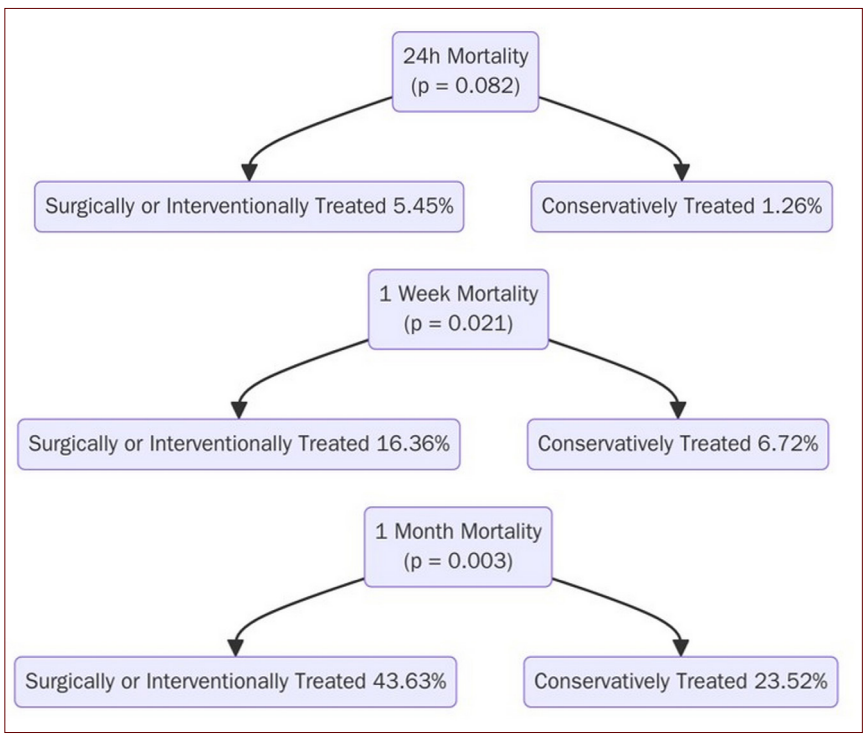


Figure 5. Mortality outcomes by treatment modality. This diagram illustrates temporal mortality rates in patients with acute abdominal pathology, comparing those managed with surgical or image-guided interventional procedures versus those treated conservatively. Although early (24-hour) mortality did not differ significantly (5.45% vs. 1.26%, p=0.082), one-week and one-month mortality rates were significantly higher in the intervention group (16.36% and 43.63%, respectively) compared to conservative management (6.72% and 23.52%, p=0.021 and p=0.003). These findings likely reflect underlying disease severity necessitating intervention.

select indications, it is associated with a higher short- and mid-term mortality, likely reflecting underlying severity and complexity of the treated cases.

The comparison of mortality rates between patients who underwent surgical or interventional treatment and those managed conservatively is illustrated in Figure 5.

Effect Size and Survival Analyses

Unadjusted effect sizes were consistent with the above proportions. For positive CT vs no acute findings, the odds of 7-day mortality were higher (OR 2.66; 95% CI 1.18–6.01), as were the odds of 30-day mortality (OR 4.84; 95% CI 2.77–8.44); 24-hour mortality did not differ significantly (OR 2.45; 95% CI 0.49–12.23). For malignancy-related vs non-malignant etiologies (within positive CT cases), 30-day mortality was higher (OR 4.78; 95% CI 2.76–8.27); 7-day and 24-hour comparisons were not significant. For intervention vs no intervention (within positive CT cases), higher odds were observed at 7 days (OR 2.71; 95% CI 1.13–6.52) and 30 days (OR 2.52; 95% CI 1.37–4.64), with no significant difference at 24 hours (OR 4.52; 95% CI 0.89–23.03).

Kaplan–Meier analyses over 30 days showed clear separation of survival curves. Thirty-day survival estimates were 72.7% (95% CI 67.4–77.3) for positive CT and 92.8% (95% CI 89.0–95.3) for no acute findings (log-rank χ^2 38.7, df=1, p<0.001). Within positive CT cases, survival was 50.5% (95% CI 40.1–60.2) for malignancy-related etiologies and 83.0% (95% CI 77.0–87.6) for non-malignant etiologies (log-rank χ^2 31.5, df=1, p<0.001). For intervention status, survival was 56.4% (95% CI 42.6–68.5) with intervention and 76.5% (95% CI 70.6–81.5) without intervention (log-rank χ^2 8.7, df=1, p=0.003).

Multivariable Analysis (Primary Endpoint: 30-Day Mortality)

In a prespecified logistic regression model including age, sex, positive CT, etiologic subgroup indicators (reference: gastroenterocolitis), malignancy-related etiology, IV contrast, and intervention status, the following associations were observed: positive CT (adjusted OR 3.98; 95% CI 2.20–7.21; p<0.001), malignancy-related etiology (adjusted OR 3.62; 95% CI 2.01–6.53; p<0.001), and intervention (adjusted OR 1.98; 95% CI 1.05–3.75; p=0.035). IV contrast (adjusted OR 0.89; 95% CI 0.53–1.50; p=0.660), age per year (adjusted OR 1.04; 95% CI 0.95–1.14; p=0.390), and male sex (adjusted OR 1.12; 95% CI 0.69–1.80; p=0.650) were not significant.

DISCUSSION

This study demonstrated that over half of nonagenarian patients undergoing abdominal CT for non-traumatic acute abdomen had identifiable etiologies, with predominant causes being hepatopancreatobiliary disorders, vascular emergencies, and intestinal obstruction/torsion. Mortality increased over time—although early (day1) mortality was low and non-significant, both 1week and 1month mortality rates were substantially elevated, particularly among patients with certain etiologies and those with a need for surgery or interventions.

Our study adds to the limited body of literature on etiological patterns in nonagenarians, a group under-represented in acute abdomen research (1, 13). Recent reviews highlight that while bowel obstruction and ischemia are common in elderly patients, most studies focus on those aged >75 rather than the aged ≥90 years. For instance, Coutureau et al. (12) reported bowel obstruction and colonic ischemia as frequent CT findings in the elderly, while other sources broadly list causes of acute abdomen without providing detailed stratification by age decade (7). Gangadhar et al. underscored that a multimodality approach—including CT, ultrasound, and MRI—remains critical in rapidly identifying non-traumatic abdominal emergencies across diverse etiologies, ranging from obstruction to vascular events (14). In contrast, our study specifically categorizes 12 etiological



subgroups in patients in their 90s, offering a more granular perspective and uncovering substantial rates of hepatopancreatobiliary and genitourinary causes.

Consistent with prior studies highlighting the high morbidity burden in elderly patients with acute abdominal conditions, our cohort demonstrated a progressive increase in mortality, reaching 18.3% at one month (1, 6). However, our study provides a novel contribution by delineating etiology-specific mortality trajectories within a nonagenarian population—an age group rarely analyzed in this level of detail. Mortality was particularly elevated in patients with intestinal perforation and gastrointestinal bleeding, especially in the early phase, whereas inflammation-related causes such as gastroenterocolitis and diverticulitis were associated with lower mortality. These findings not only corroborate existing knowledge regarding the poor prognosis of vascular and perforative emergencies in older adults (15, 16) but also offer a refined, CT-based stratification that may enhance clinical decision-making in this high-risk group (11, 17).

Furthermore, our study uniquely highlights the prognostic impact of malignancy-related etiologies in nonagenarians with acute abdomen. One-month mortality was markedly higher in patients whose CT findings were secondary to malignancy (49.5%) compared to non-malignant cases (17.0%), a difference that reached strong statistical significance. While previous studies have acknowledged the role of cancer in worsening outcomes among older patients (7), our results provide focused evidence in a well-defined nonagenarian-only cohort. Morani et al. further highlighted the diagnostic and management challenges of acute abdominal conditions in cancer patients, who frequently present with obstruction, perforation, or ischemia in the setting of advanced malignancy (18). In our nonagenarian cohort, malignancy-related etiologies accounted for nearly one-third of positive CT findings and were associated with significantly higher 30-day mortality, corroborating these earlier observations and underscoring the prognostic implications of cancer-associated acute abdomen. Together, these data emphasize that radiologists must not only provide accurate etiologic diagnosis but also recognize malignancy-driven emergencies as a uniquely high-risk subset in the oldest-old population. This malignancy-specific stratification underscores the prognostic value of radiologically confirmed oncologic causes in acute abdomen, reinforcing the need for early recognition and individualized management strategies in this exceptionally vulnerable population.

Intervention—whether surgical or image-guided—was associated with significantly higher mortality at both one week (16.4% vs. 6.7%) and one month (43.6% vs. 23.5%). While this likely reflects the greater baseline severity and complexity of cases selected for intervention, it underscores the substantial procedural risk inherent in managing nonagenarians (8, 9). Many surgical admissions in this age group are ultimately managed conservatively or discharged without operative care (7, 9); however, when intervention is required, mortality rates remain markedly elevated—corroborating trends observed in broader geriatric surgical populations (13).

In our cohort, the choice between surgical/image-guided intervention and conservative management was not determined by CT findings alone, but rather by multidisciplinary clinical judgment incorporating the overall condition of each patient. In routine emergency care for nonagenarians, treatment decisions are commonly influenced by factors beyond imaging, including frailty-related features such as functional dependence, poor premorbid performance status, multimorbidity burden, cognitive impairment, and limited physiological reserve, as well as patient- or family-centered goals of care and, when available, advance directives (19, 20). Because of the retrospective design, these parameters were

not captured in a standardized form suitable for quantitative analysis in all patients, and their precise contribution to management decisions could therefore not be measured. This limitation should be considered when interpreting the higher mortality observed in the intervention group, which likely reflects, at least in part, selection of patients with greater illness severity and more complex clinical circumstances rather than a direct effect of the procedures themselves.

In nonagenarians with acute abdomen, survival at 30 days does not by itself fully reflect clinical success; in geriatric populations, functional status and the ability to maintain activities of daily living are also closely linked to prognosis, independence, and quality of life (21). Unfortunately, due to the retrospective nature of our dataset, standardized information regarding functional recovery at 30 days—such as activities of daily living, discharge disposition, or need for new institutional support—was not available in a sufficiently complete manner to permit reliable analysis. This represents an important limitation of the current study and highlights the need for future prospective geriatric emergency imaging studies to integrate functional endpoints alongside mortality.

Although this retrospective, single-center study may be subject to inherent limitations such as limited generalizability, it offers several notable strengths. The relatively large sample size of 529 nonagenarian patients represents a substantial cohort compared to previous small-scale studies in this population. Moreover, the standardized radiological review and structured classification into 12 distinct etiological subgroups provide clarity and enhance the interpretability of findings. These results can serve as a valuable foundation for future multicenter prospective studies aimed at refining diagnostic and prognostic strategies in the oldest-old population.

In summary, this study offers novel insight into the etiologic landscape and outcome trajectories of non-traumatic acute abdomen in nonagenarians—an age group rarely examined in isolation. By classifying CT findings into 12 distinct etiological subgroups and assessing mortality at three time points, we provide a detailed, time-sensitive risk profile for each diagnostic category. The integration of malignancy status and interventional treatment into outcome analysis further highlights high-risk subsets, particularly malignancy-related cases and those undergoing procedures. These findings contribute valuable guidance for acute care management in the oldest-old, where clinical decisions are often complicated by diagnostic uncertainty and limited physiological reserve.

Acknowledgements: None.

Conflict of Interest: None.

Funding: None.

REFERENCES

1. Solakoglu GA, Nuhoğlu Ç, Al B, et al. Prognostic factors influencing survival in nonagenarian patients admitted to the emergency department: a retrospective study. BMC Geriatr 25, 2025; 25(1):391. doi: 10.1186/s12877-025-06047-9
2. Westendorp RG, Van Heemst D, Rozing MP, et al. Nonagenarian siblings and their offspring display lower risk of mortality and morbidity than sporadic nonagenarians: The Leiden Longevity Study. J Am Geriatr Soc 57, 2009; 7(9):1634-7. doi: 10.1111/j.1532-5415.2009.02381.x
3. Ashman JJ, Schappert SM, and Santo L. Emergency department visits among adults aged 60 and over: United States, NCHS Data Brief 2020; 6(367):1-8.
4. Senguldur E and Selki K. Today's Problem Tomorrow's Crisis: A Retrospective, Single-Centre Observational Study of Nonagenarians in the Emergency Department. Cureus, 2024; 16(11):e73460. doi: 10.7759/cureus.73460.
5. Greenwood-Ericksen MB and Kocher, K. Trends in emergency department use by rural and urban populations in the United States. JAMA Netw Open 2019; 5(4):e191919. doi: 10.1001/jamanetworkopen.2019.1919.

6. Manning S and Luba M. GI and Abdominal Pain Emergencies in Geriatric Emergency Medicine Patients. Curr Geriatr Rep 2025; 14(2). doi. org/10.1007/s13670-025-00427-0
7. Latifi R. Fausto Catena, and Federico Coccolini. Geriatrics: Traumatic and Non-traumatic Surgical Emergencies. In: Textbook of Emergency General Surgery: Traumatic and Non-traumatic Surgical Emergencies. 1th Edition, Springer International Publishing, Switzerland 2021, pp 347-365.
8. Portinari M, Bianchi L, De Troia A, et al. Non-traumatic emergency abdominal surgery in nonagenarian patients: a retrospective study. Eur J Trauma Emerg Surg 2022; 48(2):1205-1216. doi: 10.1007/s00068-021-01646-8
9. Toumi Z, Kesterton A, Bhowmick A, et al. Nonagenarian surgical admissions for the acute abdomen: who benefits? Int J Clin Pract 2010; 64(11):1570-1572. doi: 10.1111/j.1742-1241.2010.02468.x
10. Millet I, Alili C, Bouic-Pages E et al. Journal club: acute abdominal pain in elderly patients: effect of radiologist awareness of clinicobiologic information on CT accuracy. AJR Am J Roentgenol 2013; 201(6):1171-8. doi: 10.2214/AJR.12.10287
11. Millet I, Sebbane M, Molinari N, et al. Systematic unenhanced CT for acute abdominal symptoms in the elderly patients improves both emergency department diagnosis and prompt clinical management. Eur Radiol 2017; 27(2):868-877. doi: 10.1007/s00330-016-4425-0
12. Coutureau J, Millet I, and Taourel P. CT of acute abdomen in the elderly. Insights Imaging 2025; 7;16(1):95. doi: 10.1186/s13244-025-01955-1
13. Costamagna D, Federico PN, Erra S, et al. Acute abdomen in the elderly. A peripheral general hospital experience. G Chir 2009; 30(6-7):315-22.
14. Gangadhar K, Awasthi A, Mendiratta-Lala M, et al. Multimodality approach for imaging of non-traumatic acute abdominal emergencies. Abdom Radiol 2016; 41(1):136-48. doi: 10.1007/s00261-015-0586-6
15. Bakopoulos A, Koliakos N, Katsaros I, et al. An extremely rare clinical manifestation of acute appendicitis in a nonagenarian patient: lessons still to be learned. Folia Med 2022; 30(3):527-531. doi: 10.3897/folmed.64.e62008
16. Fruauff A, Trepanier C, Shaish H, et al. Delays in imaging diagnosis of acute abdominal pain in the emergency setting. Clin Imaging 2022; 90:32-38. doi: 10.1016/j.clinimag.2022.06.015
17. Malhotra L, Stephen AH, Goosman M, et al. Extra-abdominal CT imaging indicates increased severity of illness in advanced age patients requiring emergency abdominal surgery. Am J Surg 2025; 244:116297. doi: 10.1016/j.amjsurg.2025.116297
18. Morani AC, Hanafy AK, Marcal LP, et al. Imaging of acute abdomen in cancer patients. Abdom Radiol 2020; 45(8):2287-2304. doi: 10.1007/s00261-019-02332-5
19. Elliott A, Hull L, and Conroy SP. Frailty identification in the emergency department—a systematic review focussing on feasibility. Age Ageing 2017; 46(3):509-513. doi: 10.1093/ageing/afx019
20. Yücel M, Altuncı YA, Özçete E, Kılavuz A, and Akarca FK. Comparison of clinical frailty scale and Edmonton Frail Scale in older adults presenting to the emergency department. Turk J Geriatr 2024; 27(1):108−117. doi: 10.29400/tjgeri.2024.384
21. Abitağaoğlu S, Köksal C, Çiyiltepe H, Bayram T, Turan G, and Arı DE. Factors affecting intensive care unit admission and mortality rates of geriatric patients who undergo emergency abdominal surgery. Turk J Geriatr 2019;22 (4):391-399. doi: 10.31086/tjgeri.2020.117

ORIGINAL ARTICLE

ASSESSMENT OF THE RELATIONSHIP BETWEEN HOPELESSNESS LEVEL AND DEATH ANXIETY IN GERIATRIC INDIVIDUALS

Turkish Journal of Geriatrics
2026; 29(1):86–97

DOI: 10.29400/tjgeri.2026.481

Meltem ÇAPAR ÇİFTÇİ[1]
Funda KAVAK BUDAK[2]

[1] Agın Community Health Center , psychiatric nursing, Elazıg, Türkiye

[2] Inonu University, psychiatric nursing, Malatya, Türkiye

Abstract

Introduction: This study aimed to examine the relationship between hopelessness and death anxiety among geriatric individuals.

Materials and Method: A cross-sectional study was conducted with individuals aged 65 years and older (N = 220) registered at a community health center in Turkey. Participants completed the Descriptive Characteristics Form and as well as the Death Anxiety Scale and the Beck Hopelessness Scale.

Results: The mean scores for death anxiety and hopelessness were 53.32 ± 13.29 and 9.42 ± 3.86, respectively. The study revealed that the subdimensions of the Death Anxiety Scale were predominantly positively and weakly correlated with hopelessness and hope components, while motivation loss showed varying levels of negative correlation ($p < 0.05$).

Conclusion: The findings indicate that geriatric individuals experience above-moderate levels of death anxiety and report moderate levels of hopelessness. Furthermore, it was observed that as feelings of hopelessness increased, death anxiety intensified accordingly.

Keywords: Aged; Anxiety; Death; Mental Health.

Correspondence

Meltem ÇAPAR ÇİFTÇİ
Phone : +904245512030
e-mail : sevdai_naram@hotmail.com

Received : Dec 17, 2025
Accepted: Mar 01, 2026

Cite this article as:
Çapar Çiftçi M, Kavak Budak F. Assessment of the Relationship Between Hopelessness Level and Death Anxiety in Geriatric Individuals. Turkish Journal of Geriatrics 2026; 29(1):86–97. doi: 10.29400/tjgeri.2026.481

INTRODUCTION

Aging is a period in which individuals encounter biological, psychological, and social changes, while simultaneously experiencing an increased awareness of the finitude of life. With the rise in average life expectancy, the number of geriatric individuals has grown, thereby underscoring the importance of mental health issues within this population (1). During this stage, chronic illnesses, changes in social roles, loneliness, increased levels of dependency, and various losses may adversely affect psychological well-being. In particular, hopelessness and death anxiety stand out as prevalent and impactful constructs among older adults, both of which significantly diminish quality of life (2, 3). Hopelessness is characterized by pessimistic expectations about the future and the belief that potential solutions have been exhausted, whereas death anxiety refers to the fear and apprehension arising from an individual's awareness of the inevitability of death(1, 2). In the literature, the co-occurrence of these two constructs in older adults is shown not only to impair psychological well-being but also to exert detrimental effects on physical health, social relationships, and overall quality of life. Indeed, a study conducted in Türkiye demonstrated that higher levels of depression and negative attitudes toward aging increased death anxiety among older individuals, indicating a strong association between depressive symptoms and death anxiety (4).

Similarly, a study conducted with older adults residing in nursing homes reported a significant positive correlation between depression levels and death anxiety. This finding suggests that depressive symptoms may be directly associated with both hopelessness and death anxiety (5). Furthermore, research has shown that death anxiety in older adults is linked to ego integrity, with life satisfaction playing a moderating role in this relationship (6). Beyond their psychological dimensions, hopelessness and death anxiety have also been found to relate to broader health outcomes. Another study demonstrated that both hopelessness and death anxiety predicted depression, whereas acceptance of one's past served as a protective factor for ego integrity (7). In addition, a hospital-based study conducted in Europe reported that hopelessness is a strong predictor of short-term mortality, with individuals exhibiting symptoms of hopelessness during emergency hospital admission facing a significantly increased risk of death (8).

These findings indicate that hopelessness and death anxiety play a critical role in both the psychological well-being and physical health of geriatric individuals. Therefore, examining the relationship between these two variables is essential for identifying the psychosocial support needs of older adults, protecting their mental health, and developing appropriate interventions. However, research conducted in Türkiye remains limited, and existing studies predominantly focus on the relationship between depression and death anxiety (4, 7). Outpatient older adults differ from hospitalized older adults in terms of health status, level of functional independence, and social engagement. Hospitalized individuals often present with more severe medical conditions and greater physical limitations, which may directly influence their levels of death anxiety and hopelessness. Therefore, findings derived from inpatient populations cannot be directly generalized to community-dwelling outpatient older adults. Examining outpatient individuals enables a more accurate evaluation of death anxiety and hopelessness among older adults with relatively stable health conditions and may contribute to the development of early, community-based psychosocial interventions. Yet, investigating the direct association between hopelessness and death anxiety is crucial for understanding the psychological needs of older adults and designing suitable psychosocial interventions. Nursing—particularly psychiatric nursing—holds a pivotal role in supporting emotional well-being, facilitating the early identification of hopelessness and death

anxiety, and implementing holistic care approaches for older adults (9). Existing literature examining the relationship between hopelessness and death anxiety has predominantly focused on hospitalized patients, nursing home residents, or clinical populations, which often include individuals with more severe physical or psychiatric conditions. This limits the generalizability of findings to community-dwelling older adults receiving outpatient care. In this context, the present study, conducted among geriatric individuals attending a community healthcare center, provides an important contribution by evaluating this relationship in a community-based outpatient population. This approach enables a more accurate understanding of the psychosocial needs of older adults living in the community and offers valuable evidence for preventive mental health services, early identification, and community-based psychosocial interventions. In this context, generating scientific evidence to address the gap in the literature is of considerable importance. The primary aim of this study is to examine the direct association between hopelessness and death anxiety among older adults attending a community health center. In this context, the study goes beyond merely assessing the statistical relationship between two psychometric measures and seeks to contribute to a deeper understanding of the psychological vulnerabilities of older individuals. The findings are expected to contribute to strengthening the mental health of older adults, improving their quality of life, and informing gerontological and psychiatric nursing practices, as well as guiding clinical initiatives and mental health policies.

Research Question:

1. What are the hopelessness levels of geriatric individuals?
2. What are the death anxiety levels of geriatric individuals?
3. Is there a significant relationship between hopelessness and death anxiety?

MATERIALS AND METHOD

Design

The study used a descriptive cross-sectional fashion and looked at 220 people aged 65 and up who were registered at a Community Healthcare center in Elazığ between November 2024 and August 2025.

Sample and Participants

In the main hypotheses of the study, it was planned to investigate the relationships between the measured variables. In this research, since the population size was known, the sample size was calculated at a 95% confidence level. The population size was determined as 500, and the prevalence rate of the targeted sample profile within the population was assumed to be 0.50. When the significance level was set at $\alpha = 0.05$, the z test statistic was 1.96. Based on these parameters, the minimum required sample size was calculated as 217. With the effort of the researcher, the study was completed with a total of 220 older adults. A computer-assisted simple random sampling method was used to determine the participants included in the research.

Inclusion Criteria

- Being open to communication and collaboration
- Volunteering to participate in the study

Exclusion Criteria

- Having a communication problem
- Having a psychiatric disease

Data Collection Tools

The Descriptive Characteristics Form, Thorson–Powell Death Anxiety Scale, Beck Hopelessness Scale were employed to collect the data.

Descriptive Characteristics Form

The form had 11 questions prepared by the researcher by scanning the literature, Age, gender, marital



status, educational status, income level, employment status, presence of chronic illness, with whom they live, perspective on the future, frequency of death-related thoughts, and level of life satisfaction.

Thorson–Powell Death Anxiety Scale

The Thorson and Powell (1992) scale is a 25-item instrument structured in a five-point Likert format. The scale consists of 17 positively worded and 8 negatively worded items, and comprises four subdimensions: uncertainty related to death, fear of suffering, the dying process, and decay and deterioration. The internal consistency coefficient of the original form was reported as 0.85 (10). The initial Turkish adaptation of the scale was conducted by Karaca (2000), who reported a test–retest reliability of 0.90. In a subsequent adaptation, Karaca and Yıldız (2001) found the internal consistency coefficient to be 0.84. In the present study, the Turkish version adapted by Karaca and Yıldız (2001) was used, and the items were scored on a five-point Likert scale ranging from "0 = Strongly Disagree" to "4 = Strongly Agree" (11). The reliability analysis conducted in this study yielded an internal consistency coefficient of 0.85.

Beck Hopelessness Scale

The Beck Hopelessness Scale was developed by Beck and colleagues in 1974 and consists of 20 items answered in a true–false format. (12). The scale includes 11 true statements and 9 false statements, and responses consistent with the scoring key are assigned 1 point, while inconsistent responses are scored as 0. The total score ranges from 0 to 20, with higher scores indicating greater levels of hopelessness. The scale comprises three subdimensions: feelings about the future, loss of motivation, and future expectations. The Turkish adaptation of the scale was conducted by Seber et al.1993, who reported a test–retest reliability coefficient of 0.72 and an internal consistency coefficient of 0.86. (13) In the present study, the Turkish version adapted by Seber et al. was used, and the internal consistency coefficient obtained was 0.82.

Data Collection

Researcher collected data in a Community Healthcare Center in Elazığ using the face-to-face interview method in a room. The researcher read data collection tools to participants and filled in according to the answers received, which took 20-25 min.

Data Analysis

The data were analyzed using the SPSS 25 statistical software package. The internal consistency of the scales was assessed using Cronbach's alpha coefficients. Normality was examined through skewness–kurtosis values within the +3/–3 range. The data were presented using percentages, frequencies, mean scores, and standard deviations. For normally distributed measurements, the Independent Samples t-Test was used to compare the mean scores of two independent groups, while the One-Way ANOVA test was used to compare the mean scores of three or more independent groups. For non-normally distributed measurements, the Mann–Whitney U Test was used for comparisons between two independent groups, and the Kruskal–Wallis Test was used for comparisons involving three or more independent groups. To determine relational inferences, Pearson correlation analysis was used for normally distributed data, whereas Spearman correlation analysis was applied to non-normally distributed data. Effect sizes were reported using partial eta squared and Cohen's d values.

Ethical Aspects of the Study

Health Sciences Non-Interventional Clinical Research Ethics Committee of Inonu University approved the study (15-10-2024, 2024/6499).

RESULTS

The study found that 59.1% of the older adults were between 65 and 69 years of age, 69.5% were male, 74.1% were married, and 61.8% had completed primary education. Moreover, 69.1% reported a moderate level of income, 51.8% were employed, 82.7% had at least one chronic disease, and 52.8% were living with their spouse. In addition, 59.1% stated that they had a hopeful outlook toward the future, 46.4% reported thinking about death occasionally, and 42.7% indicated low levels of life satisfaction (Table 1).

It was determined that the mean scores of older adults were 12.65 ± 4.15 for the "Deprivation and Helplessness" subscale, 19.63 ± 7.73 for the "Uncertainty of the Afterlife" subscale, 8.39 ± 2.78 for the "Decay and Deterioration" subscale, and 12.65 ± 4.85 for the "Death Process and Suffering"

Table 1. Distribution of Older Adults According to Sociodemographic Characteristics (n= 220)

Characteristics	Variables	N	%
Age	65-60	130	59.1
	70 and above	90	40.9
Gender	Male	153	69.5
	Female	67	30.5
Marital status	Married	163	74.1
	Single	57	25.9
Educational status	Primary education	136	61.8
	Secondary education	62	28.2
	Bachelor's degree and above	22	10.0
Income level	Poor	43	19.5
	Average	152	69.1
	Good	25	11.4
Employment status	Employed	114	51.8
	Unemployed	106	48.2
Chronic illness status	Present	182	82.7
	Absent	38	17.3
Living arrangements	Alone	72	32.7
	With spouse	128	58.2
	With spouse and children	20	9.1
Outlook on the future	Hopeful	130	59.1
	Hopeless	90	40.9
Frequency of thoughts of death	Frequently	73	33.2
	Occasionally	102	46.4
	Never	45	20.5
Level of satisfaction with life	None	26	11.8
	Low	94	42.7
	Moderate	87	39.5
	High	13	5.9

Table 2. Mean Scores and Minimum–Maximum Values of the Scale and Its Subscales

Scale and Subscales Names	$\bar{x}$±SD	Min-Max
Deprivation and Helplessness	12.65±4.15	2-25
Uncertainty of the Afterlife	19.63±7.73	4-58
Decay and Deterioration	8.39±2.78	0-15
Death Process and Suffering	12.65±4.85	6-49
Thorson–Powell Death Anxiety Scale	53.32±13.29	29-130
Feelings and Expectations About the Future	2.27±1.95	0-22
Loss of Motivation	4.12±2.06	0-8
Hope	3.04±2.10	0-9
Beck Hopelessness Scale	9.42±3.86	1-28

subscale. The mean total score of the Thorson–Powell Death Anxiety Scale among older adults was found to be 53.32 ± 13.29.

It was further identified that the mean score for the "Feelings and Expectations About the Future" subscale was 2.27 ± 1.95, the mean score for the "Loss of Motivation" subscale was 4.12 ± 2.06, and the mean score for the "Hope" subscale was 3.04 ± 2.10. The mean total score of the Beck Hopelessness Scale among older adults was determined to be 9.42 ± 3.86 (Table 2).

It was observed that older adults aged 60–65 had higher mean scores on the Thorson–Powell Death Anxiety Scale compared to those aged 70 and above ($p < 0.05$). Individuals with a pessimistic outlook toward the future had higher mean Thorson–Powell Death Anxiety Scale scores than those with an optimistic outlook ($p < 0.05$).

No statistically significant differences were found between the mean Thorson–Powell Death Anxiety Scale scores and variables such as gender, marital status, educational level, income level, employment status, presence of chronic illness, cohabitation status, frequency of death-related thoughts, and level of life satisfaction ($p > 0.05$) (Table 3).

It was observed that single individuals had higher mean Beck Hopelessness Scale scores compared to married individuals ($p < 0.05$). Those who reported having death-related thoughts occasionally had lower mean Beck Hopelessness Scale scores than those who reported having no such thoughts ($p < 0.05$) (Tablo 3).

No statistically significant differences were found between the mean Beck Hopelessness Scale scores and variables such as age, gender, educational level, income level, employment status, presence of chronic illness, cohabitation status, future outlook, and level of life satisfaction ($p > 0.05$) (Table 3).

It was determined that the 'Deprivation and Helplessness' subdimension of the Death Anxiety Scale showed a positive and weak correlation with the 'Feelings and Expectations About the Future' and 'Hope' subdimensions, as well as with the total score of the Beck Hopelessness Scale ($p < 0.05$). The 'Uncertainty After Death' subdimension was found to have a negative and moderate correlation with the 'Loss of Motivation' subdimension ($p < 0.05$). Additionally, the 'Uncertainty After Death' subdimension demonstrated a positive and weak correlation with the 'Hope' subdimension ($p < 0.05$). The 'Decay and Deterioration' subdimension was observed to be positively and weakly correlated with the 'Loss of Motivation' subdimension ($p < 0.05$) (Table 4) (Figure 1).

It was determined that the 'Death Process and Suffering' subdimension showed a positive

Table 3. Comparison of Scale Scores According to Sociodemographic Characteristics of the Elderly (n=220)

Characteristics	Variables	Thorson–Powell Death Anxiety Scale		Beck Hopelessness Scale	
		x̄±SD		x̄±SD	
Age	65-60	54.68±12.38	**U=4659.50 p=0.010**	9.42±3.70	t=-0.022 p=0.983 d=0.003
	70 and above	51.34±14.34		9.43±4.10	
Gender	Male	53.27±13.16	U=5100.00 p=0.953	9.49±3.76	t=0.423 p=0.673 d=0.062
	Female	53.43±13.67		9.25±4.10	
Marital status	Married	53.64±13.71	U=4543.50 p=0.805	9.08±3.92	**t=-2.217 p=0.028 d=0.341**
	Single	52.40±12.07		10.39±3.54	
Educational status	Primary education	54.09±12.97	KW=1.460 p=0.482	9.02±3.52	F=1.926 p=0.148 η^2=0.018
	Secondary education	51.94±11.74		10.08±4.60	
	Bachelor's degree level and above	52.45±18.67		10.05±3.39	
Income level	Poor	53.40±13.81	KW=3.513 p=0.173	9.16±3.73	F=0.340 p=0.712 η^2=0.003
	Average	53.98±13.33		9.40±3.89	
	Good	49.16±11.76		9.96±3.96	
Employment status	Employed	53.21±13.68	U=6001.50 p=0.932	9.47±3.63	t=0.214 p=0.831 d=0.029
	Unemployed	53.43±12.92		9.36±4.10	
Chronic illness status	Present	53.00±12.47	U=3441.00 p=0.962	9.36±3.99	t=-0.463 p=0.644 d=0.083
	Absent	54.84±16.79		9.68±3.18	
Living arrangements	Alone	51.83±11.28	KW=4.011 p=0.135	9.38±4.13	F=0.052 p=0.949 η^2=0.001
	With spouse	54.68±14.35		9.48±3.78	
	With spouse and children	49.95±12.25		9.20±3.50	
Outlook on the future	Hopeful	51.55±11.38	**U=4929.00 p=0.047**	9.43±3.66	t=0.029 p=0.977 d=0.004
	Hopeless	55.88±15.35		9.41±4.14	
Frequency of thoughts of death	Frequently	53.68±12.36	KW=0.069 p=0.792	9.60±3.68	**F=4.150 p=0.017 η^2=0.037 2-3**
	Occasionally	53.77±14.99		8.73±3.52	
	Never	51.69±10.46		10.67±4.54	
Level of satisfaction with life	None	56.92±18.74	KW=4.235 p=0.235	10.69±3.58	F=1.214 p=0.306 η^2=0.017
	Low	54.60±12.66		9.29±4.08	
	Moderate	51.06±11.87		9.12±3.65	
	High	52.00±12.63		9.85±3.93	

and weak correlation with the 'Feelings and Expectations About the Future' and 'Hope' subdimensions, as well as with the total score of the Beck Hopelessness Scale ($p < 0.05$). The 'Death Process and Suffering' subdimension was also found to have a negative and weak correlation with the 'Loss of Motivation' subdimension ($p < 0.05$). The Thorson–Powell Death Anxiety Scale demonstrated a positive and weak correlation with the 'Feelings and Expectations About the Future' and 'Hope' subdimensions ($p < 0.05$). Additionally, the Thorson–Powell Death Anxiety Scale showed a negative and weak correlation with the 'Loss of Motivation' subdimension ($p < 0.05$) (Table 4) (Figure 1).

Table 4. Mean Scale Scores of Older Adults and Correlation Analysis Results Regarding Mean Scores (N = 220)

		Feelings and Expectations About the Future	Loss of Motivation	Hope	Beck Hopelessness Scale
Deprivation and Helplessness	r	**0.197^{y}**	-0.001^{x}	**0.294^{x}**	**0.233^{x}**
	p	**0.003**	0.988	**0.001**	**0.001**
Uncertainty of the Afterlife	r	0.048^{y}	**-0.378^{x}**	**0.227^{x}**	-0.091^{x}
	p	0.483	**0.001**	**0.001**	0.181
Decay and Deterioration	r	-0.051^{y}	**0.236^{x}**	-0.116^{x}	0.058^{x}
	p	0.447	**0.001**	0.085	0.393
Death Process and Suffering	r	**0.211^{y}**	**-0.182^{y}**	**0.287^{y}**	**0.162^{y}**
	p	**0.002**	**0.007**	**0.001**	**0.016**
Thorson Powell Death Anxiety Scale	r	**0.155^{y}**	**-0.257^{y}**	**0.288^{y}**	0.095^{y}
	p	**0.022**	**0.001**	**0.001**	0.161

x= Pearson correlation analysis, y=Spearman rho correlation analysis

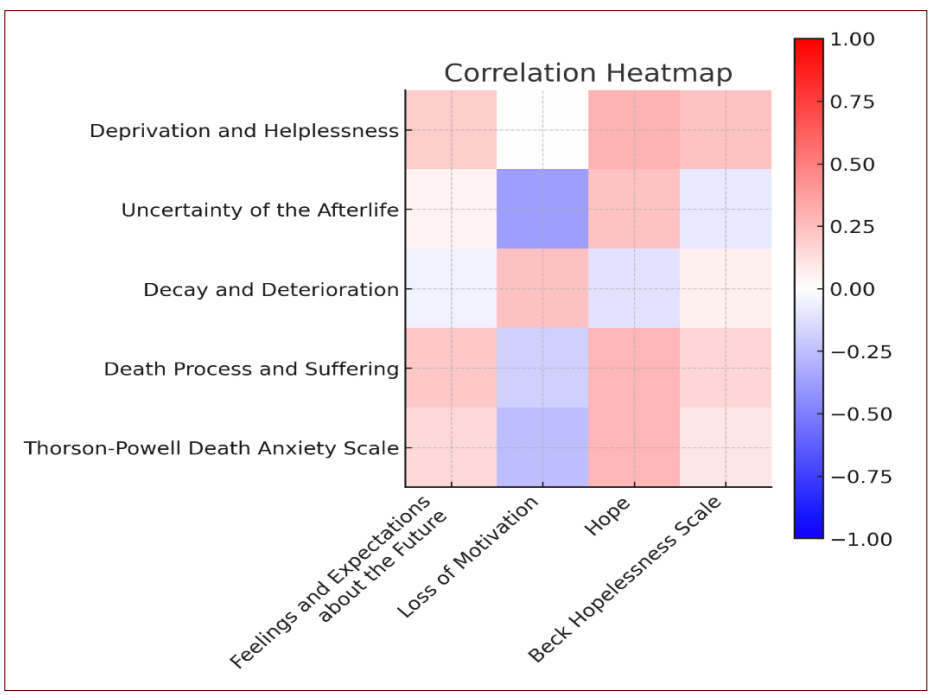


Figure 1. Corelation Heatmap

DISCUSSION

In this study, the mean total score of older adults on the Thorson–Powell Death Anxiety Scale was found to be 53.32 ± 13.29, indicating that death anxiety is above a moderate level. The decline in physical capacity specific to old age, the increase in chronic illnesses, and changes in social roles are identified in the current literature as key determinants of death anxiety (14). Recent studies have demonstrated that loneliness, negative attitudes toward aging, and higher levels of depression significantly increase death anxiety among older adults (4, 5). In this context, the mean score obtained in our study being consistent with the literature supports the notion that cognitive and emotional processes related to death are distinctly active in older individuals (2, 5). The findings indicate that reducing death anxiety requires strengthening older adults' coping strategies regarding the concept of death by expanding their social support networks, as well as implementing psychosocial support programs and death-related awareness initiatives. The fact that death anxiety among older adults remains above a moderate level can be explained by the interaction of biological, psychological, and social factors inherent to the aging process. The rising prevalence of physical health problems and chronic illnesses may elevate anxiety levels by causing individuals to confront the reality of death more directly. Moreover, social isolation factors—such as changes in social roles associated with aging, a reduction in close social contacts, and increasing loneliness—can intensify fears and anxieties related to death (14). Psychologically, confronting the inevitability of death, uncertainty about the future, and the awareness that life will eventually come to an end may trigger existential concerns in older adults, thereby contributing to increased levels of death anxiety (9, 15). For these reasons, the presence of moderate or high levels of death anxiety among older adults is considered a multidimensional phenomenon that emerges not only from physiological factors but also from the influence of psychosocial processes.

In our study, the mean total score of the Beck Hopelessness Scale among older adults was found to be 9.42 ± 3.86, which is consistent with the moderate level of hopelessness described in the literature. International research indicates that hopelessness is an important factor negatively affecting psychological health and quality of life in the older population (2, 16). In particular, hopelessness in older adults has been associated with pessimistic future expectations, loss of motivation, and depressive symptoms. Furthermore, a lack of social support and the presence of chronic illnesses may also contribute to increased levels of hopelessness (17). In this context, the findings highlight the importance of interventions targeting hopelessness in older adults and support the necessity of developing psychosocial support programs. The underlying reasons for the observation of moderate levels of hopelessness among older individuals stem from multiple biopsychosocial factors associated with the aging process. Increasing physical health problems and the prevalence of chronic diseases may reduce quality of life, leading individuals to develop pessimistic expectations about the future (18). In addition, the narrowing of social networks, the loss of family members, and increasing social isolation in later life are significant factors that contribute to heightened feelings of hopelessness. Psychologically, role loss experienced during old age and the heightened awareness of approaching the end of life may intensify feelings of helplessness and reduce motivation (19). In this context, the presence of moderate levels of hopelessness among older adults can be viewed not only as a reflection of their health status but also as an outcome of insufficient social support and challenges in psychological adaptation.

In the present study, death anxiety levels were found to be higher among older adults who had a hopeless outlook toward the future compared to those who were hopeful, which is consistent with findings in the literature. Indeed, studies



demonstrating that individuals with higher levels of depression and hopelessness also experience increased death anxiety support the systematic emergence of this relationship across different populations (4, 20). However, the findings of the present study demonstrate that hopelessness is associated with death anxiety independently of depression. This suggests that hopelessness may function as an early cognitive risk indicator even in the absence of clinically significant depressive symptoms. Hopelessness is recognized as a critical psychological construct associated with adverse clinical outcomes in older adults and has been identified as one of the strongest predictors of suicide risk, particularly among older men. In this context, the independent association between hopelessness and death anxiety observed in the present study further underscores the clinical relevance of hopelessness beyond depressive symptomatology. This finding highlights the importance of routinely assessing hopelessness in geriatric care, as it may facilitate the early identification of psychologically vulnerable individuals and support the implementation of targeted psychosocial interventions aimed at reducing death-related distress and improving psychological well-being.Therefore, evaluating hopelessness as a distinct construct may facilitate the early identification of older adults at risk and support the implementation of targeted psychosocial interventions aimed at strengthening positive future expectations, enhancing coping capacities, and reducing death-related anxiety. In this respect, the present study contributes to the literature by demonstrating that hopelessness is not merely a reflection of depressive symptoms, but rather an independent and clinically meaningful factor associated with death anxiety among community-dwelling older adults. The emergence of this result may be explained by the lack of positive future expectations among hopeless individuals, psychosocial vulnerabilities, and a weakened sense of life meaning, all of which may contribute to heightened death anxiety. Furthermore, the higher levels of hopelessness observed among single individuals compared with married individuals may be attributed to the protective effects of marriage, such as increased social support, a sense of belonging, and emotional security, which collectively help mitigate hopelessness. Marriage enhances individuals' psychological resilience by providing a sense of meaning and future orientation in life (21). On the other hand, the finding that individuals with thoughts of death exhibited lower hopelessness scores suggests that psychological processes other than hopelessness—such as anxiety or fear—may be more prominent in this group (6). This situation may also be influenced by variables such as individuals' cognitive or emotional defense mechanisms, levels of awareness, or belief systems that shape how they confront thoughts of death (5).

In our study, the predominantly positive and weak correlations observed between the Death Anxiety Scale subdimensions and the components of hopelessness and hope, as well as the varying degrees of negative correlations with loss of motivation, are largely consistent with the general findings in the literature. Although previous research frequently reports a positive association between death anxiety and hopelessness or depression (4, 15), the inverse relationship found with loss of motivation suggests that death anxiety is not always a destructive psychological process; rather, in some individuals, it may be associated with existential awareness and an enhanced motivation to hold onto life (3). Furthermore, various studies emphasize that social support, belief systems, and individual coping mechanisms influence the direction and strength of the relationship between death anxiety and hopelessness (14, 22). In this regard, the psychological effects of death anxiety can be considered multidimensional and complex, with the dynamics among hope, motivation, and hopelessness shaped by individual differences.

The findings of our study highlight that death anxiety may serve both risk-related and potentially protective functions, underscoring the importance of examining subdimensions and individual psychosocial factors in greater detail in future research on hopelessness.

CONCLUSION

The findings of this study indicate that older adults attending a community health center experience above-moderate levels of death anxiety and moderate levels of hopelessness, and that increases in hopelessness are associated with corresponding increases in death anxiety. The predominantly positive, albeit weak, associations between the subdimensions of the Death Anxiety Scale and the components of hope and hopelessness suggest that the emotional dimension of death anxiety is closely linked to cognitive appraisal processes and future-oriented expectations. In contrast, the negative associations observed between loss of motivation and certain subdimensions of death anxiety indicate that motivational processes may play a differential role in shaping how older individuals perceive and experience death-related concerns. These findings highlight that death anxiety in later life should be understood as a multidimensional psychological construct influenced not only by emotional responses but also by cognitive and motivational factors. Furthermore, demonstrating this association in a community-based outpatient population underscores that psychological vulnerabilities such as hopelessness and death anxiety are not limited to hospitalized or clinically diagnosed individuals, but are also relevant among older adults living in the community. In this respect, the present study contributes to the literature by situating hopelessness as an important psychological factor associated with death anxiety within a community health context and by emphasizing the importance of assessing cognitive vulnerability factors in aging populations. Based on these findings, it is recommended that hopelessness, hope, and motivational levels be systematically assessed in geriatric and psychiatric nursing practice. In addition, integrating psychoeducation, hope-enhancement interventions, life-review therapies, and social support–based approaches into care programs may help strengthen psychological resilience and reduce existential distress among older adults. Furthermore, incorporating routine screening for hopelessness and death anxiety into community-based elderly health services may facilitate the early identification of at-risk individuals and support the implementation of timely preventive psychosocial interventions. In conclusion, this study demonstrates that hopelessness is significantly associated with death anxiety among community-dwelling older adults and underscores the importance of incorporating the assessment of cognitive vulnerability factors into geriatric mental health care. These findings highlight the need for comprehensive, preventive, and community-based psychosocial approaches to support psychological well-being and improve overall quality of life in aging populations.

REFERENCES

1. Kashfi SM, Haydoura A, Bahja H, et al. The İmpact of Depression and Death Anxiety on the Qality of Life of the Older People. BMC Geriatr 2025;25(1):905. doi:10.1186/s12877-025-06491-7.
2. Bekircan E, Okanlı A. Determination of Depression and Hopelessness Levels Among Older Adults. Journal of Elderly Issues Research 2023;16(1):16-22. (in Turkish). doi:10.46414/yasad.1284791
3. Dursun P, Alyagut P, Yılmaz I. Meaning in Life, Psychological Hardiness and Death Anxiety: İndividuals With or Without Generalized Anxiety Disorder (GAD). Curr Psychol. 2022;41(6):3299-317. doi: 10.1007/s12144-021-02695-3.
4. Kulakçı Altıntaş H, Ercan Şahin N. Attitudes to aging, depression, and death anxiety among community-dwelling older adults: a cross-sectional correlational study. BMC geriatrics 2025;25(1):454. doi: 10.1186/s12877-025-05839-3.

5. Lok N, Aydın Z, Uzun G, Kayaaslan B, Selçuk Tosun A. Relationship of Depression, Hopelessness and Life Satisfaction with Death Anxiety in İndividuals Who Have Had COVID-19. Omega (Westport). 2025;92(1):5-24. doi: 10.1177/00302228231174602.
6. Menzies RE, McMullen K, Riotto GD, et. Al. From Dread to Disorder: A Meta-Analysis of the İmpact of Death Anxiety on Mental İllness Symptoms. Clin Psychol Rev 2024;113:102490. doi: 10.1016/j.cpr.2024.102490.
7. Cetinkol G, Bastug G, Kizil ETO. Poor Acceptance of the Past is Related to Depressive Symptoms in Older Adults. GeroPsych 2020; 33(4). doi: 10.1024/1662-9647/a000227.
8. Reichardt LA, Nederveen FE, Van Seben R, et al. Hopelessness and Other Depressive Symptoms in Adults 70 Years and Older as Predictors of All-cause Mortality Within 3 months After Acute Hospitalization: the Hospital-ADL Study. Psychosom Med 2019;81(5):477-85. doi: 10.1097/PSY.0000000000000694.
9. Abdel-Aziz HR, Zaghamir DEF, Ibrahim AM. Enhancing Nursing's Role in Community-based Palliative Care: Closing Gaps to İmprove Patient Outcomes. BMC Nurs 2025;24(1):326. doi: 10.1186/s12912-025-02959-4.
10. Thorson JA, Powell FC. A Revised Death Anxiety Scale. Death Anxiety Handbook: Research, İnstrumentation, and Application: Taylor & Francis 2007;31-43. doi: 10.1080/07481189208252595.
11. Karaca F, Yıldız M. Validity and reliability study of the turkish translation of the thorson-powell death anxiety scale in a normal population. Tabula Rasa 2001; 1(1), 43-5.
12. Beck AT, Ward CH, Mendelson M, Mock J, Erbaugh J. An İnventory for Measuring Depression. Arch Gen Psychiatry 1961;4(6):561-71. doi: 10.1001/archpsyc.1961.01710120031004.
13. Seber G, Dilbaz N, Kaptanoğlu C, Tekin D. Hopelessness Scale: Validity and Reliability. Crisis Journal 1993;1(3). (in Turkish).
14. Feng Y, Liu X, Lin T, et al. Exploring the Relationship Between Spiritual Well-being and Death anxiety in Patients with Gynecological Cancer: A cross-section study. BMC Palliat Care 2021;20(1):78. doi: 10.1186/s12904-021-00778-3.
15. Çam F, Boy Y, Mollaoğlu M, Korkmaz S. Does Illness Perception Predict Hopelessness and Death Anxiety in Palliative Care Patients? Omega (Westport) 2024. doi: 10.1177/00302228241309958.
16. Chen G, Mo Q, Chen X, et al. Quality of Life, Hopelessness, İmpulsivity, and Suicide in the Rural Elderly in China: A moderated Mediation Analysis of Psychological Autopsy Data. Front Public Health 2022;10:900156. doi: 10.3389/fpubh.2022.900156.
17. Meléndez JC, Delhom I, Satorres E, Abella M, Real E. Hopelessness as a Predictor of Loneliness in Older Adults. Rev Esp Geriatr Gerontol 2022;57(2):85-9. doi: 10.1016/j.regg.2022.01.002
18. Şahin NE, Özçetin YÜ. Life Satisfaction and Hopelessness Levels of Elderly Individuals Living in Nursing Homes. Mersin University Journal of Health Sciences 2020;13(2):167-76. (in Turkish). doi: 10.26559/mersinsbd.674370.
19. Blazer D. The health and medical dimensions of social isolation and loneliness in older adults. JAMA Psychiatry 2020; 77(10):990-1. doi: 10.1001/jamapsychiatry.2020.1054.
20. Uslu-Sahan F, Terzioglu F, Koc G. Hopelessness, Death Anxiety, and Social Support of Hospitalized Patients with Gynecologic Cancer and Their Caregivers. Cancer Nurs 2019;42(5):373-80. doi: 10.1097/NCC.0000000000000622.
21. Gutiérrez-Vega M, Esparza-Del Villar OA, Carrillo-Saucedo IC, Montañez-Alvarado P. The Possible Protective Effect of Marital Status in Quality of Life Among Elders in a US-Mexico Border City. Community Ment Health J 2018;54(4):480-4. doi: 10.1007/s10597-017-0166-z.
22. Kasapoğlu F. The Relationship Among Spirituality, Self-efficacy, COVID-19 Anxiety, and Hopelessness During the COVID-19 Process in Turkey: A Path Analysis. J Relig Health 2022;61(1):767-85. doi: 10.1007/s10943-021-01472-7.

ORIGINAL ARTICLE

ATTITUDES OF THORACIC SURGEONS AND RESIDENTS TOWARD THORACIC SURGERY IN ELDERLY PATIENTS

Turkish Journal of Geriatrics
2026; 29(1):98–109

DOI: 10.29400/tjgeri.2026.482

Atilla CAN
Hüseyin YILDIRAN

Selçuk University, Faculty of Medicine, Department of Thoracic Surgery, Konya, Türkiye

Abstract

Introduction: We evaluated the clinical attitudes of thoracic surgery specialists and residents in Turkey toward thoracic surgery in elderly patients, their perceptions of geriatric support in surgical decision-making, and their educational needs.

Materials and Method: This descriptive, cross-sectional survey study included thoracic surgery specialists, academic surgeons, and residents currently practicing in Turkey. Data were collected anonymously via Google Forms between July and September 2025. The questionnaire comprised items related to demographic characteristics, surgical decision-making, geriatric support, multidisciplinary approach, and educational needs. Statistical analysis included descriptive statistics, comparative tests, effect size calculations, and multivariable logistic regression analysis.

Results: The study recruited 103 participants. A large majority of participants (90.3%) reported that minimally invasive approaches were advantageous for patients aged ≥65 years, and strong agreement was observed with the statement that chronological age alone should not be considered a contraindication to surgery. Overall performance status was identified as the primary determinant in surgical decision-making. Overall, 62.1% of participants reported limited access to geriatric specialists at their institution, and 60.2% stated that they had not received structured education on the management of elderly patients. In addition, residents demonstrated a more indecisive attitude toward non-operative approaches compared with specialists and academic surgeons, with 60.0% of residents reporting uncertainty.

Conclusion: Thoracic surgeons support an individualized, multidisciplinary approach to surgical care in elderly patients, but limited access to geriatric support and gaps in education restrict the full implementation of this approach in clinical practice. Stronger geriatric-based multidisciplinary models and educational programs could improve the quality of care for elderly patients when they undergo thoracic surgery.

Keywords: Aged; Thoracic Surgery; Geriatrics; Patient Care Team; Decision Making.

Correspondence

Atilla CAN
Phone : +905355557436
e-mail : atillacan_ac@yahoo.com

Received : Jan 28, 2026
Accepted: Mar 02, 2026

Cite this article as:
Can A, Yıldıran H. Attitudes of Thoracic Surgeons and Residents Toward Thoracic Surgery in Elderly Patients. Turkish Journal of Geriatrics 2026; 29(1):98–109. doi: 10.29400/tjgeri.2026.482

INTRODUCTION

The global population of those aged 65 years and older has more than doubled over the past three decades, from 327.6 million in 1990 to 673.7 million in 2017, with the proportion of older adults rising from 6.1% to 8.8% of the total population. In high-income countries, the proportion of such individuals increased from 12.1% in 1990 to 17.5% in 2017. Annual rates of population aging of 0.08% in Asia and 0.15% in Europe have been reported (1, 2). Similarly, the proportion of Turkey's population aged 65 and older increased from 9.7% in 2021 to 10.6% in 2024 and is projected to exceed 16% by 2040. The nation's aging trajectory, which parallels that of European countries, underscores the need of its healthcare systems to prepare for this demographic transition (3).

The demand for thoracic surgical interventions has grown with the elderly population. Because the incidence of lung cancer rises with age, individuals aged 65 and older constitute a substantial proportion of patients undergoing thoracic oncologic surgery (4). The incidence of conditions requiring surgical management, such as pneumonia, empyema, and traumatic thoracic injuries, also increases with advancing age (5). Advances in surgical techniques, particularly the adoption of video-assisted thoracoscopic surgery (VATS) and robotic surgery, have improved surgical feasibility and outcomes in appropriately selected elderly patients (4, 6).

Aging is associated with reduced physiological reserve and increased postoperative risk. However, chronological age alone is an insufficient predictor of surgical outcomes; frailty, respiratory function, and overall functional status are more decisive. For instance, low forced expiratory volume in one second (FEV_1) is linked to higher complication risk. Nonetheless, carefully selected elderly patients may achieve outcomes comparable to younger individuals (6, 7).

Consequently, multidisciplinary care models centered on comprehensive geriatric assessment (CGA) are increasingly important in the management of elderly surgical patients. Systematic reviews have demonstrated that CGA-based multidisciplinary care reduces postoperative complications, delirium rates, and length of hospital stay. Geriatric consultation and co-management models have also been reported effective in preserving functional capacity, reducing complications, and improving discharge planning (8, 9).

Surgeons' attitudes toward elderly patients are described in the literature as heterogeneous. Some surgeons tend to adopt a more conservative or avoidant approach due to concerns about elevated complication risk, and evidence of age-related bias suggests that surgical options may be restricted solely on the basis of chronological age, even in patients with limited comorbidity and good functional status (10). Limited access to geriatric consultation, shortages of geriatric specialists, structural and communication barriers, and regulatory constraints play significant roles in this context. Improved alignment with patient goals, better complication management, and enhanced discharge planning have been reported for centers where geriatric support becomes available (11). In addition, surveys conducted in surgical and geriatric disciplines have identified substantial educational needs in areas such as frailty assessment, delirium management, and multidisciplinary collaboration. Microlearning and hands-on training approaches can enhance surgical residents' knowledge and skills in the care of elderly patients (12). To date, no study has specifically evaluated the perspectives of surgeons in Turkey regarding the management of elderly patients and collaboration with geriatric services.

This study was conducted to assess the clinical approaches of thoracic surgeons and residents regarding thoracic surgery in elderly patients, their perceptions of geriatric support in surgical decision-making, and their educational needs in this field. Specifically, the study examined which clinical factors

physicians prioritize in the management of elderly patients, their access to geriatric consultation, their views on multidisciplinary collaboration, and the challenges encountered in the current healthcare system. The findings are intended to contribute to strengthening geriatric-oriented models in the care of elderly thoracic surgery patients and to identifying areas requiring improvement.

In this study, the term "elderly" primarily refers to individuals aged ≥65 years, consistent with international demographic definitions. However, specific age subgroups (e.g., ≥80 and ≥85 years) were explored separately to assess variations in surgical attitudes toward advanced age.

MATERIALS AND METHOD

This study was designed as a descriptive, cross-sectional, questionnaire-based survey to evaluate attitudes toward thoracic surgery in elderly patients, perceptions of geriatric support, and related educational needs. The study population consisted of thoracic surgery specialists and residents actively practicing in Turkey. Questionnaires with more than 20% missing responses were excluded from analysis. As this was an exploratory national survey without a predefined primary hypothesis, no formal a priori sample size calculation was performed; the final sample reflects voluntary participation during the study period.

Participants were recruited through professional communication groups and networks that included thoracic surgery specialists and residents across Turkey. Convenience and snowball sampling methods were used concurrently, with participants encouraged to share the survey link with colleagues. Because recruitment relied on network-based dissemination, the exact number of individuals who received or viewed the invitation could not be determined; therefore, a precise response rate could not be calculated. As participation was voluntary and anonymous, non-responder analysis was not feasible. Participants were recruited via a professional communication group of thoracic surgeons practicing in Turkey (approximately >300 members) and through snowball dissemination to residents within their clinics.

The questionnaire included sections on demographic characteristics, surgical decision-making processes, experiences and attitudes toward geriatric support, multidisciplinary collaboration, and educational needs in the management of elderly patients. A 5-point Likert scale was used for attitudinal items, while selected questions included three response options.

Questionnaire Development

The questionnaire was developed through a structured multi-step process. A focused literature review was conducted in PubMed to identify key domains related to geriatric surgical care, multidisciplinary management, perioperative risk perception, and educational needs in elderly patients. Based on these domains, an initial item pool was generated by the research team. The draft instrument was reviewed by senior thoracic surgeons with substantial clinical experience to assess content relevance, clarity, and comprehensiveness. Following iterative revisions, minor refinements in wording and response structure were made, and the final version was approved for dissemination.

No formal pilot testing, Content Validity Index (CVI) calculation, or test–retest reliability assessment was conducted, as the questionnaire was designed as an exploratory descriptive instrument intended to map national attitudes rather than to establish a validated psychometric construct. This methodological approach is consistent with exploratory attitude surveys in surgical research and is acknowledged as a limitation of the study. The complete questionnaire is provided as Supplementary File 1.

Data were collected anonymously via Google Forms between July and September 2025. At the



beginning of the survey, participants were informed about the purpose and scope of the study, and electronic informed consent was obtained prior to participation. No identifiable personal data were collected, and responses were stored in a password-protected database accessible only to the research team. The study was conducted in accordance with the Declaration of Helsinki and received approval from the local ethics committee (Approval No: 431; July 8, 2025).

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics. Categorical variables are presented as frequencies and percentages, and continuous variables as mean ± standard deviation or median (interquartile range), as appropriate. Comparisons between specialists and residents were conducted using chi-square or Fisher's exact tests for categorical variables and independent samples t-test, Mann–Whitney U test, or Kruskal–Wallis test for continuous or ordinal variables, depending on distributional assumptions.

A p-value <0.05 was considered statistically significant. Given the exploratory nature of the study, no formal adjustment for multiple comparisons was applied; therefore, subgroup findings should be interpreted cautiously. However, inferential emphasis was placed on a limited number of pre-specified primary comparisons, particularly differences in surgical willingness between professional groups, defined a priori based on the study objectives.

Effect sizes were reported alongside p values (Cramér's V for chi-square tests, Cohen's d for between-group mean differences, and η^2 for Kruskal–Wallis tests). A multivariable logistic regression model was used to identify independent predictors of high surgical willingness. Adjusted odds ratios (ORs) with 95% confidence intervals (CIs) were reported. As this was an exploratory descriptive survey, no a priori sample size or power calculation was performed.

RESULTS

A total of 103 thoracic surgery specialists, residents, and academicians participated. Unless otherwise stated, percentages are reported based on the number of participants who responded to each specific question.

Demographic and professional characteristics of participants

Of the participants, 49.5% (51/103) were specialists, 26.2% (27/103) were academicians, and 24.3% (25/103) were residents. The duration of professional experience in thoracic surgery was 1–5 years for 36.3% (37/102), 6–10 years for 30.4% (31/102), 10–20 years for 22.5% (23/102), and ≥20 years for 10.8% (11/102); one participant did not respond to this item. Overall, 66.0% (68/103) of participants were male, and 34.0% (35/103) were female.

Among the 102 respondents who answered the question regarding institution type, 40.2% (41/102) worked in training and research hospitals, 36.3% (37/102) in university hospitals, 14.7% (15/102) in state hospitals, and 8.8% (9/102) in private hospitals. Regarding surgical involvement in patients aged ≥65 years, 59.2% (61/103) reported performing ≥31 surgeries annually, 13.6% (14/103) performed 21–30, 15.5% (16/103) performed 11–20, and 11.7% (12/103) performed 0–10 such procedures. Demographic and professional characteristics are summarized in Table 1.

When asked about the most important factor influencing surgical decision-making in patients aged ≥65 years, 57.3% (59/103) identified overall performance status, 36.9% (38/103) tumor stage and extent, 3.9% (4/103) postoperative complication risk, and 1.9% (2/103) patient and family preferences.

Among the primary perceived surgical risks, 78.6% (81/103) emphasized postoperative pulmonary complications, 69.9% (72/103) cardiac risks (myocardial infarction, arrhythmia), 52.4% (54/103) prolonged hospitalization and

Table 1. Demographic and professional characteristics of participants (n = 103)

Variable	Category	n	%
Professional title (n = 103)	Specialist	51	49.5
	Academic surgeon	27	26.2
	Resident	25	24.3
Years in specialty (n = 102)*	1–5 years	37	36.3
	6–10 years	31	30.4
	10–20 years	23	22.5
	≥20 years	11	10.8
Gender (n=103)	Male	68	66.0
	Female	35	34.0
Type of institution (n = 102)†	Training and research hospital	41	40.2
	University hospital	37	36.3
	State hospital	15	14.7
	Private hospital	9	8.8
Annual number of surgical cases ≥65 years (n = 103)	0–10	12	11.7
	11–20	16	15.5
	21–30	14	13.6
	≥31	61	59.2

* One participant did not respond to the question on years in specialty. † One participant did not respond to the question on institution type.

rehabilitation, and 24.3% (25/103) cognitive decline/delirium. Incorrect expectations of patients or relatives were identified as a major risk by only 1.0% (1/103) of participants.

Surgical technique preferences and age-related considerations

Minimally invasive surgery (VATS or robotic surgery) was identified as an appropriate option for patients aged ≥65 years by 90.3% (93/103; 95% CI: 83.0%–94.7%) of participants. Open surgery was considered appropriate by 23.3% (24/103), and non-operative treatments (e.g., radiotherapy/immunotherapy) by 20.4% (21/103) (multiple responses allowed).

Regarding age groups generally considered suitable for surgery, among the 102 respondents, 99.0% (101/102) reported 65–75 years, 58.8% (60/102) reported 75–80 years, and 30.4% (31/102) reported ≥80 years as generally appropriate for surgical intervention (multiple responses allowed). This distribution is illustrated in Figure 1.

In response to the question "Are non-operative alternatives more appropriate for patients aged ≥65 years?", 53.4% (55/103) answered "no," 35.9% (37/103) were undecided, and 10.7% (11/103) answered "yes." Among residents, 60.0% (15/25; 95% CI: 38.7%–78.9%) were undecided, compared with 27.8% (22/79) among specialists/academicians. This difference was statistically significant ($\chi^2 = 14.9$, $p < 0.001$), with a moderate effect size (Cramér's V = 0.38).

Factors perceived to accelerate postoperative recovery included physiotherapy and early mobilization (95.1%, 98/103), intensive preoperative assessment (69.9%, 72/103), nutritional support (65.0%, 67/103), and multidisciplinary follow-up involving a geriatric specialist (29.1%, 30/103) (multiple responses allowed).

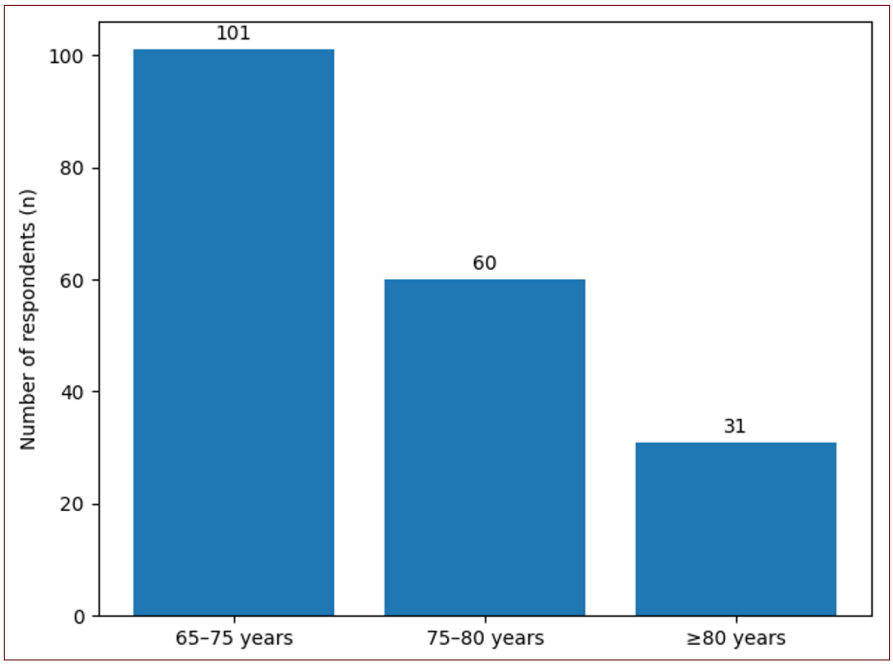


Figure 1. Age groups generally considered suitable for surgery according to respondents (n=102). Multiple responses were allowed.

Attitudes toward surgical decision-making

Responses to Likert-scale items (1 = strongly disagree, 5 = strongly agree) demonstrated generally positive attitudes toward individualized and multidisciplinary surgical care in patients aged ≥65 years.

Agreement with the statement "Surgery is generally safe between the ages of 65–75 years" showed a mean score of 3.94 (median 4). In contrast, the statement "Surgery is generally not recommended in patients aged ≥85 years" yielded a lower mean score of 3.07 (median 3), indicating more cautious and heterogeneous views regarding advanced age.

Participants strongly agreed that "Minimally invasive surgery is more advantageous for patients aged ≥65 years" (mean 4.38, median 5) and that "Age alone should not be considered a contraindication for surgery" (mean 4.43, median 5).

Agreement with "Surgical decisions in patients aged ≥65 years should be made by a multidisciplinary board" had a mean score of 3.99 (median 4).

The perception that "The risk of complications is significantly higher in patients aged ≥65 years than in younger patients" (n=102) showed a high mean score of 4.48 (median 5).

Similarly, the statement "An individualized approach should be preferred over avoiding surgery in patients aged ≥65 years" (n=102) demonstrated strong agreement (mean 4.41, median 5).

Collaboration with geriatrics, guideline awareness, and educational needs

Overall, 40.8% (42/103) of participants reported awareness of any clinical guidelines or protocols related to patients aged ≥65 years, while 59.2% (61/103) reported no such knowledge. A comprehensive overview of responses related to geriatric support, guideline awareness, and educational needs is summarized in Table 2.

When asked whether they had received specific training on patients aged ≥65 years care

Table 2. Participants' responses regarding access to geriatric specialists, guideline awareness, and education

Question / Variable	Response category	n	%
Awareness of guidelines/protocols for elderly patients (n = 103)	Yes	42	40.8
	No	61	59.2
Specific training on elderly patient care during residency (n = 103)	Yes	10	9.7
	Partially	31	30.1
	No	62	60.2
Would you like additional education/support in this area? (n = 103)	Yes	84	81.6
	No	19	18.4
Availability of a geriatric specialist in the institution (n = 103)	Yes	39	37.9
	No	64	62.1
Preoperative/postoperative geriatric support (n = 100)*	No access to geriatric support	36	36.0
	Yes, but not always available	32	32.0
	Yes, regular support available	25	25.0
	No, but support obtained from another center	7	7.0
Would you communicate with a geriatric specialist if available? (n = 102)†	Yes	77	75.5
	Undecided	18	17.6
	No	7	6.9

* Three participants did not respond to this question.† One participant did not respond to this question.

during residency, 60.2% (62/103) responded "no," 30.1% (31/103) "some," and 9.7% (10/103) "yes." Nevertheless, 81.6% (84/103; 95% CI: 72.9%–88.1%) expressed a desire for additional education or support in this area.

Regarding institutional availability of geriatric specialists, 62.1% (64/103; 95% CI: 52.4%–71.0%) (64/103) reported none, while 37.9% (39/103) reported availability.

Among the 100 respondents addressing perioperative geriatric support, 36.0% (36/100) reported receiving no support, 32.0% (32/100) reported intermittent support, 25.0% (25/100) reported regular support, and 7.0% (7/100) reported accessing support from external institutions.

Among the 102 respondents, 75.5% (77/102) stated that they would like to communicate with a geriatric specialist during the surgical process if one were available, 17.6% (18/102) were undecided, and 6.9% (7/102) responded "no."

Support services for improving the surgical process, rated on a 1–5 scale, yielded mean scores of 4.47 for nutrition/dietitian support (102/102), 4.80 for pulmonary rehabilitation (102/102), 4.27 for psychosocial support (102/102), and 4.36 for collaboration with palliative care teams (101/101), all indicating high perceived importance.

Comparisons by professional title and experience

Of the 94 participants who responded to this item (22 residents and 72 specialists/academicians), residents demonstrated a lower mean willingness score (3.14) compared with specialists/academicians (4.03), and this difference was statistically significant ($p < 0.001$; Cohen's $d = 0.88$). The effect size of this difference was large (Cohen's $d = 0.88$), suggesting substantial divergence in surgical willingness between trainees and experienced surgeons. When willingness was analyzed by years of professional



Table 3. Comparison of key attitudinal variables by professional title

Variable	Resident (n=25)	Specialist (n=51)	Academic surgeon (n=27)	p value*
Undecided about non-operative alternatives (≥65 years)	15/25 (60.0%)	13/51 (25.5%)	9/27 (33.3%)	<0.001
Mean surgical willingness score (1–5)	3.14 ± 0.83	3.88 ± 0.75	4.35 ± 0.78	<0.001
High surgical willingness (Likert 4–5)	6/25 (24.0%)	34/51 (66.7%)	21/27 (77.8%)	<0.001
Awareness of guidelines	6/25 (24.0%)	21/51 (41.2%)	15/27 (55.6%)	0.084
Received structured geriatric training during residency	2/25 (8.0%)	5/51 (9.8%)	3/27 (11.1%)	0.930

Chi-square test for categorical variables; Kruskal–Wallis test for continuous variables.

experience, mean scores were 3.33 for 1–5 years, 4.07 for 6–10 years, 4.33 for 10–20 years, and 3.67 for ≥20 years, with a significant overall difference ($H = 20.3$, $p < 0.001$). The estimated effect size ($\eta^2 = 0.20$) indicated a large effect of professional experience on surgical willingness. Subgroup analyses across three professional categories (resident, specialist, academic surgeon) revealed significant between-group differences in surgical willingness and indecision rates. Full subgroup comparisons with explicit N values are provided in Table 3.

Awareness of guidelines or protocols for patients aged ≥65 years was reported by 24.0% (6/25) of residents and 46.2% (36/78) of specialists/academicians; this difference did not reach statistical significance ($p = 0.084$).

To further explore independent predictors of surgical willingness, a multivariate logistic regression analysis was performed. Willingness scores were dichotomized into high (Likert 4–5) versus low/moderate (Likert 1–3). Independent variables included professional title (resident vs specialist/academician), years of experience, availability of geriatric support, and prior training in elderly patient care. After adjustment, being a specialist/academician remained independently associated with higher surgical willingness (OR 3.21, 95% CI 1.42–7.25, $p = 0.005$), and having 6–20 years of experience was also an independent predictor (OR 2.87, 95% CI 1.18–6.94, $p = 0.020$). Availability of geriatric support and prior training did not reach statistical significance in the adjusted model.

DISCUSSION

In this study, we evaluated the clinical approaches, risk perceptions, attitudes toward geriatric support, and educational needs of thoracic surgery specialists and residents practicing in Turkey with regard to surgical management of elderly patients. Our findings indicate a strong consensus that chronological age alone should not be a determining factor in surgical decision-making; however, decision-making remains heterogeneous and cautious regarding more advanced age groups. The widespread preference for minimally invasive surgery, support for multidisciplinary care, and emphasis on individualized decision-making are consistent with contemporary trends described in the literature. Nevertheless, limited access to geriatric support and the lack of structured education appear to hinder the full translation of these principles into routine clinical practice.

In the literature, decision-making regarding elderly surgical patients is frequently described as "not quite shared," as surgeons tend to focus primarily on risk assessment and management of potential complications, while patients are only partially involved as active decision partners (13, 14). In oncologic surgery in particular, elderly patients have been shown to receive guideline-concordant treatments less frequently, largely due

to age-related treatment hesitancy (10). In our study, the prioritization of overall performance status as the key determinant of surgical decisions and the high perceived complication risk in elderly patients support this risk-oriented decision-making pattern. At the same time, the fact that nearly all participants considered surgery appropriate in the 65–75-year age group suggests that age is not viewed as an absolute contraindication, although greater caution is evident at more advanced ages.

Studies examining surgeons' risk perception in elderly patients indicate that decisions are often based on personal experience, perceived "physiological age," and clinical judgment rather than formal risk scores (13). Research in various surgical fields, including breast, colorectal, and pancreatic surgery, has demonstrated that even fit elderly patients may receive less aggressive treatment, which potentially reflects age-related bias (10, 15, 16). Although thoracic surgery–specific data are limited, lower resection rates in older patients suggest a similar mismatch between stated attitudes and actual practice (10, 15). In our cohort, despite strong agreement that age alone should not be considered a contraindication, the more hesitant and heterogeneous attitudes toward surgery in patients aged ≥85 years reflect this ongoing discrepancy.

The impact of CGA and geriatric consultation on surgical outcomes remains a subject of active debate. Recent meta-analyses have demonstrated that CGA significantly reduces postoperative delirium, whereas its effects on length of hospital stay and functional outcomes are more limited and heterogeneous (8, 17). Importantly, reactive, recommendation-based geriatric consultations alone have not consistently improved outcomes, while proactive, team-based co-management models appear more effective (9, 18, 19). In our study, the strong support for multidisciplinary collaboration with geriatric specialists, coupled with reported limitations in access to such support, aligns with this structural gap.

Studies on multidisciplinary and geriatric co-management models have reported favorable effects on delirium, complication rates, and length of hospital stay (9, 20, 21). Evidence from vascular and orthopedic surgery suggests that similar benefits could potentially be achieved in thoracic surgery. In our findings, the high importance attributed to physiotherapy, early mobilization, and intensive preoperative assessment underscores a strong awareness of Enhanced Recovery After Surgery (ERAS) based and multidisciplinary principles. However, restricted access to geriatric services appears to limit the practical implementation of these approaches.

Similar training gaps have been reported in other surgical specialties, particularly in general surgery and orthopedics, where residents and practicing surgeons cite unmet needs in frailty assessment, delirium prevention, and interdisciplinary coordination (22–24). In our cohort, 60.2% of participants reported not receiving structured education in elderly patient management during residency, and residents demonstrated significantly greater indecision regarding non-operative alternatives compared with specialists. These findings suggest that the educational gap observed in other surgical disciplines is also present in thoracic surgery and may directly influence clinical decision-making patterns. Given evidence supporting the effectiveness of microlearning, structured geriatric rotations, and multidisciplinary educational models (12, 24), integrating similar approaches into thoracic surgery training emerges as an important unmet need.

An interesting finding was the discrepancy between the high perceived importance of multidisciplinary support services (e.g., physiotherapy and geriatric involvement) and the relatively low proportion of participants who believed that geriatric support directly accelerates postoperative recovery. This may reflect a perception of geriatrics primarily as a consultative



or risk-assessment service rather than an integrated rehabilitation partner. Such a perception gap highlights the need to strengthen awareness of evidence-based geriatric co-management models.

The cautious attitude toward patients aged ≥85 years may reflect both evidence-based clinical concern and potential age-related bias. While advanced age is associated with higher perioperative risk, contemporary literature suggests that carefully selected very elderly patients can benefit from surgery. Distinguishing between appropriate clinical caution and age-based therapeutic nihilism remains a critical challenge.

In the Turkish healthcare context, the availability of minimally invasive technologies such as VATS and robotic surgery may vary across institutions. Differences in technological access could influence attitudes toward surgical feasibility in elderly patients.

Although the survey was distributed nationally through professional networks, the sample may not fully represent all thoracic surgeons in Turkey, particularly those not engaged in professional communication groups.

Strengths and limitations

One of the main strengths of this study is the inclusion of thoracic surgery specialists, academicians, and residents from various institution types across Turkey, allowing evaluation of attitudes toward elderly thoracic surgical care at different levels of experience and practice settings. The combined assessment of surgical decision-making, perspectives on geriatric support, and educational needs enhances the clinical relevance of the findings.

Several limitations should also be acknowledged. The cross-sectional, survey-based design limits causal interpretation of the results. The use of convenience and snowball sampling may affect generalizability. Additionally, the reliance on self-reported data reflects perceived attitudes rather than actual clinical practice. Despite these limitations, the study provides novel and valuable insights into thoracic surgeons' perspectives on elderly patient care and geriatric collaboration in Turkey.

The questionnaire did not undergo formal psychometric validation procedures such as CVI calculation or test–retest reliability analysis. As this study was exploratory and descriptive in nature, the findings should be interpreted as reflecting perceived attitudes rather than validated behavioral measures.

Selection bias cannot be excluded, as surgeons with a greater interest in geriatric care may have been more likely to participate. Furthermore, the inability to determine the exact response rate and perform non-responder analysis limits the assessment of representativeness, and the reliance on self-reported attitudes may not fully reflect real-world surgical decision-making patterns. Although the survey was distributed nationally through professional networks, participants may have been more likely to respond if they had a particular interest in geriatric care, which could have influenced the overall attitudinal distribution.

Future research directions

Future studies should prospectively and multicentrically evaluate the impact of geriatric-based multidisciplinary approaches on clinical outcomes in elderly thoracic surgery patients. In particular, the effects of CGA and co-management models on complications, functional outcomes, quality of life, and healthcare utilization should be assessed using standardized outcome measures. Interventional studies examining the impact of structured geriatric education programs integrated into surgical training on surgeons' knowledge, decision-making processes, and patient outcomes would also be valuable. In the Turkish context, defining feasible models of geriatric-surgical collaboration and assessing their sustainability in different healthcare settings may improve the quality of care for elderly thoracic surgery patients.

CONCLUSION

This study demonstrates that thoracic surgery specialists and residents in Turkey generally adopt a decision-making framework for elderly patients that prioritizes functional status and individualized risk assessment over chronological age, and they strongly support minimally invasive surgery and multidisciplinary care. Nevertheless, heterogeneity in decision-making for advanced age groups, limited access to geriatric support, and the absence of structured education in elderly patient management continue to challenge the translation of these principles into daily practice. Our findings highlight the need to strengthen geriatric-based multidisciplinary workflows at the institutional level and to integrate practical, geriatric-focused content into thoracic surgery training programs. Addressing these gaps may contribute to the standardization of perioperative care and improved clinical outcomes for elderly thoracic surgery patients.

REFERENCES

1. Li J, Han X, Zhang X, Wang S. Spatiotemporal evolution of global population ageing from 1960 to 2017. BMC Public Health. 2019;19(1):127. doi:10.1186/s12889-019-6465-2.
2. Wang H, Abbas KM, Abbasifard M, et al. Global age-sex-specific fertility, mortality, healthy life expectancy (HALE), and population estimates in 204 countries and territories, 1950–2019: a comprehensive demographic analysis for the Global Burden of Disease Study 2019. Lancet. 2020;396(10258):1160-203. doi:10.1016/S0140-6736(20)30977-6.
3. Arayici ME, Kose A, Dolu S, et al. Epidemiological assessment of depression, activities of daily living and associated factors in elderly individuals aged 65 years and older: evidence from a population-based study. J Clin Med. 2025;14(8):2853. doi:10.3390/jcm14082853.
4. Rivera C, Dahan M, Bernard A, Falcoz P-E, Thomas P. Surgical treatment of lung cancer in the octogenarians: results of a nationwide audit. Eur J Cardiothorac Surg. 2011;39(6):981-6. doi:10.1016/j.ejcts.2010.09.022.
5. Fukuse T, Satoda N, Hijiya K, Takuji F. Importance of a comprehensive geriatric assessment in prediction of complications following thoracic surgery in elderly patients. Chest. 2005;127(3):886-91. doi:10.1378/chest.127.3.886.
6. Novellis P, Di Fonzo R, Bottoni E, et al. Robotic surgery is a safe treatment in very elderly patients with resectable lung cancer. J Clin Med. 2025;14(12):4314. doi:10.3390/jcm14124314.
7. Ko F, Ritchey K. Using frailty screening to inform preoperative management of high-risk surgical patients. Innov Aging. 2024;8(Suppl 1):478. doi:10.1093/geroni/igae098.1560.
8. Chen L, Zong W, Luo M, Yu H. The impact of comprehensive geriatric assessment on postoperative outcomes in elderly surgery: a systematic review and meta-analysis. PLoS One. 2024;19(8):e0306308. doi:10.1371/journal.pone.0306308.
9. Van Grootven B, Flamaing J, Dierckx de Casterlé B, et al. Effectiveness of in-hospital geriatric co-management: a systematic review and meta-analysis. Age Ageing. 2017;46(6):903-10. doi:10.1093/ageing/afx051.
10. Audisio RA, Balch CM. Why can't surgeons treat older patients the same as younger patients? Ann Surg Oncol. 2016;23(13):4123-5. doi:10.1245/s10434-016-5459-x.
11. Yousef A, Moustaqim-Barrette M, Allen MB, et al. Anesthesiologists' and surgeons' perceptions of the impact of the American College of Surgeons Geriatric Verification Program on co-management of older surgical patients: a qualitative mixed methods analysis. J Am Geriatr Soc. 2025. doi:10.1111/jgs.70027.
12. Thillainadesan J, Naganathan V, Hilmer SN, Kerdic R, Aitken SJ. Microlearning for surgical residents enhances perioperative comprehensive geriatric assessment. J Am Geriatr Soc. 2023;71(12):E30. doi:10.1111/jgs.18612.
13. De Roo AC, Vitous CA, Rivard SJ, et al. High-risk surgery among older adults: not-quite shared decision-making. Surgery. 2021;170(3):756-63. doi:10.1016/j.surg.2021.02.005.
14. Taylor LJ, Johnson SK, Nabozny MJ, et al. Barriers to goal-concordant care for older patients with acute surgical illness: communication patterns extrinsic to decision aids. Ann Surg. 2018;267(4):677-82. doi:10.1097/SLA.0000000000002282.



15. Korc-Grodzicki B, Downey RJ, Shahrokni A, Kingham TP, Patel SG, Audisio RA. Surgical considerations in older adults with cancer. J Clin Oncol. 2014;32(24):2647-53. doi:10.1200/JCO.2014.55.0962.

16. Sutton W, Genberg B, Prescott JD, Segev DL, Zeiger MA, Bandeen-Roche K, et al. Understanding surgical decision-making in older adults with differentiated thyroid cancer: a discrete choice experiment. Surgery. 2021;169(1):14-21. doi:10.1016/j.surg.2020.03.022.

17. Partridge JSL, Harari D, Martin F, Dhesi JK. The impact of pre-operative comprehensive geriatric assessment on postoperative outcomes in older patients undergoing scheduled surgery: a systematic review. Anaesthesia. 2014;69:8-16. doi:10.1111/anae.12494.

18. Janssens S, Dejaeger M, Sermon A, et al. Orthogeriatric co-management for older patients with a major osteoporotic fracture: Protocol of an observational pre-post study. PLoS One. 2023;18(4):e0283552. doi:10.1371/journal.pone.0283552.

19. Pilotto A, Cella A, Pilotto A, et al. Three decades of comprehensive geriatric assessment: evidence coming from different healthcare settings and specific clinical conditions. J Am Med Dir Assoc. 2017;18(2):192:e1-e11. doi:10.1016/j.jamda.2016.11.004.

20. Manuel K, Samuel K, Aggeler K, Dietrich M. The influence of orthogeriatric co-management on clinical outcomes after treatment of proximal femoral fractures—real world data of comparable cohorts originating from the same geographic area. J Clin Med. 2025;14(21):7464. doi:10.3390/jcm14217464.

21. Koprowski MA, Nagengast AK, Finlayson E, Brasel KJ. Surgical trainees and the geriatric patient: a scoping review. J Surg Educ. 2022;79(1):179-89. doi:10.1016/j.jsurg.2021.06.019.

22. Chesney TR, Pang G, Ahmed N. Caring for older surgical patients: contemporary attitudes, knowledge, practices, and needs of general surgeons and residents. Ann Surg. 2018;268(1):77-85. doi:10.1097/SLA.0000000000002363.

23. Barbas AS, Haney JC, Henry BV, Heflin MT, Lagoo SA. Development and implementation of a formalized geriatric surgery curriculum for general surgery residents. Gerontol Geriatr Educ. 2014;35(4):380-94. doi:10.1080/02701960.2013.879444.

24. Chan AC, Chuen V, Perrella A, Limfat G, Ng K, Chau V. A mixed methods evaluation of a 4-week geriatrics curriculum in strengthening knowledge and comfort among orthopaedic surgery residents. BMC Med Educ. 2021;21(1):283. doi:10.1186/s12909-021-02716-6.

ORIGINAL ARTICLE

EVALUATION OF COGNITIVE IMPAIRMENTS IN GLAUCOMA SUBTYPES: PRIMARY OPEN-ANGLE GLAUCOMA, PSEUDOEXFOLIATION SYNDROME, AND PSEUDOEXFOLIATION GLAUCOMA

Turkish Journal of Geriatrics
2026; 29(1):110–115

DOI: 10.29400/tjgeri.2026.483

Nur Ebru BARÇIN[1]
Hatice Deniz İLHAN[2]
Ali ÜNAL[1]

[1] Akdeniz University Faculty of Medicine, Neurology, Antalya, Türkiye

[2] Akdeniz University Faculty of Medicine, Ophtalmology, Antalya, Türkiye

Correspondence

Ali ÜNAL
Phone : +902422496300
e-mail : aunal@akdeniz.edu.tr

Received : Nov 30, 2025
Accepted: Feb 12, 2026

Cite this article as:
Barçın NE, İlhan HD, Ünal A. Evaluation of Cognitive Impairments in Glaucoma Subtypes: Primary Open-Angle Glaucoma, Pseudoexfoliation Syndrome, and Pseudoexfoliation Glaucoma. Turkish Journal of Geriatrics 2026; 29(1):110–115. doi: 10.29400/tjgeri.2026.483

Abstract

Introduction: Pseudoexfoliation syndrome is an age-related condition characterized by abnormal fibrillar material accumulation in the ocular and systemic tissues. Several studies have suggested that pseudoexfoliation syndrome is associated with neurodegenerative processes via different mechanisms. In our study, cognitive function was evaluated using the Mini-Mental State Examination in patients with pseudoexfoliation syndrome, pseudoexfoliation glaucoma, and primary open-angle glaucoma and compared with healthy controls.

Materials and Method: In this prospective study, 43 patients aged ≥60 years were diagnosed with pseudoexfoliation syndrome (Group I), 40 with pseudoexfoliation glaucoma (Group II), 43 with primary open-angle glaucoma (Group III), and 72 healthy individuals who served as controls (Group IV). The Mini-Mental State Examination was administered in a quiet room by the same neurologist who was blinded to the participants' diagnoses.

Results: A statistically significant difference was observed among the groups in Mini-Mental State Examination scores (p=0.001). Pairwise comparisons adjusted using the Bonferroni correction revealed significant differences between Groups I and IV, Groups II and III, and Groups II and IV (p=0.036; p=0.036; p=0.0012, respectively). In patients with pseudoexfoliation syndrome, Mini-Mental State Examination scores inversely correlated with age (p=0.003, r=−0.323); however, this association was not observed in the other groups (p=0.09).

Conclusion: Mini-Mental State Examination scores were significantly lower in patients with pseudoexfoliation syndrome and pseudoexfoliation glaucoma than in the control group and patients with primary open-angle glaucoma. Additionally, Mini-Mental State Examination performance inversely correlated with age in the pseudoexfoliation group. These findings suggest that pseudoexfoliation may not be confined to ocular pathology alone but may also be associated with systemic cognitive impairment.

Keywords: Exfoliation Syndromes; Glaucoma, Open-Angle; Cognition; Mental Status and Dementia Tests; Alzheimer Disease; Aged.

INTRODUCTION

Pseudoexfoliation syndrome (PXS) is the accumulation of abnormal extracellular fibrillar deposits in age-related intraocular and extraocular systemic tissues (1,2). The accumulation of these abnormal fibrils in the trabecular meshwork obstructs aqueous outflow and increases intraocular pressure (IOP). PXS is the most common identifiable cause of secondary glaucoma, and when accompanied by elevated IOP and glaucomatous optic neuropathy, it is termed pseudoexfoliative glaucoma (PXG). PXG follows a more aggressive clinical course than primary open-angle glaucoma (POAG) and exhibits a poorer response to topical therapy. In addition to glaucoma, the presence of pseudoexfoliated material contributes to cataract formation, lens subluxation, and increased intraoperative difficulty (3).

Abnormal fibrillar deposits have also been identified in various systemic organs, including vascular structures, the heart, lungs, kidneys, liver, skin, and meninges (3). Consequently, PXS has been associated with multiple systemic conditions such as hypertension, stroke, aneurysm formation, and renal artery stenosis. It has been reported that the abnormal elastic microfibrillar aggregates characteristic of PXS share similarities with the amyloid accumulation observed in Alzheimer's disease (AD) (4,5). Moreover, amyloid and alpha-1 antichymotrypsin, enzymes involved in the regulation of amyloid formation, have been detected in pseudoexfoliation materials (4). The aim of the present study was to compare the cognitive functions of patients diagnosed with PXS, PXG, and POAG using the Mini-Mental State Examination (MMSE).

MATERIALS AND METHOD

This prospective study evaluated patients who visited the Ophthalmology Outpatient Clinic at Akdeniz University between September 2013 and June 2014. Patients aged 60 years or older, whose native language was Turkish, who had received at least eight years of formal education, and who did not report hearing impairment that could interfere with their cooperation in the MMSE were included. Patients with chronic neurological disorders (such as epilepsy, stroke, Parkinson's Disease or dementia); mental retardation; chronic heart or kidney failure; insulin-dependent diabetes mellitus; age-related macular degeneration; retinal vascular diseases; a history of ophthalmic surgery; ocular trauma; uveitis; or any ocular condition that could affect the evaluation of the iris, lens, or optic disc were excluded. Given the reported association between pseudoexfoliation syndrome and systemic or ocular vascular conditions, patients with major vascular comorbidities that could independently influence cognitive performance or ophthalmic findings were excluded. The study was not designed to establish a diagnosis of dementia; therefore, neuroimaging studies such as brain MRI were not routinely performed. Individuals with corrected visual acuity below 20/40, except for those with cataracts, were also excluded. The control group consisted of relatives of patients with no chronic systemic illnesses.

All participants underwent a comprehensive ophthalmological examination that included detailed ocular history, best-corrected visual acuity, slit-lamp examination after pupillary dilation, Goldmann applanation tonometry, gonioscopy with Goldmann's three-mirror lens, visual field testing, and fundus examination. Pseudoexfoliative material was assessed after dilation, and the presence of fibrillar deposits in the anterior segment, whether unilateral or bilateral was defined as PXS. PXG was diagnosed based on the presence of pseudoexfoliative material on the anterior segment, together with glaucomatous optic neuropathy characterized by an increased cup-to-disc ratio and/or neuroretinal rim thinning, and corresponding visual field defects, with or without elevated intraocular pressure. POAG was diagnosed based on an open anterior chamber angle on gonioscopy, the presence of glaucomatous optic neuropathy, and corresponding reproducible visual field defects.

The study was not designed to establish a diagnosis of dementia; therefore, neuroimaging studies such as brain MRI were not routinely performed. Cognitive assessment was conducted using the MMSE, a widely used screening tool for global cognitive status. The MMSE evaluates orientation, registration, attention and calculation, recall, language, and visuospatial abilities, and requires approximately 5–10 minutes to administer. The MMSE, whose Turkish validity and reliability have been established, was administered in a quiet room by a neurologist blinded to the patient and control groups (6). In the present study, MMSE scores were classified as ≤19 indicating modarate to severe cognitive impairment, 20–25 indicating mild cognitive impairment, and ≥26 indicating normal cognitive performance. In patients who underwent cataract surgery, the MMSE was administered only after postoperative improvement in visual acuity. Although hemispheric dominance was not a primary focus of the study, recording dominant hand aimed to reduce potential confounding effects on cognitive screening results.

The study was approved by the Ethics Committee of the Akdeniz University, Faculty of Medicine (reference number: 15.05.2013/93), and written informed consent was obtained from all participants.

Statistical Analysis:

Statistical analyses were performed using SPSS software (version 16.0; SPSS Inc., Chicago, IL, USA). Data were presented as mean ± standard deviation, while categorical variables were expressed as numbers and percentages. The chi-square test was used to compare categorical variables, and the Mann–Whitney U test was used to compare continuous variables. For multiple group comparisons, the Kruskal–Wallis test with Bonferroni correction was used. Quantitative relationships between variables that did not follow a normal distribution were assessed using Spearman's correlation coefficient, whereas Pearson correlation test was used for variables that showed a normal distribution.

RESULTS

A total of 198 patients who met the inclusion criteria were enrolled in this study. Of these, 106 (53.5%) were female and 92 (46.5%) were male. Group I (PXS) consisted of 43 patients; Group II (PXG), 40 patients; Group III (POAG), 43 patients; and Group IV (control group), 72 patients. The mean age of all participants was 70.9 ± 5.9 years. No statistically significant differences were observed between the groups in terms of age or sex ($P > 0.05$). A total of 191 patients were right-handed, and seven were left-handed. The demographic characteristics of the study groups are shown in Table 1. Dominant hand was recorded to account for potential effects of hemispheric dominance on cognitive performance.

The mean MMSE scores in the groups were 25.8 ± 3.4, 25.5 ± 3, 27 ± 2.4, and 27.4 ± 2.1, respectively.

Table 1. Demographic characteristics of the study groups

	Group I (PXS)	Group II (PXG)	Group III (POAG)	Group IV (Control)
Number of patients (n)	43	40	43	72
Female/Male (n)	19/24	21/19	40/32	26/17
Age	72.3±6.9	71.8± 6.7	70.1±5.6	70.5±4.8
Dominant hand (left/right)	2/41	1/39	3/40	1/71
MMSE	25.8±3.4	25.5±3	27±2.4	27.4±2.1

MMSE: Mini-Mental State Examination, PXS: Pseudoexfoliation syndrome, PXG: Pseudoexfoliative glaucoma, POAG: Primary open-angle glaucoma



Table 2. Distribution of MMSE scores across subgroups

MMSE	Group I (PXS)	Group II (PXG)	Group III (POAG)	Group IV (Control)	Total (n=198)
≤ 19	4	2	1	0	7
20-25	13	15	7	8	44
≥26	26	23	35	63	147

MMSE: Mini-Mental State Examination, PXS: Pseudoexfoliation syndrome, PXG: Pseudoexfoliative glaucoma, POAG: Primary open-angle glaucoma

MMSE scores differed significantly between the groups (p=0.001). In pairwise comparisons using Bonferroni correction, statistically significant differences were found between Groups I and IV, Groups II and III, and Groups II and IV (p=0.036, p=0.036, and p=0.0012, respectively), whereas no significant differences were detected in the remaining comparisons. A negative correlation between MMSE scores and age was observed in patients with PXS (p=0.003; r=−0.323), but no such correlation was found in patients without PXS (p=0.09). The mean MMSE score was 26.5 ± 3 in women and 26.7 ± 2.5 in men, with no statistically significant difference between sexes (p=0.74).

A total of 51 patients (25.3%) had an MMSE score < 26/30, and the presence of PXS was significantly higher in this group (p=0.000025). Of these, 17 (34%) were in Group I, 17 (34%) in Group II, 8 (16%) in Group III, and 8 (16%) in Group IV. The distribution of MMSE scores across the subgroups is presented in Table 2. There was no significant difference in whether PXS was bilateral or unilateral (p=0.52). PXS was present in both eyes of 48 patients, the left eye of 25 patients, and the right eye of 10 patients.

DISCUSSION

In this study, the cognitive function of patients diagnosed with PXS, PXG, and POAG was evaluated using the MMSE. MMSE total scores differed significantly between groups. This difference was most apparent in the PXS group, which had lower scores than the control group, and in the PXG group, which had lower scores than those of the POAG and control groups. No significant differences were observed in the remaining pairwise comparisons. Additionally, PXS was significantly more common among the 51 patients with an MMSE score < 26/30 (p=0.000025). The negative correlation between MMSE scores and age in patients with PXS further supports the notion that PXS may have an age-related impact on cognitive function. Cognitive findings were based on screening assessment, and no participant was started on treatment for cognitive impairment during the study period. Although dominant hand was recorded to account for potential effects of hemispheric dominance on cognitive performance, the majority of both patients and controls were right-handed. Therefore, hemispheric dominance is unlikely to have significantly influenced the MMSE results in the present study.

AD is the most common progressive neurodegenerative disorder, characterized by cognitive decline and subsequent impairment of activities of daily living. AD and glaucoma are age-related disorders that exhibit neurodegenerative features and share partially overlapping biological mechanisms. In both conditions, factors such as neuroinflammation, elevated tumor necrosis factor-alpha (TNF-α) levels, and upregulation of complement component C1q contribute to pathogenesis (7). It has been demonstrated that Aβ 1–42 levels decrease in the cerebrospinal fluid of patients with AD and in the vitreous fluid of patients

with glaucoma, while tau protein levels increase (4). In an experimental glaucoma model, chronic ocular hypertension was shown to enhance Aβ production through abnormal processing of amyloid precursor protein (APP) and caspase activation (8). This creates a vicious cycle involving APP accumulation, caspase activation, and increased Aβ synthesis, ultimately leading to retinal ganglion cell loss and neuronal degeneration. This mechanism provides an important model that may explain the progressive nature of glaucoma and its potential pathogenic link to AD (8). Overall, current evidence suggests that pseudoexfoliation and glaucoma shares several biochemical and pathological features with neurodegenerative processes, including amyloid accumulation, oxidative stress, and neuroinflammation.

A comprehensive meta-analysis by Xu et al. reported that the risk of developing AD was significantly higher in patients with glaucoma than in those without glaucoma (9). However, findings across studies have not been entirely consistent. A large population-based study (Beijing Eye Study) reported no significant association between open-angle glaucoma or pseudoexfoliation and MMSE scores, highlighting the complexity and potential heterogeneity of the relationship between ocular diseases and cognitive function(10).

In a community-based 30-year longitudinal cohort study, pseudoexfoliation was not identified as a predictor of AD, and no significant association was found between POAG and AD (11). However, the methodological limitations of this study may limit the strength of its conclusions. For example, dementia diagnoses were based solely on clinical evaluations, and cases of AD, mixed dementia, and undiagnosed dementia were grouped into a single category. This approach likely increases diagnostic heterogeneity, making it difficult to clarify the potentially specific relationship between PXS and AD. Furthermore, the small number of reported Alzheimer's disease cases may have contributed to the conclusion that pseudoexfoliation is not a precursor to AD.

In a cross-sectional study, 67 patients diagnosed with PXS were compared with 67 age- and education-matched controls. The prevalence of AD was 67.2% in the PXS group and 26.9% in the control group, a statistically significant difference (12).

A total of 48 patients with PXS, subdivided into those with and without glaucoma, were compared with 48 age- and sex-matched healthy controls retrospectively. Global cortical, posterior parietal, and medial temporal lobe atrophy were evaluated using visual rating scales on brain MRI scans. Global cortical and parietal atrophy scores were significantly higher in the PXS group, whereas medial temporal atrophy was more prevalent, although not statistically significant. Additionally, although not statistically significant, an inverse correlation was observed between PXG severity and the MMSE score (13). In Alzheimer's disease, MMSE scores typically decline to below 26 in mild stages and further decrease with disease progression. In the our study, mean MMSE scores in all groups largely remained within the non-demented range, supporting the interpretation that the observed differences likely represent subtle or subclinical cognitive changes rather than clinically overt dementia.

Limitations

The primary limitation of this cross-sectional study is that cognitive function was assessed using a single screening tool (MMSE), without comprehensive neuropsychological evaluation. Therefore, the findings should be interpreted with caution and considered hypothesis-generating rather than definitive, given the observational design. Another limitation is that the data were collected between 2013 and 2014; however, the clinical association between pseudoexfoliation-related conditions and cognitive function remains relevant. In addition, the relatively small sample size limits the generalizability of the results.

Furthermore, detailed quantitative ophthalmic parameters reflecting glaucomatous disease severity, such as standardized visual field indices or structural measurements, were not available. As a result, the relationship between the extent of glaucomatous damage and cognitive performance could not be formally analyzed, as the study focused on cognitive screening in patients with established ophthalmic diagnoses rather than on disease severity.

CONCLUSION

MMSE scores were significantly lower in patients with PXS and PXG. MMSE scores also showed a significant negative correlation with age in patients with PXS and PXG, whereas no such relationship was observed in the control group. Although the present study could not directly determine the relationship between PXS and AD, it demonstrated that cognitive function is reduced in individuals diagnosed with PXS and PXG. This finding is consistent with the literature, suggesting that PXS is not merely an ocular disorder but a systemic microfibrillopathy that may also affect central nervous system involvement. Future longitudinal studies with larger sample sizes, comprehensive neurocognitive assessments, and neurologist-confirmed dementia diagnoses are warranted to better clarify the relationship between pseudoexfoliation and cognitive impairment.

Conflict of Interest Statement: The authors declare that they have no conflict of interest regarding this study.

REFERENCES

1. Ritch R, Schlötzer-Schrehardt U. Exfoliation syndrome. Surv Ophthalmol 2001;45(4):265–315. doi: 10.1016/s0039-6257(00)00196-x.
2. Aviv U, Ben Ner D, Sharif N, Gur Z, Achiron A. Pseudoexfoliation: An ocular finding with possible systemic implications. Isr Med Assoc J 2017;19(1):49-54.
3. Schlötzer-Schrehardt U, Naumann GO. Ocular and systemic pseudoexfoliation syndrome. Am J Ophthalmol 2006;141(5):921-937. doi: 10.1016/j.ajo.2006.01.047.
4. Janciauskiene S, Krakau T. Alzheimer's peptide and serine proteinase inhibitors in glaucoma and exfoliation syndrome. Doc Ophthalmol. 2003;106:215–223. doi: 10.1023/a:1022949121078
5. Loffler KU, Edward DP, Tso MO. Immunoreactivity against tau, amyloid precursor protein, and beta-amyloid in the human retina. Invest Ophthalmol Vis Sci 1995;36:24-31.
6. Güngen C, Ertan T, Eker E, et al. Reliability and validity of the Standardized Mini Mental State Examination in the diagnosis of mild dementia in Turkish population. Turk J Pschiatry 2002;13(4):272-281. (in Turkish).
7. McKinnon SJ. The cell and molecular biology of glaucoma: Common neurodegenerative pathways and relevance to glaucoma. Invest Ophthalmol Vis Sci 2012 ;53(5):2485–2487. doi: 10.1167/iovs.12-9483j.
8. McKinnon SJ, Lehman DM, Kerrigan-Baumrind LA, et al. Caspase activation and amyloid precursor protein cleavage in rat ocular hypertension. Invest Ophthalmol Vis Sci 2002;43(4):1077–1087.
9. Xu XH, Zou JY, Geng W, Wang AY. Association between glaucoma and the risk of Alzheimer's disease: A systematic review of observational studies. Acta Ophthalmol 2019;97(7):665-671. doi: 10.1111/aos.14114. Epub 2019 Apr 23.
10. Jonas JB, Wei WB, Zhu LP, Xu L, Wang YX. Cognitive Function and Ophthalmological Diseases: The Beijing Eye Study Sci Rep 2018;8(1):4816.
11. Ekström C, Kilander L. Pseudoexfoliation and Alzheimer's disease: a population-based 30-year follow-up study. Acta Ophthalmol 2014;92(4):355-358. doi: 10.1038/s41598-018-23314-5.
12. Cumurcu T, Dorak F, Cumurcu BE, Erbay LG, Ozsoy E. Is there any relation between Pseudoexfoliation syndrome and Alzheimer's Type Dementia? Semin Ophthalmol 2013;28(4):224-229. doi: 10.3109/08820538.2013.793726.
13. Jeong W.C, Min JY , Kang T.G., Bae H. Association between pseudoexfoliation and Alzheimer's disease-related brain atrophy. PLOS One 2023;18(6):0286727. doi: 10.1371/journal.pone.0286727.

ORIGINAL ARTICLE

IMPACT OF AGE ON EARLY MORTALITY AND CLINICAL OUTCOMES AFTER EMERGENCY HIP ARTHROPLASTY IN ELDERLY PATIENTS

Turkish Journal of Geriatrics
2026; 29(1):116–124

DOI: 10.29400/tjgeri.2026.484

Furkan TONTU[1]
Abdurrahman Engin BAYDEMİR[1]
Payam RAHİMİ[2]
Sinan AŞAR[3]
Bilal Faruk KARADOĞAN[1]
Funda GÜMÜŞ ÖZCAN[1]

[1] Basaksehir Cam and Sakura City Hospital, Anesthesiology and Reanimation, Istanbul, Türkiye

[2] Mehmet Akif Inan Training Hospital, Reanimation, Urfa, Türkiye

[3] Mardin Training Hospital, Reanimation, Mardin, Türkiye

Correspondence

Furkan TONTU
e-mail : furkantontu@gmail.com

Received : Jan 19, 2026
Accepted: Mar 03, 2026

Cite this article as:
Tontu F, Baydemir AE, Rahimi P et al. Impact of Age on Early Mortality and Clinical Outcomes After Emergency Hip Arthroplasty in Elderly Patients. Turkish Journal of Geriatrics 2026; 29(1):116–124. doi: 10.29400/tjgeri.2026.484

Abstract

Introduction: The increasing elderly population has led to a rising number of emergency hip fractures requiring surgical treatment. Evidence regarding early mortality and intensive care outcomes across different elderly age groups remains limited. This study aimed to assess the effect of age on early clinical outcomes in elderly patients undergoing emergency hip arthroplasty.

Materials and Method: This retrospective observational cohort study included 599 patients aged 65–95 years who underwent emergency hip arthroplasty between January 1, 2021, and May 15, 2025. Patients were categorized into three age groups: 65–74 years, 75–84 years, and 85–95 years. Demographic data, comorbidities, perioperative variables, laboratory and arterial blood gas parameters, mortality outcomes, and lengths of hospital and intensive care unit stay were analyzed and compared between groups.

Results: In-hospital and intensive care unit mortality increased significantly from the 65–74 to the 75–84 age group, with no further increase observed in patients aged 85–95 years. Postoperative intensive care unit admission rates increased with age. Hospital and intensive care unit lengths of stay were similar across age groups. Admission laboratory and arterial blood gas parameters were comparable, except for serum albumin levels, which declined significantly with age.

Conclusion: Although age was associated with increased early mortality and higher intensive care unit admission rates, very advanced age was not linked to additional increases in early mortality.

Keywords: Hip Fractures; Arthroplasty; Aged; Mortality; Intensive Care Units.

INTRODUCTION

The elderly population in Türkiye is rapidly increasing and substantially reshaping the demographic structure. According to the 2024 Turkish Statistical Institute report, individuals aged ≥65 years now comprise 10.6% of the population, and this proportion is projected to rise to 13.5% by 2030 and 27% by 2060, particularly driven by growth in individuals aged ≥75 years (1).

As the elderly population continues to grow, an increase in the incidence of hip fractures and demand for hip arthroplasty is inevitable. Surgeons and anesthesiologists often approach surgical intervention in this age group with caution because of the high burden of comorbidities and increased risk of perioperative complications (2). However, increasing life expectancy necessitates that these patients be offered surgical treatment under appropriate conditions. Studies involving octogenarian (80–89 years) and nonagenarian (≥90 years) patients have reported higher mortality rates than those among younger populations; nevertheless, optimization of preoperative and postoperative care has been shown to yield improved outcomes in these age groups (3-6). In nonagenarian cohorts, perioperative mortality has been reported to be lower than expected despite a higher comorbidity burden, and surgery has been associated with meaningful functional gains (3).

In Türkiye, large cohort studies evaluating 1-year survival after hip arthroplasty in patients aged ≥65 years have identified age as a significant risk factor for mortality (7, 8). However, studies specifically examining in-hospital mortality and intensive care unit admission rates are limited (9), and most do not distinguish between elective and emergency surgery. Therefore, the primary purpose of this study was to evaluate the impact of age on in-hospital and ICU mortality in patients undergoing arthroplasty for emergency hip fractures, while the secondary purpose was to assess the effect of age on postoperative ICU admission rates. By addressing these outcomes, this study aimed to provide clinically relevant data to inform decision-making in the management of elderly patients.

MATERIALS AND METHOD

Study Design and Population

This study was designed as a retrospective observational cohort study and was approved by the Ethics Committee of the University of Health Sciences, Başakşehir Çam and Sakura City Hospital (protocol code: 2025-232). All patients aged 65–95 years who were admitted to Başakşehir Çam and Sakura City Hospital between January 1, 2021, and May 15, 2025, with an acute hip fracture and subsequently underwent surgical treatment with either total hip arthroplasty or hemiarthroplasty were screened.

Only patients who underwent arterial blood gas analysis at admission and had complete laboratory and clinical data were included in the study. Patients with missing blood gas parameters or incomplete laboratory data were excluded. Clinical and demographic data were obtained from the electronic hospital information system, with supplementary review of physical medical records when necessary.

Age Stratification

Patients were stratified into three age-based groups according to clinically relevant geriatric thresholds: Group A (65–74 years), Group B (75–84 years), and Group C (85–95 years). This stratification was used to evaluate age-related differences in clinical outcomes across progressively older geriatric subgroups.

The following variables were recorded: demographic characteristics including age and sex; comorbid conditions such as diabetes mellitus, hypertension, chronic heart failure, chronic renal failure, and chronic obstructive pulmonary disease; perioperative outcomes including postoperative intensive care unit admission; clinical outcomes including in-hospital mortality and intensive care unit mortality; length of stay in the hospital and in the

intensive care unit; laboratory parameters at admission including urea, creatinine, albumin, procalcitonin, platelet count, hemoglobin, white blood cell count, and glucose; arterial blood gas variables including pH, bicarbonate, lactate, sodium, chloride, anion gap (AG) and albumin-corrected anion gap (AGc).

Statistical Analysis

Statistical analyses were performed after assessing the normality of continuous variables. Depending on whether the data followed a normal distribution, appropriate parametric or non-parametric statistical methods were used.

Categorical variables were expressed as numbers and percentages and compared using the chi-square test, with pairwise comparisons between groups (Group A vs Group B, Group A vs Group C, and Group B vs Group C).

Continuous variables were expressed as mean±standard deviation, and were compared between groups using the Kruskal–Wallis test. When a statistically significant difference was observed, Dunn's multiple comparison post hoc test was performed to identify between-group differences. Time-to-event analyses for in-hospital mortality were performed using the Kaplan–Meier method, and survival curves were compared using the log-rank test.

A *p*-value < 0.05 was considered statistically significant.

RESULTS

Baseline Characteristics and Clinical Outcomes

A total of 727 consecutive patients aged ≥65 years who underwent emergency hip surgery were initially screened for eligibility. After excluding 128 patients because of missing or incomplete clinical, laboratory, or outcome data, the final cohort comprised 599 patients, who were stratified into three age groups: Group A (65–74 years, n = 199), Group B (75–84 years, n = 235), and Group C (85–95 years, n = 165) (see Figure 1 for the study

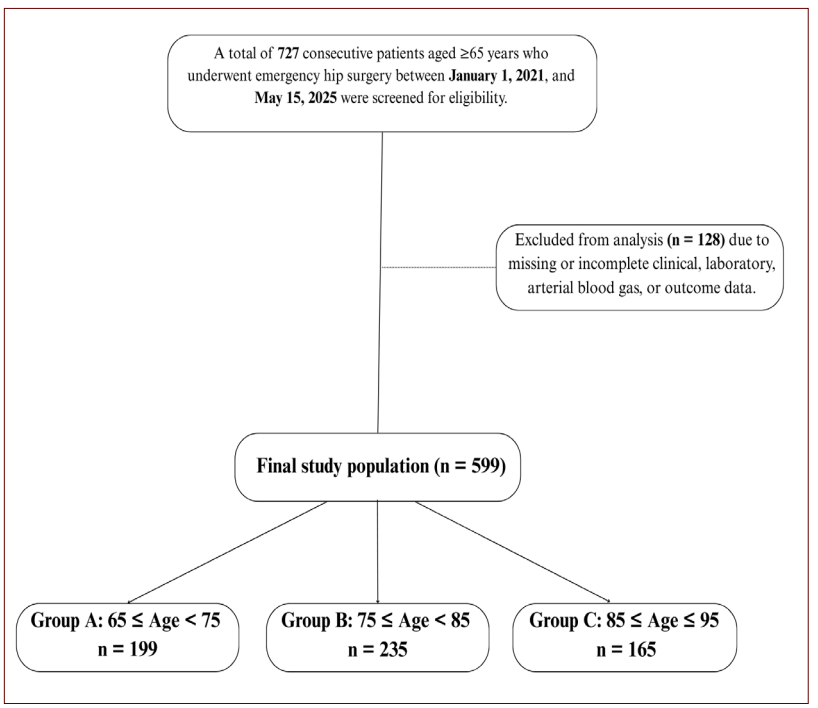


Figure 1. Flow chart of patient selection.



flow chart). Sex distribution was similar across groups, with no statistically significant difference in female predominance. Body mass index (BMI) decreased with advancing age and was lowest in Group C, while the proportion of patients with higher American Society of Anesthesiologists (ASA) physical status classes increased progressively across the groups; the distribution of anesthesia type was comparable among all groups. Regarding procedure type, hemiarthroplasty constituted the majority of surgeries across all age strata (90.9% in Group A, 89.8% in Group B, and 89.0% in Group C), while total hip arthroplasty accounted for 9.1%, 10.2%, and 11.0% of procedures, respectively. The distribution of arthroplasty type did not differ significantly between age groups (Table 1).

Table 1. Baseline characteristics, comorbidities, and clinical outcomes according to age groups

Groups	A 65 ≤Age<75	B 75 ≤Age<85	C 85 ≤Age ≤95
n	199	235	165
Female, n(%)	120 (60%)	152 (65%)	114 (69%)
BMI, kg/m^2	32 ± 4.2	30 ± 3.5	27 ± 3.7*‡
Type of Anesthesia			
General	40 (20%)	42 (18%)	36 (22%)
Regional	159 (80%)	193 (82%)	129 (78%)
Type of Surgery			
Hemiarthroplasty	181 (90.9%)	211 (89.8%)	147 (89%)
Total Arthroplasty	18 (9.1%)	24 (10.2%)	18 (11%)
ASA score			
II	36 (18%)	15 (6%)*	4 (2%)*
III	132 (66%)	178 (76%)*	127 (77%)*
IV	31 (16%)	42 (18%)*	34 (21%)*
Comorbidities			
CHF	12 (6%)	11 (5%)	9 (5%)
COPD	5 (2.5%)	12 (5%)	3 (2%)
CRF	16 (8%)	26 (11%)	15 (9%)
DM	62 (31%)	70 (30%)	50 (30%)
HT	65 (33%)	76 (32%)	59 (36%)
Hospital Mortality, n(%)	13 (6.5%)	29 (12%)*	18 (11%)
ICU Mortality, n(%)	13 (6.5%)	27 (11.5%)*	15 (9%)
ICU Admission, n(%)	76 (38%)‡	131 (56%)	119 (72%)*‡
Stay in hospital, days	12.2 ± 8.2	14.5 ± 10.9	11.2 ± 6.1‡
Stay in ICU, days	4.0 ± 7.1	3.3 ± 5.5	2.7 ± 2.5

CHF, chronic heart failure; COPD, chronic obstructive pulmonary disease; CRF, chronic renal failure; DM, diabetes mellitus; Hb, hemoglobin; HT, hypertension; ICU, intensive care unit; LOS, length of stay.

Data are presented as mean ± standard deviation or number (%), as appropriate. * indicates a statistically significant difference compared with Group A ($p < 0.05$); ‡ indicates a statistically significant difference compared with Group B ($p < 0.05$).

Categorical variables were compared using the chi-square test with pairwise comparisons between groups (A–B, A–C, and B–C). Continuous variables, including BMI, ASA, and hospital and ICU length of stay, were analyzed using the Kruskal–Wallis test, followed by Dunn's multiple comparisons test for post hoc analysis. Variables not marked with symbols indicate no statistically significant difference between groups.

Hospital mortality was significantly higher in Group B compared with Group A (12% vs 6.5%, p = 0.01), while mortality rates were comparable between Group B and Group C (12% vs 11%, p > 0.05). Based on the absence of a significant difference between Groups B and C, time-to-event analysis was limited to the comparison between Groups A and B. Kaplan–Meier survival analysis demonstrated no significant difference in in-hospital survival between patients aged 65–74 years and those aged 75–84 years (hazard ratio 0.96, 95% confidence interval 0.46–2.00; log-rank p = 0.91) (Figure 2). Similarly, ICU mortality was higher in Group B than in Group A (11.5% vs 6.5%, p = 0.02), with no further increase observed in Group C (6.5% vs 9%, p > 0.05). Postoperative ICU admission rates were significantly higher in Group C compared with both Group A and Group B (72% vs 38% and 56%, respectively; p < 0.0001 for A–B, B–C, and A–C comparisons). Despite higher ICU admission rates, ICU length of stay did not differ significantly among age groups (p > 0.05). Hospital length of stay, however, was significantly shorter in Group C compared with Group B (11.2 ± 6.1 vs 14.5 ± 10.9 days, p = 0.01). The prevalence of comorbid conditions, including diabetes mellitus, hypertension, chronic heart failure, chronic renal failure, and chronic obstructive pulmonary disease, was similar across the three age groups (p > 0.05) (Table 1).

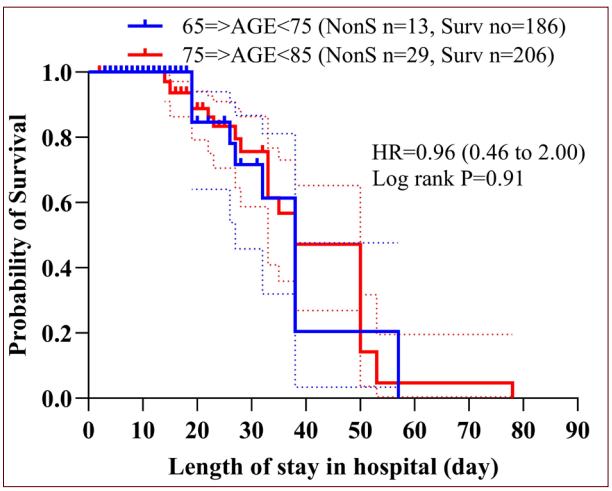


Figure 2. Kaplan–Meier survival curves comparing in-hospital survival between patients aged 65–74 and 75–84 years (hazard ratio: 0.96, 95% confidence interval: 0.46–2.00; log-rank p = 0.91).

Acute Physiology and Chronic Health Evaluation II (APACHE II) and Sequential Organ Failure Assessment (SOFA) scores at ICU admission were comparable across age groups among patients requiring intensive care. Mean APACHE II scores were 20 ± 6 in Group A, 21 ± 7 in Group B, and 22 ± 7 in Group C (p = 0.18). Corresponding SOFA scores were 7 ± 3, 7 ± 3 and 8 ± 3 respectively, with no statistically significant difference between the groups (p = 0.11).

Laboratory and Acid–Base Findings

The laboratory and arterial blood gas parameters at admission were largely comparable across the age groups, with no significant differences in renal function, electrolytes, inflammatory markers, pH, bicarbonate (HCO_3), lactate, anion gap (AG), or albumin-corrected anion gap (AGc). Serum albumin levels declined significantly with age, with the lowest values observed in Group C ($p < 0.0001$) (Table 2).

Association Between Arthroplasty Type and Mortality Within Age Groups

Within each age group, arthroplasty type was not associated with in-hospital mortality. In the 65–74 age group, mortality was 6.2% after hemiarthroplasty and 5.3% after total hip arthroplasty (p>0.99). In the 75–84 age group, mortality rates were 11.0% and 11.1%, respectively (p>0.99). Similarly, in patients aged ≥85 years, mortality was 9.8% after hemiarthroplasty and 10.0% after total hip arthroplasty (p>0.99; Fisher's exact test for all comparisons). These findings indicate that procedure type did not influence mortality within age strata (Table 3).

Table 2. Admission laboratory and arterial blood gas parameters according to age groups

Parameter	A 65 ≤Age<75	B 75 ≤Age<85	C 85 ≤Age ≤95	p
Urea (mg/dL)	51 ± 27	53 ± 28	57 ± 29	0.06
Cr (mg/dL)	1.1 ± 1	1 ± 0.7	0.9 ± 0.5	0.40
Alb (g/dL)	35 ± 5	33 ± 5	32 ± 4*‡	<0.0001
Na (mmol/L)	137 ± 4	137 ± 4	137 ± 4	0.5
Cl (mmol/L)	100 ± 5	101 ± 5	101 ± 4	0.08
Procalcitonin (ng/mL)	0.5 ± 1	0.4 ± 1.6	0.8 ± 1.5	0.36
Platelet (×10³/µL)	291 ± 142	287 ± 106	288 ± 101	0.65
Hb (g/dL)	8.7 ± 4.5	9 ± 3.9	9.1 ± 3.7	0.51
WBC (×10³/µL)	6.7 ± 4.3	6.9 ± 4.5	7 ± 4.9	0.99
Glucose (mg/dL)	152 ± 70	147 ± 63	139 ± 57	0.79
pH	7.42 ± 0.07	7.43 ± 0.06	7.42 ± 0.06	0.12
HCO_3 (mmol/L)	26.3 ± 3.1	26 ± 3.3	27.7 ± 3.3	0.62
Lactate (mmol/L)	1.3 ± 0.6	1.2 ± 0.6	1.3± 0.7	0.7
AG (mmol/L)	9.3 ± 10.3	8.7 ± 9.9	8.6 ± 9.7	0.54
AGc (mmol/L)	11.5 ± 6.2	11.8 ± 3.7	11.4 ± 3	0.46

AG, anion gap; AGc, albumin-corrected anion gap; Alb, albumin; Cl, chloride; Cr, creatinine; Hb, hemoglobin; HCO_3, bicarbonate; Na, sodium; WBC, white blood cell count.

Laboratory parameters were compared using the Kruskal–Wallis test with Dunn's post hoc multiple comparisons. * denotes $p < 0.05$ versus Group A, and ‡ denotes $p < 0.05$ versus Group B. Variables without symbols were not statistically different.

Table 3. Association Between Arthroplasty Type and In-Hospital Mortality Within Each Age Group

Age Group	Procedure	Survivors n (%)	Mortality n (%)	p
65–74 years	Hemiarthroplasty	181 (93.8%)	12 (6.2%)	>0.99
	Total Arthroplasty	18 (94.7%)	1 (5.3%)	
75–84 years	Hemiarthroplasty	211 (89.0%)	26 (11.0%)	>0.99
	Total Arthroplasty	24 (88.9%)	3 (11.1%)	
≥85 years	Hemiarthroplasty	147 (90.2%)	16 (9.8%)	>0.99
	Total Arthroplasty	18 (90.0%)	2 (10.0%)	

DISCUSSION

This study evaluated the effect of age on mortality and clinical outcomes in patients aged 65–95 years who underwent arthroplasty for emergency hip fractures. The findings demonstrated that both in-hospital and ICU mortality increased significantly from the 65–74 to the 75–84 age group, whereas no further increase was observed in patients aged 85 years and older. Although crude mortality rates differed between the 65–74 and 75–84 age groups, Kaplan–Meier analysis did not demonstrate an increase in time-dependent mortality risk. In addition, although the likelihood of ICU admission increased markedly with advancing age, hospital and ICU lengths of stay did not increase in the 85–95 age group and were shorter than those observed in the 75–84 age group.

The existing literature consistently demonstrates that advancing age is associated with increased mortality and complication rates following arthroplasty. In a large cohort of 79,557 patients from the Norwegian Arthroplasty Register, age was identified as one of the strongest predictors of perioperative and short-term mortality, with significant increases observed in the 3-day, 30-day, and 90-day mortality rates as age increased (10). Similarly, in an analysis of 66,839 patients by Boniello et al., the 30-day mortality rate was 0.9% in patients aged ≥80 years compared with a rate of 0.1% in those younger than 80 years, with age identified as an independent risk factor for both complications and mortality (odds ratio: 2.02) (11). Nevertheless, the literature includes studies emphasizing that despite higher mortality rates in advanced age groups, arthroplasty remains feasible and may be performed with acceptable risk profiles in appropriately selected patients (2, 12). In octogenarian and nonagenarian cohorts, 30-day mortality increases with age, yet arthroplasty remains feasible at acceptable risk levels when optimal perioperative and postoperative management is provided (2, 12). In this context, Alfonso et al. reported higher 30-day mortality in patients aged >90 years; however, they also noted that surgery remained a feasible treatment option in appropriately selected patients within this population (3). Similarly, Skinner et al. demonstrated that although mortality rates were higher in nonagenarian patients, the complication profile remained acceptable and arthroplasty provided meaningful functional benefits (12). In a large analysis of octogenarian patients, mortality increased with age, and malnutrition, renal disease, and a higher ASA class were identified as factors associated with increased mortality (11). Considering these findings, the prevailing consensus in the literature is that mortality increases with advancing age; however, advanced age alone should not be considered a contraindication to arthroplasty. The benefits of surgery, particularly in terms of early mobilization and prevention of complications, remain evident for most patients (3, 11-13).

One notable finding of this study was that although mortality increased significantly in patients aged 75–84 years, no further increase was observed in patients aged ≥85 years. While advancing age is consistently associated with higher mortality, studies focusing on nonagenarian and very elderly patients suggest that arthroplasty remains feasible with acceptable outcomes in selected patients (2, 6). This observation may reflect a threshold effect or a plateau in risk escalation at very advanced ages; however, this interpretation should be considered hypothesis-generating rather than definitive. This pattern may also reflect selection bias, as only patients deemed suitable for surgical intervention were included in the present cohort. Frailer very elderly individuals who were not considered surgical candidates may therefore not have been captured, and differences in perioperative management practices across age groups may have further influenced outcomes. In addition, stratified analyses did not demonstrate a significant association between arthroplasty type and mortality within age strata, suggesting that variation in procedure type alone is unlikely to account for the observed age-related mortality pattern.

In our cohort, patients aged ≥85 years were admitted to the ICU more frequently. In this context, ICU admission likely reflects differences in illness severity and institutional practices. Similarly, a previous study evaluating patients undergoing hip arthroplasty reported increasing ICU admission rates with advancing age (9).

The shorter hospital and ICU lengths of stay observed in patients aged ≥85 years may be related to clinical practice patterns in this age group, including earlier discharge strategies, more limited rehabilitation goals, or earlier mortality in patients with a fatal course. Elderly patients are more prone to disturbances in acid–base



homeostasis due to age-related reductions in physiological reserve and diminished adaptive responses of organ systems (14). The similarity in demographic characteristics, comorbidities, and admission laboratory and arterial blood gas parameters across the three age groups suggests that the observed differences in mortality may be largely attributable to the physiological changes associated with chronological aging.

A progressive decline in serum albumin levels was observed with advancing age, whereas no significant age-related changes were detected in other arterial blood gas or laboratory parameters. Given the well-established association between higher AGc scores and mortality in elderly patients, the observed intergroup differences are more likely attributable to age-related factors rather than to baseline biochemical abnormalities (15, 16). Body mass index also decreased with age, consistent with findings from previous large-scale registry studies in very elderly arthroplasty patients (17).

Age is consistently associated with long-term mortality in population-based studies (7, 9, 18, 19). Following total hip arthroplasty, 25-year survival has been reported to be only 11.6% (18). Therefore, comparisons of long-term mortality across age groups are of limited relevance because the higher long-term mortality observed in patients aged 85–95 years primarily reflects biological aging rather than surgical effects. A recent large-scale study showed that, although mortality increased with age after hip surgery, nonagenarian patients did not exhibit higher mortality than their age-matched counterparts in the general population (2). This finding supports the methodological focus of the present study on early postoperative mortality outcomes.

Limitations

This retrospective study is inherently limited by its observational design, which precludes causal inference. Although conducted at a high-volume tertiary trauma center, enhancing cohort size and data consistency, the single-center setting may limit generalizability. Importantly, detailed data on frailty indices, cognitive status, and pre-fracture functional capacity were unavailable. Chronological age alone may not adequately reflect biological vulnerability, and the absence of these measures limits our ability to differentiate physiological resilience from age-related risk. Consequently, the observed mortality patterns—particularly in the ≥85-year group—should be interpreted with caution, as unmeasured frailty may have influenced both treatment selection and outcomes. ICU admission decisions were based on institutional practices rather than standardized criteria, which may have introduced variability in postoperative monitoring and management. Additionally, only early in-hospital outcomes were evaluated, and laboratory and arterial blood gas parameters were limited to admission values, precluding longitudinal assessment. Finally, the retrospective design and inclusion of only surgically treated patients introduce the possibility of selection bias, particularly among the very elderly. Frailer individuals who were not considered surgical candidates were not captured in this cohort, which may have influenced the observed age-related mortality patterns.

CONCLUSION

Age group was associated with differences in early postoperative mortality among patients undergoing emergency hip arthroplasty, with the 75–84 age group exhibiting a marked increase compared with those aged 65–74 years. Notably, no further increase in mortality was observed in patients aged ≥85 years, despite higher ICU admission rates. This pattern suggests that surgical intervention may still be considered in carefully selected very elderly patients. Nevertheless, given the retrospective design of the study, these findings should be confirmed in prospective investigations.

REFERENCES

1. Kocaman Y. A Theoretical Perspective on the Demographic Transition in Türkiye: From Key Demographic Indicators to Social Outcomes. Senectus 2025;3(2):169-204. doi:10.26650/senectus.2025.3.2.0749.
2. Beckers G, Simon D, Grimberg A, et al. Morbidity and mortality analysis of primary total knee arthroplasty in patients over 90 years of age: Insights from the German Arthroplasty Registry. J Arthroplasty. 2025; [Epub ahead of print]. doi: 10.1016/j.arth.2025.10.120.
3. Alfonso DT, Howell RD, Strauss EJ, et al. Total hip and knee arthroplasty in nonagenarians. J Arthroplasty. 2007;22(6):807-11. doi: 10.1016/j.arth.2006.10.016.
4. Kitridis D, Tsikopoulos K, Givissis P, et al. Mortality and complication rates in nonagenarians and octogenarians undergoing total hip and knee arthroplasty: A systematic review and meta-analysis. Eur Geriatr Med. 2022;13(3):725-33. doi: 10.1007/s41999-022-00610-y.
5. Lee SH, Kim DH, Lee YS. Is there an optimal age for total knee arthroplasty?: A systematic review. Knee Surg Relat Res. 2020;32(1):60. doi: 10.1186/s43019-020-00080-1.
6. Sherman AE, Plantz MA, Hardt KD. Outcomes of elective total hip arthroplasty in nonagenarians and centenarians. J Arthroplasty. 2020;35(8):2149-54. doi: 10.1016/j.arth.2020.03.026.
7. Uzel K, Birinci M, Hakyemez ÖS, et al. Comparison of hemiarthroplasty, total hip arthroplasty, and internal fixation for hip fractures in patients over eighty years of age: Factors affecting mortality: A nationwide cohort study of fifty three thousand, four hundred and ninety five patients from Türkiye. Int Orthop. 2025;49(3):729-36. doi: 10.1007/s00264-025-06412-8.
8. Demirel M, Birinci M, Hakyemez ÖS, et al. Epidemiology, treatment, and mortality of femoral neck fractures in patients over the age of 65 years: A nationwide retrospective cohort study of 83,789 cases in Turkey. Hip Int. 2025;35(3):278-89. doi: 10.1177/11207000241312887.
9. Yılmaz ET, Şahin Y, Keleş BO, et al. Factors associated with thirty-day mortality and intensive care unit admission in patients undergoing hip fracture surgery. Ulus Travma Acil Cerrahi Derg. 2024;30(8):571. doi: 10.14744/tjtes.2024.24186.
10. Dale H, Børsheim S, Kristensen TB, et al. Perioperative, short-, and long-term mortality related to fixation in primary total hip arthroplasty: A study on 79,557 patients in the Norwegian Arthroplasty Register. Acta Orthop. 2020;91(2):152-8. doi: 10.1080/17453674.2019.1701312.
11. Boniello AJ, Simon MS, Emenari CC, et al. Complications and mortality following total hip arthroplasty in the octogenarians: An analysis of a national database. J Arthroplasty. 2018;33(7s):S167-S171. doi: 10.1016/j.arth.2017.08.030.
12. Skinner D, Tadros BJ, Bray E, et al. Clinical outcome following primary total hip or knee replacement in nonagenarians. Ann R Coll Surg Engl. 2016;98(4):258-64. doi: 10.1308/rcsann.2016.0095.
13. Karuppiah S, Banaszkiewicz P, Ledingham W. The mortality, morbidity and cost benefits of elective total knee arthroplasty in the nonagenarian population. Int Orthop. 2008;32(3):339-43. doi: 10.1007/s00264-007-0324-y.
14. Musso CG, Vilas MF. Water, electrolyte, and acid-base disorders in the elderly. In: Musso CG, Jauregui JR, Macías-Núñez JF, Covic A (eds). Clinical Nephrogeriatrics: An Evidence-Based Guide. 1st ed. Springer Nature, Switzerland; 2019. pp. 43-62. doi: 10.1007/978-3-030-18711-8_4.
15. Ahn SY, Ryu J, Baek SH, et al. Serum anion gap is predictive of mortality in an elderly population. Exp Gerontol. 2014;50:122-7. doi: 10.1016/j.exger.2013.12.002.
16. Wang Y, Zhong L, Min J, et al. Albumin corrected anion gap and clinical outcomes in elderly patients with acute kidney injury caused or accompanied by sepsis: A MIMIC-IV retrospective study. Eur J Med Res. 2025;30(1):11. doi: 10.1186/s40001-024-02238-z.
17. Leopold VJ, Krull P, Hardt S, et al. Is elective total hip arthroplasty safe in nonagenarians?: An arthroplasty registry analysis. J Bone Joint Surg Am. 2023;105(20):1583-93. doi: 10.2106/jbjs.23.00092.
18. Schwartsmann CR, Spinelli LdeF, Boschin LC, et al. Correlation between patient age at total hip replacement surgery and life expectancy. Acta Ortop Bras. 2015;23(6):323-5. doi: 10.1590/1413-785220152306148609.
19. Lie S, Havelin L, Furnes O, et al. Failure rates for 4762 revision total hip arthroplasties in the Norwegian Arthroplasty Register. J Bone Joint Surg Br. 2004;86(4):504-9. doi:10.1302/0301-620X.86B4.14799.

Turkish Journal of Geriatrics
2026; 29(1)

FROM THE EDITOR IN CHIEF
Yeşim GÖKÇE KUTSAL

REVIEW ARTICLE

FROM ACUTE RESPIRATORY INFECTION TO FUNCTIONAL DISABILITY: TRAJECTORIES OF POST-ILLNESS FUNCTIONAL DECLINE IN OLDER ADULTS
Lale ÖZIŞIK

ORIGINAL ARTICLES

ROLES OF THE C-REACTIVE PROTEIN-ALBUMIN-LYMPHOCYTE INDEX AND PAN-IMMUNE-INFLAMMATION VALUE INDICES AS NEW INDICATORS OF DEMENTIA SEVERITY
Emel SABAZ KARAKEÇİ, Nesibe AYDOĞDU, Serpil DOĞAN

INFLAMMATORY AND NUTRITIONAL BIOMARKERS FOR PREDICTING MORTALITY IN ELDERLY PATIENTS WITH COMMUNITY-ACQUIRED PNEUMONIA
Gülhan AYHAN ALBAYRAK, Mustafa İlteriş BARDAKÇI

ANALYSIS OF RISK FACTORS FOR PREOPERATIVE DELIRIUM FOLLOWING GERIATRIC HIP FRACTURE AND ITS RELATIONSHIP WITH MORTALITY: A RETROSPECTIVE COHORT STUDY
Murat EREM, Savaş YILDIRIM, Eşref SELÇUK, Mehmet Tuğrul ALVER, Sinem EREM

CLINICAL OUTCOMES OF SUPRASCAPULAR NERVE PULSED RADIOFREQUENCY IN ELDERLY PATIENTS WITH ADHESIVE CAPSULITIS: A RETROSPECTIVE COHORT STUDY
Salim Taner GÖZÜKIZIL, Halil İbrahim ALTUN

THE EFFECT OF BLOOD PARAMETERS AND SURGICAL TREATMENT METHODS ON MORTALITY IN GERIATRIC HIP FRACTURES: CAN PREOPERATIVE ALBUMIN AND LYMPHOCYTE LEVELS PREDICT MORTALITY
Ömer Levent KARADAMAR, Ali Murat BAŞAK, Anıl ÖZGÜR, Ali AYDİLEK, Uğur YÜZÜGÜLDÜ, Enes KELEŞ, Mustafa KARA

COMPARISON OF PERIOPERATIVE OUTCOMES IN YOUNG AND GERIATRIC LIVING KIDNEY DONORS: A SINGLE-CENTER RETROSPECTIVE COHORT STUDY
Emrah ŞAHİN, Ender ANILIR, Adem TUNCER, Abuzer DİRİCAN, Bülent ÜNAL

ACUTE ABDOMEN IN THE OLDEST-OLD: ETIOLOGIES AND MORTALITY OUTCOMES IN NONAGENARIANS
Ahmet Gürkan ERDEMİR, Ayşenur BOLUKÇU, Esra AKÇİÇEK, Gökhan KAHRAMAN, Ali BATUR, İlkay Sedakat İDİLMAN, Mehmet Ruhi ONUR, Erhan AKPINAR

ASSESSMENT OF THE RELATIONSHIP BETWEEN HOPELESSNESS LEVEL AND DEATH ANXIETY IN GERIATRIC INDIVIDUALS
Meltem ÇAPAR ÇİFTÇİ, Funda KAVAK BUDAK

ATTITUDES OF THORACIC SURGEONS AND RESIDENTS TOWARD THORACIC SURGERY IN ELDERLY PATIENTS
Atilla CAN, Hüseyin YILDIRAN

EVALUATION OF COGNITIVE IMPAIRMENTS IN GLAUCOMA SUBTYPES: PRIMARY OPEN-ANGLE GLAUCOMA, PSEUDOEXFOLIATION SYNDROME, AND PSEUDOEXFOLIATION GLAUCOMA
Nur Ebru BARÇIN, Hatice Deniz İLHAN, Ali ÜNAL

IMPACT OF AGE ON EARLY MORTALITY AND CLINICAL OUTCOMES AFTER EMERGENCY HIP ARTHROPLASTY IN ELDERLY PATIENTS
Furkan TONTU, Abdurrahman Engin BAYDEMİR, Payam RAHİMİ, Sinan AŞAR, Bilal Faruk KARADOĞAN, Funda GÜMÜŞ ÖZCAN