September 2023 Vol. 27, No. 3

Editorial

Annals of Geriatric Medicine and Research receives the First Impact Factor of 3.6 by Journal Citation Reports

Original Articles

Geriatric and Gerontology Research: A Scienometric Investigation of Open Access Journal Articles Indexed in the Scopus Database

Effectiveness of Vitamin D Supplements in Reducing the Risk of Falls among Older Adults: A Meta-Analysis of Randomized Controlled Trials

The Clinical Frailty Scale as a Risk Assessment Tool for Dysphagia in Older Inpatients: A Cross-Sectional Study

The Effect of Neuromuscular Blockade Reversal Agents on Postoperative Pulmonary Complications in Patients undergoing Femur Fracture Repair Surgery: A Retrospective Observational Study

Factors Associated with Improvement in Activities of Daily Living during Hospitalization: A Retrospective Study of Older Patients with Hip Fractures

Predictive Ability of the 2-Minute Step Test for Functional Fitness in Older Individuals with Hypertension

Balance Ability and Quality of Life in Older Adult with Recovery from Mild COVID-19

The Risk Factors of COVID-19 Infection and Mortality among Older Adults in South Korea

The Relationship between Chronic Musculoskeletal Pain and Sarcopenia Risk in Community-Dwelling Older Adults: A Cross-Sectional Study

The Triglyceride-Glucose Index is Independently Associated with Chronic Kidney Disease in the Geriatric Population, Regardless of Obesity and Sex

Case Reports

Mucous Membrane Pemphigoid in a Nonagenarian: A Case Report

Clostridium tetani Infection in a Geriatric Patient: Do Not Let Your Guard Off!!!

Letter to the Editor

Association between Support after Dementia Diagnosis and Subsequent Decrease in Social Participation
Aims and Scope

Annals of Geriatric Medicine and Research (Ann Geriatr Med Res, AGMR) is a peer-reviewed journal that aims to introduce new knowledge related to geriatric medicine and to provide a forum for the analysis of gerontology, broadly defined. As a leading journal of geriatrics and gerontology in Korea, one of the fastest aging countries, AGMR offers future perspectives on policymaking for older adults, clinical and biological science in aging researches especially for Asian emerging countries. Original manuscripts relating to any aspect of geriatrics, including clinical research, aging-related basic research, and policy research related to senior health and welfare will be considered for publication. Professionals from a wide range of geriatric specialties, multidisciplinary areas, and related disciplines are encouraged to submit manuscripts for publication.

General Information

The official journal title has been Annals of Geriatric Medicine and Research since September 2016 which followed the Journal of the Korean Geriatrics Society (1997-2016, pISSN: 1229-2397, eISSN: 2208-1239). It is the official journal of the Korean Geriatrics Society (http://www.geriatrics.or.kr/eng/) and the Korean Society for Gerontology (http://www.korea-biogerontology.co.kr). It is published in English quarterly on the last days of March, June, September, and December. The journal publishes original research articles, case reports, reviews, special contributions, and commentaries. Review board consists of members in 7 different countries. Articles are welcome for submission from all over the world. The contents of this Journal are indexed in Web of Science, Scopus, PubMed, PubMed Central (PMC), EBSCO, DOAJ, Embase, KoreaMed, KCI, DOAJ Directory, and Google Scholar. It is accessible without barrier from Korea Citation Index (https://www.kci.go.kr) or National Library of Korea (http://nl.go.kr) in the event a journal is no longer published.

Subscription Information

For subscription and all other information visit our website available from: http://www-agmr.org. To subscribe to this journal or renew your current subscription, please contact us through Fax (+82-2-2269-1040) or E-mail (agmr.editorial@gmail.com). The printed journal also can be ordered by contacting our Editorial Office.

Revenue Source

AGMR is mainly funded by the Korean Geriatrics Society. The journal is also financed by receiving an article processing charge (reprinting cost) paid by the authors, advertising and academic/corporate sponsors. This Journal is supported by the Korean Federation of Science and Technology Societies (KOFST) Grant funded by the Korean Government.

Open Access

This is an open-access journal distributed under the term of the Creative Common Attribution Non-Commercial License (http://creativecommons.org/licenses/by-nc/4.0) which permits unrestricted noncommercial use, distribution, and reproduction in any medium, provided the original work is properly cited.
# Editorial board

## Editor-in-Chief

<table>
<thead>
<tr>
<th>Name</th>
<th>Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jae-Young Lim</td>
<td>Seoul National University, Korea</td>
</tr>
</tbody>
</table>

## Deputy Editor-in-Chief

<table>
<thead>
<tr>
<th>Name</th>
<th>Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyuk Ga</td>
<td>Incheon Eun-Hye Convalescent Hospital, Korea</td>
</tr>
<tr>
<td>Hee-Won Jung</td>
<td>University of Ulsan, Korea</td>
</tr>
</tbody>
</table>

## Emeritus Editors

<table>
<thead>
<tr>
<th>Name</th>
<th>Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chang Won Won</td>
<td>Kyung Hee University, Korea</td>
</tr>
<tr>
<td>Jun Hyun Yoo</td>
<td>Sungkyunkwan University, Korea</td>
</tr>
</tbody>
</table>

## Executive Editor

<table>
<thead>
<tr>
<th>Name</th>
<th>Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hee-Won Jung</td>
<td>University of Ulsan, Korea</td>
</tr>
</tbody>
</table>

## Associate Editors

<table>
<thead>
<tr>
<th>Name</th>
<th>Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tung Wai Auyeung</td>
<td>The Chinese University of Hong Kong, Hong Kong</td>
</tr>
<tr>
<td>Jae Kyung Choi</td>
<td>Kunkook University, Korea</td>
</tr>
<tr>
<td>Jongkyoung Choi</td>
<td>National Medical Center, Korea</td>
</tr>
<tr>
<td>Milan Chang Gudjonsson</td>
<td>University of Iceland, Iceland</td>
</tr>
</tbody>
</table>

## Editors

<table>
<thead>
<tr>
<th>Name</th>
<th>Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hidenori Arai</td>
<td>National Center for Geriatrics and Gerontology, Japan</td>
</tr>
<tr>
<td>Prasert Assantachai</td>
<td>Mahidol University, Thailand</td>
</tr>
<tr>
<td>Ji Yeon Baek</td>
<td>University of Ulsan, Korea</td>
</tr>
<tr>
<td>Ramanarayana Boyapati</td>
<td>Sihan Institute of Dental Sciences, India</td>
</tr>
<tr>
<td>Ian Cameron</td>
<td>The University of Sydney, Australia</td>
</tr>
<tr>
<td>Matteo Cesari</td>
<td>University of Milan, Italy</td>
</tr>
<tr>
<td>Liang-Kung Chen</td>
<td>Taipei Veterans General Hospital, Taiwan</td>
</tr>
<tr>
<td>Han Sung Choi</td>
<td>Kyung Hee University, Korea</td>
</tr>
<tr>
<td>Ming-Yueh Chou</td>
<td>Kaohsiung Veterans General Hospital, Taiwan</td>
</tr>
<tr>
<td>Walter Frontera</td>
<td>University of Puerto Rico School of Medicine, USA</td>
</tr>
<tr>
<td>Emiel Hoogendijk</td>
<td>Longitudinal Aging Study Amsterdam, Netherlands</td>
</tr>
<tr>
<td>Der-Sheng Han</td>
<td>National Taiwan University, Taiwan</td>
</tr>
<tr>
<td>Eun Seong Hwang</td>
<td>University of Seoul, Korea</td>
</tr>
<tr>
<td>Soong-Nang Jang</td>
<td>Chung Ang University, Korea</td>
</tr>
<tr>
<td>Il-Young Jang</td>
<td>Asan Medical Center, Korea</td>
</tr>
<tr>
<td>Kyong Yeun Jung</td>
<td>Eulji General Hospital, Korea</td>
</tr>
<tr>
<td>Dae Hyun Kim</td>
<td>Harvard Medical School, USA</td>
</tr>
<tr>
<td>Sun Young Kim</td>
<td>Kyung Hee University, Korea</td>
</tr>
<tr>
<td>Ki-Sun Kwon</td>
<td>Korea Research Institute of Bioscience and Biotechnology, Korea</td>
</tr>
<tr>
<td>Cheol-Koo Lee</td>
<td>Korea University, Korea</td>
</tr>
<tr>
<td>Dong-Woo Lee</td>
<td>Inje University, Korea</td>
</tr>
<tr>
<td>Sang Yoon Lee</td>
<td>SNU Boramee Medical Center, Korea</td>
</tr>
<tr>
<td>Jean-Pierre Michel</td>
<td>Geneva Hospitals and Medical University, Switzerland</td>
</tr>
<tr>
<td>Khor Hui Min</td>
<td>University of Malaya, Malaysia</td>
</tr>
<tr>
<td>John Morley</td>
<td>Saint Louis University, USA</td>
</tr>
<tr>
<td>Li-Ning Peng</td>
<td>Taipei Veterans General Hospital, Taiwan</td>
</tr>
<tr>
<td>Dong Hoon Shin</td>
<td>Seoul National University, Korea</td>
</tr>
<tr>
<td>Myung Jun Shin</td>
<td>Pusan National University, Korea</td>
</tr>
<tr>
<td>Wee-Shiong Lim</td>
<td>Tan Tock Seng Hospital, Singapore</td>
</tr>
<tr>
<td>Irewin Tabu</td>
<td>College of Medicine, Philippines</td>
</tr>
<tr>
<td>Maw Pin Tan</td>
<td>University of Malaya, Kuala Lumpur, Malaysia</td>
</tr>
<tr>
<td>Shyh Poh, Teo</td>
<td>Hospital RIPAS (Raja Isteri Pengiran Anak Saleha Hospital), Brunei</td>
</tr>
<tr>
<td>Olga Theou</td>
<td>Dalhousie University, Canada</td>
</tr>
<tr>
<td>Joe Verghese</td>
<td>Albert Einstein College of Medicine, USA</td>
</tr>
<tr>
<td>Vijaya Krishna Prasad Vudathaneni</td>
<td>Albert Einstein College of Medicine, USA</td>
</tr>
<tr>
<td>Debra L. Waters</td>
<td>University of Otago, New Zealand</td>
</tr>
<tr>
<td>Jun-II Yoo</td>
<td>Gyeongsang National University, Korea</td>
</tr>
</tbody>
</table>

## Statistical Editor

<table>
<thead>
<tr>
<th>Name</th>
<th>Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rockli Kim</td>
<td>Korea University, Korea</td>
</tr>
</tbody>
</table>

## Journal Management Team

<table>
<thead>
<tr>
<th>Role</th>
<th>Name</th>
<th>Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Journal Manager</td>
<td>Na Ri Jung</td>
<td>The Korean Geriatrics Society, Korea</td>
</tr>
<tr>
<td>Manager of the Review Process</td>
<td>Hee-Won Jung</td>
<td>University of Ulsan, Korea</td>
</tr>
<tr>
<td>Manuscript Editors</td>
<td>Jee-Hyun Noh</td>
<td>Seoul National University, Korea</td>
</tr>
<tr>
<td></td>
<td>Ji Hye Kim</td>
<td>Infolumi, Korea</td>
</tr>
<tr>
<td>Layout editor</td>
<td>In A Park</td>
<td>M2PI, Korea</td>
</tr>
<tr>
<td>Website and JATS XML File Producers</td>
<td>Minyoung Choi</td>
<td>M2PI, Korea</td>
</tr>
</tbody>
</table>
Editorial

181  Annals of Geriatric Medicine and Research receives the First Impact Factor of 3.6 by Journal Citation Reports
   Jae-Young Lim

Original Articles

183  Geriatric and Gerontology Research: A Scientometric Investigation of Open Access Journal Articles Indexed in the Scopus Database
   Luiz Sinésio Silva Neto, Thiago dos Santos Rosa, Matheus Dias Freire, Hugo de Luca Correa, Raymundo Célvio Pedreira, Feliipe Camargo Ferreira Dias, Daniel Vicentini de Oliveira, Neila Barbosa Osório

192  Effectiveness of Vitamin D Supplements in Reducing the Risk of Falls among Older Adults: A Meta-Analysis of Randomized Controlled Trials
   Tiara Octary, Made Satya Nugraha Gautama, Hai Duong

204  The Clinical Frailty Scale as a Risk Assessment Tool for Dysphagia in Older Inpatients: A Cross-Sectional Study
   Min-gu Kang, Sungwhwan Ji, Young Ki Park, Ji Yeon Baek, Young Hye Kwon, Yeon mi Seo, Seung Hak Lee, Eunju Lee, Il-Young Jang, Hee-Won Jung

212  The Effect of Neuromuscular Blockade Reversal Agents on Postoperative Pulmonary Complications in Patients undergoing Femur Fracture Repair Surgery: A Retrospective Observational Study
   Sung-Ae Cho, Jun-ho Kim, Choon-Kyu Cho, Tae-Yun Sung

220  Factors Associated with Improvement in Activities of Daily Living during Hospitalization: A Retrospective Study of Older Patients with Hip Fractures
   Kazuya Takeda, Mineko Wada, Kyosuke Yorozuya, Yuhei Hara, Toyoaki Watanabe, Hideaki Hanaoka

228  Predictive Ability of the 2-Minute Step Test for Functional Fitness in Older Individuals with Hypertension
   Puttipong Poncumhak, Patchareeya Amput, Noppharath Sangkarit, Tichanon Promsrisuk, Arunrat Srithawong

235  Balance Ability and Quality of Life in Older Adult with Recovery from Mild COVID-19
   Patchareeya Amput, Weerasak Tapanya, Noppharath Sangkarit, Saisunee Konsanit, Sirima Wongphon

241  The Risk Factors of COVID-19 Infection and Mortality among Older Adults in South Korea
   Sungmin Lee, Jungha Park, Jae-ryun Lee, Jin Yong Lee, Byung sung Kim, Chang Won Won, Hyejin Lee, Sunyoung Kim
Contents

September 2023 Vol. 27, No. 3

250  The Relationship between Chronic Musculoskeletal Pain and Sarcopenia Risk in Community-Dwelling Older Adults: A Cross-Sectional Study  
Ulku Kezban Sahin, Aysun Yaşcı Şentürk

258  The Triglyceride-Glucose Index is Independently Associated with Chronic Kidney Disease in the Geriatric Population, Regardless of Obesity and Sex  
Bokun Kim, Gwon-Min Kim, Kihoon Han, Naoki Maki, Keisuke Taniguchi, Sechang Oh

Case Reports

266  Mucous Membrane Pemphigoid in a Nonagenarian: A Case Report  
Océane Babin de Lignac, Priscille Carvalho, Marion Carrette, Lucie Cellier, Philippe Courville, Billal Tedbirt

269  Clostridium tetani Infection in a Geriatric Patient: Do Not Let Your Guard Off!  
Alessandra Piscitelli, Stefano Cacciatore, Fiorella Ambrosio, Rosa Ragozzino, Francesco Maria Pasquini, Francesco Incordino, Emanuela D’Angelo, Laura Gerardino, Loredana Maggi, Francesco Landi

Letter to the Editor

274  Association between Support after Dementia Diagnosis and Subsequent Decrease in Social Participation  
Hiroshige Matsumoto, Shuji Tsuda, Shun Takehara, Tomoyuki Yabuki, Satoko Hotta
Annals of Geriatric Medicine and Research (AGMR) has grown into an academic platform offering future perspectives on the research needs related to geriatrics and gerontology.1 The journal’s comprehensive aim and scope cover not only clinical research of geriatric medicine, but aging-related basic research, pre-clinical, and translational studies in the field of gerontology. Policy and health system research related to senior health and welfare are also considered for publication. As the official journal of the Korean Geriatrics Society and the Korean Society for Gerontology, the journal provides a non-profit, open-access platform supported by the Korean Geriatrics Society and the Korean Federation of Science and Technology Societies Grant funded by the Korean government. Our journal was listed in the Emerging Sources Citation Index database, one of the Web of Science Core Collections in 2018, and indexed in Scopus, a comprehensive abstract and citation database in 2019. The contents of AGMR published since 2018 are now available in PubMed ensuring greater visibility of the research published in AGMR.2

AGMR has captured the seminal research findings from various researchers worldwide and the readership has expanded widely around the world. Noting the challenge of addressing the tremendous research gaps in Asian countries experiencing the rapid aging of their populations, AGMR sought to become a high-profile journal to first serve and support this region with evidence-based materials and to embrace a dualistic outlook of harnessing the eclectic richness of international and regional perspectives.3 During the pandemic and at the beginning of the post-pandemic era, the journal has contributed to delivering critical information related to coronavirus disease 2019 and highlighting the challenge of geriatric care in the unprecedented global health crisis.4–5

As a result, AGMR could release innovative research results for the professional geriatric community. As a fast-growing journal in the multidisciplinary aging research field, the visibility of our scientific literature to researchers working in relevant fields continues to improve. From the 2023 release, Clarivate has included all Web of Science Core Collection journals for Journal Impact Factor (JIF). This year, AGMR gained the first JIF of 3.6 by Journal Citation Reports, which is the official source to find a journal’s impact factor integrated with the Web of Science platform.6 It means that the citable articles published during 2020 or 2021 in AGMR have been cited 3.6 times on average in 2022. This is a splendid achievement given that the impact factor of AGMR was comparable to some prestigious journals of the geriatric field such as European Geriatric Medicine (JIF = 3.8) and Geriatrics Gerontology International (JIF = 3.3). In addition to JIF, the CiteScore 2022 of AGMR was 4.2 which continues to rise every year (Fig. 1).7 The CiteScore is an average of citations per document over the past 3 years and a useful journal evaluation metric released by Scopus to give a comprehensive and transparent view of a journal’s impact. SCImago Journal & Country Rank (SJR) published by Scopus ranked AGMR 49 among 113 journals in Geriatric and Gerontology category, which is the second quartile (Q2) of indexed journals.8 This achievement would not have been possible without the enthusiastic support and contributions of our editorial board members, reviewers, authors, and readers to develop a rigorous academic platform in the field of geriatric and gerontology.

In recent years, AGMR has been actively participating in the global call to action for the Decade of Healthy Ageing declared by the United Nations.9 The Decade of Healthy Ageing is a concerted global action urgently needed to ensure that older adults enjoy dignity, equality, and a healthy environment. In 2022, the World Rehabilitation Alliance has been established in the World Health Organization Rehabilitation program to strengthen networks and partnerships for the integration of rehabilitation into health systems.9 AGMR has endorsed the call to action from the research workstream of the World Rehabilitation Alliance to promote the
health policy and systems research for strengthening rehabilitation ahead of global aging society. Furthermore, challenges and opportunities for our journal to serve the older population in global aging will be presented at the Research Symposium on publishing high-impact Asian research at the Asian Conference of Frailty and Sarcopenia to be held in Singapore in this October.

In order to increase its global influence beyond emerging countries in Asia, our journal continues to cover the new agenda to improve the health outcomes of older adults in post-pandemic future, and to drive the issues of geriatric care in developing countries heading towards a super-aging society, and to promote the health policy and systems research on geriatric care services in each country. It is our hope that the AGMR continue to serve an arena highlighting the importance of geriatric and gerontological research to address the unique needs of older adults in the globe.

ACKNOWLEDGMENTS

CONFLICT OF INTEREST
The other author claims no conflicts of interest.

FUNDING
None.

REFERENCES


Corresponding Author: Jae Young Lim, MD, PhD
Department of Rehabilitation Medicine, Seoul National University Bundang Hospital, Seoul National University College of Medicine, 82 Gumi-ro 173 Beon-gil, Bundang-gu, Seongnam 13620, Korea
E-mail: drlim1@snu.ac.kr
ORCID: https://orcid.org/0000-0002-9454-0344

Received: September 26, 2023; Accepted: September 26, 2023
Geriatric and Gerontology Research: A Scientometric Investigation of Open Access Journal Articles Indexed in the Scopus Database

Luiz Sinésio Silva Neto\textsuperscript{1,2}, Thiago dos Santos Rosa\textsuperscript{3}, Matheus Dias Freire\textsuperscript{2}, Hugo de Luca Correa\textsuperscript{3}, Raymundo Célio Pedreira\textsuperscript{2}, Fellipe Camargo Ferreira Dias\textsuperscript{2}, Daniel Vicentini de Oliveira\textsuperscript{1}, Neila Barbosa Osório\textsuperscript{3}

\textsuperscript{1}Faculty of Medicine, Federal University of Tocantins, Tocantins, Brazil
\textsuperscript{2}University of Maturity, Federal University of Tocantins, Tocantins, Brazil
\textsuperscript{3}Faculty of Physical Education, Catholic University of Brasilia, Taguatinga, Brazil
\textsuperscript{4}State University of Maringá, Maringá, Brazil

Corresponding Author:
Luiz Sinésio Silva Neto, MD
Faculty of Medicine, Federal University of Tocantins, Avenida NS15, 109 Norte Plano Diretor Norte Palmas, Tocantins, Brazil
E-mail: luizneto@uft.edu.br
ORCID: https://orcid.org/0000-0002-3182-7727

Received: May 24, 2023
Revised: July 6, 2023
Accepted: July 18, 2023

Background: Scientometric analyses of specific topics in geriatrics and gerontology have grown robustly in scientific literature. However, analyses using holistic and interdisciplinary approaches are scarce in this field of research. This article aimed to demonstrate research trends and provide an overview of bibliometric information on publications related to geriatrics and gerontology.

Methods: We identified relevant articles on geriatrics and gerontology using the search terms “geriatrics,” “gerontology,” “older people,” and “elderly.” VOSviewer was used to perform bibliometric analysis.

Results: A total of 858 analyzed articles were published in 340 journals. Among the 10 most contributory journals, five were in the United States, with the top journal being the Journal of the American Geriatrics Society. The United States was the leading country in research, followed by Japan, Canada, and the United Kingdom. A total of 5,278 keywords were analyzed. In the analysis of research hotspots, the main global research topics in geriatrics and gerontology were older adults (n=663), education and training (n=471), and adults aged 80 years (n=461). These were gradually expanded to include areas related to caring for older adults, such as geriatric assessments (n=395).

Conclusion: These results provide direction for fellow researchers to conduct studies in geriatrics and gerontology. In addition, they provide government departments with guidance for formulating and implementing policies that affect older adults, not only in setting academic and professional priorities but also in understanding key topics related to them.

Key Words: Older adults, Geriatrics, Gerontology, Bibliometric analysis, Trends

INTRODUCTION

Due to the accelerated growth of older adult populations worldwide, there is an urgent need for the development of research and public health policy to understand and support healthy aging.\textsuperscript{(1)} A growing research consensus indicates that the characteristics of aging, once considered disparate, are likely interconnected. This scenario promotes a greater need for interdisciplinary research as this field of study is extremely complex. Interdisciplinary research enables a greater understanding of the extent of topics of interest to increase scientific productivity and provide theoretical and practical support for professional training.\textsuperscript{(2-4)} The exponential increase in interdisciplinary research in the field of geriatrics and gerontology results from the accelerated aging process worldwide and the financial investments of public and private institutions.\textsuperscript{(5)} Considerable progress has been made in understanding the aging process through multidisciplinary and/or interdisciplinary methods. However, despite these developments, many important issues require better understanding.

In an editorial on new perspectives in gerontology and geriat-
Bibliometric methods are an integral part of research evaluation methodology within scientific fields and are increasingly used in the study of various aspects of science. This study analyzed the Scopus database, an Elsevier product with a broad scope, which is the largest database, with citation data from peer-reviewed articles in various disciplines. The Scopus database offers several features that facilitate bibliometric analysis. These operational functions include the journal name, document type, year of publication, authors and their affiliations, citation count, and h-index metrics for documents. Screening of this database revealed 858 articles, which were included in the bibliometric analysis. Fig. 1 shows the schematic flowchart of the article selection process.

Search Strategy
The data for this study were acquired from the Scopus database without defining the analysis period. The search started on January 21, 2023, and contained all articles with terms using the Medical Subject Headings (MeSH) combination: (geriatrics AND gerontology AND elderly OR older AND adult) AND (LIMIT-TO (DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE, "re")). This strategy enabled a broader and interdisciplinary analysis of geriatrics and gerontology. Therefore, these keywords were used such that the maximum number of relevant publications were incorporated into the extracted data.

Inclusion and Exclusion Criteria
All data from the Scopus database, including article information, such as author names, titles, journals, keywords, institutional affiliations, citations, and abstracts, were downloaded. All data were imported into a Microsoft Excel file (xls format) to check for data errors. Then, all downloaded data were filtered by the inclusion criteria, as follows: (1) open access (OA) publications (all OA publications were included); (2) papers published as articles; and (3) articles published in English. The corresponding authors of the present study, LSSN and NBO, reviewed the titles of all articles.

Fig. 1. Research flowchart.
Bibliometric analysis provides an idea of the progress of research and the contributions of researchers in a given field. In this study, we searched the Scopus database to analyze the current status and research development trends in geriatrics and gerontology to identify the contributions of different nations, institutions, and partnerships. Research hotspots were tracked using cluster keyword mapping and burst term analysis. Finally, co-citation analysis was used on the Scopus database, and global trends and the most-contributing articles in geriatrics and gerontology were compared to encourage further dialogue among scholars.

**Statistical Analysis**
Scientometrics is involved in productivity analysis and the measurement of scientific fields. The quantitative assessment of publication productivity through scientometric parameters is a reliable technique used to understand the impact of any research on a community. We explored global publications related to geriatrics and gerontology through the quantitative metrics of scientometrics and bibliometrics. OA articles were analyzed. The large increase in subscription rates for conventional subscription-based journals and traditional publication editions led to the formation of the Open Access Academic Communication Movement. In this study, we used Microsoft Excel version 2019 (v16.0) and VOSviewer (v1.6.18; https://www.vosviewer.com/) to describe the basic characteristics of the publications, countries, institutions, keywords, and citations. VOSviewer uses text mining functions and advanced visual analysis to perform co-occurrence analyses. Co-occurrence analysis helps quantify common information in various data, revealing the association between content and common information relations. The types of co-occurrence analysis research are broad, including co-country, co-institution, co-keyword, and co-citation analyses. After searching the literature, we extracted publication dates, journals, countries, institutions, and keywords using Microsoft Excel. The analysis was then separated into three stages: (1) a descriptive statistical analysis of the growth patterns, numbers, years, institutions, countries, and main journals of the publications; (2) a co-occurrence analysis of keywords using VOSviewer; and (3) a co-citation analysis to rank the most influential articles in this field.

The results and discussion are presented together for clarity. The topics include survey status, hotspots and co-institutions, survey hotspots, and top topics.

**Ethics Statement**
This study complied the ethical guidelines for authorship and publishing in the *Annals of Geriatric Medicine and Research*.

**RESULTS**
Bibliometric analysis provides an idea of the progress of research...
with OA, making them immediately and permanently available for everyone to read and download. Researchers can access most studies in geriatrics and gerontology by following the journals listed in Table 1.

The United States (n = 378) was the leading country in geriatrics and gerontology research, followed by Japan (n = 127), Canada (n = 79), the United Kingdom (n = 34), and Germany (n = 32). We observed a stable cooperative relationship between North America and Europe as well as in Asian countries such as Japan and South Korea. The institutions listed in Fig. 3 illustrate the partnerships and cooperation between those actively publishing in the fields of geriatrics and gerontology. Xiao et al.\(^{23}\) identified the economy as one of the main factors affecting the productivity of countries. Additionally, countries with high rates of population aging, such as Japan and European countries, are also significant contributors of research on older adult populations, especially those aged \(\geq 80\) years.\(^{24}\) We observed that the keyword “80+ elderly” was cited 461 times, confirming that these countries are also studying older adult individuals in this age group.

In the co-citation analysis, the article by Jerome A. Yesavage, MD, published in 1988, titled “The Geriatric Depression Scale” (GDS) was the most cited (n = 478) (Table 2). We believe that this study made important contributions to the development of this research field. Krishnamoorthy et al.\(^{25}\) described the GDS as one of the most commonly used instruments to track and detect older adults with or at risk of depression, which is a public health problem. These data are consistent with the results of our analysis of the frequency of occurrence of the 20 main keywords (Table 3) and our identified key terms such as geriatric assessment, psychological aspects, depression, and risk factors.

Classification of the studies in Table 2 by macro-themes revealed three themes: cognitive assessment (articles #1, #3, #7, and #10), functional capacity (articles #2, #4, #5, and #9), and frailty (articles #6 and #8).

Research Hotspots and Topics
We analyzed 5,278 keywords. The analysis of research hotspots showed that the main global research topics in geriatrics and gerontology were older adults (n = 663), education and training (educational research) (n = 471), and older adults aged \(\geq 80\) years (n = 461). These hotspots gradually expanded to include care for older adults through geriatric assessments (n = 395), geriatric nursing (n = 367), and procedures and management (n = 308) (Table 3, Fig. 4). Topics related to mental health, classified into sub-areas such as psychiatry and psychology, as well as the macro-theme of functional capacity, were also research hotspots in geriatrics and gerontology. These themes were also frequently reported in other bibliometric analyses.\(^{13,23}\)

In contrast, the term dementia, which was prominently featured in the studies above, appeared in only 44 articles in the co-occurrence analysis; we attribute this contrary finding to the choice of database and search strings. However, the analysis of the co-occurrence of the term dementia with the term “oldest-old” (80+) (n = 44 publications) showed that 73% of studies on dementia focused on elderly people aged \(\geq 80\) years; thus, it seemed to be a research topic.\(^{26}\) Original studies (n = 178), reviews (n = 93), and epidemiological prevalence studies (n = 52) appeared to be more commonly reported by researchers in geriatrics and gerontology.\(^{27-29}\)

Fig. 2. Trends in publications of research on geriatrics and gerontology from 1965 to January 2023.
### Table 1. Top-10 journal contributions

<table>
<thead>
<tr>
<th>Rank</th>
<th>Journal title</th>
<th>Country</th>
<th>Number of articles</th>
<th>IF</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Journal of the American Geriatrics Society</td>
<td>USA</td>
<td>100</td>
<td>7.538</td>
</tr>
<tr>
<td>2</td>
<td>Journal of the American Medical Directors Association</td>
<td>USA</td>
<td>27</td>
<td>7.802</td>
</tr>
<tr>
<td>3</td>
<td>Gerontology</td>
<td>Switzerland</td>
<td>27</td>
<td>5.597</td>
</tr>
<tr>
<td>4</td>
<td>Gerontologist</td>
<td>USA</td>
<td>26</td>
<td>5.422</td>
</tr>
<tr>
<td>5</td>
<td>The Journal of Nutrition, Health &amp; Aging</td>
<td>Italy</td>
<td>17</td>
<td>5.285</td>
</tr>
<tr>
<td>6</td>
<td>Archives of Gerontology and Geriatrics</td>
<td>Ireland</td>
<td>17</td>
<td>4.163</td>
</tr>
<tr>
<td>7</td>
<td>International Journal of Environmental and Health Research</td>
<td>England</td>
<td>16</td>
<td>4.477</td>
</tr>
<tr>
<td>8</td>
<td>Journal of Gerontological Social Work</td>
<td>USA</td>
<td>15</td>
<td>3.608</td>
</tr>
<tr>
<td>9</td>
<td>Geriatrics and Gerontology International</td>
<td>Japan</td>
<td>14</td>
<td>3.387</td>
</tr>
<tr>
<td>10</td>
<td>Educational Gerontology</td>
<td>USA</td>
<td>12</td>
<td>1.389</td>
</tr>
</tbody>
</table>

IF, impact factor (Clarivate Science Citation Index-2021).

### Table 2. Top-10 most cited articles

<table>
<thead>
<tr>
<th>Rank</th>
<th>Title</th>
<th>Year</th>
<th>Number of citations</th>
<th>Journal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Geriatric Depression Scale</td>
<td>1988</td>
<td>478</td>
<td>Psychopharmacology Bulletin</td>
</tr>
<tr>
<td>2</td>
<td>Assessment of older people: self-maintaining and instrumental activities of daily living</td>
<td>1969</td>
<td>256</td>
<td>The Gerontologist</td>
</tr>
<tr>
<td>3</td>
<td>The mini-mental state examination</td>
<td>1983</td>
<td>177</td>
<td>Archives of General Psychiatry</td>
</tr>
<tr>
<td>4</td>
<td>Human aging: usual and successful</td>
<td>1987</td>
<td>175</td>
<td>Science</td>
</tr>
<tr>
<td>5</td>
<td>Barthel index</td>
<td>1965</td>
<td>156</td>
<td>Maryland State Medical Journal</td>
</tr>
<tr>
<td>6</td>
<td>Frailty in older adults: evidence for a phenotype</td>
<td>2001</td>
<td>149</td>
<td>The Journals of Gerontology Series A</td>
</tr>
<tr>
<td>7</td>
<td>Measurement of competence: reliability and validity of the TMIG Index of Competence</td>
<td>1991</td>
<td>136</td>
<td>Archives of Gerontology and Geriatrics</td>
</tr>
<tr>
<td>8</td>
<td>Frailty in elderly people</td>
<td>2013</td>
<td>132</td>
<td>The Lancet</td>
</tr>
<tr>
<td>9</td>
<td>The timed “Up &amp; Go”: a test of basic functional mobility for frail elderly persons</td>
<td>1991</td>
<td>126</td>
<td>Journal of the American Geriatrics Society</td>
</tr>
<tr>
<td>10</td>
<td>Practice parameter: Early detection of dementia: Mild cognitive impairment (an evidence-based review) [RETIRED]: Report of the Quality Standards Subcommittee of the American Academy of Neurology</td>
<td>2001</td>
<td>120</td>
<td>Neurology</td>
</tr>
</tbody>
</table>

TMIG, Tokyo Metropolitan Institute of Gerontology.

### Fig. 3. Global research co-country analysis.
Table 3. Frequencies of occurrence of the top-20 keywords

<table>
<thead>
<tr>
<th>Rank</th>
<th>Keyword</th>
<th>Frequency of occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Human</td>
<td>782</td>
</tr>
<tr>
<td>2</td>
<td>Older adult</td>
<td>663</td>
</tr>
<tr>
<td>3</td>
<td>Geriatrics</td>
<td>598</td>
</tr>
<tr>
<td>4</td>
<td>Gerontology</td>
<td>524</td>
</tr>
<tr>
<td>5</td>
<td>Education and training</td>
<td>471</td>
</tr>
<tr>
<td>6</td>
<td>80+ elderly</td>
<td>461</td>
</tr>
<tr>
<td>7</td>
<td>Geriatric assessment</td>
<td>395</td>
</tr>
<tr>
<td>8</td>
<td>Geriatric nursing</td>
<td>367</td>
</tr>
<tr>
<td>9</td>
<td>Procedures</td>
<td>308</td>
</tr>
<tr>
<td>10</td>
<td>Management</td>
<td>290</td>
</tr>
<tr>
<td>11</td>
<td>Psychological aspects</td>
<td>237</td>
</tr>
<tr>
<td>12</td>
<td>Revision</td>
<td>192</td>
</tr>
<tr>
<td>13</td>
<td>Quality of life</td>
<td>178</td>
</tr>
<tr>
<td>14</td>
<td>Activities of daily life</td>
<td>170</td>
</tr>
<tr>
<td>15</td>
<td>Cognition</td>
<td>153</td>
</tr>
<tr>
<td>16</td>
<td>Health staff attitude</td>
<td>147</td>
</tr>
<tr>
<td>17</td>
<td>Depression</td>
<td>131</td>
</tr>
<tr>
<td>18</td>
<td>Risk factor</td>
<td>119</td>
</tr>
<tr>
<td>19</td>
<td>Frailty</td>
<td>117</td>
</tr>
<tr>
<td>20</td>
<td>Prevalence</td>
<td>113</td>
</tr>
</tbody>
</table>

The burst analysis of keywords did not reveal a drastic pattern of change in the searches for geriatrics and gerontology (Fig. 5). The keyword “older adults” (n = 663) showed the most robust growth in this field. Keywords related to the health of older adults were highlighted when analyzed on a macro-theme, such as geriatric assessment (n = 395), geriatric nursing (n = 367), attitudes of health personnel (n = 147), depression (n = 131), and prevalence (n = 113) (Table 3). The keyword “older adults (80+)” also appeared at a high frequency in the included studies (n = 461). A bibliometric analysis by Gonzalez-Alcaide et al. reported a significant growth in scientific studies on the population aged ≥ 80 years, with a focus on cardiovascular and cerebrovascular diseases, dementia, and neoplasia. Moreover, > 96% of these studies were published in European, North American, and Asian countries. Therefore, this is a research hotspot in geriatrics and gerontology, enabling a vast field of research with new approaches, such as geriatric syndromes, as well as the social and psychosocial aspects of the population in this age group.

DISCUSSION

This study has several limitations, which should be noted when in-
Fig. 5. Keyword burst analysis.

terpreting the results. First, we used only the Scopus database, which may have limited access to articles that are not indexed in this database. However, Scopus is one of the most widely used databases worldwide, with high-quality literature. Second, we excluded non-English articles, which may explain why some studies were missing. The VOSviewer analysis in this study was quantitative. Future studies should adopt qualitative methods to address the limitations of quantitative research. Further research is also needed to employ a more comprehensive search strategy to validate our results or to provide a broader perspective on geriatric and gerontology research. Our study has several strengths. To our knowledge, studies using holistic bibliometric analysis to assess hotspots and frontiers in the fields of geriatrics and gerontology are scarce. As aging is a priority for countries worldwide, scientometric analyses can reveal the factors driving knowledge advances in the aging agenda, such as vital academic institutions, individual researchers, and research groups. Our analysis of the Scopus database revealed a total of 340 academic journals with 858 publications in geriatrics and gerontology. We analyzed the number of publications, impact factors of the major journals, collaborations between countries/institutions, and reference co-citation and keyword analysis.

In conclusion, this study collected relevant literature on geriatrics and gerontology; analyzed information from leading countries, institutions, and journals in this field; and summarized the critical points and research frontiers. The number of publications in the analyzed field of study has increased rapidly, especially in the last decade. Most of these publications are associated with older adults, education, and training (educational research), and those aged ≥ 80 years, gradually expanding to care for older adults, such as geriatric assessment, geriatric nursing, procedures, and management. Topics related to mental health, classified into sub-areas such as psychiatry and psychology as well as functional capacity, appeared at high frequency among the citations in the analyzed studies. These findings suggest that reinforcing interinstitutional and interdisciplinary cooperation is essential for progress and development in this scientific field. American and European countries, especially the United States, dominate in the number of publications, journals with the highest number of co-citations, and research collaborations in geriatrics and gerontology. Asian countries, such as Japan and Taiwan, are actively seeking international cooperation to increase their global influence on the development of this field. Our results provide direction for fellow researchers to conduct studies in geriatrics and gerontology.
ACKNOWLEDGMENTS

CONFLICT OF INTEREST
The researchers claim no conflicts of interest.

FUNDING
None.

AUTHOR CONTRIBUTIONS
Conceptualization, LSSN, NBO; Data curation, FCFD, MDF; Investigation, FCFD, MDF; Methodology, FCFD, MDF; Writing-original draft, ABF, TSR, RCP, HLC, DVO; Writing-review & editing, LSSN, NBO.

REFERENCES

14. Vogel B, Reichard RJ, Batistic S, Cerne M. A bibliometric review of the leadership development field: How we got here, where we are, and where we are headed. Leadersh Q 2021;32:101381.
25. Krishnamoorthy Y, Rajaa S, Rehman T. Diagnostic accuracy of various forms of geriatric depression scale for screening of depression among older adults: systematic review and meta-analy-


Effectiveness of Vitamin D Supplements in Reducing the Risk of Falls among Older Adults: A Meta-Analysis of Randomized Controlled Trials

Tiara Octary1,2, Made Satya Nugraha Gautama1,3, Hai Duong4,5

1School of Nursing, College of Nursing, Taipei Medical University, Taipei, Taiwan
2Department of Nursing, Poltekkes Kemenkes Pontianak, Kalimantan Barat, Indonesia
3Master of Nursing Program, Faculty of Medicine, Public Health, and Nursing, Universitas Gadjah Mada, Yogyakarta, Indonesia
4International Master/PhD Program in Medicine, Taipei Medical University, Taipei, Taiwan
5Department of Community Health, School of Medicine, Vietnam National University, Ho Chi Minh City, Vietnam

Background: The role of vitamin D in reducing the risk of falls in older adults has not been clearly demonstrated. This study examined the effectiveness of vitamin D supplementation in reducing the risk of falls in older adults. Methods: Four databases (Cochrane Library, Embase, PubMed, and CINAHL) were searched without language restrictions or time limitations. These articles were comprehensively screened using EndNote version 20.1 software. A manual search of the reference lists of the identified studies was also performed. The analysis was performed according to the Preferred Reporting Items for Systematic Reviews and Meta–Analyses (PRISMA) guidelines. Results: Seventeen studies met inclusion criteria among 550 potentially relevant studies. The pooled analysis of 38,598 older adults showed that vitamin D supplementation decreased the odds of having at least one fall by 1% (odds ratio [OR]=1.01; 95% confidence interval [CI], 0.92–1.11; p=0.86); however, the difference was not statistically significant. Of eight studies with 19,946 older adults, the pooled analysis showed a 12% (OR=1.12; 95% CI, 0.97–1.29; p=0.11) decrease in the odds of having at least one fracture among older adults; however, the difference was also not statistically significant. Pooled subgroup analysis showed that neither low (<2,000 IU/day) nor high (≥2,000 and <4,000 IU/day) doses of vitamin D supplementation had any significant effect on the incidence of falls and fractures. Conclusion: Vitamin D supplementation had no beneficial effect in reducing fall and fracture incidence among older adults.

Key Words: Accidental falls, Bone fractures, Frail elderly, Meta-analysis

INTRODUCTION

Falls is the most frequent accident type and the main reason for injury-related hospitalizations in adults aged 65 years and older.1) Three million older adults receive emergency room care each year for fall-related injuries.2) Injuries caused by falls are associated with increased mortality.3) The World Health Organization reports that falls are the second largest cause of unintentional injury death globally, leading to > 684,000 deaths annually.5) Although all people are at risk of falls, age, sex, unsafe environments, socioeconomic factors, medication, and health of an individual can impact the risk of falling.5) Recent epidemiological studies support a relationship between vitamin D and increased muscle function related to the prevention of injurious falls.6,7

Ergocalciferol (vitamin D2) and cholecalciferol (vitamin D3) are the two primary forms of vitamin D, a fat-soluble nutrient that is present in plants as vitamin D2 and as vitamin D3 in humans and animals. Vitamin D is primarily produced by the skin upon exposure to ultraviolet (UV) rays from the sun, supplements, and food. Vitamin D increases calcium and phosphate levels, which are...
cruel for bone formation and muscle contractions, immune system function, and glucose metabolism. Vitamin D deficiency is a cause for concern, especially in older adults, due to its association with poor physical performance, increased risk of falling, and osteoporosis-related fractures. Moreover, vitamin D may play a role in preserving or enhancing muscle strength, function, physical performance, and balance in older adults, as well as in lowering hip and non-vertebral fractures. By enhancing intestinal calcium absorption, vitamin D may enhance bone health and improve bone mineralization.

One study reported that 24 weeks of vitamin D supplementation reduced the incidence of falls in older adult populations. However, several systematic reviews concluded that vitamin D and calcium supplementation did not improve fracture or fall risks or bone mineral density. Recent studies showed no significant influence of vitamin D on the risk of injuries such as fractures compared to placebo and on falls among older adults. Therefore, the effects of vitamin D on fall prevention remain inconclusive. Therefore, the present comprehensive review of the literature and meta-analysis of randomized controlled trials (RCTs) aimed to establish the overall effectiveness of vitamin D in reducing falls in older persons.

MATERIALS AND METHODS

Search Strategy

This study was registered in the International Prospective Register of Systematic Reviews (PROSPERO) (CRD42022383154) and was conducted in accordance with the 2020 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. We conducted a review based on literature identified in the Cochrane Library, Embase, PubMed, and CINAHL databases. A manual search was conducted by looking at the reference lists of published studies and Google searches. The search was performed using the combinations of keywords and Medical Subject Headings (MeSH) terms of "accidental falls" OR "falling" OR "falls" OR "slip and fall" AND "vitamin deficiency" OR "vitamin D" OR "calciferol" AND "aged" OR "elderly" OR "frail elderly" OR "older people" and without date of publication and language restrictions (Table 1). The last update of the search was conducted on December 12, 2022.

Eligibility Criteria and Screening Procedures

EndNote version 20.1 was used to thoroughly screen each article in the databases. Three independent reviewers systematically screened the articles to identify relevant studies. The study inclusion criteria based on the Population, Intervention, Comparison, Outcome and Study (PICOS) criteria included: (1) older community-dwelling or institutionalized adults (≥ 60 years of age); (2) no use of vitamin D and calcium supplements at screening; (3) a control group taking a placebo or other complement such as calcium at the same dosage in all groups; (4) primary outcome of the assessment of the number of people with at least one fall and the secondary outcomes of the number of people with at least one fracture; and (5) RCT study design.

Articles meeting any of the following exclusion criteria were excluded: (1) not pertaining to the study topic; (2) irrelevant population, (3) non-research articles or inappropriate study design (such as a case-cross over, cross-sectional study, or case-control study); (4) study protocol; (5) an inappropriate outcome regarding the number of falls among the participants; (6) reporting from the same data set as other RCTs; (7) insufficient data after email review.

Table 1. Search string databases

<table>
<thead>
<tr>
<th>Database</th>
<th>Result</th>
<th>Date of search</th>
<th>Search string</th>
</tr>
</thead>
<tbody>
<tr>
<td>CINAHL</td>
<td>58</td>
<td>12/12/2022</td>
<td>(AB falls OR falling OR falls, accidental OR accidental fall OR fall, accidental OR slip and fall OR fall and slip) AND (AB vitamin deficiency) AND (AB aged OR elderly)</td>
</tr>
<tr>
<td>EMBASE</td>
<td>432</td>
<td>12/12/2022</td>
<td>'aged'/exp OR 'aged' AND 'vitamin deficiency'/exp OR 'vitamin deficiency' AND 'falls'/exp OR 'falls'</td>
</tr>
<tr>
<td>PubMed</td>
<td>57</td>
<td>12/12/2022</td>
<td>(((‘vitamin d’[MeSH Terms] OR ‘ergocalciferol’[MeSH Terms] OR (‘vitamin d’[Title/Abstract] OR ‘Calciferol’[Title/Abstract])) AND (‘frail elderly’[MeSH Terms]) OR (‘older adults’[Title/Abstract] OR ‘elder adults’[Title/Abstract]) OR ‘elderly adults’[Title/Abstract] OR ‘elderly people’[Title/Abstract] OR ‘elder people’[Title/Abstract]) AND (‘accidental falls’[MeSH Terms]) OR (‘fall’[Title/Abstract] OR ‘slip’[Title/Abstract])) AND (clinicaltrial[Filter] OR randomizedcontrolledtrial[Filter])</td>
</tr>
<tr>
<td>Translations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitamin D[Mesh]; ‘vitamin d’[MeSH Terms] OR ‘ergocalciferol’[MeSH Terms]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frail Elderly[MeSH Terms]; ‘frail elderly’[MeSH Terms]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accidental Falls[Mesh]; ‘accidental falls’[MeSH Terms]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cochrane</td>
<td>3</td>
<td>12/12/2022</td>
<td>MeSH descriptor: [Vitamin D] explode all trees AND MeSH descriptor: [Frail Elderly] explode all trees AND MeSH descriptor: [Accidental Falls] explode all trees</td>
</tr>
</tbody>
</table>

MeSH, medical subject headings.
requests to eligible authors for missing information; and (8) lack of full text.

**Extraction and Outcomes**
The extracted data included study identity, study characteristics (author, year of publication, title, study design, and country), participant characteristics (study setting, sample size, mean age, and sex), intervention characteristics (frequency, duration, and dose), and outcomes (number of people who had at least one fall and/or number of people who had at least one fracture).

**Quality Assessment**
The risks of bias in the eligible RCTs were independently assessed by three reviewers following the approach in the Cochrane Handbook version 2 for a systematic review of interventions. Version 2 of the Cochrane risk of bias tool for randomized trials (RoB 2) is the instrument recommended for assessing the risk of bias in randomized trials. With a specific focus on various facets of trial design, conduct, and reporting, the RoB 2 is organized into a predetermined set of bias domains. A set of inquiries (referred to as "signaling questions") within each domain seeks to elicit details about trial characteristics that are important to the risk of bias. Based on the responses to the signaling questions, an algorithm generates a proposed conclusion regarding the probability of bias originating from each domain.

**Statistical Analysis**
We assessed the accumulated evidence using RevMan version 5.4.1 (Copenhagen, Nordic Cochrane Center; The Cochrane Collaboration, 2020). The number of participants who fell at least once and sustained a fracture was statistically estimated in a standard event and total format with 95% confidence intervals (CIs).

We calculated the Q and I² statistics to evaluate the heterogeneity of treatment effects across studies. I² indicates the consistency of a study’s findings. The result is interpreted as the fraction of the overall variation across studies, which may be attributed to heterogeneity rather than random variance.22 We applied a scale of low, moderate, and high heterogeneity, with upper limits of 25%, 50%, and 75% for I², respectively.33 Models for random effects were also computed. The analysis applied a random-effects model to account for differences between the included studies.44

**Moderator Analysis**
We conducted a subgroup analysis among the included studies.22 We conducted subgroup analyses for several potential moderator variables, including vitamin D type (vitamin D2 or vitamin D3) and doses (vitamin D2 or D3; low dose < 2,000 IU/day, high dose ≥ 2,000 and < 4,000 IU/day).23 We transformed the doses of vitamin D from either monthly or annual to daily intake.

**RESULTS**

**Description of the Included Studies**
Searches of the Embase, Cochrane, PubMed, and CINAHL electronic databases using the PRISMA flowchart identified 550 studies. Eighty studies were identified as duplicate records and were removed from the screening of the titles and abstracts. An additional 40 studies were excluded because of irrelevant topics, 69 studies had irrelevant populations, 36 studies were either reviews or meta-analyses, three studies were non-research articles, two studies were protocols, and 298 studies had irrelevant study designs. Therefore, the full texts of 22 studies were selected. Among these, one study was excluded because it was a duplicate publication, and 12 other studies were excluded because they did not measure the outcome of interest in this study. The manual, Google Scholar, and citation searches yielded 12 studies. Four of these studies were excluded because the populations were irrelevant. Finally, 17 studies presented sufficient information for data extraction and were eligible for enrollment in our study (Fig. 1).

**Study Characteristics**
Among 47,206 older adults enrolled in this study among the 17 included studies, 19,313 received vitamin D interventions, and 19,298 were assigned to placebo control groups. The mean ages ranged from 61.0 to 85.4 years. Approximately 25,361 patients (53.8%) were women. The included studies were conducted in Switzerland (17.6%), the United Kingdom (35.2%), Australia (23.6%), the United States (17.6%), and Germany (6.0%). The populations of the studies were all older adults and were heterogeneous. Most of the study participants were community-dwelling. The number of participants in the study ranged from 68 to 21,315, and the follow-up duration varied from 4 to 62 months. The vitamin D regimens in the intervention groups varied between studies in terms of the dose and method of administration. Most of the studies compared the effects of vitamin D3 supplementation among the intervention groups compared to the control group mostly administered placebos. Fifteen of the 17 studies indicated that administration occurred via the oral route (Table 2).36,38-41

We assessed the risk of bias for all 17 included studies using the Cochrane Library’s RoB 2 tool. Among the assessed domains, all included studies had low risks of bias due to missing outcome data, measurement of outcomes, and selection of reported results. Regarding the risk of bias due to the randomization process, four studies16,30,36,39 were of some concern, while the other studies were
of low risk. Regarding the risk of bias due to deviations from the intended interventions, only one study was of concern, whereas the others were of low risk. The overall risk of bias showed 13 with low risk and four studies with “some concern” (Table 2). The risks of bias according to the five domains are presented in Supplemental Table S1.

Main Outcomes

The forest plot of the effects of vitamin D (D2 and D3) supplementation on fall incidence included 17 studies with a total population of 38,598 individuals. The pooled result showed an odds ratio (OR) of 1.01 (95% CI, 0.92–1.11), indicating that vitamin D supplementation decreased the odds of having at least one fall by only 1% compared to placebo among older adults. The incidence of falls did not differ significantly between the vitamin D and placebo groups (p = 0.86). We observed moderate statistical heterogeneity among the studies (I² = 52%).

The pooled results of the forest plot of eight studies on vitamin D (D2 and D3) (Fig. 3) and fracture incidence among older adults, with a total population of 19,946 showed an OR of 1.12 (95% CI, 0.97–1.29), indicating that vitamin D supplementation decreased the odds of having at least one fracture by 12% compared to placebo among older adults. The incidence of fractures did not differ significantly between the vitamin D and placebo groups (p = 0.11). We observed low statistical heterogeneity in this meta-analysis (I² = 24%).

A subgroup analysis of three studies on vitamin D2 supplementation revealed no statistically significant reduction in fracture incidences between the two groups (OR = 1.09; 95% CI, 0.82–1.45; p = 0.56). The analysis included a total of 13,782 participants. High heterogeneity was observed among these studies (I² = 60%).

The results of the subgroup analysis of five studies that administered vitamin D3 supplementation showed no statistically significant reduction in fracture incidences between the two groups (OR = 1.13; 95% CI, 0.96–1.34; p = 0.15). The analysis included a total of 6,164 participants included in the analysis. Low heterogeneity was observed among studies (I² = 4%).

Effects of vitamin D doses on falls and fractures

A pooled analysis of the effects of low doses (< 2,000 IU/day) including nine studies with 10,806 participants and high doses (≥ 2,000 and < 4,000 IU/day) including eight studies with 27,792
Table 2. Characteristics of randomized controlled trials included in the meta-analysis (n=17)

<table>
<thead>
<tr>
<th>Study</th>
<th>Year</th>
<th>Country</th>
<th>Study setting</th>
<th>Populations</th>
<th>Duration (mo)</th>
<th>Group type</th>
<th>Study quality (RoB Cochrane 2.0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Bischoff et al. [16]</td>
<td>2003</td>
<td>Switzerland</td>
<td>Long-stay geriatric care</td>
<td>Mean age: 85.3 y</td>
<td>4</td>
<td>Vitamin D3 + calcium</td>
<td>Calcium</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sample size: 122</td>
<td></td>
<td>Dose: 800 IU (vitamin D) daily</td>
<td>Route: per oral</td>
</tr>
<tr>
<td>2 Bischoff-Ferrari et al. [17]</td>
<td>2022</td>
<td>Switzerland, Germany, Austria, France, and Portugal</td>
<td>Community</td>
<td>Mean age: 74.9 y</td>
<td>36</td>
<td>Vitamin D3</td>
<td>Placebo</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sample size: 2,157</td>
<td></td>
<td>Dose: 2,000 IU daily</td>
<td>Route: per oral</td>
</tr>
<tr>
<td>3 Dhesi et al. [18]</td>
<td>2004</td>
<td>UK</td>
<td>Community</td>
<td>Mean age: 76.8 y</td>
<td>6</td>
<td>Vitamin D2</td>
<td>Placebo</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sample size: 138</td>
<td></td>
<td>Dose: 600,000 IU per 6 month (~3,000 IU daily)</td>
<td>Route: intramuscular</td>
</tr>
<tr>
<td>4 Dukas et al. [19]</td>
<td>2005</td>
<td>Switzerland</td>
<td>Community</td>
<td>Mean age: 75.0 y</td>
<td>9</td>
<td>Vitamin D3</td>
<td>Placebo</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sample size: 378</td>
<td></td>
<td>Dose: 1 µg alpha D3 capsules (40 IU daily)</td>
<td>Route: per oral</td>
</tr>
<tr>
<td>5 Flicker et al. [20]</td>
<td>2005</td>
<td>Australia</td>
<td>Nursing home</td>
<td>Mean age: 85.4 y</td>
<td>24</td>
<td>Vitamin D2</td>
<td>Placebo</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sample size: 625</td>
<td></td>
<td>Dose: 10,000 IU given once weekly (~1,000 IU daily)</td>
<td>Route: per oral</td>
</tr>
<tr>
<td>6 Glendenning et al. [21]</td>
<td>2012</td>
<td>Australia</td>
<td>Community</td>
<td>Mean age: 76.7 y</td>
<td>9</td>
<td>Vitamin D3</td>
<td>Placebo</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sample size: 686</td>
<td></td>
<td>Dose: 150,000 IU every 3 months (~1,600 IU daily)</td>
<td>Route: per oral</td>
</tr>
<tr>
<td>7 Grant et al. [22]</td>
<td>2005</td>
<td>UK</td>
<td>Hospital</td>
<td>Mean age: 77.0 y</td>
<td>62</td>
<td>Vitamin D3</td>
<td>Placebo (calcium)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sample size: 5,292</td>
<td></td>
<td>Dose: 800 IU daily</td>
<td>Route: per oral</td>
</tr>
<tr>
<td>8 Hansen et al. [23]</td>
<td>2015</td>
<td>USA</td>
<td>Institutionalized</td>
<td>Mean age: 61.0 y</td>
<td>12</td>
<td>Vitamin D3</td>
<td>Placebo</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sample size: 230</td>
<td></td>
<td>Dose: 50,000 IU twice monthly (~3,000 IU daily)</td>
<td>Route: per oral</td>
</tr>
<tr>
<td>9 Hin et al. [24]</td>
<td>2017</td>
<td>UK</td>
<td>Community</td>
<td>Mean age: 72.0 y</td>
<td>12</td>
<td>Vitamin D3</td>
<td>Placebo</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sample size: 305</td>
<td></td>
<td>Dose: 2,000 IU daily and 4,000 IU daily</td>
<td>Route: per oral</td>
</tr>
<tr>
<td>10 Houston et al. [25]</td>
<td>2015</td>
<td>USA</td>
<td>Community</td>
<td>Mean age: 77.9 y</td>
<td>5</td>
<td>Vitamin D3</td>
<td>Placebo (vitamin E)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sample size: 68</td>
<td></td>
<td>Dose: 100,000 IU per month (~3,000 IU daily)</td>
<td>Route: per oral</td>
</tr>
<tr>
<td>Study</td>
<td>Year</td>
<td>Country</td>
<td>Study setting</td>
<td>Populations</td>
<td>Duration (mo)</td>
<td>Group type</td>
<td>Study quality (RoB Cochrane 2.0)</td>
</tr>
<tr>
<td>-------</td>
<td>------</td>
<td>---------</td>
<td>---------------</td>
<td>-------------</td>
<td>--------------</td>
<td>------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>Law et al.</td>
<td>2006</td>
<td>UK</td>
<td>Nursing home</td>
<td>Mean age: 85.0 y Sample size: 3,717 Sex: male 892 (24.0%), female 2,825 (76.0%)</td>
<td>10</td>
<td>Vitamin D3 Dose: 1,100 IU daily Route: per oral</td>
<td>Control</td>
</tr>
<tr>
<td>Levis et al.</td>
<td>2017</td>
<td>USA</td>
<td>Institutionalized</td>
<td>Mean age: 72.4 y Sample size: 130 Sex: male 130 (100%), female 0 (0%)</td>
<td>9</td>
<td>Vitamin D3 Dose: 4,000 IU daily Route: per oral</td>
<td>Placebo</td>
</tr>
<tr>
<td>Pfeifer et al.</td>
<td>2009</td>
<td>Germany</td>
<td>Community</td>
<td>Mean age: 77.0 y Sample size: 242 Sex: male 123 (50.8%), female 119 (49.2%)</td>
<td>12</td>
<td>Vitamin D3+calcium Dose: 800 IU daily (vitamin D3) Route: per oral</td>
<td>Placebo (calcium)</td>
</tr>
<tr>
<td>Sanders et al.</td>
<td>2010</td>
<td>Australia</td>
<td>Community</td>
<td>Mean age: 76.3 y Sample size: 2,256 Sex: male 0 (0%), female 2,256 (100%)</td>
<td>60</td>
<td>Vitamin D3 Dose: 500,000 IU annually (~1,300 IU daily) Route: per oral</td>
<td>Placebo</td>
</tr>
<tr>
<td>Smith et al.</td>
<td>2007</td>
<td>UK</td>
<td>Community</td>
<td>Mean age: 79.4 y Sample size: 9,440 Sex: male 4,354 (46.1%), female 5,086 (53.9%)</td>
<td>36</td>
<td>Vitamin D2 Dose: 300,000 IU annually every autumn (~3,000 IU daily) Route: intramuscular</td>
<td>Placebo</td>
</tr>
<tr>
<td>Waterhouse et al.</td>
<td>2021</td>
<td>Australia</td>
<td>Community</td>
<td>Mean age: 69.3 y Sample size: 21,315 Sex: male 14,241 (66.8%), female 7,074 (33.2%)</td>
<td>60</td>
<td>Vitamin D3 Dose: 60,000 IU monthly (~2,000 IU daily) Route: per oral</td>
<td>Placebo</td>
</tr>
<tr>
<td>Witham et al.</td>
<td>2010</td>
<td>UK</td>
<td>Community</td>
<td>Mean age: 79.7 y Sample size: 105 Sex: male 69 (65.7%), female 36 (34.3%)</td>
<td>5</td>
<td>Vitamin D2 Dose: 100,000 IU per 4 months (~600 IU daily) Route: per oral</td>
<td>Placebo</td>
</tr>
</tbody>
</table>

IU, international unit.

Table 3. Continued
participants on fall incidence showed an OR of 0.95 (95% CI, 0.78–1.14; p = 0.56) and OR of 1.03 (95% CI, 0.95–1.11; p = 0.50). These results indicated no significant difference between the two groups. We observed high heterogeneity for low doses ($I^2 = 69%$) and low heterogeneity for high doses ($I^2 = 16%$) (Fig. 4).

A pooled analysis of low doses (< 2,000 IU/day) including six studies with 10,201 participants and high doses (≥ 2,000 and < 4,000 IU/day) including two studies on fracture incidence that enrolled 9,745 participants, which reported OR values of 1.10 (95% CI, 0.90–1.35; p = 0.36) and OR of 1.11 (95% CI, 0.94–1.31; p = 0.23). These results indicated a lack of significant difference between the two groups. Low heterogeneity was observed in both subgroups ($I^2 < 50\%$) (Fig. 5).

**DISCUSSION**

Our meta-analysis included 17 studies with 47,206 older adults who received vitamin D supplementation or a placebo for 5 months to 5 years. The total population of all included studies and the total population of the intervention and placebo groups differed because the participants were not followed up to the end of the study, they were divided into more than just vitamin D intervention or placebo groups in some studies, or they were moved to long-term care or died during the study period.

We observed no significant difference in the likelihood of falls among people who took vitamin D supplements versus the placebo group for either vitamin D2 or vitamin D3 products. The results of our meta-analysis support those of a previous study showing that vitamin D treatment alone did not result in lower falls in older persons with D3 levels > 50 nmol/L. However, we did not analyze the effect of vitamin D supplements based on D3 concentrations measured in the participants’ bodies. More studies, like RCTs or meta-analyses, etc. are needed to analyze the effects of vitamin D supplements on the concentrations of D3 in participants’ bodies measured before they take these supplements. Previous meta-analyses have also demonstrated the effectiveness of vitamin D in reducing the incidence of falls among older adults.

![Fig. 2. Forest plot of vitamin D on the incidence of falls among older adults.](https://www.e-agmr.org)
Effectiveness of Vitamin D Supplements in Older Adults

Fig. 3. Forest plot of vitamin D on the incidence of fracture among older adults.

Fig. 4. Forest plot of falls incidence based on vitamin D doses among older adults.
Our results differed due to the contradictory results of the included randomized studies. The pooled results of the analysis of four RCTs that used vitamin D2 as an intervention showed that vitamin D2 reduced the number of older adults falling in all studies, however, the difference was not statistically significant.30-33 In contrast, among 13 studies that used vitamin D3 as an intervention, five RCTs showed that vitamin D3 reduced the risk of falls in older adults,6,25,34,36 while the remaining eight revealed the opposite, in which vitamin D3 supplementation increased the number of people falling.6,25,34-36 Sanders et al.31 and Waterhouse et al.37 showed that vitamin D3 significantly increased the number of older adults falling compared to placebo. This raises the possibility of adverse outcomes for high doses of vitamin D3. In 2010, Sanders et al.33 administered an annual dose of 500,000 IU of cholecalciferol to the intervention group. Similarly, in 2012, Yang34 recommended monthly vitamin D doses of 24,000 IU as a daily supplement. Finally, a recent study by Waterhouse et al.37 administered 60,000 IU of cholecalciferol monthly.

A major concern in studies on falls in older adults is the occurrence of fractures following falls. Similarly, analyses of fracture outcomes revealed no statistically significant difference in fracture risk between older adults who received vitamin D2, vitamin D3, or a placebo. Among the RCTs that administered vitamin D2 as an intervention, two showed that vitamin D2 increased the number of older adults with fractures32,39; the other showed that vitamin D2 reduced the number of fractures.31 However, these results were not statistically significant. The same was true for vitamin D3, with two RCTs showing that vitamin D3 reduced the risk of fractures6,40 and another three showing an increased number of fractures in the vitamin D3 group.28,38,43 The results of our meta-analysis were similar to those of a previous study reporting that vitamin D3 supplementation did not significantly reduce fracture risk compared to placebo among older adults.19 However, another meta-analysis on the combination of vitamin D3 and calcium showed the opposite results. Using a daily oral supplement, the results showed that supplementation with 800 IU of vitamin D3 combined with 1,200 mg of calcium reduced the risks of hip and non-vertebral fractures.25 These findings raise the possibility of an effective combination of calcium and vitamin D to reduce the fracture risk in older adults. Future RCTs are needed to further investigate the results of this combination with different doses and timings of vitamin D administration, and with other uses such as intramuscular injection.

After converting the vitamin D dose in the intervention groups of all RCTs to daily dosing, the results of the meta-analyses showed no statistically significant differences in the number of older adults with falls and fractures between the vitamin D intervention and placebo groups. Most RCTs showed no statistically significant dif-
ference in falls; however, Pfeifer et al. demonstrated the protective effect of vitamin D, specifically vitamin D3. The authors observed a statistically significant reduction in the number of older adults with falls compared with the placebo. In contrast, Sanders et al. showed a higher number of older adults with falls in the vitamin D3 group compared to the placebo group; however, the difference was not significantly significant. However, the final pooled result of all RCTs revealed no significant difference.

The major strength of our study is that it included 17 RCTs with many total participants, including 47,206 older adults from different countries worldwide. In addition to the pooled results of the total included studies, sub-analyses of vitamins D2 and D3 were also performed to determine the results for different forms of vitamin D. However, our study also has several limitations. Most of the participants were from Western countries, except for one study that included Caucasian, Afro-Caribbean, and Middle Eastern participants; moreover, none of the included studies was conducted in Asian regions. Another limitation was that our meta-analysis considered only English-language publications. All of the above limitations underscore the need for future studies to identify relevant studies in populations in all regions, with no restriction on languages from databases to obtain more data to analyze the effect and safety of vitamin D supplementation. Additional meta-analyses of other subgroups such as oral administration groups, injection-using groups, and short- and long-term use are needed to support shared decision-making for a nutritionist to help patients make good choices regarding vitamin D supplementation.

In conclusion, the effects of vitamin D on the promotion of calcium and phosphate concentrations for bone growth and muscle activity are well-known. However, evidence for the effect of vitamin D in reducing falls remains inconsistent. The results of our study showed that, compared to a placebo, vitamin D supplementation did not significantly reduce the incidence of falls or fractures in older adults.

ACKNOWLEDGMENTS

We thank the “Klinik Bahasa” (editing/proofreading) Services, Faculty of Medicine, Public Health, and Nursing, Universitas Gadjah Mada, Yogyakarta, Indonesia. We also thank all the authors of the included studies.

CONFLICT OF INTEREST

The researchers claim no conflicts of interest.

FUNDING

None.

AUTHOR CONTRIBUTIONS

Conceptualization, TQ, HD; Methodology, TQ; Formal analysis, TQ, HD; Software, TQ; Data curation, TQ, HD; Visualization, TQ; Supervision, HD; Validation, MSNG, HD; Writing-original draft, TQ; Writing-review & editing, MSNG, HD.

SUPPLEMENTARY MATERIALS

Supplementary materials can be found via https://doi.org/10.4235/agmgr.23.0047.

REFERENCES


www.e-agmr.org


41. Sanders KM, Stuart AL, Williamson EJ, Simpson JA, Kotowicz MA, Young D, et al. Annual high-dose oral vitamin D and falls and fractures in older women: a randomized controlled trial. JAMA 2010;303:1815-22.


The Clinical Frailty Scale as a Risk Assessment Tool for Dysphagia in Older Inpatients: A Cross-Sectional Study

Min-gu Kang¹, Sunghwan Ji², Young Ki Park²,³, Ji Yeon Baek¹, Young Hye Kwon¹, Yeon mi Seo¹, Seung Hak Lee¹, Eunju Lee⁴, Il-Young Jang⁵, Hee-Won Jung⁶

¹Department of Internal Medicine, Chonnam National University Bitgoeul Hospital, Gwangju, Korea
²Division of Geriatrics, Department of Internal Medicine, Asan Medical Center, University of Ulsan College of Medicine, Seoul, Korea
³Department of Rehabilitation Medicine, Asan Medical Center, University of Ulsan College of Medicine, Seoul, Korea
⁴Department of Nursing, Asan Medical Center, Seoul, Korea

Background: Dysphagia is a common problem with potentially serious consequences including malnutrition, dehydration, pneumonia, and death. However, there are challenges in screening for dysphagia in older adults. We assessed the feasibility of using the Clinical Frailty Scale (CFS) as a risk assessment tool for dysphagia.

Methods: This cross-sectional study was conducted at a tertiary teaching hospital from November 2021 to May 2022 and included 131 older patients (age ≥65 years) admitted to acute wards. We used the Eating Assessment Tool-10 (EAT-10), which is a simple measure for identifying individuals at risk of dysphagia, to assess the relationship between EAT-10 score and frailty status as measured using the CFS.

Results: The mean age of the participants was 74.3 ± 6.7 years, and 44.3% were male. Twenty-nine (22.1%) participants had an EAT-10 score ≥3. The CFS was significantly associated with an EAT-10 score ≥3 after adjusting for age and sex (odds ratio=1.48; 95% confidence interval [CI], 1.09–2.02). The CFS was able to classify the presence of an EAT-10 score ≥3 (area under the receiver operating characteristic [ROC] curve=0.650; 95% CI, 0.544–0.756). The cutoff point for predicting an EAT-10 score ≥3 was a CFS of 5 according to the highest Youden index, with a sensitivity of 82.8% and a specificity of 46.1%. The positive and negative predictive values were 30.4% and 90.4%, respectively.

Conclusion: The CFS can be used as a tool to screen for the risk of swallowing difficulty in older inpatients to determine clinical management encompassing drug administration routes, nutritional support, prevention of dehydration, and further evaluation of dysphagia.

Key Words: Dysphagia, Frailty, Clinical Frailty Scale, Older adults

INTRODUCTION

The ability to swallow is an essential aspect of human physiology and necessary for maintaining proper nutrition and hydration.¹ Dysphagia, or difficulty swallowing, is a common problem that can have serious consequences, including malnutrition, dehydration, pneumonia, and even death.³ In addition to its negative health effects, dysphagia can affect the quality of life in older adults.³ Swallowing difficulty can lead to social isolation and decreased enjoyment of meals, which are important aspects of overall well-being.³,⁴

As dysphagia disproportionately affects older adults with frailty, identifying dysphagia in frail individuals is crucial. The prevalence of dysphagia is up to one-third among community-dwelling older...
CFS as a Dysphagia Risk Assessment Tool

MATERIALS AND METHODS

Study Design and Participants
This cross-sectional study was conducted at Asan Medical Center, a tertiary teaching hospital in Seoul, Korea, between November 2021 and May 2022. The Institutional Review Board of Asan Medical Center reviewed and approved the study protocol (IRB No. 2022-1400) and waived the requirement for informed consent because evaluating the general health status of patients at admission is a routine procedure and no additional harm was anticipated. A convenience sample of older patients (age ≥ 65 years) admitted to acute wards who underwent a brief geriatric risk evaluation by a geriatric nurse specialist was included. Patients who were hemodynamically unstable or were approaching death were excluded from the study. Additionally, patients with neurological diseases such as stroke and Parkinson’s disease, which can directly cause dysphagia, and patients hospitalized for respiratory infections and upper gastrointestinal diseases, which can temporarily cause or worsen dysphagia, were excluded from the analysis.

This study complied the ethical guidelines for authorship and publishing in the Annals of Geriatric Medicine and Research.13

Patient Assessments
The CFS and EAT-10 were measured once on the day after admission by a trained geriatric nurse specialist and an occupational therapist, respectively.

Among the many tools available for measuring frailty, the CFS is a simple tool with a score ranging from 0 to 9 with brief descriptors and pictographs. It was developed to stratify older patients according to their relative degrees of frailty.14 After its initial validation, the CFS has been widely used in multiple settings to predict the clinical outcomes of the aging population.15 We used the Korean-translated version of the CFS, the construct validity of which has been established in Korean geriatric patients.16,17

Dysphagia screening was performed using the EAT-10.18 The EAT-10 consists of 10 questions that are scored from 0 (no problem) to 4 (severe problem), resulting in a total score ranging from 0 to 40. Previous studies considered an EAT-10 score of ≥ 3 as positive for screening.8,18 In contrast, this study, defined each EAT-10 question with a score ≥ 1 as positive. The Korean translation of EAT-10 has also been validated in Korea.19 The baseline patient characteristics, including demographic, anthropometric, and laboratory data, were retrieved from electronic medical records. The Geriatric Nutritional Risk Index (GNRI) was calculated using the following formula derived from previous studies20,21:

\[
\text{GNRI} = 1.489 \times \text{albumin (g/L)} + 41.7 \times \left(\frac{\text{body weight}}{\text{WLo}}\right).
\]

WLo (Ideal weight calculated from the Lorentz equations) was calculated as follows:

\[
\begin{align*}
\text{WLo} &= \text{height (cm)} - 100 - \frac{150}{4} \left\{ \begin{array}{ll}
\text{for men} \\
\text{for women}
\end{array} \right. \\
\text{WLo} &= \text{height (cm)} - 100 - \frac{150}{2.5} \left\{ \begin{array}{ll}
\text{for men} \\
\text{for women}
\end{array} \right.
\end{align*}
\]

Statistical Analysis
All statistical analyses were performed using IBM SPSS Statistics for Windows, version 21.0 (IBM Corp., Armonk, NY, USA). Continuous variables are expressed as mean ± standard deviation, while discrete variables are presented as counts and percentages. Statistical differences were assessed using t-test, Pearson chi-square test, or Fisher exact test. We performed binary logistic and linear regression analyses to evaluate the relationship between the EAT-10 score and frailty status as measured by the CFS. To assess the ability to classify for the presence of an EAT-10 score ≥ 3 and positivity for each question of the EAT-10, we performed receiver operating characteristic (ROC) analyses using the CFS as the test variable and these outcomes as the state variables. The cutoff point of the CFS was determined according to the highest Youden index, and
the sensitivity, specificity, and positive and negative predictive values were determined. All statistical analyses were two-tailed, and statistical significance was set at \( p < 0.05 \).

### RESULTS

#### General Characteristics of the Study Participants

During the study period, we assessed the EAT-10 and CFS in 131 patients aged \( \geq 65 \) years who were admitted to acute wards. The mean age of the patients was \( 74.3 \pm 6.7 \) years and 44.3% were male. Twenty-nine (22.1%) patients had an EAT-10 score \( \geq 3 \). The general characteristics of the study participants with EAT-10 scores \( < 3 \) or \( \geq 3 \) are presented in Table 1. Patients with EAT-10 scores \( \geq 3 \) had significantly lower body mass index and albumin levels than those with EAT-10 scores \( < 3 \). In addition, their CFS scores were higher and they had a greater risk of malnutrition.

#### Relationship between EAT-10 Score and Frailty Status

To identify the factors associated with an EAT-10 score \( \geq 3 \), we performed binary logistic regression analysis. After adjusting for age and sex, CFS was significantly associated with an EAT-10 \( \geq 3 \) (odds ratio = 1.48; 95% confidence interval [CI], 1.09–2.02) (Table 2). Linear regression analysis performed to identify factors associated with the EAT-10 score revealed that CFS was significantly associated with EAT-10 score (\( p = 0.027 \)) (Table 3).

#### CFS as a Dysphagia Indicator

CFS was able to classify the presence of an EAT-10 score \( \geq 3 \) (area

---

**Table 1. General characteristics of the study participants according to presence of an EAT-10 score \( \geq 3 \)**

<table>
<thead>
<tr>
<th></th>
<th>Total (n = 131)</th>
<th>EAT-10 &lt; 3 (n = 102)</th>
<th>EAT-10 ( \geq 3 ) (n = 29)</th>
<th>( p )-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>74.3 ± 6.7</td>
<td>74.4 ± 6.9</td>
<td>74.0 ± 6.0</td>
<td>0.765</td>
</tr>
<tr>
<td>Sex, male</td>
<td>58 (44.3)</td>
<td>41 (40.2)</td>
<td>17 (58.6)</td>
<td>0.078</td>
</tr>
<tr>
<td>BMI (kg/m(^2))</td>
<td>24.0 ± 3.9</td>
<td>24.5 ± 3.9</td>
<td>21.9 ± 3.1</td>
<td>0.001</td>
</tr>
<tr>
<td>Albumin (g/dL)</td>
<td>3.0 ± 0.6</td>
<td>3.1 ± 0.6</td>
<td>2.7 ± 0.6</td>
<td>0.004</td>
</tr>
<tr>
<td>EAT-10 score</td>
<td>2.7 ± 6.2</td>
<td>0.3 ± 0.6</td>
<td>11.1 ± 9.1</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>GNRI</td>
<td>89.4 ± 13.2</td>
<td>91.7 ± 12.6</td>
<td>81.0 ± 11.9</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Clinical Frailty Scale</td>
<td>5.1 ± 1.5</td>
<td>4.9 ± 1.5</td>
<td>5.7 ± 1.3</td>
<td>0.015</td>
</tr>
<tr>
<td>EAT-10 questions (positive)a)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>My swallowing problem has caused me to lose weight.</td>
<td>14 (10.7)</td>
<td>1 (1.0)</td>
<td>13 (44.8)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>My swallowing problem interferes with my ability to go out for meals.</td>
<td>12 (9.2)</td>
<td>0 (0.0)</td>
<td>12 (41.4)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Swallowing liquids takes extra efforts.</td>
<td>18 (13.7)</td>
<td>2 (2.0)</td>
<td>16 (55.2)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Swallowing solids takes extra efforts.</td>
<td>25 (19.1)</td>
<td>1 (1.0)</td>
<td>24 (82.8)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Swallowing pills takes extra efforts.</td>
<td>22 (16.8)</td>
<td>3 (2.9)</td>
<td>19 (65.5)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Swallowing is painful.</td>
<td>21 (16.0)</td>
<td>1 (1.0)</td>
<td>20 (69.0)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>The pleasure of eating is affected by my swallowing.</td>
<td>18 (13.7)</td>
<td>0 (0.0)</td>
<td>18 (62.1)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>When I swallow food sticks in my throat.</td>
<td>20 (15.3)</td>
<td>2 (2.0)</td>
<td>18 (62.1)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>I cough when I eat.</td>
<td>37 (28.2)</td>
<td>19 (18.6)</td>
<td>18 (62.1)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Swallowing is stressful.</td>
<td>22 (16.8)</td>
<td>2 (2.0)</td>
<td>20 (69.0)</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

Values are presented as mean±standard deviation or number (%).

EAT-10, Eating Assessment Tool-10; BMI, body mass index; GNRI, Geriatric Nutritional Risk Index.
Continuous variables (age, BMI, Albumin, EAT-10 score, GNRI, Clinical Frailty Scale) were compared using the t-test. Discrete variables (sex, EAT-10 questions) were compared using either the Pearson chi-square test or Fisher exact test.

a) Each EAT-10 question was defined as positive if the score for that question was answered as \( \geq 1 \).

---

**Table 2. Binary logistic regression analysis for the presence of an EAT-10 score \( \geq 3 \)**

<table>
<thead>
<tr>
<th></th>
<th>EAT-10 score ( \geq 3 )</th>
<th>Multivariatea)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Univariate</td>
<td>p-value</td>
</tr>
<tr>
<td>Age (1 year higher)</td>
<td>0.99 (0.93–1.06)</td>
<td>0.763</td>
</tr>
<tr>
<td>Sex (male)</td>
<td>2.11 (0.91–4.87)</td>
<td>0.081</td>
</tr>
<tr>
<td>CFS (1 higher)</td>
<td>1.42 (1.06–1.89)</td>
<td>0.018</td>
</tr>
</tbody>
</table>

A value in bold indicates statistical significance.

EAT-10, Eating Assessment Tool-10; CFS, Clinical Frailty Scale; OR, odds ratio; CI, confidence interval.

a) All variables in the univariate analysis were entered into the multivariate analysis.
under the ROC curve \( \text{AUC} = 0.650; 95\% \text{ CI}, 0.544–0.756 \) (Fig. 1). A CFS score of 5 was the cutoff score for predicting the presence of an EAT-10 score ≥ 3, according to the highest Youden index, with a sensitivity of 82.8% and a specificity of 46.1%. The positive and negative predictive values were 30.4% and 90.4%, respectively. The CFS was able to predict positivity for two questions of the EAT-10 (Fig. 2); namely pill swallowing difficulty (AUC = 0.700; 95\% \text{ CI}, 0.590–0.810) and painful swallowing (AUC = 0.718; 95\% \text{ CI}, 0.603–0.833). The CFS cutoff score according to the highest Youden index for each question and the corresponding sensitivity, specificity, and positive and negative predictive values are shown in Table 4.

**DISCUSSION**

Our results showed a higher risk of malnutrition among older patients with an EAT-10 score ≥ 3 admitted to acute wards. CFS score was significantly associated with the EAT-10 score, and a CFS of 5 was the cutoff score predicting the presence of an EAT-10 score ≥ 3. Additionally, the CFS could also be used to predict pill-swallowing difficulty and swallowing pain.

Dysphagia is common in older adults and can occur due to problems during various eating phases. Oropharyngeal dysphagia commonly occurs after stroke and during the course of many neurodegenerative diseases such as dementia and Parkinson disease. The prevalence of dysphagia varies among studies. Several meta-analyses have reported estimated prevalence rates of dysphagia of > 10% and > 20% in community-dwelling and hospitalized older patients, respectively. Dysphagia is known to increase the risk of malnutrition. As nutrition is considered a cornerstone in the

*Table 3. Linear regression analysis for the EAT-10 score*

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>Beta</th>
<th>95% CI</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (1 year higher)</td>
<td>-0.04</td>
<td>-0.04</td>
<td>-0.20–0.13</td>
<td>0.672</td>
</tr>
<tr>
<td>Sex (male)</td>
<td>2.19</td>
<td>0.18</td>
<td>0.08–4.30</td>
<td>0.042</td>
</tr>
<tr>
<td>CFS (1 higher)</td>
<td>0.85</td>
<td>0.20</td>
<td>0.10–1.59</td>
<td>0.027</td>
</tr>
</tbody>
</table>

EAT-10, Eating Assessment Tool-10; CFS, Clinical Frailty Scale; CI, confidence interval.
concept of the “cycle of frailty,” a self-deteriorating cycle of negative energy balance, reduced physical activity, and further decline in physical performance, several studies have suggested that dysphagia is associated with frailty. In addition, dysphagia is a risk factor for the development of aspiration pneumonia, and increased dysphagia is associated with reduced health-related quality of life. Therefore, in an aging society, identifying older adults at risk of dysphagia, performing diagnostic tests, and administering appropriate treatments based on the test results are important.

Frailty, which reflects a decline in physiological reserves, is strongly associated with biological age, concurrent medical conditions, morbidity, and reduced survival in older adults. Frailty is generally assessed through different operational definitions, and the prominent models encompass physical and biological models, deficit accumulation models, and multidimensional biopsychosocial models. Among the many tools for measuring frailty, the CFS has the advantage of being able to intuitively assess the frailty status of patients. Studies have shown that the CFS can predict vulnerability to various adverse geriatric outcomes in both community-dwelling older adults and hospitalized patients. As shown in the present study, the CFS may be useful for screening for dysphagia and stratifying hospitalized older patients according to frailty status.

Assessing the presence of dysphagia in hospitalized older adult patients is essential for several reasons. First, the oral route is widely utilized and favored for drug administration owing to its benefits, including its noninvasive nature, patient compliance, and convenience in drug delivery. Therefore, the presence or absence of dysphagia must be evaluated in hospitalized older adult patients who must maintain the effects of drugs through steady drug administration. The use of the CFS at the time of hospitalization and using a defined cutoff point may effectively identify patients who require evaluation for dysphagia. Following evaluation, interventions such as changing the dosage form or administration route for patients with dysphagia can be considered.

Second, screening acutely hospitalized older patients at high risk for dysphagia is useful for reducing the risk of aspiration or malnutrition and identifying patients who can benefit from nutritional interventions. Malnutrition has a severe impact on recovery from disease and is associated with increased morbidity and mortality. Poor nutritional status is also associated with the development of geriatric syndrome. Previous studies confirmed the role of malnutrition in the occurrence of delirium and pressure ulcers in hospitalized older patients. Additionally, malnutrition upon hospital admission is a significant risk factor for falls during hospital stays. A cutoff point is useful for identifying high-risk patients requiring accurate testing and close observation.

Third, older adults have decreased thirst sensation and a decline in urinary concentration ability; if additional functional problems are present, dehydration can easily occur. Dehydration is very common, particularly in patients with dysphagia, with the prevalence of dehydration ranging from 44% to 75%. As a result, dehydration ranks as one of the top 10 most commonly diagnosed medical conditions leading to hospital admission among older adults. Dehydration is also associated with the development of geriatric syndromes such as delirium and falls. Identification of the risk of dysphagia in hospitalized older adult patients is necessary to reduce the risk of dehydration.

Given the challenges in screening for dysphagia in older adults, particularly in those with cognitive or functional impairments, the use of the CFS as a dysphagia indicator can aid healthcare providers in identifying at-risk patients and facilitating early interventions. By incorporating CFS assessment into routine geriatric care, healthcare providers can enhance their ability to detect swallowing difficulties in frail older adults, ultimately reducing the risks of malnutrition, dehydration, pneumonia, and other adverse consequences of dysphagia. Additionally, timely intervention may improve the effectiveness of exercise and nutritional support in preventing the progression of frailty and improving patient functional status. Future research should explore the implementation of CFS-based screening strategies in various healthcare settings and their impact on dysphagia management and frailty outcomes.

Of the 131 patients included in the study, only two underwent a videofluoroscopic swallow study (VFSS), a substantially low number considering the prevalence of patients at risk according to the EAT-10 questionnaire. Many factors may contribute to the potential underuse of formal evaluation methods for treating dysphagia, including the current bottleneck in VFSS volume per day in Korean academic hospitals.

Although the pathophysiology of dysphagia is complex and the
spectrum of its severity is wide, some issues can be addressed using this simple scale. Suspecting dysphagia in patients, especially in those with advanced frailty, may prevent delayed recognition of dysphagia after pneumonia caused by repeated aspiration. Additionally, this approach has the advantage of being widely applicable in real clinical settings due to its relatively simple predictive nature. A clinical suspicion of dysphagia using the CFS may provide healthcare professionals with an early opportunity to perform formal, in-depth assessments of this condition in patients, especially those with medical conditions that affect their swallowing ability.

This study has several limitations. First, the cross-sectional design limited our ability to establish causality between the EAT-10 score and frailty status as measured by the CFS. Longitudinal studies are needed to investigate the causal relationship between dysphagia and frailty in older adults. Second, this study was conducted at a single tertiary teaching hospital in South Korea, which may limit the generalizability of the findings to other healthcare settings and populations. Future research should include larger and more diverse samples from multiple centers to enhance the generalizability of the results. Third, this study relied on self-reported measures to assess dysphagia using the EAT-10, which may have been influenced by recall bias and subjectivity. Objective assessments of swallowing function, such as VFSS, would provide more accurate information on dysphagia presence and severity. Finally, we excluded patients who were hemodynamically unstable or approaching death, which may have led to an underestimation of the prevalence of dysphagia and its association with frailty in the overall older adult population.

In conclusion, the CFS can be used as a risk assessment tool for dysphagia in hospitalized older adults. The presence or absence of dysphagia has important implications for determining the drug administration route, nutritional intervention, and prevention of dehydration in acutely hospitalized patients. Therefore, the CFS can be effectively used to determine whether interventions can be performed to improve the prognosis of older inpatients.

ACKNOWLEDGMENTS

CONFLICT OF INTEREST
Hee-Won Jung cofounded Dyphi Inc, a startup company developing sensor technologies for human movement and robotics. Otherwise, authors declare that there are no potential conflicts of interest.

FUNDING
None.

AUTHOR CONTRIBUTIONS
Conceptualization, MK, EL, IYJ, HWJ; Data curation, SHJ, YKP, JYB, SHL, HWJ; Investigation, SHJ, YHK, YS, SHL, HWJ; Methodology: MK, EL, IYJ, HWJ; Project administration: SHJ, YKP, JYB, YHK, YS, SHL; Supervision, EL, IYJ, HWJ; Writing—original draft: MK, HWJ; Writing—review & editing: MK, SHJ, YKP, JYB, YHK, YS, SHL, EL, IYJ, HWJ.

REFERENCES


42. Murray J, Doelting S, Miller M, Scholten I. A descriptive study of the fluid intake, hydration, and health status of rehabilitation in-
The Effect of Neuromuscular Blockade Reversal Agents on Postoperative Pulmonary Complications in Patients undergoing Femur Fracture Repair Surgery: A Retrospective Observational Study

Sung-Ae Cho¹,², Jun-ho Kim¹, Choon-Kyu Cho¹,², Tae-Yun Sung¹,²

¹Department of Anaesthesiology and Pain Medicine, Konyang University Hospital, Konyang University College of Medicine, Daejeon, Korea
²Myunggok Medical Research Center, Konyang University Hospital, Daejeon, Korea

Background: Femoral fracture repair surgery under general anesthesia is associated with postoperative pulmonary complications (PPCs). However, information on PPCs caused by residual neuromuscular blockade following perioperative use of neuromuscular blockers is limited. This study aimed to identify the differences in the incidence of PPCs according to the type of neuromuscular blockade reversal agent used in femoral fracture repair surgery, as well as the risk factors for PPCs.

Methods: We retrospectively analyzed the electronic medical records of 604 patients aged >18 years who underwent general anesthesia for femoral fracture repair surgery at a single university hospital between March 2017 and March 2022. Patients in whom sugammadex or anticholinesterase was used to reverse the neuromuscular block were subjected to propensity score matching. Multivariate logistic regression analysis was performed to identify risk factors for PPCs.

Results: Among the 604 patients, 108 were matched in each group. The incidence rates of PPCs overall and in the anticholinesterase and sugammadex groups were 7.0%, 8.3%, and 5.6%, respectively, with no significant differences between the groups. Older age, higher ASA (American Society of Anesthesiologists) physical status, and lower preoperative oxygen saturation were risk factors, whereas emergency surgery was a preventive factor.

Conclusions: Our results demonstrated that the incidence of PPC did not differ significantly between sugammadex and anticholinesterase in patients undergoing femur fracture repair under general anesthesia. Identifying the risk factors and confirming complete recovery from neuromuscular blockade might be more important.

Key Words: Femoral fractures, General anesthesia, Postoperative complications, Cholinesterase inhibitors, Sugammadex, Risk factors

INTRODUCTION

Femur fracture repair surgeries have an increased risk of postoperative pulmonary complications (PPCs), which occur in 4.1%–40% of cases, depending on the definition of PPCs.⁰,¹ Although the overall mortality rates when surgery is performed under general or spinal anesthesia are similar, spinal anesthesia is preferred, given the stability of respiratory function postoperatively.⁰,¹ However, in situations where spinal anesthesia cannot be performed, such as coagulopathy, puncture site infection, or uncooperative patients, general anesthesia is a main anesthetic method used in femoral fracture surgery. Therefore, it is important to understand the incidence of PPCs and related risk factors during general anesthesia for femoral fracture surgery.⁰,¹

One of the most important elements of general anesthesia is the use of neuromuscular blockers. A neuromuscular blockade reduc-
es intraoperative movement and facilitates surgery. However, resid-
ual neuromuscular blockade is a well-known risk factor for anes-
thesia-related PPCs.7 Two major drugs contribute to recovery
from neuromuscular blockade: anticholinesterase, a competitive
inhibitor, and sugammadex, a direct inhibitor. Traditionally, anti-
cholinesterases competitively interfere with neuromuscular block-
ers. However, they have a ceiling effect that is ineffective above a
specific dose, do not reverse deep neuromuscular blockade, and
increase PPCs dose-dependently.8

Sugammadex has also recently been used. It can directly reverse
all stages of neuromuscular block, regardless of the depth of the
neuromuscular block. However, it is only effective for a specific
class of neuromuscular blockers.9 Various studies have compared
these two drugs for residual neuromuscular block and PPCs, but
not for femoral fracture repair surgery, which has a high incidence
of PPCs.10,11 Therefore, the present study aimed to identify the
differences in the incidence of PPCs according to the type of neu-
romuscular blockade reversal agent (anticholinesterase or sugam-
dex) (primary aim) and identify the risk factors for PPCs (sec-
ondary aim) in patients undergoing general anesthesia for femur
fracture repair surgery.

MATERIALS AND METHODS

Study Design and Populations
This retrospective observational study was conducted in accor-
dance with the 2013 revisions of the Declaration of Helsinki, was
approved by the Institutional Review Board of Konyang University
Hospital (No. KYUH 2022-04-005), and was registered with the
Korea Clinical Research Information Service. This study followed
the Strengthening the Reporting of Observational Studies in Epi-
demiology reporting guidelines. The requirement for informed
consent was waived due to the retrospective nature of the study.
Also this study complied the ethical guidelines for authorship and
publishing in the Annals of Geriatric Medicine and Research.12

We retrospectively reviewed the medical records of patients aged
> 18 years who underwent femur fracture repair surgery under
general anesthesia between March 2017 and March 2022 at our
university hospital. We excluded patients in whom atracurium was
used as a neuromuscular blocker, no neuromuscular block reversal
agent was used, as well as those who underwent combined opera-
tions and with insufficient medical records.

Femoral fractures included the femoral neck, trochanter, shaft,
and distal femur. The types of surgeries performed were closed re-
duction, open reduction, bipolar hemiarthroplasty, and total hip
replacement.

Perioperative Management
The patients arrived in the operating room without premedication
and were monitored using electrocardiography, noninvasive blood
pressure, pulse oximetry, neuromuscular monitoring with acceler-
omyography or electromyography, and baseline body temperature.
All medications used during anesthesia, including induction and
maintenance agents for anesthesia, neuromuscular blocking
agents, and hypotensive agents or vasopressors, were selected at
the anesthesiologist’s discretion according to each patient’s condi-
tion.

Postoperatively, the neuromuscular blockade was reversed with
an anticholinesterase or sugammadex at the anesthesiologist’s dis-
cretion. After emergence from anesthesia, the patients were trans-
ferred to the intensive care unit (ICU) or post-anesthetic care unit,
depending on their condition. Patients transferred to the post-an-
esthetic care unit stayed there for at least 40 minutes. Postoperative
management was performed for all patients according to the pro-
tocol at our institution.

Definition and Variables
The investigation was conducted for up to 7 days postoperatively,
according to the following definitions. The investigator checked
for the presence of complications based on the records of the in-
cluded patients. Complications were diagnosed postoperatively ac-
cording to the Korean Standard Classification of Diseases. PPCs
were defined as a composite of respiratory diagnoses that shared
common pathophysiological mechanisms, including atelectasis,
pneumonia, acute respiratory distress syndrome, and pulmonary
aspiration within 7 days postoperatively. Atelectasis was detected
by computed tomography or chest radiography, and pneumonia
was diagnosed using the US Centers for Disease Control and Pre-
vention criteria. Acute respiratory distress syndrome was diag-
nosed using the Berlin consensus definition, and pulmonary aspi-
ration was diagnosed with a clear clinical history and radiological
evidence.13 The length of hospital stay was defined as the period
from admission to discharge. Major adverse cardiac events includ-
ed composites of myocardial infarction, stroke, heart transplanta-
tion, heart failure, other ischemic cardiovascular events, and
death.14 Death was defined as in-hospital death.

The following variables were collected from the electronic med-
ical records: demographic data; preoperative status and history;
preoperative laboratory findings; intraoperative data; and postop-
erative outcomes such as PPCs, length of hospital stay, major ad-
derse cardiac events, and deaths (Tables 1, 2).

The primary outcome was the incidence of PPCs according to
the type of neuromuscular blockade reversal agent used. The sec-
Table 1. Perioperative data before and after propensity score matching between cholinesterase inhibitor and sugammadex

<table>
<thead>
<tr>
<th></th>
<th>Before propensity score matching</th>
<th>After propensity score matching</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sugammadex (n = 496)</td>
<td>Anticholinesterase (n = 108)</td>
</tr>
<tr>
<td>Sex, male</td>
<td>152 (30.6)</td>
<td>41 (38.0)</td>
</tr>
<tr>
<td>Age (y)</td>
<td>79.0 (72.0–84.0)</td>
<td>67.0 (57.0–78.5)</td>
</tr>
<tr>
<td>ASA physical status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>3 (0.6)</td>
<td>3 (2.8)</td>
</tr>
<tr>
<td>2</td>
<td>197 (39.7)</td>
<td>72 (66.7)</td>
</tr>
<tr>
<td>3</td>
<td>282 (56.9)</td>
<td>32 (29.6)</td>
</tr>
<tr>
<td>4</td>
<td>14 (2.8)</td>
<td>1 (0.9)</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>22.0 (19.6–24.5)</td>
<td>22.1 (19.8–24.4)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>320 (64.5)</td>
<td>61 (56.5)</td>
</tr>
<tr>
<td>Cerebrovascular disease</td>
<td>140 (28.2)</td>
<td>19 (17.6)</td>
</tr>
<tr>
<td>Preoperative respiratory</td>
<td>7 (1.4)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>infection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preoperative anemia</td>
<td>204 (41.1)</td>
<td>39 (36.1)</td>
</tr>
<tr>
<td>Preoperative saturation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥ 96%</td>
<td>302 (60.9)</td>
<td>79 (73.1)</td>
</tr>
<tr>
<td>91%–95%</td>
<td>162 (32.7)</td>
<td>25 (23.1)</td>
</tr>
<tr>
<td>≤ 90%</td>
<td>32 (6.5)</td>
<td>4 (3.7)</td>
</tr>
<tr>
<td>Smoking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonsmoker</td>
<td>435 (87.7)</td>
<td>96 (88.9)</td>
</tr>
<tr>
<td>Ex-smoker</td>
<td>28 (5.6)</td>
<td>5 (4.6)</td>
</tr>
<tr>
<td>Current smoker</td>
<td>33 (6.7)</td>
<td>7 (6.5)</td>
</tr>
<tr>
<td>Estimated blood loss</td>
<td>100.0 (50.0–100.0)</td>
<td>100.0 (50.0–100.0)</td>
</tr>
<tr>
<td>Emergency operation</td>
<td>107 (21.6)</td>
<td>20 (18.5)</td>
</tr>
<tr>
<td>Use of NMT</td>
<td>83 (16.7)</td>
<td>4 (3.7)</td>
</tr>
<tr>
<td>Time to extubation from last NMB</td>
<td>71.0 (48.0–92.0)</td>
<td>75.5 (57.0–98.0)</td>
</tr>
<tr>
<td>Use of PEEP</td>
<td>365 (73.6)</td>
<td>73 (67.6)</td>
</tr>
<tr>
<td>Duration of anesthesia</td>
<td>120.0 (95.0–160.0)</td>
<td>135.0 (107.5–185.0)</td>
</tr>
</tbody>
</table>

Values are presented as number (%) or median (interquartile range).

ASA, American Society of Anesthesiologists; NMT, neuromuscular monitoring; NMB, neuromuscular blockade; PEEP, positive end-expiratory pressure; SMD, standardized mean difference.

Table 2. Postoperative outcomes with cholinesterase inhibitor and sugammadex

<table>
<thead>
<tr>
<th></th>
<th>Before propensity score matching</th>
<th>After propensity score matching</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sugammadex (n = 496)</td>
<td>Anticholinesterase (n = 108)</td>
</tr>
<tr>
<td>Postoperative pulmonary complication</td>
<td>55 (11.1)</td>
<td>9 (8.3)</td>
</tr>
<tr>
<td>Hospital length of stay</td>
<td>18.0 (14.5–24.0)</td>
<td>21.0 (16.0–27.0)</td>
</tr>
<tr>
<td>Major adverse cardiac event</td>
<td>9 (1.8)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Death</td>
<td>8 (1.6)</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>

Values are presented as number (%) or median (interquartile range).

Secondary outcome was the risk factor for PPCs in patients who underwent femur fracture repair surgery under general anesthesia.

Statistical Analyses

To determine the incidence of PPCs, we divided the groups according to the neuromuscular blockade reversal agent used (sugammadex or anticholinesterase). All demographic and perioperative data were compared between groups before and after propensity score matching. Propensity score matching was performed using the nearest-neighbor method with a 0.2 caliper width and a 1:1 ratio. The following variables were used: age, sex, American Society of Anesthesiologists physical status (ASA PS), comorbidities, hypertension history, cerebrovascular disease history, preoperative respiratory infection, preoperative anemia, preoperative pe-
Peripheral capillary oxygen saturation (SpO₂), smoking history, estimated blood loss, emergency operation, use of neuromuscular monitoring, time to extubation from the last neuromuscular blocking agent injection, use of positive end-expiratory pressure, and duration of anesthesia.

An absolute standardized mean difference (SMD) < 0.1 indicated that both groups were well-balanced. Student t-test or Mann–Whitney U test was used for continuous variables after assessing the data distribution using the Kolmogorov–Smirnov test. The χ² test for trends (linear-by-linear association) or Fisher exact test was used to analyze categorical variables. In these analyses, a two-sided p < 0.05 was considered significant.

To identify variables associated with PPCs, univariate and multivariate logistic regression analyses were conducted using unmatched and matched data, respectively. The patients were divided into groups based on the occurrence of PPCs. Multivariate logistic regression analysis using backward selection included the variables with p < 0.2 between the two groups (PPCs and no PPCs) in the univariate analysis to identify the independent risk factors of PPCs. The analysis was performed using unmatched and matched data. All statistical analyses were performed using IBM SPSS Statistics for Windows, version 27.0 (IBM Corp, Armonk, NY, USA) and R 3.4.4 (www.r-project.org).

RESULTS

Among 637 patients aged > 18 years who underwent femoral fracture repair surgery under general anesthesia, 33 were excluded because of the use of atracurium, requirement for intubation after surgery, or incomplete data. Thus, the analysis included 604 patients (108 in the anticholinesterase group and 496 in the sugammadex group). After propensity score matching, 108 patients in each group were matched (Fig. 1) and all covariates were balanced (Fig. 2). Perioperative data before and after propensity score matching are shown in Table 1. The absolute SMD values of all variables were < 0.1 after propensity score matching.

![Fig. 1. Flow chart of the study.](image)

![Fig. 2. Love plot of absolute standardized mean difference (SMD) before and after propensity score matching. ASA, American Society of Anesthesiologists; NMT, neuromuscular monitoring; NMB, neuromuscular blockade; PEEP, positive end-expiratory pressure.](image)
The postoperative outcomes are presented in Table 2. The overall incidence rates of PPCs before and after matching were 10.6% and 7.0%, respectively. The incidence rates of PPCs in the matched data were 8.3% and 5.6% in the anticholinesterase and sugammadex groups, respectively, with no significant difference between the groups. The median (interquartile range) length of hospital stay was 21 (16–27) days and 19 (14–27) days in the anticholinesterase and sugammadex groups, respectively. Neither group experienced major adverse cardiac events in matched data. One patient died in the sugammadex group.

The perihospital data and results of the regression analysis according to the occurrence of PPCs before and after propensity score matching are presented in Table 3 (univariate analysis) and Table 4 (odds ratio [OR] of univariate and multivariate analyses).

In the unmatched data, the variables with p < 0.2 were age, ASA PS, history of hypertension, preoperative saturation, smoking, and emergency operation. In the matched data, the variables with p < 0.2 were age, ASA PS, preoperative saturation, estimated blood loss, and time to extubation from the last neuromuscular blocker.

### DISCUSSION

Femur fractures, whose risk factors are old age and osteoporosis, can be corrected surgically. The postoperative complications include acute respiratory distress syndrome, fat embolism, and pneumonia caused by prolonged bed rest. These complications are reduced through early mobilization, thereby reducing related morbidity and mortality by decreasing the ICU and hospital lengths of stay. Various surgeries have shown differences in the incidence of PPCs according to the type of neuromuscular blockade reversal.

### Table 3. Perioperative data before and after propensity score matching according to the occurrence of postoperative pulmonary complications

<table>
<thead>
<tr>
<th></th>
<th>Before propensity score matching</th>
<th>After propensity score matching</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No PPC (n = 540)</td>
<td>PPC (n = 64)</td>
<td>p-value</td>
</tr>
<tr>
<td>Sex, male</td>
<td>174 (32.2)</td>
<td>19 (29.7)</td>
<td>0.788</td>
</tr>
<tr>
<td>Age (y)</td>
<td>78.0 (66.5–83.0)</td>
<td>81.0 (76.0–86.0)</td>
<td>0.002</td>
</tr>
<tr>
<td>ASA physical status</td>
<td>&gt; 0.999</td>
<td>0.109</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>6 (1.1)</td>
<td>0 (0)</td>
<td>0.001</td>
</tr>
<tr>
<td>2</td>
<td>256 (47.4)</td>
<td>13 (20.3)</td>
<td>0.273</td>
</tr>
<tr>
<td>3</td>
<td>267 (49.4)</td>
<td>47 (73.4)</td>
<td>0.273</td>
</tr>
<tr>
<td>4</td>
<td>11 (2.0)</td>
<td>4 (6.2)</td>
<td>0.273</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>22.1 (19.6–24.5)</td>
<td>21.2 (20.0–23.6)</td>
<td>0.373</td>
</tr>
<tr>
<td>Hypertension</td>
<td>331 (61.3)</td>
<td>50 (78.1)</td>
<td>0.012</td>
</tr>
<tr>
<td>Cerebrovascular disease</td>
<td>138 (25.6)</td>
<td>21 (32.8)</td>
<td>0.273</td>
</tr>
<tr>
<td>Preoperative respiratory infection</td>
<td>4 (0.7)</td>
<td>3 (4.7)</td>
<td>0.030</td>
</tr>
<tr>
<td>Preoperative anaemia</td>
<td>217 (40.2)</td>
<td>26 (40.6)</td>
<td>&gt; 0.999</td>
</tr>
<tr>
<td>Preoperative anaemia ≥ 96%</td>
<td>346 (64.1)</td>
<td>35 (54.7)</td>
<td>0.013</td>
</tr>
<tr>
<td>Preoperative anaemia 91%–95%</td>
<td>167 (30.9)</td>
<td>20 (31.2)</td>
<td>0.013</td>
</tr>
<tr>
<td>Preoperative anaemia ≤ 90%</td>
<td>27 (5.0)</td>
<td>9 (14.1)</td>
<td>0.013</td>
</tr>
<tr>
<td>Smoking</td>
<td>0.029</td>
<td>0.439</td>
<td></td>
</tr>
<tr>
<td>Nonsmoking</td>
<td>478 (88.5)</td>
<td>53 (82.8)</td>
<td>0.029</td>
</tr>
<tr>
<td>Ex-smoker</td>
<td>25 (4.6)</td>
<td>8 (12.5)</td>
<td>0.029</td>
</tr>
<tr>
<td>Current smoker</td>
<td>37 (6.9)</td>
<td>3 (4.7)</td>
<td>0.029</td>
</tr>
<tr>
<td>Estimated blood loss</td>
<td>100.0 (50.0–100.0)</td>
<td>100.0 (50.0–135.0)</td>
<td>0.984</td>
</tr>
<tr>
<td>Emergency operation</td>
<td>123 (22.8)</td>
<td>4 (6.2)</td>
<td>0.004</td>
</tr>
<tr>
<td>Use of NMT</td>
<td>81 (15.0)</td>
<td>6 (9.4)</td>
<td>0.306</td>
</tr>
<tr>
<td>Time to extubation from last NMB</td>
<td>72.5 (50.0–94.0)</td>
<td>68.5 (51.5–90.5)</td>
<td>0.513</td>
</tr>
<tr>
<td>Use of PEEP</td>
<td>390 (72.2)</td>
<td>48 (75.0)</td>
<td>0.747</td>
</tr>
<tr>
<td>Duration of anesthesia</td>
<td>125.0 (95.0–160.0)</td>
<td>115.0 (100.0–152.5)</td>
<td>0.775</td>
</tr>
</tbody>
</table>

Values are presented as number (%) or median (interquartile range).

ASA, American Society of Anesthesiologists; NMT, neuromuscular monitoring; NMB, neuromuscular blockade; PEEP, positive end-expiratory pressure.

www.e-agmr.org
Table 4. Logistic regression of postoperative pulmonary complications in femur fracture surgery

<table>
<thead>
<tr>
<th></th>
<th>Before propensity score matching</th>
<th>After propensity score matching</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unadjusted OR (95% CI)</td>
<td>p-value</td>
</tr>
<tr>
<td>Sex, male</td>
<td>0.89 (0.50–1.56)</td>
<td>0.681</td>
</tr>
<tr>
<td>Age (y)</td>
<td>1.03 (1.01–1.03)</td>
<td>0.007</td>
</tr>
<tr>
<td>ASA physical status</td>
<td>3.07 (1.85–5.08)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>0.97 (0.90–1.05)</td>
<td>0.447</td>
</tr>
<tr>
<td>Hypertension</td>
<td>2.26 (1.22–4.18)</td>
<td>0.010</td>
</tr>
<tr>
<td>Cerebrovascular disease</td>
<td>1.42 (0.82–2.48)</td>
<td>0.214</td>
</tr>
<tr>
<td>Preoperative respiratory infection</td>
<td>6.59 (1.44–30.14)</td>
<td>0.015</td>
</tr>
<tr>
<td>Preoperative anemia</td>
<td>1.02 (0.60–1.73)</td>
<td>0.946</td>
</tr>
<tr>
<td>Preoperative saturation</td>
<td>1.58 (1.07–2.34)</td>
<td>0.022</td>
</tr>
<tr>
<td>Smoking</td>
<td>1.12 (0.71–1.77)</td>
<td>0.616</td>
</tr>
<tr>
<td>Estimated blood loss</td>
<td>1.00 (1.00–1.00)</td>
<td>0.450</td>
</tr>
<tr>
<td>Emergency operation</td>
<td>0.23 (0.08–0.63)</td>
<td>0.005</td>
</tr>
<tr>
<td>Use of NMT</td>
<td>0.59 (0.24–1.40)</td>
<td>0.231</td>
</tr>
<tr>
<td>Time to extubation from last NMB</td>
<td>1.00 (0.99–1.00)</td>
<td>0.381</td>
</tr>
<tr>
<td>Use of PEEP</td>
<td>1.15 (0.64–2.09)</td>
<td>0.638</td>
</tr>
<tr>
<td>Duration of anesthesia</td>
<td>1.00 (1.00–1.00)</td>
<td>0.950</td>
</tr>
</tbody>
</table>

ASA, American Society of Anesthesiologists; NMT, neuromuscular monitoring; NMB, neuromuscular blockade; PEEP, positive end-expiratory pressure; OR, odds ratio; CI, confidence interval.

agent used. 10,11 However, we observed no difference in the incidence of PPCs between sugammadex and anticholinesterase in femur fracture surgery under general anesthesia.

General anesthesia is an important method used in femur fracture repair surgeries when regional anesthesia cannot be administered. Neuromuscular blockers are essential drugs used during general anesthesia. They facilitate surgery by preventing intraoperative movement. However, they may increase the risk of PPCs due to residual neuromuscular block, which may affect postoperative management. In femur fractures, a representative long bone fracture, immobility caused by the fracture increases the risk of pulmonary embolism due to deep vein thrombosis. It can cause fatal pulmonary complications such as fat embolism syndrome. 20 In particular, a high proportion of older patients experience femur fractures, and the incidence of residual neuromuscular block in older adults is approximately twice that in younger patients. 21

The previously reported incidence rates of PPCs were 31% in several types of surgeries and 40% in patients with femur fractures. 2,10,11 However, the incidence in our study was 7%, which is slightly different from that in previous studies. This difference might be due to the retrospective nature of the study; additionally, underestimation was possible due to insufficient reporting and poor investigation compared to prospective studies. Additionally, unlike previous studies on PPCs in femur fracture surgeries that only included older adults, this study included all adults. The incidence might be lower in all adults than in older people. 22,23 In our data, the incidence was 12% in patients aged > 65 years.

The use of sugammadex reduces PPCs in older patients undergoing femur fracture repair surgery under general anesthesia. 24 In our study, the incidence of PPCs did not significantly differ between both types of reversal agents used in our study. However, the lower incidence with sugammadex is consistent with the results of other studies. 10,11 The reasons why the incidence of PPCs did not differ significantly between the reversal agents in our study are as follows. First, femoral fracture repair surgery is associated with a high risk of PPCs owing to the high proportion of older people and the risk of embolism. Second, the tendency to preferentially consider sugammadex for high-risk patients or those expected to have PPCs upon emergence from anesthesia could have affected the results. In addition, although our retrospective findings confirmed the relevance of PPCs related to the type of neuromuscular block reversal agent, a causal relationship could not be confirmed, and the results may have been affected by various uncontrolled influencing factors.

Some variables identified as risk factors in this study, including higher ASA PS, higher age, and lower preoperative saturation, were also representative risk factors for PPCs in previous studies. 25-27 In particular, the latter two are meaningful components of the Assess Respiratory Risk in Surgical Patients in Catalonia (ARISCAT) score, the only validated method for scoring PPCs risk factors.
Therefore, efforts to identify risk factors using various methods, such as prospective or large-scale studies, are necessary. In addition, unlike previous studies, we identified emergency surgery as a preventive factor. In our hospital, we aim to perform femur fracture surgeries as emergency surgeries for patients with no specific contraindications. This is probably related to the fact that performing surgery as soon as possible reduces mortality; thus, a quick operation may have affected PPCs. Moreover, it is easier to perform emergency surgery in patients without comorbidities than for those with multiple comorbidities owing to cooperation with other departments. However, as the time from injury to surgery was not recorded in this study, it was difficult to confirm this correlation.

The limitations of this study are as follows. First, as this was a retrospective study, it included many uncontrolled factors, which made it difficult to confirm a causal relationship. For PPCs in which preoperative lung status and medical history are important, the results of this study may have been influenced by several factors. However, as it is difficult to conduct a well-controlled prospective study because most patients with femoral fractures are in poor condition or are older individuals, we considered it sufficient to confirm its relevance. Second, as this was a single-center study, group bias was possible. A multicenter or big data study is required to confirm the overall effects of PPCs in patients with femoral fractures undergoing general anesthesia. Finally, the surgical site is an important risk factor for PPC. We included all types of femoral fracture repair surgeries performed in our hospital and did not analyze them by type. However, based on previous studies evaluating the risk factors of PPC, a more detailed classification of surgical types, such as closed reduction, open reduction, bipolar hemiarthroplasty, and total hip replacement, would not have significantly affected our results.

In conclusion, we observed no significant difference in PPCs according to the type of neuromuscular block reversal agent used in patients undergoing femoral fracture repair surgery under general anesthesia. However, the relationship between PPCs and the neuromuscular blockade reversal agents remains unclear. It is important to thoroughly determine the patient’s condition before surgery and to properly evaluate the patient’s risk according to the risk factors identified in this study.

ACKNOWLEDGMENTS

CONFLICT OF INTEREST
The researchers claim no conflicts of interest.

FUNDING
None.

AUTHOR CONTRIBUTIONS
Conceptualization, TYS; Data curation, SAC, JHK, CKC; Investigation, SAC, TYS, CKC; Methodology, SAC, TYS; Supervision, TYS; Writing—original draft, SAC, SSL; Writing—review & editing, SAC, TYS.

REFERENCES


Factors Associated with Improvement in Activities of Daily Living during Hospitalization: A Retrospective Study of Older Patients with Hip Fractures

Kazuya Takeda, Mineko Wada, Kyosuke Yorozuya, Yuhei Hara, Toyoaki Watanabe, Hideaki Hanaoka

Background: In this study, we aimed to examine the changes in delirium during hospitalization of patients and its association with behavioral and psychological symptoms of dementia (BPSD), as well as improvements in activities of daily living (ADL).

Methods: A longitudinal, retrospective cohort study was conducted involving 83 older adults (≥65 years) with hip fractures. We collected Mini-Mental State Examination (MMSE) and Functional Independence Measure-motor domain (m-FIM) assessment results from the medical charts at two time points: baseline (first week of hospitalization) and pre-discharge (final week before discharge). Additionally, we collected data on delirium and BPSD at three points: baseline, week 2 post-admission, and pre-discharge. We performed univariate logistic regression analysis using changes in m-FIM scores as the dependent variable and MMSE and m-FIM scores at baseline and pre-discharge, along with delirium and BPSD subtypes at baseline, week 2 post-admission, and pre-discharge, as the explanatory variables. Finally, we performed a multivariate logistic regression analysis incorporating the significant variables from the univariate analysis to identify factors associated with ADL improvement during hospitalization.

Results: We observed significant correlations between ADL improvement during hospitalization and baseline m-FIM and MMSE scores, hypoactive delirium state, and BPSD subtype pre-discharge. Notably, all participants with hypoactive symptoms before discharge exhibited some subtype of delirium and BPSD at baseline.

Conclusion: Besides ADL ability and cognitive function at admission, the presence of hypoactive delirium and BPSD subtype before discharge may hinder ADL improvement during hospitalization.

Key Words: Activities of daily living, Delirium, Dementia, Behavioral symptoms, Apathy, Hip fractures
ments in ADL. Marcantonio et al. reported that patients with delirium at admission may experience deterioration of their mental state, and Gialanella et al. reported that BPSD at admission hinders engagement in rehabilitation, potentially hindering ADL improvement during hospitalization among older adults with hip fractures. However, no longitudinal studies have investigated the subtypes of delirium and BPSD that hinder ADL improvement at specific time points.

Delirium and BPSD can be divided into several subtypes based on symptoms, such as hallucinations and delusions, disturbing speech, excitatory behavior, and an altered sleep-wake cycle; it can generally be categorized into hyperactive, hypoactive, and mixed subtypes. Moreover, these subtypes can change during hospitalization, suggesting the need to study these subtypes over time. However, most studies investigating the factors associated with ADL improvement among patients with hip fracture during hospitalization have categorized delirium and BPSD as simply “present” or “not present” and few studies have investigated the subtypes. Furthermore, existing studies have only focused on assessing the status upon admission, but no studies have assessed chronological changes in delirium and BPSD.

Therefore, to clarify the association of delirium and BPSD with ADL improvement, we investigated the changes in delirium and BPSD subtypes throughout the hospitalization period among older adult patients with hip fractures. By elucidating the association between ADL improvement and the timing and onset of subtypes of delirium and BPSD in patients with hip fractures, our findings study could offer valuable insights and important directions and implications for the assessment of delirium and BPSD during hospitalization at general hospitals, guiding appropriate care at each stage of hospitalization.

MATERIALS AND METHODS

Design

We conducted a retrospective cohort study using longitudinal data in accordance with the STROBE guidelines. This study was approved by the Hiroshima University’s Ethics Review Committee for Life Science and Medical Research with Human Participants (No. Epidemiology 3972) and Kaneda Hospital, Okayama, Japan. Also, this study complied the ethical guidelines for authorship and publishing in the Annals of Geriatric Medicine and Research.

Participants

The inclusion criteria for participating in this study were patients who were aged ≥ 65 years underwent hip fracture surgery and were prescribed rehabilitation at a Japanese general hospital between September 2016 and October 2022. We excluded patients who (1) did not undergo cognitive function assessment, (2) received conservative treatment, (3) were transferred to another hospital or transitioned to treatment for comorbidities, or (4) died.

Among the 261 patients, 93 underwent cognitive function assessments. The remaining 168 patients either did not have adequate cognitive function to undergo assessment or did not consent to participate in the study. Of the 93 remaining patients, six received conservative treatments due to contraindications to surgery, three were transferred to another hospital or transitioned to treatment because of complications, and one patient died. Consequently, our final analysis included 83 patients (Fig. 1).

Following hip fracture surgery, all patients were prescribed physical therapy as a part of rehabilitation plan. Additionally, we prescribed occupational and speech therapies based on each patient’s comorbidities, physical function, and cognitive function, with the goal of maintaining or improving physical and cognitive capabilities.

Measures

We assessed the basic characteristics, cognitive function, delirium, BPSD, and ADL of all 83 patients using data from their medical charts. To assess cognitive function, we utilized the results of their Mini-Mental State Examination (MMSE), and for evaluating ADL, we utilized the motor domain scores of the Functional Independence Measures (m-FIM), which served as our outcome variable.

We defined the first week of hospitalization (beginning at admission) as the baseline, the second week of hospitalization (from the end of week 1 to the end of week 2) as week 2 post-admission, and the end of week 2 to the end of week 3 as week 3 post-admission.

Fig. 1. Study enrollment summary. MMSE, Mini-Mental State Examination.
and the week before discharge (ending at discharge) as pre-discharge. Data on the types of medications, MMSE scores, and m-FIM scores were collected at two points: at baseline and pre-discharge. Delirium and BPSD results were collected at three time points: baseline, week 2 post-admission, and pre-discharge. As delirium is classified into cases based on whether symptoms resolved within 1 week or persisted for a longer period, cases in which delirium persists for at least 1 week are considered to be more severe. Therefore, we assessed delirium and BPSD results at week 2 post-admission in addition to baseline and pre-discharge.

**Patient Characteristics**

We collected the following patient characteristics: age, sex, length of stay, type of surgery (arthroplasty, internal fixation), comorbidities (orthopedic disease, heart disease, lung disease, mental illness, neurodegenerative disease, and cancer), dementia diagnosis and type (Alzheimer disease, Lewy body dementia), pre-fracture walking ability (independent: yes/no), and types of medications (anti-psychotic drugs, anti-dementia drugs, and anti-anxiety drugs).

**Mini-Mental State Examination**

We collected data from MMSEs for the assessment of cognitive function. The MMSE is a simple assessment tool with established reliability and validity. The maximum score is 30 points, with scores ≤ 23 points indicating dementia and lower scores indicating more severe cognitive impairment. These assessments were performed by occupational or speech therapists.

**Delirium and Behavioral and Psychological Symptoms of Dementia**

Delirium and BPSD are typically observed in older adults with dementia. Although they are classified differently, their clinical symptoms are similar. Thus, it is difficult to differentiate between these conditions after disease onset. Therefore, we considered these two conditions as one. Delirium is classified into three subtypes, including hyperactive, hypoactive, and mixed, whereas BPSD is classified into 12 subtypes: delusions, hallucinations, agitation/aggression, depression/dysphoria, anxiety, elation/euphoria, apathy, disinhibition, irritability/lability, aberrant motor behavior, nighttime behavior disturbances, and appetite and eating abnormalities. A previous study classifying BPSD using cluster analysis reported that it can be clinically classified as hyperactive or hypoactive. We identified data on patients’ speech and behavior corresponding to delirium and BPSD from their medical charts using these classifications. We then categorized these into the following subtypes: hyperactive, hypoactive, and mixed.

For the hyperactive subtype, we considered delirium symptoms including abnormal verbal output, hyperalertness, irritability, euphoria, and combativeness, along with BPSD symptoms including delusions, hallucinations, agitation/aggression, elation/euphoria, disinhibition, irritability/lability, aberrant motor behavior, nighttime behavior disturbances, and appetite and eating abnormalities. Patients with any of these symptoms were classified as hyperactive. For the hypoactive subtype, we considered delirium symptoms including apathy, decreased alertness, withdrawal, and hypersomnolence, along with BPSD symptoms including apathy, depression/dysphoria, and anxiety. Patients exhibiting any of these symptoms were classified as hypoactive. The mixed subtype was defined as a combination of symptoms from hyperactive and hypoactive subtypes. Specifically, this subtype included cases in which the patient exhibited both hyperactive and hypoactive symptoms, such as agitation followed by apathy, during a single assessment period.

**Functional Independence Measure**

The FIM is used to evaluate the extent of an individual’s ADL care needs. In this study, we used the assessment results for the motor domain (m-FIM). The m-FIM comprises self-care, sphincter control, and transfers. The m-FIM is known for its high reliability, sensitivity to changes in the functional status of patients undergoing rehabilitation, and ease of implementation. Each item is assessed on a 7-point scale, ranging from requiring total assistance to being completely independent. The total scores range from 13 to 91 points, with a lower score indicating lower ADL independence. These assessments were performed by physiotherapists.

**Data Analysis**

We calculated the mean, standard deviation, and percentage based on the descriptive statistics of the patient characteristics and assessment results. Statistical analyses were performed using R software (version 4.0.5; R Foundation for Statistical Computing, Vienna, Austria). All tests were performed at a significance level of 0.05. First, we calculated the median change in the m-FIM score. Subsequently, we categorized the patients into high and low groups based on the changes in their ADL scores, with those at or above the median categorized into the high group and those below the median categorized into the low group.

Thereafter, using a univariate logistic regression model, we analyzed the factors associated with changes in m-FIM scores. The high or low group change in m-FIM scores was set as the outcome variable, whereas the explanatory variables encompassed basic characteristics, types of medications (baseline and pre-discharge), MMSE scores (baseline and pre-discharge), m-FIM scores (baseline and pre-discharge), and delirium and BPSD subtypes (base-
Finally, we performed multivariate logistic regression analysis to organize and investigate the multiple factors associated with changes in m-FIM. The high or low group change in m-FIM scores was set as the outcome variable, whereas the explanatory variables comprised those with significant associations in the univariate logistic regression analysis. Notably, we observed multicollinearity for m-FIM scores, MMSE scores, and types of medications; therefore, only the baseline values were used as explanatory variables for these items. We confirmed the goodness of fit of the explanatory variables to the outcome variable using the Hosmer–Lemeshow test.

RESULTS

Patient Characteristics
Table 1 presents the patients’ basic characteristics. In this study, 72 patients (86.7%) were women, 63 (75.9%) had comorbidities, 69 (83.1%) had not been diagnosed with dementia, and 38 (45.8%) could walk independently before admission. The mean age was 89.1 ± 7.2 years, the mean length of stay was 51.9 ± 19.8 days, and the mean MMSE score at baseline was 15.5 ± 8.4 points. Among the patients, 73 (88.0%) exhibited delirium or BPSD at least one of the three data collection points.

Factors Associated with Changes in ADL (Univariate Analysis)
The median change in the m-FIM score was 27. Thus, the high (n = 41) and low (n = 42) groups comprised patients with changes in their m-FIM scores of ≥ 27 points and ≤ 26 points, respectively. The univariate analysis, performed to identify factors associated with the change in m-FIM scores, revealed significant associations with age (odds ratio [OR] = 0.94; 95% confidence interval [CI], 0.87–0.97), independent walking before admission (OR = 3.17; 95% CI, 1.31–7.99), anti-psychotic type medications (OR = 0.34; 95% CI, 0.19–0.59), m-FIM scores (OR = 1.07; 95% CI, 1.01–1.15), MMSE scores (OR = 1.27; 95% CI, 1.16–1.42), and pre-discharge hypoactive symptomology (OR = 0.17; 95% CI, 0.03–0.57) (Table 2).

Factors Associated with Changes in ADL (Multivariate Analysis)
The results of the multivariate analysis revealed significant associations among low baseline m-FIM score (OR = 0.86; 95% CI, 0.77–0.95), high baseline MMSE score (OR = 1.41; 95% CI, 1.22–1.71), and pre-discharge hypoactive symptomology (OR = 0.07; 95% CI, 0.01–0.43) (Table 3). The result of the Hosmer–Lemeshow test was not significant (X²(8) = 0.64).

Table 1. Demographic and characteristics data (n=83)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>89.1 ± 7.2</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>11 (13.2)</td>
</tr>
<tr>
<td>Female</td>
<td>72 (86.7)</td>
</tr>
<tr>
<td>Length of stay (day)</td>
<td>52.0 ± 19.8</td>
</tr>
<tr>
<td>Type of surgery</td>
<td></td>
</tr>
<tr>
<td>Arthroplasty</td>
<td>28 (33.7)</td>
</tr>
<tr>
<td>Internal fixation</td>
<td>55 (66.3)</td>
</tr>
<tr>
<td>Comorbidity</td>
<td></td>
</tr>
<tr>
<td>Orthopedic disease</td>
<td>14 (16.9)</td>
</tr>
<tr>
<td>Heart disease</td>
<td>19 (22.9)</td>
</tr>
<tr>
<td>Lung disease</td>
<td>8 (9.6)</td>
</tr>
<tr>
<td>Mental illness</td>
<td>15 (18.1)</td>
</tr>
<tr>
<td>Neurodegenerative disease</td>
<td>4 (4.8)</td>
</tr>
<tr>
<td>Cancer</td>
<td>3 (3.6)</td>
</tr>
<tr>
<td>Type of dementia</td>
<td></td>
</tr>
<tr>
<td>No dementia</td>
<td>69 (83.1)</td>
</tr>
<tr>
<td>Alzheimer’s disease</td>
<td>13 (15.6)</td>
</tr>
<tr>
<td>Lewy body dementia</td>
<td>1 (1.2)</td>
</tr>
<tr>
<td>Pre-fracture walking ability</td>
<td></td>
</tr>
<tr>
<td>Independent</td>
<td>38 (45.8)</td>
</tr>
<tr>
<td>Number of drugs for anti-psychotic</td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>46 (55.4)</td>
</tr>
<tr>
<td>Pre-discharge</td>
<td>36 (43.3)</td>
</tr>
<tr>
<td>Number of drugs for anti-dementia</td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>7 (8.4)</td>
</tr>
<tr>
<td>Pre-discharge</td>
<td>5 (6.0)</td>
</tr>
<tr>
<td>Number of drugs for anti-anxiety</td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>18 (21.7)</td>
</tr>
<tr>
<td>Pre-discharge</td>
<td>18 (21.7)</td>
</tr>
<tr>
<td>FIM motor score (13–91)</td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>20.5 ± 9.1</td>
</tr>
<tr>
<td>Pre-discharge</td>
<td>50.4 ± 27.0</td>
</tr>
<tr>
<td>MMSE total score (0–30)</td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>15.5 ± 8.4</td>
</tr>
<tr>
<td>Pre-discharge</td>
<td>16.3 ± 8.3</td>
</tr>
<tr>
<td>Delirium and BPSD</td>
<td>60 (72.3)</td>
</tr>
<tr>
<td>Hyperactive</td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>42 (50.6)</td>
</tr>
<tr>
<td>Week 2</td>
<td>33 (39.6)</td>
</tr>
<tr>
<td>Pre-discharge</td>
<td>33 (39.6)</td>
</tr>
<tr>
<td>Hypoactive</td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>7 (8.4)</td>
</tr>
<tr>
<td>Week 2</td>
<td>12 (14.5)</td>
</tr>
<tr>
<td>Pre-discharge</td>
<td>16 (19.3)</td>
</tr>
<tr>
<td>Mixed</td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>33 (39.8)</td>
</tr>
<tr>
<td>Week 2</td>
<td>19 (22.9)</td>
</tr>
<tr>
<td>Pre-discharge</td>
<td>14 (16.9)</td>
</tr>
</tbody>
</table>

Values are presented as mean ± standard deviation or number (%).

FIM, Functional Independent Measure motor score; MMSE, Mini-Mental State Examination; BPSD, behavioral and psychological symptoms of dementia.

aFirst week of hospitalization, bsecond week of hospitalization, c1-week period before discharge.
Values are presented as mean±standard deviation or number (%).

m-FIM, Functional Independent Measure motor score; MMSE, Mini-Mental State Examination; SE, standard error; OR, odds ratio; CI, confidence interval.

*p<0.05.

Kazuya Takeda et al.

**Table 2. Univariate logistic regression for each variable**

<table>
<thead>
<tr>
<th>Variable</th>
<th>m-FIM gain</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low group</td>
<td>High group</td>
</tr>
<tr>
<td>Age (y)</td>
<td>90.8 ± 6.5</td>
<td>87.6 ± 7.7</td>
</tr>
<tr>
<td>Sex</td>
<td>7 (8.4)</td>
<td>4 (4.8)</td>
</tr>
<tr>
<td>Male</td>
<td>34 (40.9)</td>
<td>38 (45.8)</td>
</tr>
<tr>
<td>Female</td>
<td></td>
<td>28 (33.7)</td>
</tr>
<tr>
<td>Length of stay (day)</td>
<td>49.0 ± 22.8</td>
<td>54.9 ± 16.2</td>
</tr>
<tr>
<td>Type of surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arthroplasty</td>
<td>13 (15.7)</td>
<td>15 (18.1)</td>
</tr>
<tr>
<td>Internal fixation</td>
<td>2 (2.4)</td>
<td>2 (2.4)</td>
</tr>
<tr>
<td>Comorbidity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Orthopedic disease</td>
<td>6 (7.2)</td>
<td>8 (9.6)</td>
</tr>
<tr>
<td>Heart disease</td>
<td>7 (8.4)</td>
<td>12 (14.5)</td>
</tr>
<tr>
<td>Lung disease</td>
<td>2 (2.4)</td>
<td>6 (7.2)</td>
</tr>
<tr>
<td>Mental illness</td>
<td>10 (12.0)</td>
<td>5 (6.0)</td>
</tr>
<tr>
<td>Neurodegenerative disease</td>
<td>2 (2.4)</td>
<td>2 (2.4)</td>
</tr>
<tr>
<td>Cancer</td>
<td>-</td>
<td>3 (3.6)</td>
</tr>
<tr>
<td>Types of dementia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alzheimer’s disease</td>
<td>9 (10.8)</td>
<td>4 (4.8)</td>
</tr>
<tr>
<td>Lewy body dementia</td>
<td>1 (1.2)</td>
<td>-</td>
</tr>
<tr>
<td>Pre-fracture walking ability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Independent</td>
<td>13 (15.7)</td>
<td>25 (30.1)</td>
</tr>
<tr>
<td>Number of drugs for anti-psychotic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>31 (37.3)</td>
<td>15 (18.1)</td>
</tr>
<tr>
<td>Pre-discharge</td>
<td>28 (33.7)</td>
<td>8 (9.6)</td>
</tr>
<tr>
<td>Number of drugs for anti-dementia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>5 (6.0)</td>
<td>2 (2.4)</td>
</tr>
<tr>
<td>Pre-discharge</td>
<td>3 (3.6)</td>
<td>2 (2.4)</td>
</tr>
<tr>
<td>Number of drugs for anti-anxiety</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>7 (8.4)</td>
<td>11 (13.3)</td>
</tr>
<tr>
<td>Pre-discharge</td>
<td>7 (8.4)</td>
<td>11 (13.3)</td>
</tr>
<tr>
<td>FIM motor score (13–91)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>18.3 ± 9.9</td>
<td>22.5 ± 7.8</td>
</tr>
<tr>
<td>Pre-discharge</td>
<td>27.0 ± 14.3</td>
<td>73.2 ± 13.0</td>
</tr>
<tr>
<td>MMSE total score (0–30)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>10.0 ± 7.2</td>
<td>20.8 ± 5.7</td>
</tr>
<tr>
<td>Pre-discharge</td>
<td>11.3 ± 7.5</td>
<td>21.2 ± 5.7</td>
</tr>
<tr>
<td>Delirium and BPSD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hyperactive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>25 (59.5)</td>
<td>17 (40.5)</td>
</tr>
<tr>
<td>Week 2¹</td>
<td>20 (60.6)</td>
<td>13 (39.4)</td>
</tr>
<tr>
<td>Pre-discharge</td>
<td>17 (51.5)</td>
<td>16 (48.5)</td>
</tr>
<tr>
<td>Hypoactive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>4 (57.1)</td>
<td>3 (42.9)</td>
</tr>
<tr>
<td>Week 2¹</td>
<td>7 (58.3)</td>
<td>5 (41.7)</td>
</tr>
<tr>
<td>Pre-discharge</td>
<td>13 (81.3)</td>
<td>3 (18.8)</td>
</tr>
<tr>
<td>Mixed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>11 (57.9)</td>
<td>8 (42.1)</td>
</tr>
<tr>
<td>Week 2¹</td>
<td>9 (64.3)</td>
<td>5 (35.7)</td>
</tr>
<tr>
<td>Pre-discharge</td>
<td>7 (87.5)</td>
<td>1 (12.5)</td>
</tr>
</tbody>
</table>

**Table 3. Multivariate logistic regression**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
<th>SE</th>
<th>OR (95% CI)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>-0.04</td>
<td>0.06</td>
<td>0.96 (0.85–1.08)</td>
<td>0.490</td>
</tr>
<tr>
<td>FIM motor score</td>
<td>-0.15</td>
<td>0.05</td>
<td>0.86 (0.77–0.95)</td>
<td>0.003*</td>
</tr>
<tr>
<td>Drugs for anti-psychotic</td>
<td>-0.58</td>
<td>0.45</td>
<td>0.56 (0.22–1.36)</td>
<td>0.200</td>
</tr>
<tr>
<td>Walking ability</td>
<td>1.06</td>
<td>0.74</td>
<td>2.89 (0.68–13.27)</td>
<td>0.150</td>
</tr>
<tr>
<td>MMSE total score</td>
<td>0.34</td>
<td>0.09</td>
<td>1.41 (1.22–1.71)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Hypoactive</td>
<td>-2.66</td>
<td>1.02</td>
<td>0.07 (0.01–0.43)</td>
<td>0.008*</td>
</tr>
</tbody>
</table>

FIM motor score, drugs for anti-psychotic, and MMSE score are mentioned at the baseline level. Walking ability was recorded as pre-fracture (independent: yes/no); hypoactive status was recorded pre-discharge.

FIM, Functional Independent Measure motor score; MMSE, Mini-Mental State Examination; SE, standard error; OR, odds ratio; CI, confidence interval.

Subtypes at Baseline and Week 2 Post-admission among Patients with Pre-discharge Hypoactive Symptomology

In this study, we classified 16 patients as having the hypoactive subtype of delirium and BPSD pre-discharge. We confirmed the subtypes that these participants exhibited at baseline and week 2 post-admission, as shown in Fig. 2. All 16 patients exhibited some form of delirium and BPSD at baseline. However, four patients (25%) did not show delirium or BPSD at week 2 post-admission. Furthermore, eight (50%) and six (37.5%) patients exhibited hyperactive symptomatology at baseline and week 2 post-admission, respectively. Finally, two participants (12.5%) exhibited hypoactive symptomatology at baseline and three (18.8%) exhibited hypoactive symptomatology at week 2 post-admission.

**DISCUSSION**

Our investigation of the factors associated with ADL improvement during hospitalization among older adult patients with hip fractures revealed better improvement among patients with higher cognitive function at admission and non-hypoactive delirium and BPSD symptomatology before discharge than those among patients without these symptomologies. We also observed that the lower a patient’s ADL independence at admission, the greater the improvement in ADL.

**Factors Associated with Changes in ADL**

Our results indicated that ADL improved during hospitalization among patients with higher MMSE scores at admission. One explanation for this finding may be that patient cooperation with rehabilitation following hip fracture surgery is easier to achieve when cognitive function is better at admission. Thus, patients with better cognitive function at admission may have been open to future ADL improvement and proactive engagement in rehabilitation,
even with the presence of postoperative pain and physical dysfunction. Regarding the association between rehabilitation and ADL improvement, Lenze et al.\(^{31}\) reported that executive dysfunction and apathy caused by cognitive impairment may impede engagement in rehabilitation and act as barriers to ADL improvement. Similarly, Kang et al.\(^{32}\) observed that higher MMSE scores are positively associated with improved walking ability. Although we did not investigate patients’ engagement in rehabilitation, we conjecture that ADL improvement was better among patients with stronger cognitive function at admission as they were proactively engaged in rehabilitation.

Furthermore, our results demonstrated that ADL improvement was more difficult in participants who had hypoactive symptoms as discharge approached. In a study conducted in an acute-phase hospital with similar results, Lenze et al.\(^{31}\) reported reduced ADL improvement in patients with apathy and hypoactive symptoms before discharge, suggesting that a hypoactive state before discharge may impede engagement in rehabilitation and negatively impact ADL improvement. However, Gialanella et al.\(^{16}\) reported that hyperactive symptoms at admission may impede ADL improvement. Although, in our study, a hyperactive state at admission was not identified as a barrier to ADL improvement, further research on the association between the timing of the onset of hyperactive symptoms and ADL is required.

Patients in a hypoactive state are unlikely to regularly exhibit this behavior in everyday context. Thus, they are often misdiagnosed by hospital staff as being “well-behaved” with no symptomatic behaviors.\(^{34}\) However, if hospital staffs do not diagnose a patient’s hypoactivity, ADL improvement may be impeded by the patient’s decreased motivation for rehabilitation and ADL, ultimately reducing opportunities for their participation.\(^{35}\) Thus, hospital staffs must pay close attention to changes in patients’ hypoactivity not only after admission and surgery but also on a daily basis to ensure that they do not overlook hypoactive symptoms during hospitalization. Moreover, providing rehabilitation and everyday care is particularly important to prevent the development of hypoactive symptoms before discharge.

Finally, our results demonstrated that patients with lower ADL independence at admission (i.e., lower FIM scores) exhibited better ADL improvement. Previous studies have reported similar results suggesting that the lower a patient’s FIM score at admission, the greater is the improvement.\(^{36}\) When the FIM score was high at the time of admission, any subsequent improvement in their ADL might have been constrained, due to limitation for further increase in the maximum FIM score. Since the FIM includes tasks with a relatively low difficulty level, the possibility of a ceiling effect cannot be ruled out. This may explain the lack of association between high ADL independence upon admission and ADL improvement in our study.

**Subtype Fluctuations among Patients with Pre-discharge Hypoactivity**

Considering that most patients in a hypoactive state with subtype symptoms of delirium and BPSD during the study period were in a hyperactive state at admission, only a few remained hypoactive throughout the hospitalization period. Hospitalization phase for these patients included the acute stage after surgery, in which patients experienced a combination of physical factors, such as limited movement; psychological factors including interaction with unfamiliar hospital staff; and environmental factors that differ from their ordinary lives, such as the presence of intravenous drips. This combination of factors may lead them to transition into a hyperactive state. Furthermore, studies have indicated that the use of pharmacotherapy to treat hyperactive patients upon admission may lead to a hypoactive state.\(^{37,38}\) Similarly, based on the number of anti-psychotic drugs used at admission and week 2 after admission compared to pre-discharge, we conjecture that hypoactivity induced by pharmacotherapy cannot be ruled out. Considering these findings, hospital staffs may contribute to ADL improvement during hospitalization through careful multidisciplinary observation and communication of any changes in the patient’s delirium and BPSD subtypes after the first 2 weeks of hospitalization and address these symptoms primarily through non-pharmacological methods.\(^{37,40}\)

**Limitations and Future Directions**  This study had several limitations. First, due to the retrospective nature of our delirium and BPSD assessments, we could not perform detailed quantitative evaluation of subtype categories. Second, we could not perform a
follow-up on pre-discharge hypoactive symptoms, as a factor impeding ADL improvement beyond the first 2 weeks after admission, preventing us from determining the timing and persistence of the hypoactive state until pre-discharge. Third, we could not consider the impact of physical functioning, such as muscle strength, on ADL improvement. Future prospective longitudinal studies using qualitative assessments of delirium and BPSD along with extended follow-ups beyond the second week of hospitalization are necessary. Moreover, future studies are required to examine whether subtypes continue to change after discharge, and if so, how hospital care may influence such changes as well as their impact on ADL post-discharge.

Despite these limitations, the results of our investigation of the change in delirium and BPSD subtypes over time during hospitalization among older patients with hip fractures demonstrated that ADL improvement may be impeded in patients with hypoactive pre-discharge delirium and BPSD symptoms. Previous studies have demonstrated that delirium and BPSD at admission can hinder ADL improvement. However, only a few studies have investigated the chronological changes and subtypes of delirium and BPSD that can hinder ADL improvement during hospitalization. The significance of this study lies in elucidating the potential negative effects of pre-discharge hypoactivity on ADL improvement. These results have implications for patient care in clinical practice. They further underscore the importance of continuous monitoring of changes in delirium and BPSD subtypes throughout hospitalization and preventing any shift to hypoactivity to effectively improve ADL outcomes.

ACKNOWLEDGMENTS

We express our appreciation to all participants who offered their cooperation in our research, the attending physicians Yusuke Morchizuki and Teruhito Yoshitaka, and all staff members at Kaneda Hospital.

CONFLICT OF INTEREST

The researchers claim no conflicts of interest.

FUNDING

None.

AUTHOR CONTRIBUTIONS

Conceptualization, KT, HH; Data curation, KT, KY; Formal analysis, KT; Investigation, KT; Methodology, KT, KY, YH, TW, HH; Project administration, KT, HH; Supervision, MW, HH; Writing-original draft, KT; Writing-review & editing, MW, HH.

REFERENCES

Predictive Ability of the 2-Minute Step Test for Functional Fitness in Older Individuals with Hypertension

Puttipong Poncumhak1,2, Patchareeya Amput1,2, Noppharat Sangkarit1,2, Tichanon Promsrisuk3, Arunrat Srithawong1,2

1Department of Physical Therapy, School of Allied Health Sciences, University of Phayao, Phayao, Thailand
2Unit of Excellence of Human Performance and Rehabilitation, University of Phayao, Phayao, Thailand
3Division of Physiology, School of Medical Sciences, University of Phayao, Phayao, Thailand

Corresponding Author:
Arunrat Srithawong, MSc
Department of Physical Therapy, School of Allied Health Sciences, University of Phayao, 19 Moo 2 Tambon Maeka, Amphur Muang, Phayao 56000, Thailand
E-mail: Arunrat sr.up.ac.th
ORCID: https://orcid.org/0000-0002-7647-5657

Received: May 16, 2023
Revised: June 29, 2023
Accepted: July 21, 2023

Background: The 2-minute step test (2MST) is a simple and inexpensive functional test that measures an individual's ability to perform continuous stepping up and down on a step platform for two minutes. This study evaluated the 2MST as a tool for assessing functional fitness in older individuals with hypertension and determined the correlation between the 2MST and physical fitness tests, including the 2MST, 6-minute walk test (6MWT), five times sit-to-stand test (FTSST), grip strength and leg strength assessments, and timed up and go test (TUG) to collectively assess their physical fitness. Results: A cutoff score of ≤60 steps in the 2MST had 87.50% sensitivity and 70.59% specificity in predicting functional exercise performance in older individuals with hypertension. Additionally, the number of steps in the 2MST was positively correlated with the distance covered in the 6MWT, isometric grip strength, and isometric leg strength and negatively correlated with the duration of the FTSST and TUG. Conclusions: A cutoff score of ≤60 steps in the 2MST predicted functional exercise performance in older individuals with hypertension with 87.50% sensitivity and 70.59% specificity and was correlated with other physical fitness tests, suggesting that the 2MST is a useful tool for assessing functional exercise performance.

Key Words: Hypertension, Aging, Step test, Physical fitness testing

INTRODUCTION

The world’s aging population is increasing, and the elderly population is projected to constitute approximately 30% of the global population by 2050.1 Aging is a significant risk factor for chronic diseases and can trigger the onset of geriatric syndromes and illnesses owing to changes in physiological systems.2-4 Hypertension is a prevalent condition in older adults, affecting > 70% of the population. This condition is associated with increased risks of cardiovascular disease, cognitive decline, and physical disability.5 Moreover, sarcopenia is characterized by the age-related loss of muscle mass and strength; hypertension can exacerbate this process, leading to further deterioration in physical capabilities.5,6

Functional fitness, which is the ability to perform daily tasks safely and independently without exhaustion or discomfort, is a critical component of healthy aging. It enables individuals to maintain their independence and quality of life.7 The increase in the number of functionally limited individuals with hypertension highlights the need for early detection and interventions to alleviate the burden of hypertension-aging-disability.8 Therefore, the accurate identification of functional impairment can assist in tailoring interventions to improve fitness, set achievable goals, and educate individuals about the importance of physical fitness for daily tasks and overall health.

Aerobic capacity, a key aspect of physical fitness, is commonly assessed in healthy and diseased populations.9 The 6-minute walk test (6MWT) is a common method used to evaluate the submaximal functional aerobic capacity in older adults10-11 but its adminis-
tation requires a 30-m hallway and can be time-consuming for routine outpatient consultations. Simple and quick office-based field exercise tests, such as the 2-minute step test (2MST)\textsuperscript{(12,13)} may be valuable options as first screening tools before a detailed assessment of functional status and subsequent treatment. The 2MST is highly correlated with the 6MWT\textsuperscript{(14–16)} indicating its potential as a measure of functional aerobic capacity. Its correlation with the timed up and go test (TUG),\textsuperscript{16} five times sit-to-stand test (FTSST), and leg strength\textsuperscript{(13)} highlights the close relationship between cardiovascular endurance, muscle strength, and functional mobility.\textsuperscript{(7)}

Evaluating functional fitness using the available tools can be difficult because of variations in body composition, physical capacity, and perceptions of physical functioning among different populations and research settings.\textsuperscript{(12,14)} The assessment of functional capacity is particularly critical in estimating the functional consequences and disability among patients with hypertension. Owing to the limitations of studies evaluating the tests to assess the functional capacity evaluation test specifically in individuals with hypertension, the present study investigated the predictive ability of the 2MST to identify functional impairment in hypertensive older adults and its correlation with other functional measures, including the 6MWT, FTSST, TUG, grip strength, and leg strength.

**MATERIALS AND METHODS**

1. **Participants**

This cross-sectional study included on 91 older individuals with hypertension in Phayao Province, Thailand, who were undergoing routine antihypertensive medication therapy. We identified and recruited eligible participants during their routine appointments at a primary healthcare center, and informed consent was obtained from all individuals before their participation. The study included participants who met specific criteria, including a diagnosis of hypertension, age > 60 years, body mass index (BMI) < 30 kg/m\textsuperscript{2}, and absence of any physical limitations that would impact their ability to walk or perform stepping movements. Participants with respiratory diseases or clinical conditions such as cognitive impairment, uncontrolled hypertension, unstable angina, and infectious diseases were excluded from the study. This study was approved by the Human Research Ethics Committee of the University of Phayao (No. 1.2/056/65). The minimum estimated sample size required was 62 participants for a diagnostic study, with a 90% power, 0.05 p-value, and 80% sensitivity based on a previous study.\textsuperscript{(19)}

This study complied the ethical guidelines for authorship and publishing in the *Annals of Geriatric Medicine and Research*.\textsuperscript{20}

2. **Procedure**

The experimental protocol was divided into two visits. On the first visit, we assessed the participants’ general information using a self-reported questionnaire, and collected socio-demographic (age and sex), anthropometric (height and weight to compute BMI), and general clinical data (duration of hypertension, medical conditions, and physical activity) using the Physical Activity Questionnaire for Elderly Japanese.\textsuperscript{21} Subsequently, a physical fitness test, handgrip strength measurement, leg strength measurement, TUG, FTSST, and 2MST were performed for each participant with a 30-minute rest between tests. During the second visit on the following week, the participants performed the 6MWT.

Hand grip strength was measured with a Jamar Hand Dynamometer (Sammons Preston, Bolingbrook, IL, USA). After a practice test, participants were instructed to stand with their arms extended, and squeeze the dynamometer twice as hard as possible for 3 seconds with the dominant arm. The participants were allowed to rest between measurements. Three trials were performed and the average values were recorded, regardless of hand dominance.\textsuperscript{(22)}

In the 6MWT protocol, the participants were asked to sit on a chair for 5 minutes to record their vital signs, dyspnea, and leg fatigue. They were then instructed to walk as fast as possible for 6 minutes without running and to continue at the same pace without stopping. The distance covered by each participant was recorded.\textsuperscript{(1)} One minute after the test, the participants’ vital signs, dyspnea, and leg fatigue were recorded.

In the 2MST protocol, the participants were instructed to stand against a wall, and marks were made on the wall at the level of the anterior superior iliac crest and patella. Half of the distance between the two marks was marked using a piece of tape. The participants were asked to lift their knees to the height marked by the tape while treading in place as quickly as possible for 2 minutes. The number of steps taken on the right side to reach the criterion height was counted for each participant and recorded.\textsuperscript{23}

In the FTSST protocol, the participants were asked to stand up and sit down as fast as possible five times with their arms folded across their chests. Two trials were conducted with a rest period of 1 minute between trials. The average time of two trials was recorded as the test result.\textsuperscript{24}

In the leg strength protocol, the participants were instructed to stand with their feet shoulder-width apart on the dynamometer base and hold onto a bar with their hands. The chain was adjusted such that the knees were flexed at 110°. The participants were then asked to pull as hard as possible on the chain while trying to straighten their legs and keep their upper limbs straight without flexing their backs. Each subject performed two trials and the max-
The TUG protocol involved measuring the time required for the participants to rise from a chair with an approximate seat height of 46 cm, walk 3 m to a line on the floor, turn, walk back to the chair, and sit down again. The participants had one practice walk-through before being timed for three attempts with 1-minute rest intervals and verbal encouragement. The shortest time was recorded for analysis.

3. Statistical Analysis
We computed the descriptive statistics, including means, standard deviations, and percentages, for the participant characteristics and study outcomes. Receiver operating characteristic (ROC) curve analysis was used to identify the accuracy of the 2MST in differentiating older adults with hypertension with and without functional impairment. We used a 6MWT cut-off of 320 m, which is associated with low exercise endurance in older adults. Based on these cutoffs, we identified the threshold for the 2MST to identify functional impairments. The area under the curve (AUC), best cut-off point, sensitivity, and specificity were identified. We compared older adults with hypertension below or above the cut-off point in the 2MST using the independent samples t-test or Mann–Whitney U test, as appropriate. Physiological responses—blood pressure (BP), heart rate (HR), and oxygen saturation (O2 sat)—and differences between the 2MST and 6MWT were evaluated using dependent samples t-test or signed-rank test. Leg fatigue and dyspnea scores were measured using the signed-rank test. Pearson correlation coefficient was used to verify the correlation between the 2MST and 6MWT, handgrip strength, leg strength, TUG, FTSST, and 6MWT distances. The AUC was 0.91 (95% confidence interval, 0.84–0.97).

Table 1. Characteristics of hypertensive older adults (n=91)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Hypertensive older adults</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>70.29 ± 4.95</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>45 (49.45)</td>
</tr>
<tr>
<td>Female</td>
<td>46 (50.55)</td>
</tr>
<tr>
<td>Body weight (kg)</td>
<td>58.59 ± 0.71</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>160.94 ± 12.02</td>
</tr>
<tr>
<td>BMI (kg/m2)</td>
<td>22.59 ± 3.85</td>
</tr>
<tr>
<td>PAQ-EJ score (METs, hr/wk)</td>
<td>8.77 ± 5.23</td>
</tr>
<tr>
<td>SBP (mmHg)</td>
<td>135.91 ± 16.55</td>
</tr>
<tr>
<td>DBP (mmHg)</td>
<td>73.31 ± 9.20</td>
</tr>
<tr>
<td>Duration of hypertension (y)</td>
<td>8.87 ± 3.54</td>
</tr>
<tr>
<td>Comorbidities</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>8 (8.79)</td>
</tr>
<tr>
<td>Diabetes</td>
<td>44 (48.4)</td>
</tr>
<tr>
<td>Dyslipidemia</td>
<td>35 (38.46)</td>
</tr>
<tr>
<td>Orthopedic problems (gout, rheumatoid disease)</td>
<td>9 (9.89)</td>
</tr>
<tr>
<td>Cardiovascular disease</td>
<td>8 (8.79)</td>
</tr>
</tbody>
</table>

Values are presented as mean±standard deviation or number (%).

As shown in Table 2, the 2MST had an optimal cut-off score of ≤ 60 steps, with a sensitivity of 87.50% and a specificity of 70.59%. The AUC was 0.91 (95% confidence interval, 0.84–0.97).

Compared to the group of participants that completed the 2MST with ≥ 60 steps, those that completed the test with < 60 steps had significantly lower handgrip strength, leg strength, TUG, FTSST, and 6MWT distances (p < 0.001), as well as significantly lower systolic blood pressure (SBP) and diastolic blood pressure (DBP) (p < 0.001 and p = 0.036, respectively). The HR, HR as a percentage of the predicted maximum, O2 sat, and dyspnea grade did not differ significantly between the groups (Table 3).

Table 4 shows the results of the comparison of physiological responses, dyspnea, and leg fatigue between the 2MST and 6MWT in older adults with hypertension. The HR in beats per minute (bpm) during the 2MST was significantly increased when compared to the 6MWT (86.91 ± 14.10 bpm vs. 83.02 ± 15.36 bpm; p < 0.001), as well as the HR in percentage of predicted maximum HR (57.10% ± 2.56% vs. 54.69% ± 2.20%; p < 0.001). SBP during the 2MST was also significantly higher than that during the 6MWT (154.33 ± 21.61 mmHg vs. 144.42 ± 18.71 mmHg; p < 0.001). The DBP and O2 sat levels did not differ significantly between the two tests (p = 0.452 and p = 0.050, respectively).

Regarding the subjective responses, the dyspnea and leg fatigue levels were significantly higher during the 2MST than those during the 6MWT (11.48 ± 2.73 vs. 10.54 ± 2.92, p = 0.004 and 2.12 ± 1.67 vs. 1.45 ± 1.33, p < 0.001, respectively). These results suggested...
Table 2. Optimal cut-off score, sensitivity, specificity, and AUC of the 2MST in all participants

<table>
<thead>
<tr>
<th>Number of participants</th>
<th>Cut-off (steps)</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>AUC (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>91</td>
<td>≤ 60</td>
<td>87.50</td>
<td>87.50</td>
<td>70.59</td>
</tr>
</tbody>
</table>

2MST, 2-minute step test; AUC, area under the curve; CI, confidence interval.

Table 3. Comparing physiological responses, dyspnea, leg fatigue, and functional ability in individuals below (n=31) or above (n=60) the 2MST cut-off point

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total (n = 91)</th>
<th>&lt; 60 steps (n = 31)</th>
<th>≥ 60 steps (n = 60)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>HR (beats/min)</td>
<td>85.26 ± 6.36</td>
<td>88.63 ± 10.20</td>
<td>88.63 ± 10.69</td>
<td>0.080</td>
</tr>
<tr>
<td>HR (%pred)</td>
<td>57.10 ± 2.56</td>
<td>58.61 ± 2.76</td>
<td>58.61 ± 2.76</td>
<td>0.182</td>
</tr>
<tr>
<td>SBP (mmHg)</td>
<td>153.16 ± 28.28</td>
<td>143.61 ± 18.62</td>
<td>143.61 ± 18.62</td>
<td>0.350</td>
</tr>
<tr>
<td>DBP (mmHg)</td>
<td>78.03 ± 1.41</td>
<td>76.13 ± 10.22</td>
<td>76.13 ± 10.22</td>
<td>0.036*</td>
</tr>
<tr>
<td>O₂ sat (%)</td>
<td>97.26 ± 0.00</td>
<td>97.82 ± 1.11</td>
<td>97.82 ± 1.11</td>
<td>0.357</td>
</tr>
<tr>
<td>Dyspnea (6–20 grade)</td>
<td>9.77 ± 0.00</td>
<td>11.60 ± 2.76</td>
<td>11.60 ± 2.76</td>
<td>0.595</td>
</tr>
<tr>
<td>Leg fatigue (0–10 grade)</td>
<td>1.47 ± 3.54</td>
<td>1.88 ± 1.69</td>
<td>1.88 ± 1.69</td>
<td>0.040*</td>
</tr>
<tr>
<td>2MST (step)</td>
<td>62.47 ± 14.68</td>
<td>70.35 ± 8.43</td>
<td>70.35 ± 8.43</td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td>Leg strength (kg)</td>
<td>50.04 ± 24.65</td>
<td>57.90 ± 25.65</td>
<td>57.90 ± 25.65</td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td>TUG (s)</td>
<td>11.71 ± 3.88</td>
<td>14.20 ± 5.12</td>
<td>14.20 ± 5.12</td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td>FTSST (s)</td>
<td>12.21 ± 3.57</td>
<td>11.25 ± 2.83</td>
<td>11.25 ± 2.83</td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td>6MWT (m)</td>
<td>334.56 ± 83.11</td>
<td>369.62 ± 61.53</td>
<td>369.62 ± 61.53</td>
<td>&lt; 0.001*</td>
</tr>
</tbody>
</table>

Values are presented as mean±standard deviation. HR, heart rate; SBP, systolic blood pressure; DBP, diastolic blood pressure; O₂ sat, oxygen saturation; 2MST, 2-minute step test; TUG, timed up and go test; FTSST, five time sit-to-stand test; 6MWT, 6-minute walk test. *p<0.05, statistically significant.

Table 4. A comparison of physiological responses, dyspnea, and leg fatigue between 6MWT and 2MST in hypertensive older adults (n=91)

<table>
<thead>
<tr>
<th>Variable</th>
<th>2MST</th>
<th>6MWT</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>HR (beats/min)</td>
<td>86.91 ± 14.10</td>
<td>83.02 ± 15.36</td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td>HR (%pred)</td>
<td>57.10 ± 2.56</td>
<td>54.69 ± 2.20</td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td>SBP (mmHg)</td>
<td>154.33 ± 21.61</td>
<td>144.42 ± 18.71</td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td>DBP (mmHg)</td>
<td>79.43 ± 10.81</td>
<td>78.58 ± 11.34</td>
<td>0.452</td>
</tr>
<tr>
<td>O₂ sat (%)</td>
<td>97.76 ± 1.19</td>
<td>97.46 ± 1.30</td>
<td>0.050</td>
</tr>
<tr>
<td>Dyspnea (6–20 grade)</td>
<td>11.48 ± 2.73</td>
<td>10.54 ± 2.92</td>
<td>0.004*</td>
</tr>
<tr>
<td>Leg fatigue (0–10 grade)</td>
<td>2.12 ± 1.67</td>
<td>1.45 ± 1.33</td>
<td>&lt; 0.001*</td>
</tr>
</tbody>
</table>

Values are presented as mean±standard deviation. 6MWT, 6-minute walk test; 2MST, 2-minute step test; HR, heart rate; SBP, systolic blood pressure; DBP, diastolic blood pressure; O₂ sat, oxygen saturation. *p<0.05, statistically significant.

Table 5. Relationships between the 2MST and demographic factors, handgrip strength, leg strength, TUG, and FTSST in hypertensive older adults

<table>
<thead>
<tr>
<th>Variable</th>
<th>r</th>
<th>2MST p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>-0.294</td>
<td>0.005*</td>
</tr>
<tr>
<td>Height</td>
<td>0.332</td>
<td>0.001*</td>
</tr>
<tr>
<td>Weight</td>
<td>0.144</td>
<td>0.172</td>
</tr>
<tr>
<td>6MWT</td>
<td>0.747</td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td>Handgrip strength</td>
<td>0.567</td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td>Leg strength</td>
<td>0.472</td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td>FTSST</td>
<td>-0.491</td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td>TUG</td>
<td>-0.632</td>
<td>&lt; 0.001*</td>
</tr>
</tbody>
</table>

Values are presented as mean±standard deviation. 2MST, 2-minute step test; 6MWT, 6-minute walk test; FTSST, five times sit-to-stand test; TUG, timed up and go test. *p<0.05, statistically significant.

that the 2MST may be more challenging in terms of cardiovascular and subjective responses than the 6MWT in older adults with hypertension (Table 4).

Table 5 presents the associations between the number of steps taken in the 2MST and various demographic and physical factors in older adults with hypertension. The results demonstrated a negative correlation between 2MST and age (r = -0.294, p = 0.005), a positive correlation with height (r = 0.332, p = 0.001), and no significant correlation with body weight (r = 0.144, p = 0.172).

The results of several physical fitness tests in the same population, including the 6MWT’ distance, grip strength, leg strength, TUG duration, and FTSST duration showed that the number of steps in the 2MST was positively associated with the distance of the 6MWT (r = 0.747, p < 0.0001), isometric grip strength (r = 0.567, p = 0.001), and negatively correlated with leg strength (r = -0.472, p < 0.001).
p < 0.0001), and isometric leg strength (r = 0.472, p < 0.0001). In contrast, the number of steps in the 2MST was negatively associated with FTSST (r = -0.491, p < 0.0001) and TUG (r = -0.632, p < 0.0001) duration (Table 5).

DISCUSSION

This study investigated the usefulness of the 2MST for assessing functional fitness in older individuals with hypertension and its correlation with other physical fitness tests. The results showed that the 2MST was effective in identifying functional limitations in this population, with a cutoff score of ≤ 60 steps indicating lower functional ability and physiological responses. Furthermore, the 2MST was more challenging than the 6MWT and was significantly correlated with demographic factors, handgrip strength, leg strength, TUG, and FTSST.

The 2MST was originally developed as a component of the Senior Fitness Test (SFT) by Rikli and Jones in 1999.16 The SFT is a comprehensive set of tests designed to evaluate physical fitness in older adults, with the 2MST specifically assessing aerobic endurance and lower body strength.25 Various studies have demonstrated the 2MST’s usefulness in assessing functional capacity and found it to be a reliable and valid measure of physical fitness in older adults.26 Our study found that a cutoff of 60 steps in the 2MST accurately distinguished older individuals with hypertension with or without functional impairment. This result is consistent with those of a previous study that identified the 2MST as the best predictor of functional capacity in hypertensive individuals, with an average of 69 repetitions and an AUC of 0.7.25 Individuals who performed < 60 repetitions in the 2MST exhibited longer times on the TUG and FTSST, indicating potential mobility and balance issues. These findings, along with lower handgrip and leg strength and higher leg fatigue, may suggest a decrease in overall physical fitness, including reduced endurance and physical capacity. Therefore, < 60 repetitions in the 2MST may serve as a useful marker for identifying functional impairment, indicating the need for interventions to improve physical fitness and functional capacity in individuals with hypertension.

The 2MST is a good measure of cardiorespiratory fitness when other submaximal fitness tests cannot be undertaken, such as the 6MWT, and involves lifting the knees to the mid-level between the patella and iliac crest; thus, it requires more intensity and a longer duration of single-leg support than the standard step.31 In our study of older adults with hypertension, the 2MST elicited a higher HR, SBP, dyspnea, and leg fatigue compared to the 6MWT. The biomechanics of the 2MST require greater lower-body strength, physical skills, and longer periods of single-leg support,32,33 which explained the higher physiological demand and RPE compared with the 6MWT. The RPE was significantly higher in the 2MST group than in the 6MWT group.

The 2MST and 6MWT exhibit a strong correlation, indicating that both tests are reliable measures of cardiorespiratory fitness.33 Our results are consistent with those of previous studies, which suggests that the 2MST can complement the 6MWT in various populations, including those with coronary artery disease,33 hypertension in older adults,16 symptomatic peripheral artery disease,34 and systolic heart failure.35 Additionally, other studies have reported an association between these tests in both healthy older individuals3 and those with pathologies6,36 suggesting that the 2MST can assess the integrated global response to exercise of all human body systems. We observed correlations between age, height, weight, and 2MST, suggesting that these factors may impact test performance and should be considered.

Our study results revealed significant inverse correlations between the 2MST and two functional mobility tests, the FTSST and TUG, which assess the ability to complete tasks such as standing up from a chair or standing on one leg. These results reinforce the strong relationship between cardiovascular endurance and functional mobility. A negative correlation implies that poor cardiovascular endurance may lead to poor functional mobility, and vice versa. These results are consistent with those of previous studies reporting a correlation between functional capacity and functional mobility in older adults with hypertension.16,17 Moreover, we observed a significant positive correlation between 2MST, handgrip strength, and leg strength. This supports prior research indicating a relationship between the 2MST and quadriceps strength in patients with systolic heart failure.35 In older adults, maintaining strong handgrip and leg muscles is crucial not only for completing daily tasks but also for reducing the risks of mortality, functional decline, disability, and falls.37-39 Moreover, poor aerobic endurance and leg strength contribute significantly to slow gait velocity in community-dwelling patients with stroke.40

In conclusion, the 2MST is a useful tool for assessing functional capacity in older individuals with hypertension, with a cut-off of 60 steps accurately identifying functional impairment. The 2MST was positively correlated with the 6MWT, grip strength, and leg strength and negatively associated with the FTSST and TUG duration.

ACKNOWLEDGMENTS

The authors thank all the men and women who participated in this study.
CONFLICT OF INTEREST
The researcher claims no conflicts of interest.

FUNDING
This research was supported by Thailand Science Research and Innovation funds and the University of Phayao (Grant No. FF-RIM804 and FF66-UoE009).

AUTHOR CONTRIBUTIONS
Conceptualization, AS; Data curation, AS, PP; Funding acquisition, AS; Investigation, AS, TP, NS; Methodology, AS, TP, NS; Writing-original draft, AS, PA; Writing-review and editing, AS, PA, PP.

REFERENCES
25. Bandinelli S, Benvenuti E, Del Lungo I, Baccini M, Benvenuti F, Di Iorio A, et al. Measuring muscular strength of the lower limbs by hand-held dynamometer: a standard protocol. Aging (Mila-
Balance Ability and Quality of Life in Older Adult with Recovery from Mild COVID-19

Patchareeya Amput1,2, Weerasak Tapanya1,2, Noppharath Sangkarit1,2, Saisunee Konsanit3, Sirima Wongphon1

1Department of Physical Therapy, School of Allied Health Sciences, University of Phayao, Phayao, Thailand
2Unit of Excellence of Human Performance and Rehabilitation, University of Phayao, Phayao, Thailand
3Department of Traditional Chinese Medicine, School of Public Health, University of Phayao, Phayao, Thailand

Background: In this study, we aimed to assess the ability to balance and quality of life (QoL) among older adults without a history of coronavirus disease 2019 (COVID-19) and those who had recovered from mild COVID-19. Methods: We recruited 80 older adults and categorized them into the following two groups based on their history of COVID-19: those without COVID-19 (n=40) and those who had recovered from mild COVID-19 (n=40). We assessed the participants’ ability to balance using the multi-directional reach test and timed up and go (TUG) test, and evaluated their QoL using the Short Form-36. Results: Compared with older adults without a history of COVID-19, those who had recovered from mild COVID-19 demonstrated no differences in the scores of the forward, backward, right, and left directions (p>0.05), but a significantly longer duration for the TUG test (p=0.02) and a reduced QoL. Conclusion: Our study results demonstrated decreased ability to balance and poor QoL among older adults who had recovered from mild COVID-19.

Key Words: Post-COVID-19, Older adult, Balance, Quality of life, Mild-COVID-19, TUG test

INTRODUCTION

The coronavirus disease 2019 (COVID-19) first appeared in Wuhan, China, and spread rapidly worldwide.1 It is known to cause serious health problems including croup, cold, and bronchiolitis.2 In addition, COVID-19 affects the neurological system, particularly the ability to balance.3 Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) binds to angiotensin-converting enzyme 2 (ACE2) receptors and invades human cells, resulting in adverse effects on the central nervous system (CNS)4,5 and leading to blood-brain barrier damage.6 Moreover, SARS-CoV-2 activates neuroinflammation resulting from the influx of cytokines into different sites of the CNS.6 These factors lead to neurological and neuromuscular systems dysfunction, resulting in postural instability and impaired ability to balance.5,6,7 Furthermore, these impairments are not present in the acute phase of COVID-19 but rather appear post-COVID-19.7 Previous studies have reported that patients post-COVID-19 experience memory loss, headache, vertigo, sleep disturbances, myalgia, brain fog, peripheral neuropathies, fatigue, and depression.5,7 Therefore, neuromuscular changes caused by SARS-CoV-2 infection lead to poor postural balance, resulting in a low patient quality of life (QoL) post-COVID-19.8,9 Previous studies have reported poorer postural balance in patients post-COVID-19 compared to healthy controls, which is related to fatigue and low QoL.8,9 Older adults with COVID-19 show symptoms of multisystem involvement and an increased risk of death.10,11 In addition, older adults with prolonged COVID-19 infection exhibit neurocognitive symptoms, such as mood disorders, mental conditions, and anxiety.12 However, the ability to balance and QoL in older adults who have recovered from mild COVID-19 have not yet been evaluated. Therefore, in this study, we aimed to assess the ability to balance using the multi-directional reach test (MDRT) and timed up and go (TUG) test and evaluate QoL using the Short Form-36 (SF-36) in older adults who had re-
covered from mild COVID-19 and those with a history of COVID-19. This study would offer valuable insights to older adults who are recovering from mild COVID-19, aiding in the identification of balance disorders. We hypothesized that older adults recovering from mild COVID-19 would have reduced ability to balance and poor QoL than those of older adults without a history of COVID-19.

MATERIALS AND METHODS

Study Design and Participants

This cross-sectional study assessed the ability to balance using the MDRT and TUG tests and evaluated QoL using the SF-36 in older adults without a history of COVID-19 and older adults who had recovered from mild COVID-19. This study was approved by the Clinical Research Ethics Committee of the University of Phayao, Phayao, Thailand (IRB Code 1.3/032/65). Also, this study complied the ethical guidelines for authorship and publishing in the Annals of Geriatric Medicine and Research.

We recruited 80 older adults without a history of COVID-19 and those who had recovered from mild COVID-19 and categorized them into two groups (n = 40/group). The sample size was calculated using a power of 0.90, power analysis with an alpha of 0.05, and effect size d of 0.4. The inclusion criteria were as follows: patients aged 60 years or above, without a history of COVID-19 or those recovering from mild COVID-19 with confirmation of infection by SARS-CoV-2 using polymerase chain reaction (PCR) or antigen test kit performed at least 3 months before the evaluation procedure, with normal body mass index (BMI) values (18.5–24.9 kg/m²), and ability to stand and walk without assistive walking devices. The exclusion criteria were participants who had problems with hearing, communication, vision, standing, or walking; balance impairment; history of back or lower limb surgery, inability to raise the arms to 90°; or scoliosis affecting the ability to stand or walk.

Procedures

The MDRT protocol encompassed assessments in forward, backward, right-sided, and left-sided directions. A 100-cm yardstick attached to a tripod was set parallel to the floor at the height of the participant’s acromion process. The participants were instructed to stand on the floor without wearing shoes and to lift an outstretched arm to shoulder height. We recorded the lengths at the fingertips as the initial reach data. Subsequently, the participants were instructed to reach as far as they could while maintaining alignment with the yardstick, without moving their feet or taking a step from the floor. They were then instructed to lean back as far as possible toward the right and left, respectively. The distance score for each direction was calculated from the initial reach. We recorded three successful trials for each direction.

In the TUG test protocol, the participants were instructed to get up from the chair at the signal, walk to a marker, go around it, return to the chair, and sit down promptly resuming a sitting posture. The test commenced with participants seated upright with a vertical posture, hands resting on the thighs, and feet planted flat on the ground. The participants were reminded that the test was time-bound and the goal was to walk expeditiously without running.

We assessed the participants’ QoL using the SF-36. This questionnaire includes eight dimensions comprising a list of questions about various aspects of QoL, including physical functioning, physical role limitations, bodily pain, general health perceptions, vitality, social functioning, emotional role limitations, and mental health. The result is a score ranging from 0 to 100, with higher scores indicating a better QoL.

Statistical Analysis

Descriptive statistics were used to present the demographic data. The independent sample t-test was used to compare MDRT scores, TUG test duration, and SF-36 scores between older adults without a history of COVID-19 and those who had recovered from mild COVID-19. We performed the statistical analysis using IBM SPSS Statistics for Windows, version 22.0 (IBM Corp., Armonk, NY, USA), with a p-value < 0.05 indicating significance.

RESULTS

A total of 80 older adults without COVID-19 and those who recovered from mild COVID-19 voluntarily participated in this
study. The participants’ characteristics are summarized in Table 1. Most participants were female, and the average age and BMI did not differ between the two groups.

All participants completed the MDRT. We observed no differences in the scores of the forward, backward, right-side, and left-side directions between older adults who had recovered from mild COVID-19 and those without a history of COVID-19 (p > 0.05). The highest and lowest MDRT scores were observed in the forward and backward directions, respectively (Table 2).

All participants successfully completed the TUG test. Older adults who had recovered from mild COVID-19 demonstrated a significantly longer duration for the TUG test than those of the older adults without a history of COVID-19 (p = 0.02) (Table 3).

Our results demonstrated significantly lower scores in terms of physical functioning, physical role limitations, bodily pain, general health perceptions, vitality, social functioning, emotional role limitations, and mental health among older adults who had recovered from mild COVID-19 than among those without a history of COVID-19 (p < 0.05) (Table 4).

**DISCUSSION**

The results of the present study demonstrated decreased ability to balance and poor QoL among older adults who had recovered from mild COVID-19. Additionally, this group demonstrated longer duration for the TUG test and worse scores for the eight dimensions of the SF-36 questionnaire than those of the older adults without a history of COVID-19; however, no difference was observed for the scores in the four directions of the MDRT.

We observed no difference in MDRT scores in any direction between older adults with no history of COVID-19 and those who had recovered from mild COVID-19. These results may be because the participants in both the groups had similar BMI. A previous study reported lower ability to balance among older adults who were overweight or obese than among those with normal weight. Moreover, older adults who were overweight or obese had significantly reduced MDRT scores in the forward, backward, right-side, and left-side directions than those of older adults with normal weight. The amount of adipose tissue is increased in individuals with overweight and obesity, leading to reduced stability of postural control in these individuals. In addition, individuals

---

**Table 1.** Characteristics of the older adults without COVID-19 and older adults with recovery from mild COVID-19

<table>
<thead>
<tr>
<th>Variable</th>
<th>Older adults without COVID-19 (n = 40)</th>
<th>Older adults with recovery from mild COVID-19 (n = 40)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>68.95 ± 4.40</td>
<td>67.53 ± 4.55</td>
<td>0.97</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>15</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>25</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Weight (kg)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>52.13 ± 6.16</td>
<td>53.35 ± 6.45</td>
<td>0.81</td>
</tr>
<tr>
<td>High (cm)</td>
<td>155.38 ± 0.06</td>
<td>156.83 ± 0.08</td>
<td>0.22</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td></td>
<td></td>
<td>0.17</td>
</tr>
<tr>
<td></td>
<td>21.70 ± 1.98</td>
<td>21.66 ± 1.70</td>
<td></td>
</tr>
</tbody>
</table>

Values are presented as mean±standard deviation. COVID-19, coronavirus disease 2019; BMI, body mass index.

**Table 2.** The comparison between score of MDRT in older adults without COVID-19 and older adults with recovery from mild COVID-19

<table>
<thead>
<tr>
<th>Variable</th>
<th>Older adults without COVID-19 (n = 40)</th>
<th>Older adults with recovery from mild COVID-19 (n = 40)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward (cm)</td>
<td>18.77 ± 4.18</td>
<td>17.29 ± 3.03</td>
<td>0.10</td>
</tr>
<tr>
<td>Backward (cm)</td>
<td>11.75 ± 2.79</td>
<td>11.20 ± 6.24</td>
<td>0.24</td>
</tr>
<tr>
<td>Right-side (cm)</td>
<td></td>
<td></td>
<td>0.39</td>
</tr>
<tr>
<td>Left-side (cm)</td>
<td>13.85 ± 3.06</td>
<td>13.05 ± 2.76</td>
<td>0.71</td>
</tr>
</tbody>
</table>

Values are presented as mean±standard deviation. COVID-19, coronavirus disease 2019; MDRT, multi-directional reach test.

**Table 3.** Comparison between duration TUG in older adults without COVID-19 and older adults with recovery from mild COVID-19

<table>
<thead>
<tr>
<th>Variable</th>
<th>Older adults without COVID-19 (n = 40)</th>
<th>Older adults with recovery from mild COVID-19 (n = 40)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>TUG (s)</td>
<td>7.30 ± 0.86</td>
<td>10.61 ± 1.31</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Values are presented as mean±standard deviation. COVID-19, coronavirus disease 2019; TUG, time up and go test.
Older adults with recovery from mild COVID-19 (n = 40) had an average TUG test duration of 57.25 ± 8.16 seconds, indicating adequate ability to balance. However, those who had recovered from mild COVID-19 required significantly more time to complete the tests than that of older adults without a history of COVID-19 and those who had recovered from mild COVID-19. This is because the ankle and foot biomechanical arrangements provide greater forward walking ability than backward walking ability. Moreover, humans have greater control over balance in the forward direction because they are involved in moving the body forward in activities of daily life (ADL). Additionally, significant energy is required to shift the body weight to the rear because a person cannot exert visual control over the feet during movement. These findings indicate that older adults without a history of COVID-19 exhibit greater ability to balance in the forward direction than in the backward direction or to the right or left direction.

Balance is important not only for posture stability but also for performing safe ADL. ADL are associated with multiple tasks, including rising from a chair, standing, walking, and turning. Therefore, the TUG test was used to assess these conditions. This test can assess various aspects of ability to balance, including posture, mobility, agility, transitioning from sitting to standing position, walking stability, and gait speed, in older adults. Older adults with TUG test duration of > 13.5 seconds are at a higher risk of experiencing falls. However, in the present study, older adults without a history of COVID-19 and those who had recovered from mild COVID-19 had average TUG test duration of < 13.5 seconds, indicating adequate ability to balance. However, older adults who had recovered from mild COVID-19 required significantly more time to complete the tests than that of older adults without a history of COVID-19. These findings suggested that older adults who had recovered from mild COVID-19 had reduced ability to balance than those without a history of COVID-19. These findings are consistent with those of a previous study demonstrating lower postural balance among patients with post-acute COVID-19 syndrome than among healthy controls. These results may be due to the activation of neuroinflammation by SARS-CoV-2 resulting from the influx of cytokines into different sites of the CNS, leading to prolonged generalized symptoms such as impaired postural balance and fatigue.

Compared to older adults without a history of COVID-19, those who had recovered from mild COVID-19 exhibited lower QoL, including physical functioning, physical role limitations, bodily pain, general health perceptions, vitality, social functioning, emotional role limitations, and mental health. These results are consistent with those of previous studies demonstrating significant decreases in the eight domains of the SF-36 questionnaire among patients post-COVID-19 compared to a healthy controls. In addition, a previous study reported notable declines in the domains of physical functioning, physical role limitations, bodily pain, general health perceptions, and mental health in the SF-36 among patients with post-acute COVID-19 syndrome than among healthy controls. These results may be attributed to dyspnea, impaired mental health, and neuropsychological disorders, resulting in decreased QoL in patients with prolonged COVID-19 infection. Therefore, the reduced QoL in older adults recovering from mild COVID-19 may occur from their reduced ability to balance.

This study may be limited by variables that can influence an individual's ability to balance. Factors, including muscle strength and endurance of the lower limbs, may attain statistical significance with more suitable variables. Future studies should investigate these variables to enrich our understanding of balance dynamics and its implications for individuals' well-being.

In conclusion, the present study is the first to comprehensively assess the impact of COVID-19 on individuals' ability to balance in various directions and performing ADL. The findings from the

<table>
<thead>
<tr>
<th>Variable</th>
<th>Older adults without COVID-19 (n = 40)</th>
<th>Older adults with recovery from mild COVID-19 (n = 40)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical functioning</td>
<td>74.90 ± 11.96</td>
<td>61.75 ± 5.94</td>
<td>0.001</td>
</tr>
<tr>
<td>Physical role limitations</td>
<td>76.95 ± 10.50</td>
<td>62.28 ± 6.56</td>
<td>0.004</td>
</tr>
<tr>
<td>Bodily pain</td>
<td>58.75 ± 11.81</td>
<td>54.75 ± 16.17</td>
<td>0.011</td>
</tr>
<tr>
<td>General health perceptions</td>
<td>70.75 ± 10.95</td>
<td>57.25 ± 8.16</td>
<td>0.007</td>
</tr>
<tr>
<td>Vitality</td>
<td>68.50 ± 11.89</td>
<td>59.50 ± 9.04</td>
<td>0.035</td>
</tr>
<tr>
<td>Social functioning</td>
<td>70.18 ± 11.11</td>
<td>60.08 ± 7.03</td>
<td>0.007</td>
</tr>
<tr>
<td>Emotional role limitations</td>
<td>86.50 ± 8.34</td>
<td>63.25 ± 11.63</td>
<td>0.042</td>
</tr>
<tr>
<td>Mental health</td>
<td>85.00 ± 5.99</td>
<td>65.75 ± 9.64</td>
<td>0.018</td>
</tr>
</tbody>
</table>

Values are presented as mean ± standard deviation. COVID-19, coronavirus disease 2019.
References


20. Ku PX, Abu Osman NA, Yusof A, Wan Abas WA. Biomechani-
240 Pathareeya Amput et al.


INTRODUCTION

Since the World Health Organization (WHO) declared the coronavirus disease 2019 (COVID-19) pandemic on March 12, 2020, as of July 3, 2023, a total of 32,131,606 cumulative confirmed cases of COVID-19 in Korea have been recorded by the WHO. However, some individuals, particularly older adults, and those with underlying health conditions, may experience severe respiratory distress and other complications.

Previous COVID-19-related research in Korea examined the impact of the comorbidity burden on mortality in patients infected with the virus. However, these studies were limited in scope, relying on data from only 7,590 patients registered until May 15, 2020, and did not specifically focus on older adults. Although studies have been conducted in Wuhan, China, to examine the association between acute respiratory distress syndrome (ARDS), mortality,
and risk factors, these studies used data from the overall age range of infected individuals. Another study conducted in South Korea that evaluated the COVID-19 case fatality risk found that, while younger age groups had higher infection rates, older adults had higher mortality rates. However, that study had limitations owing to its relatively small sample size.

The COVID-19 pandemic has majorly impacted global health, particularly among older adults who are more vulnerable to severe illness and mortality. Understanding the risk factors associated with COVID-19 infection and mortality in this population is crucial for effective prevention and management strategies. South Korea has implemented comprehensive healthcare systems including universal health coverage, providing an ideal setting for investigating these risk factors.

This study aimed to identify key risk factors contributing to COVID-19 infection and mortality among older adults in South Korea. Age, comorbidity burden, disease severity, and insurance type were examined to assess their associations with infection and mortality rates. By utilizing a large-scale nationwide cohort, this study provides robust evidence of specific risk factors affecting this population.

**MATERIALS AND METHODS**

**Data Source**

We used the Korea Disease Control and Prevention Agency-COVID-19-National Health Insurance Service (K-FOX-N) cohort data from the National Health Insurance Service (NHIS). The data are provided through the universal health coverage for Koreans. Data from the population aged ≥ 65 years registered between January 1, 2019, and December 31, 2019, were used for analysis. Death was defined as the loss of national health insurance qualification. For COVID-19 confirmation, individuals who claimed with the coronavirus code from January 1, 2020, to March 31, 2022, were included in the analysis. COVID-19 mortality was defined as death within 30 days from the coronavirus code entered for the last time until April 30, 22.

Using data from the National Health Insurance Corporation’s qualification information for 2020, specifically the data related to insured individuals in the 0th percentile of the calculated insurance premium for January 2020, we indirectly reflected the income level by considering the eligibility for NHIS beneficiaries or Medical Aid recipients. In South Korea, the national social security system, known as Medical Aid, provides medical assistance to low-income individuals who lack the means to sustain their livelihoods or who face financial difficulties.

**Study Population**

Data from a total of 7,802,796 (n = 6,725,628 of non-COVID-19; n = 1,077,168 of COVID-19) patients registered between January 1, 2020, and March 31, 2022, were obtained from the NHID database. Based on the qualification data for 2020, those aged ≥ 65 years were included. Among them, cases where the “C” code (cancer diagnosis) was entered more than once in the primary diagnosis or sub-diagnosis during the 10 years from January 1, 2010, to December 31, 2019, were excluded. Among the group of patients with confirmed COVID-19, only data from those aged ≥ 65 years were included, and the number of people entered by combining the coronavirus codes from January 1, 2020, to March 31, 2022, was confirmed. Death from COVID-19 was defined as death within 30 days of the last entry of the code U07.1 as a primary or sub-diagnosis, and deaths up to April 30, 22 were included (Fig. 1).

**Data Collection**

We utilized data on sex, age, type of insurance, residential area, Charlson Comorbidity Index (CCI), and disease severity. The CCI was calculated based on the diagnosis codes recorded from January 1, 2019, to December 31, 2019. Age groups were categorized as 65–74, 75–84, and ≥ 85 years. The mean and standard deviation were rounded to the nearest decimal place, while the percentages were rounded to the second decimal place. Insurance eligibility was divided into National Health Insurance and Medical Aid recipients. Residential areas were classified as capital regions, including Seoul, Gyeonggi Province, and Incheon.

Disease severity was classified by assessing whether specific treatment codes were present within the infectious period, enabling us to categorize hospitalization and the condition severity.

**Fig. 1.** Flow chart of this study. COVID-19, coronavirus disease 2019; NHID, National Health Information Database.
The treatment levels of "oxygen therapy" and "oxygen by mask or nasal prongs" were defined as "hospitalized mild disease," while "non-invasive ventilation or high-flow oxygen," "intubation and mechanical ventilation," and "ventilation + additional organ support (continuous renal replacement therapy [CRRT], extracorporeal membrane oxygenation [ECMO])" were categorized as "hospitalized severe disease" if implemented. The classification was based on the most severe point of the condition.

**Ethical Consideration**

This study was approved by the Institutional Review Board of Kyung Hee University Hospital (No. KHUH 2022-11-059). The requirement for informed consent was waived because this study used de-identified administrative data. Also, this study complied with the ethical guidelines for authorship and publishing in the *Annals of Geriatric Medicine and Research*. 8

**Statistical Analysis**

Using frequencies and percentages, we compared the characteristics of COVID-19 patients and individuals without confirmed infection. Additionally, we conducted a multivariate logistic regression analysis to identify the factors associated with the occurrence of and death due to COVID-19. We calculated adjusted odds ratios (ORs) for nine factors: region, sex, age group, CCI, four specific diseases, and MA status. We defined the significance level as two-tailed p-values < 0.05.

In the analysis of disease severity, we first compared confirmed cases that were not hospitalized with those that were hospitalized. Second, we compared "hospitalized severe disease" and deceased patients with other patients. Finally, we compared deceased patients with the remaining patients.

**RESULTS**

**Characteristics and Risk Factors for COVID-19 Infection**

Among the 7,415,620 participants, 44.33% resided in the capital region. Of the 1,030,954 infected individuals, 49.26% resided in the capital region. A total of 43.53% of non-infected individuals also lived in the capital region. Men comprised 41.87%, and 41.05% of the entire study population and infected individuals, respectively. The 65–74-year age group accounted for 4,263,439 individuals, representing 57.49% of the total population. Among them, 643,625 were affected by COVID-19, corresponding to 62.43% of the 1,030,954 infected individuals. In the 75–84-year age group, 286,940 individuals were affected by COVID-19. The OR for this age group compared with the 65–74-year age group was 0.756 (95% confidence interval [CI], 0.753–0.760), indicating a lower risk of infection. The population aged ≥ 85 years (790,234

| Table 1. Baseline characteristics of study and COVID-19 infection risk factor analysis |
|-----------------------------------------------|------------------|------------------|------------------|------------------|
| All (n = 7,415,620)                        | Undiagnosed (n = 6,384,666) | Diagnosed (n = 1,030,954) | OR (95% CI) |
| Residential area (other areas)*          | 4,128,628 (55.67) | 3,605,488 (56.47) | 523,140 (50.74) | 0.794 (0.791–0.797) |
| Sex, female                              | 4,310,600 (58.13) | 3,702,839 (58)    | 607,761 (58.95) | 1.040 (1.036–1.044) |
| Age (y)                                  | 74.2 ± 7.4        | 74.4 ± 7.4        | 73.5 ± 7.3      | 0.778 (0.774–0.781) |
| 65–74                                    | 4,263,439 (57.49) | 3,619,814 (56.7)  | 643,625 (62.43) | 1 (ref) |
| 75–84                                    | 2,361,947 (31.85) | 2,075,007 (32.5)  | 286,940 (27.83) | 0.778 (0.774–0.781) |
| ≥ 85                                     | 790,234 (10.66)   | 689,845 (10.8)    | 100,389 (9.74)  | 0.772 (0.769–0.776) |
| Morbidity status (Charlson Comorbidity Index) |
| 0                                         | 1,866,266 (25.17) | 1,640,556 (25.7)  | 225,710 (21.89) | 1 (ref) |
| 1                                         | 1,816,419 (24.49) | 1,560,782 (24.45) | 255,637 (24.8)  | 1.190 (1.183–1.198) |
| ≥ 2                                       | 3,732,935 (50.34) | 3,183,328 (49.86) | 549,607 (53.31) | 1.255 (1.248–1.261) |
| Disease                                   |                  |                  |                  |                  |
| Cardiovascular disease                    | 4,657,874 (62.81) | 4,009,958 (62.81) | 647,916 (62.85) | 1 (ref) |
| Cerebrovascular disease                   | 1,129,908 (15.24) | 963,240 (15.09)   | 166,668 (16.17) | 1.085 (1.079–1.092) |
| Diabetes mellitus                         | 2,411,182 (32.51) | 2,065,802 (32.36) | 345,380 (33.5)  | 1.053 (1.049–1.058) |
| Chronic respiratory disease               | 1,495,683 (20.17) | 1,270,376 (19.9)  | 225,307 (21.85) | 1.126 (1.120–1.132) |
| Socioeconomic status represented by national insurance status |
| Insurance beneficiaries                   | 6,920,374 (93.32) | 5,952,515 (93.23) | 967,859 (93.88) | 1 (ref) |
| Medical Aid                               | 495,246 (6.68)   | 432,151 (6.77)    | 63,095 (6.12)   | 1 (ref) |

Values are presented as mean±standard deviation or number (%). COVID-19, coronavirus disease 2019; OR, odd ratio; CI, confidence interval.

*Area except Seoul metropolitan area (Seoul, Gyeonggi Province, Incheon).
individuals, 10.66%) included 100,389 confirmed cases (9.74%). The OR was 0.789 (95% CI, 0.783–0.795), indicating a lower infection risk than that in the 65–74-year age group. These results suggested that the infection risk of COVID-19 did not necessarily increase with age and that the infection rate was lower in older age groups (Table 1).

Among the 1,030,954 confirmed cases, 225,710 (21.89%), 255,637 (24.8%), and 549,607 (53.31%) had CCI scores of 0, 1, and 2, respectively. Compared with the reference group with CCI scores of 0, the ORs were 1.217 (95% CI, 1.209–1.224) for a CCI score of 1 and 1.33 (95% CI, 1.321–1.339) for a CCI score ≥ 2. Thus, the infection rate increased with higher CCI scores.

Regarding the relationship between income level and susceptibility to infection, when considering medical insurance status, the OR for Medical Aid recipients compared to that for insurance beneficiaries was 0.898 (95% CI, 0.89–0.906). Thus, Medical Aid recipients had a lower risk of infection than insurance beneficiaries.

**Characteristics and COVID-19 Mortality**

Comparison of the risk of death based on residential area showed that 47.54% of the deceased individuals resided in the capital region. When using individuals residing in the capital region as the reference, the OR for non-capital region residents confirmed to have COVID-19 was 0.928 (95% CI, 0.903–0.955). Among all confirmed and deceased cases, 41.05% and 42.35% were men, respectively. The OR for the risk of death in women compared to men was 0.607 (95% CI, 0.59–0.625), indicating a higher risk of death in men. The average age of the confirmed cases was 73.5 years, while the average age of the deceased after confirmation was 82.4 years. Among all confirmed cases, 61.43% were aged 65–74 years, 27.83% were aged 75–84 years, and 9.74% were aged ≥ 85 years. Comparison of the risk of progression to death using the group aged 65–74 years as a reference, the OR for the 75–84 years age group was 4.406 (95% CI, 4.236–4.582), while that for the ≥ 85 years age group was 16.032 (95% CI, 15.399–16.691). Compared to the reference group with a CCI score of 0, the ORs for the risk of death after confirmation among patients with CCI scores of 1 and ≥ 2 were 1.172 (95% CI, 1.111–1.236) and 1.537 (95% CI, 1.459–1.618), respectively. This indicates that as the burden of comorbidities increased (higher CCI score), the risk of death also increased. Compared to the general population with medical insurance, patients with Medical Aid showed a higher risk of death.

| Table 2. Multivariate analysis of factors associated with COVID-19 death |
|-----------------|-----------------|-----------------|-----------------|
|                 | All diagnosed  | No COVID-19 death | COVID-19 death |
|                 | (n = 1,030,954) | (n = 1,010,104) | (n = 20,850) |
|                 | Crude          | Adjusted         | Crude          | Adjusted         |
| **Demographic** |                |                  |                |
| Seoul metropolitan area | 507,814 (49.26) | 497,902 (49.29) | 9,912 (47.54) | 1 (ref)          | 1 (ref)          |
| Other areasa | 523,140 (50.74) | 512,202 (50.71)  | 10,938 (52.46) | 1.073 (1.044–1.103) | 0.928 (0.903–0.955) |
| Sex, female | 607,761 (58.95) | 595,741 (58.98)  | 12,020 (57.65) | 0.947 (0.921–0.973) | 0.607 (0.590–0.625) |
| Age (y) | 73.5 ± 7.3 | 73.4 ± 7.1 | 82.4 ± 8.1 | 1 (ref) | 1 (ref) |
| 75–84 | 286,940 (27.83) | 278,933 (27.61) | 8,007 (38.4) | 16.214 (15.604–16.847) | 16.032 (15.399–16.691) |
| ≥ 85 | 100,389 (9.74) | 91,418 (9.05) | 8,971 (43.03) | 1 (ref) | 1 (ref) |
| **Morbidity status (Charlson Comorbidity Index)** | | | |
| 0 | 225,710 (21.89) | 223,402 (22.12) | 2,308 (11.07) | 1 (ref) | 1 (ref) |
| 1 | 255,637 (24.8) | 251,803 (24.93) | 3,834 (18.39) | 1.474 (1.399–1.552) | 1.172 (1.111–1.236) |
| ≥ 2 | 549,607 (53.31) | 534,899 (52.95) | 14,708 (70.54) | 1.727 (1.674–1.782) | 1.018 (0.984–1.052) |
| **Disease** | | | |
| Cardiovascular disease | 647,916 (62.85) | 632,423 (62.61) | 15,493 (74.31) | 1.727 (1.674–1.782) | 1.018 (0.984–1.052) |
| Cerebrovascular disease | 166,668 (16.17) | 160,495 (15.89) | 6,173 (29.61) | 2.227 (2.161–2.295) | 1.338 (1.295–1.383) |
| Diabetes mellitus | 345,380 (33.5) | 336,990 (33.36) | 8,390 (40.24) | 1.345 (1.308–1.383) | 1.142 (1.107–1.178) |
| Chronic respiratory disease | 225,307 (21.85) | 220,460 (21.83) | 4,847 (23.25) | 1.085 (1.050–1.121) | 0.887 (0.857–0.918) |
| **Socioeconomic status represented by national insurance status** | | | |
| Insurance beneficiaries | 967,859 (93.88) | 949,945 (94.04) | 17,914 (85.92) | 1 (ref) | 1 (ref) |
| Medical Aid | 63,095 (6.12) | 60,159 (5.96) | 2,936 (14.08) | 2.588 (2.487–2.693) | 1.692 (1.623–1.763) |

Values are presented as mean±standard deviation or number (%).
COVID-19, coronavirus disease 2019; OR, odd ratio; CI, confidence interval.
aArea except Seoul metropolitan area (Seoul, Gyeonggi Province, Incheon).
Correlation between Age and COVID-19 Severity and Length of Hospitalization

A total of 173,816 of 1,030,954 confirmed cases aged ≥ 65 years were hospitalized. The analysis was conducted by categorizing individuals into four groups based on the severity of hospitalization: non-hospitalized, hospitalized mild disease, hospitalized severe disease, and death. We evaluated severity based on the most severe condition during the treatment period.

First, using the non-hospitalized group as a reference, we divided the hospitalized patients into age groups and assessed the risk of hospitalization according to the OR. Taking the age group of 65–74 years as the reference, the ORs of hospitalization for the 75–84 and ≥ 85 years age groups were 2.007 (95% CI, 1.983–2.032) and 4.933 (95% CI, 4.857–5.01), respectively, indicating a higher risk of hospitalization with increasing age.

The group exhibiting severe disease during hospitalization was compared with the group showing lower disease severity. Age-specific risks were also compared. Taking the age group of 65–74 years as the reference, the ORs of hospitalization for the 75–84 and ≥ 85 years age groups were 3.129 (95% CI, 3.032–3.228) and 10.012 (95% CI, 9.685–10.35), respectively. Thus, the risk of progression to severe or higher COVID-19 severity increased with age. The comparison of mortality rates by age group showed an OR for the ≥ 85-years age group of 16.032 (95% CI, 15.399–16.691), indicating a significantly higher mortality rate as age increased, especially in the ≥ 85 years age group compared to the youngest age group. Finally, we compared the length of hospitalization by age, specifically among patients who were hospitalized for more than a week, with other confirmed cases as the control group. Among all infected individuals, 126,964 (12.32%) required hospitalization for more than 1 week.

Among the 643,625 infected individuals aged 65–74 years, 56,253 (8.74%) required hospitalization for more than one week. In comparison, 15.3% of those aged 75–84 years (OR = 1.762; 95% CI, 1.738–1.786) and 26.69% of those aged ≥ 85 years (OR = 3.515; 95% CI, 3.455–3.576) required hospitalization for more than one week. These findings confirmed that as age increases, the duration of hospitalization also tends to increase, indicating a higher need for hospitalization as individuals age. Table 3 shows the severities and hospitalization dates of COVID-19 patients classified by age, and Table 4 shows the results of the multivariate analysis.

DISCUSSION

Our study was conducted using a large-scale population-based cohort. The most influential factor in the severity and mortality rate of COVID-19 in older Korean adults was age. Furthermore, being a Medical Aid recipient and having multiple comorbidities increased the risk of COVID-19 infection progressing to mortality.

The risk of infection was lower for individuals with cardiovascular disease (OR = 0.974; 95% CI, 0.969–0.978) and diabetes (OR = 0.963; 95% CI, 0.958–0.968). In contrast, the risk of infection was higher in individuals with cerebrovascular disease (OR = 1.057; 95% CI, 1.051–1.063) and chronic respiratory disease (OR = 1.066; 95% CI, 1.061–1.072).

The risk of mortality increased significantly with cerebrovascular disease (OR = 1.338; 95% CI, 1.295–1.383) and diabetes (OR = 1.142; 95% CI, 1.107–1.178) but not for cardiovascular disease (OR = 1.018; 95% CI, 0.984–1.052) and chronic respirato-

### Table 3. Data of COVID-19 confirmed patients based on severity and length of hospitalization

<table>
<thead>
<tr>
<th></th>
<th>Total (n = 1,030,954)</th>
<th>Age group (y)</th>
<th>65–74 (n = 643,625)</th>
<th>75–84 (n = 286,940)</th>
<th>≥ 85 (n = 100,389)</th>
</tr>
</thead>
<tbody>
<tr>
<td>COVID-19 severity(^a)</td>
<td></td>
<td></td>
<td>65–74</td>
<td>75–84</td>
<td>≥ 85</td>
</tr>
<tr>
<td>Not hospitalized</td>
<td>857,138 (83.14)</td>
<td>572,423 (88.94)</td>
<td>225,171 (78.47)</td>
<td>59,544 (59.31)</td>
<td></td>
</tr>
<tr>
<td>Hospitalized mild</td>
<td>146,648 (14.22)</td>
<td>64,147 (9.97)</td>
<td>51,550 (17.97)</td>
<td>30,951 (30.83)</td>
<td></td>
</tr>
<tr>
<td>Hospitalized severe</td>
<td>6,318 (0.61)</td>
<td>3,183 (0.49)</td>
<td>2,212 (0.77)</td>
<td>923 (0.92)</td>
<td></td>
</tr>
<tr>
<td>Death</td>
<td>20,850 (2.02)</td>
<td>3,872 (0.6)</td>
<td>8,007 (2.79)</td>
<td>8,971 (8.94)</td>
<td></td>
</tr>
<tr>
<td>Hospitalization day (wk)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 1</td>
<td>903,990 (87.68)</td>
<td>587,372 (91.26)</td>
<td>243,025 (84.7)</td>
<td>73,593 (73.31)</td>
<td></td>
</tr>
<tr>
<td>≥ 1</td>
<td>126,964 (12.32)</td>
<td>56,253 (8.74)</td>
<td>43,915 (15.3)</td>
<td>26,796 (26.69)</td>
<td></td>
</tr>
</tbody>
</table>

Values are presented as number (%).

\(^a\)Hospitalized mild includes oxygen therapy, oxygen by mask or nasal prongs, hospital severe includes non-invasive ventilation, high-flow oxygen, intubation and mechanical ventilation, ventilation+additional organ support (continuous renal replacement therapy, extracorporeal membrane oxygenation); classification was based on the most severe point of the condition.

Table 4. Multivariate analysis on the correlation between age, severity, and length of hospitalization

<table>
<thead>
<tr>
<th>Hospitalized, mild disease or more severe severity</th>
<th>Total (^a)</th>
<th>Event (^b)</th>
<th>Adjusted OR (^c) (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 85 y</td>
<td>1,030,954</td>
<td>173,816 (16.86)</td>
<td>1 (ref)</td>
</tr>
<tr>
<td>65–74 y</td>
<td>643,625</td>
<td>71,202 (11.06)</td>
<td>2.007 (1.983–2.032)</td>
</tr>
<tr>
<td>75–84 y</td>
<td>286,940</td>
<td>61,769 (21.53)</td>
<td>3.129 (3.032–3.228)</td>
</tr>
<tr>
<td>≥ 85 y</td>
<td>100,389</td>
<td>40,845 (40.69)</td>
<td>4.933 (4.857–5.010)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hospitalized, severe disease or more severe severity</th>
<th>Total (^c)</th>
<th>Event (^d)</th>
<th>Adjusted OR (^e) (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 85 y</td>
<td>1,030,954</td>
<td>27,168 (2.64)</td>
<td>1 (ref)</td>
</tr>
<tr>
<td>65–74 y</td>
<td>643,625</td>
<td>7,055 (1.1)</td>
<td>3.129 (3.032–3.228)</td>
</tr>
<tr>
<td>75–84 y</td>
<td>286,940</td>
<td>10,219 (3.56)</td>
<td>4.406 (4.236–4.582)</td>
</tr>
<tr>
<td>≥ 85 y</td>
<td>100,389</td>
<td>9,894 (9.86)</td>
<td>10.012 (9.685–10.350)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Death</th>
<th>1,030,954</th>
<th>20,850 (2.02)</th>
<th>1 (ref)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 85 y</td>
<td>100,389</td>
<td>8,971 (8.94)</td>
<td>16.032 (15.399–16.691)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Admission ≥ 1 week</th>
<th>1,030,954</th>
<th>126,964 (12.32)</th>
<th>1 (ref)</th>
</tr>
</thead>
<tbody>
<tr>
<td>65–74 y</td>
<td>643,625</td>
<td>56,253 (8.74)</td>
<td>3.515 (3.455–3.576)</td>
</tr>
<tr>
<td>75–84 y</td>
<td>286,940</td>
<td>43,915 (15.3)</td>
<td>17.62 (17.38–17.86)</td>
</tr>
<tr>
<td>≥ 85 y</td>
<td>100,389</td>
<td>26,796 (26.69)</td>
<td>16.032 (15.399–16.691)</td>
</tr>
</tbody>
</table>

Values are presented as number (%).
COVID-19, coronavirus disease 2019; OR, odds ratio; CI, confidence interval.

\(^a\) Number of diagnosed, \(^b\) number of hospitalized patients, \(^c\) adjusted ORs for nine factors (region, gender, age group, Charlson Comorbidity Index, four specific diseases, medical aid status); \(^d\) hospitalized mild includes oxygen therapy, oxygen by mask or nasal prongs, hospital severe includes non-invasive ventilation, high-flow oxygen, intubation and mechanical ventilation, ventilation+additional organ support (continuous renal replacement therapy, extracorporeal membrane oxygenation); classification was based on the most severe point of the condition.

Previous studies compared factors such as sex, medical history, disease severity, and mortality related to COVID-19 infection between older and younger age groups.\(^9\)\(^11\) One study found that in all age groups, men had a higher oxygen demand and greater disease severity (p < 0.01, p = 0.0083).\(^9\)\(^11\) Furthermore, univariate analysis revealed that the risk of non-mild COVID-19 was significantly higher (p < 0.05) in middle-aged and older adults than in young adults.\(^9\) Another study using data from a total of 1,537 patients reported that in-hospital mortality was associated with older age after adjusting for age, hypertension, diabetes mellitus, and corticosteroid use (risk ratio [RR] = 2.01; 95% CI, 1.59–2.52).\(^9\) These findings are consistent with the main findings of the present study. However, the previous study had limitations in terms of a smaller sample size and shorter observation period (from May 2020 to August 2020) compared to our study.

A previous study conducted using COVID-19-confirmed case data registered in South Korea until May 15, 2020, that evaluated the association between CCI values (3, 4, and 5 or higher) and mortality also found an increasing trend in mortality with increasing age-adjusted CCI score.\(^12\) Although this study included data from a younger age group, a similar trend was observed in the present study.

In this study, patients with diabetes and cerebrovascular diseases had a higher COVID-19-related mortality rate, which is consistent with previously reported findings.\(^12\) However, we observed no significant relationship between cardiovascular disease and COVID-19-related mortality rates. In this study, the cardiovascular disease categories included hypertension, ischemic heart disease, cardiomyopathy, atrial fibrillation, and heart failure. Previous studies have demonstrated that each of these conditions contributes to increased mortality in COVID-19 patients. A review reported that hypertension, which is the most common underlying disease, can increase the severity and mortality rates of COVID-19. However, the use of renin–angiotensin–aldosterone system (RAAS) inhibitors may provide benefits in the course of the disease.\(^13\) Another study found that angiotensin-converting enzyme inhibitors (ACEIs) and angiotensin receptor blockers (ARBs) mitigate COVID-19 mortality rates in patients with hypertension.\(^14\) In the management of hypertension in South Korea, the most commonly used monotherapy is ARB (50.1%). Even in combination therapies (dual therapy), ARB/ACEi regimens dominate, accounting for 89.9% of cases.\(^14\) This contradictory relationship may explain the lack of significance between cardiovascular disease and COVID-19 mortality.

The chronic respiratory disease categories in the present study included obstructive pulmonary disease, chronic bronchitis, emphysema, asthma, persistent asthma, and bronchiectasis. According to the Global Initiative for Chronic Obstructive Lung Disease (GOLD) 2023 report, chronic obstructive pulmonary disease (OR = 0.887; 95% CI, 0.857–0.918).
(COPD) is more likely to worsen with severe COVID-19. However, the impact of COPD on the risk of COVID-19 is unclear, which is consistent with the low risk of infection in our study. In another study investigating the relationship between obstructive pulmonary disease (OPD) and COVID-19, a total of 7,549 patients with a history of COPD were included for comparison of mortality rate. The study found that patients with COPD had higher hospitalization rates (62% vs. 28%) and higher mortality rates (15% vs. 4%; adjusted OR = 2.1; 95% CI, 1.96–2.26; p < 0.001) compared to those without COPD. Regarding asthma, a cohort study compared the risk of COVID-19-related mortality between adults using low-dose inhaled corticosteroids (ICS) and those without asthma. The study did not observe a significant difference in mortality risk between patients with and without asthma. Another study suggested that one mechanism of asthma, involving type 2 airway inflammation and ACE2/TMPRSS2 receptor downregulation and the use of controllers such as ICS, might underrepresent COVID-19 symptoms.

In our study, patients with chronic respiratory disease showed decreased mortality rates (OR = 0.887; 95% CI, 0.857–0.918), which could be due to asthma. Second, the prevalence of COPD in South Korea is relatively high, reaching 13.4% in individuals aged ≥ 40 years. However, in COPD, symptoms may remain mild or go unnoticed until the lung function is compromised by > 50%. Moreover, many cases are attributed to aging-related symptoms, leading to underdiagnosis. Lastly, our study has some limitations in the results as we did not consider data on the severity of chronic respiratory disease.

Previous domestic studies examining the association between mortality from COVID-19 and socioeconomic income levels, considering characteristics such as age, sex, and underlying diseases, observed no significant difference in the risk of death between Medical Aid recipients and health insurance beneficiaries. In contrast, in our study, after adjusting for factors such as region, sex, age group, CCI, and major underlying diseases, we observed a higher mortality rate than infection rate in the Medical Aid patient group. This aligns with the findings of another systematic review and meta-analysis of 4.3 million patients from 68 studies which found that socioeconomic determinants were strongly associated with COVID-19 outcomes in racial and ethnic minority populations. The previous domestic study included only 7,590 confirmed cases as of May 15, 2020, which may explain the discordant results.

We identified age as the factor with the greatest impact on the infection rates and subsequent mortality. Therefore, prioritizing the vaccination of older adults may be warranted in future infectious disease situations. Additionally, as age increased, the length of hospitalization tended to increase. Given the gradual aging of society and the increasing elderly population, policies aimed at securing an adequate number of hospital beds are needed. Analysis of the data by insurance type showed a lower infection rate among Medical Aid recipients than among NHIS beneficiaries; however, the mortality rate of Medical Aid recipients was higher. This can be attributed not only to socioeconomic differences, as pointed out in previous studies on COVID-19 infection and mortality rates in the domestic healthcare environment with universal health coverage, but also to other factors that may have had a marked impact, such as poor underlying health conditions, rapid early testing and treatment, transmission-reducing behaviors, and regional preparedness. Considering the relatively high cost of self-testing kits and the surge in demand for masks, which have increased personal hygiene expenses, it is important to implement national policies that provide appropriate support and resources to Medical Aid recipients. This is crucial for preventing economic differences from translating into differences in infection and mortality rates.

Limitations and Strengths
This study has several strengths. First, it benefits from a nationwide cohort in which the entire population is enrolled in health insurance programs. This resulted in a large sample size, which increased the statistical significance of the findings. Additionally, the study focused exclusively on the elderly population aged ≥ 65 years. By identifying the most significant factors related to disease outcomes in older adults, who are generally considered vulnerable to infections due to the high prevalence of underlying health conditions, our findings can be utilized to prioritize management with limited resources in the event of future infectious diseases.

In addition, a previous study comparing age and COVID-19-related mortality in South Korea identified malignant neoplasms as having the highest hazard ratio among comorbidities. In the present study, we excluded patients diagnosed with cancer within the past 10 years to ensure distinctiveness in our analysis. However, this study had some limitations. First, as the population decreases with increasing age, the infection rate among older adults may have been underestimated in the OR. However, the sufficiently large OR for mortality suggests that the results remain valid for evaluating the severity of COVID-19 and the importance of age in policy decisions. Second, statistical errors may have occurred due to the relatively low proportion of Medical Aid recipients compared with that in the total population. According to the “2021 Medical Aid Statistical Yearbook” jointly published by the National Health Insurance Corporation and Health Insurance Review and Assessment Service in October 2022, the number of Medical Aid recipients was 1,516,525, accounting for approximately 2.9% of...
the total population (approximately 52.92 million). However, as 39.1% of Medical Aid recipients were aged ≥ 65 years and this study focused on this age group, our findings are highly significant in evaluating the relationship between COVID-19 and insurance status.

The study’s limitation lies in the use of insurance type as a proxy for access to healthcare without accounting for other factors such as living conditions, exposure to smoking, and work environments, which could also contribute to higher infection rates. Reports have suggested an association between smoking and COVID-19 progression and mortality. However, the present study did not include such data, indicating the need for further research in this area. Moreover, the reduction in mortality among individuals surveyed later in the data collection period could be attributed to the commencement of the national COVID-19 vaccination in South Korea.

In this study, the incidence of COVID-19 among Medical Aid beneficiaries was lower than that among NHIS beneficiaries, and the mortality of COVID-19 among Medical Aid beneficiaries was higher than that among NHIS beneficiaries. These findings are in stark contrast to the results of previous studies. While other studies have examined the early phase of the COVID-19 pandemic, our study covered a longer period of exceeding 2 years. Therefore, our study better reflects the trend of the COVID-19 pandemic. Because Medical Aid beneficiaries have relatively poor jobs, they may have lost their jobs due to the prolonged COVID-19 pandemic. Due to the COVID-19 pandemic, these individuals could not use community services such as welfare centers and senior citizen centers and likely spent more time at home. This may have reduced human contact, and consequently, reduced the prevalence of COVID-19. However, this is merely speculation, and no precise analysis has been performed. Further studies are needed to confirm this hypothesis. Our results may have been better supported if we had conducted a comparative analysis between COVID-19 infection status and COVID-19-related deaths. However, this analysis was not possible, which is a limitation of our study.

Lastly, as long COVID syndrome has gained attention, discussion continues regarding its long-term effects. However, this study did not evaluate long-term complications, which is a limitation that warrants further investigation.

Conclusion

The most significant factor for COVID-19 infection was the severity of the underlying health conditions, whereas age and socioeconomic status were the most critical factors for post-infection mortality. The results of this study suggest that in the event of a large-scale respiratory infection, policies should prioritize vaccination and the provision of hospital beds for the elderly, rather than focusing solely on underlying health conditions. For individuals receiving Medical Aid, it is crucial to implement measures such as rapid screening tests and ensure the availability of healthcare supplies to correct the pathways contributing to the worsening of infection.

Overall, the results of this study provide valuable insights for the development of policies and interventions in response to respiratory infections, emphasizing the importance of age, underlying health conditions, and socioeconomic factors in determining infection and mortality rates.

ACKNOWLEDGMENTS

This study was conducted as part of the public-private joint research on COVID-19 co-hosted by the Korea Disease Control and Prevention Agency (KDCA) and the National Health Insurance Service (NHIS). This study used the database of the KDCA and the NHIS for policy and academic research. The research number of this study is KDCA-NHIS-2022-1-528.

CONFLICT OF INTEREST

The researchers claim no conflicts of interest.

FUNDING

None.

AUTHOR CONTRIBUTIONS

Conceptualization, HL, SK; Data curation, JL, HL, JYL; Formal analysis, JL, HL; Investigation, JL, HL, JYL; Methodology; HL, SK; Project administration, HL, JL; Supervision, HL, JL, SK; Validation, HL, SK, JL, JYL; Writing-original draft, SL, SK; Writing-review & editing, SL, JL, JYL, BK, CWW, CK, JP, HL, SK.

REFERENCES

The Relationship between Chronic Musculoskeletal Pain and Sarcopenia Risk in Community-Dwelling Older Adults: A Cross-Sectional Study

Ulku Kezban Sahin¹, Aysun Yağcı Şentürk²

¹Therapy and Rehabilitation, Vocational School of Health Services, Giresun University, Giresun, Turkey
²Health Care Services, Tonya Vocational School of Higher Education, Trabzon University, Trabzon, Turkey

Background: This study aimed to better understand the relationship between chronic musculoskeletal pain and the risk of sarcopenia in older adults. Methods: The risk of sarcopenia was assessed in 210 older adults using the SARC-F (strength, assistance with walking, rising from a chair, ascending stairs, and falls) questionnaire. Geriatric pain measures were used to assess pain. We also recorded the pain sites (ankles/feet, wrists/hands, upper back, lower back, neck, shoulder, hips, and knees). Results: Participant mean age was 72.4±7 years, and 109 (51.9%) of the participants were female. The prevalence rates of sarcopenia and chronic musculoskeletal pain were 60% and 92.9%, respectively. Older adults at risk of sarcopenia had a higher mean age, body mass index (BMI), number of comorbidities and falls, presence of chronic pain, pain intensity, and pain sites. Sarcopenia risk was correlated with chronic pain intensity (current and last 7 days) (r=0.506, p<0.001 and r=0.584, p<0.001, respectively), multisite pain (r=0.442, p<0.001), and Geriatric Pain Measure score (r=0.730; p<0.001). Age (odds ratio [OR]=1.1; 95% confidence interval [CI], 1.0–1.2), BMI (OR=1.1; 95% CI, 1.0–1.2), and geriatric pain (OR=1.1; 95% Cl, 1.0–1.1) were associated with sarcopenia risk. Conclusions: The risk of sarcopenia is linked to chronic pain, which frequently occurs in geriatric populations. Our study results also showed that higher pain intensity was associated with a higher risk of sarcopenia. Older adults at risk for sarcopenia often experience chronic musculoskeletal pain, which must be better recognized. Moreover, its significance must be noted in the treatment process.

Key Words: Chronic pain, Aged, Sarcopenia, Musculoskeletal pain, Muscular atrophy

INTRODUCTION

Sarcopenia is a progressive and generalized skeletal muscle disorder characterized by accelerated loss of muscle mass and function in older adults.¹ It can lead to abnormal gait, balance disorders, falls, fractures, disability, and death in older adults.³ The varying reported prevalence rates, from 0.8% to 64.8%, can be attributed to differences in population, lifestyle, age, setting, and culture, as well as the instruments used to diagnose sarcopenia.¹⁻³

One of the most prevalent medical conditions in older adults (≥65 years), chronic pain, is also highly disabling. In older adults, chronic pain impairs mobility, is linked to depression and anxiety, and can damage social and familial ties.⁴ According to estimates, >50% of older adults experience chronic pain and 70% report experiencing pain at multiple sites.⁵ The most common painful conditions affecting older adults are arthritis-related; however, older adults also experience a high incidence of chronic systemic diseases that can cause pain, such as cancer-related, diabetes-related, and post-stroke pain. Additionally, pain may be a stressor that accelerates the decline in health and function as an individual ages. Compared to older adults without pain, those with pain are less physically active, have worse functional mobility, and experience more comorbidities.⁶ The consequences of pain, such as those discussed here, may contribute to increased susceptibility to sarcopenia.
nia and other geriatric syndromes that are prevalent in older adults.

Numerous studies have examined the relationships between pain and specific geriatric syndromes, including falls, depression, cognitive decline, and functional limitations.\textsuperscript{11-13}\footnote{While an increasing number of studies have examined how pain and sarcopenia are connected, so far, the results are inconsistent.\textsuperscript{14,15} Data from a prospective study showed that pain was a strong predictor of sarcopenia, except for knee pain.\textsuperscript{16}} In addition, the risk of sarcopenia may change depending on the nature of the pain being experienced, as pain intensity and location significantly affect functional impairments caused by pain. Therefore, the present study examined the relationship between chronic musculoskeletal pain and the risk of sarcopenia, pain intensity, and pain location in community-dwelling older adults.

**MATERIALS AND METHODS**

**Study Design and Participants**

The population for this cross-sectional research consisted of community-dwelling older adults in Teyyaredüzü District in Giresun and Akçaabat-Söğütü District in Trabzon, Turkey. The populations of Teyyaredüzü district and Söğütü neighborhood are 15,576 and 23,189, respectively.\textsuperscript{17-18} According to the information obtained from the Turkish Statistical Institute (Türkiye İstatistik Kurumu), older adults comprised 9.7% of the population in 2021. Among those, this study included 3,760 older adults.\textsuperscript{19} The sample size was calculated using OpenEpi version 3.01 (https://www.openepi.com) considering the prevalence of sarcopenia risk. Erbas Sacar et al.\textsuperscript{20} reported a sarcopenia prevalence of 12.7% in Turkey. Therefore, according to this prevalence, a minimum of 164 participants was required, with a margin of error of 5% and a confidence interval of 95%. Based on this prevalence rate, we evaluated 267 community-dwelling older adults for eligibility.

Forty-three older adults did not want to participate in the study, and 14 older adults did not meet the inclusion criteria. Therefore, this study included 210 older adults (Fig. 1). The inclusion criteria were age ≥ 65 years and Mini-Mental State Examination (MMSE) score of ≥ 24.\textsuperscript{21} The exclusion criteria were hearing impairments that could limit communication, presence of depression and neuropsychiatric pain, and unwillingness to participate in the study. The 15-item Geriatric Depression Scale (GDS-15) was used to assess depression. No, mild, moderate, and severe depression were defined as scores of 0–4, 5–8, 9–11, and 12–15, respectively.\textsuperscript{21} We applied the Leeds Assessment of Neuropathic Symptoms and Signs (LANSS) pain questionnaire to evaluate neuropathic pain. Among the 24 total point, 12 points or more suggest the presence of neuropathic pain.\textsuperscript{22}

**Ethics Approval and Consent to Participate**

The Ethics Committee of Ordu University for Clinical Researches (No. 2022/134) granted permission for this study, which was conducted according to the guidelines of the Declaration of Helsinki. Before the study started, all of the participants provided written permission. This study complied the ethical guidelines for authorship and publishing in the *Annals of Geriatric Medicine and Research*.\textsuperscript{24}

**Outcome Measures**

We recorded participant physical and sociodemographic information, including age, body mass index (BMI, kg/m\textsuperscript{2}), sex, education (years), number of comorbidities (hypertension, asthma, heart attack, cancer, kidney disease, diabetes, chronic lung disease, congestive heart failure, and arthritis), medications, and falls in the previous year. The MMSE was used to determine whether older adults were cognitively capable of participating in this study. In clinical practice and research, the MMSE is frequently used to assess general cognitive function. The possible MMSE scores range from 0 to 30, with higher scores indicating better cognitive performance.\textsuperscript{21}

The responses to the survey question “have you had pain in any part of your body that has lasted for 3 months or more?” were used to determine the presence of chronic musculoskeletal pain.\textsuperscript{22} Participants who responded “yes” to this question were considered to have chronic musculoskeletal pain. They were then asked, “in what part(s) of your body do you feel this pain?” which choices among the neck, shoulder, upper back, wrists or hands, lower back, hips, knees, ankles, or feet.

Comprehensive pain was assessed using the Geriatric Pain Measure (GPM), a 24-item scale that is easily applied in geriatric outpatients. This scale consists of five dimensions: pain with movement, withdrawal due to pain, pain intensity, pain with strenuous activities, and pain with other activities. Twenty-two scale items

![Fig. 1. Flow chart of study participants.](https://www.example.com/fig1.png)
The SARC-F questionnaire consists of five sections: falls (how many times the individual has fallen in the last year), ambulation (the individual's capacity to move about their room), rising from a chair (the individual's capacity to get up from a chair), climbing stairs (the individual's capacity to climb a flight of 10 stairs), and strength (the individual's capacity to lift 2.5 kg). The scores range from 0 to 2 points, with 0 meaning no difficulty, 1 meaning some difficulty, and 2 meaning great difficulty or inability. For falls, score of 0, 1, and 2 correspond to 0, 1–3, and ≥ 4 falls in the last year, respectively. Individuals with summed scores of the five component scores of ≥ 4 points from a possible range of 0–10 points are considered to be at risk for sarcopenia.25

Statistical Analyses
We performed the statistical analysis using IBM SPSS Statistics for Windows, version 20.0 (IBM Corp., Armonk, NY, USA). The normality of the distribution of the variables was checked using the Shapiro–Wilk test. Numbers and percentages were used to represent categorical variables, whereas means and standard deviations were used to represent continuous variables. The chi-square test for categorical variables was used to compare the sarcopenia risk (SARC-F < 4 and ≥ 4) and pain (mild, moderate, and severe) groups. Both independent samples t-test and Mann–Whitney U tests were used to compare continuous variables. The Pearson correlation coefficient was used to calculate the correlations between SARC-F scores and pain assessments (GPM total score, pain intensity today and in the last 7 days, and multisite pain). The correlations were graded as follows: 0.81–1.00, very strong; 0.61–0.80, strong; 0.41–0.60, moderate; and 0.40, weak.26 We applied multivariate logistic regression analyses to determine the association between chronic musculoskeletal pain and sarcopenia risk (SARC-F). We observed no multicollinearity between the independent variables according to the variance inflation factor (VIF) and correlation coefficient values. Statistical significance was set at p < 0.05.

RESULTS
We recruited a total of 210 older adults with a mean age of 72.4 ± 7.0 years. Most of the older adults were women (51.9%) and had chronic pain, multisite pain, and sarcopenia risk (60%). The mean age, BMI, proportion of female sex, comorbidities, presence of chronic pain, pain intensity, pain sites, and number of falls were higher in older adults at risk of sarcopenia. The demographic and clinical details of the participants are presented in Table 1.

In this study, most older adults (48.1%) experienced moderate pain. The subgroup prevalence of SARC-F scores according to pain severity is shown in Table 2. The SARC-F items and total scores differed among the three pain groups. The severe pain subgroup had more difficulty with the SARC-F items. As pain severity increased, the prevalence of sarcopenia also increased.

We observed a significant correlation between sarcopenia risk and chronic pain intensity (today and last 7 days), multisite pain, and total GPM score (p < 0.001) (Table 3). Assessment of the distribution of pain sites according to sarcopenia risk showed that older adults at risk of sarcopenia had higher numbers of all pain sites than did those without sarcopenia risk.

As shown in Table 4, the logistic regression model was statistically significant, χ²(3) = 128.534, p < 0.001. The model explained 62.1% (Nagelkerke R²) of the variance in the risk of sarcopenia. Age, BMI, and GPM were statistically significant variables in the logistic regression model. Increased age, high BMI, and severe pain were associated with increased risks of sarcopenia.

In older adults with and without sarcopenia, the knee, lower back, and upper back were the most common sites of pain (Fig. 2). Older adults at risk for sarcopenia had more chronic musculoskeletal pain than those without sarcopenia. Knee pain, which is the most common site of pain, was found in 75.4% of older adults at risk of sarcopenia, while it was 35.7% in older adults without sarcopenia risk.

DISCUSSION
In face-to-face interviews with community-dwelling older adults, > 50% of the study participants reported having pain for at least three months. In addition, the prevalence of sarcopenia risk, as determined using the SARC-F scale, was 60%. We observed the significant presence and severity of chronic pain in many older adults at risk for sarcopenia. We also demonstrated a significant correlation between chronic pain and the risk of sarcopenia in this cross-sectional study of older adults. As pain severity increased, the prevalence of sarcopenia also increased. Age, BMI, and pain severity increased the risk of sarcopenia. Furthermore, older adults at risk of sarcopenia reported more incidents of knee and multisite pain compared to...
### Table 1. Demographics and basal clinical features of the participants

<table>
<thead>
<tr>
<th></th>
<th>Total (n = 210)</th>
<th>SARC-F ≥ 4 (n = 126)</th>
<th>SARC-F &lt; 4 (n = 84)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>72.4 ± 7.0</td>
<td>73.8 ± 7.6</td>
<td>70.3 ± 5.7</td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>28.7 ± 6.1</td>
<td>29.7 ± 6.9</td>
<td>27.0 ± 3.9</td>
<td>0.001*</td>
</tr>
<tr>
<td>Sex, female</td>
<td>109 (51.9)</td>
<td>80 (63.5)</td>
<td>29 (34.5)</td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td>Education (y)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>72 (34.2)</td>
<td>54 (42.9)</td>
<td>18 (21.4)</td>
<td>0.002*</td>
</tr>
<tr>
<td>0–5</td>
<td>107 (51)</td>
<td>59 (46.8)</td>
<td>48 (57.1)</td>
<td></td>
</tr>
<tr>
<td>≥ 6</td>
<td>31 (14.8)</td>
<td>13 (10.3)</td>
<td>18 (21.5)</td>
<td></td>
</tr>
<tr>
<td>Number of comorbidity</td>
<td>2 (0–6)</td>
<td>2 (0–6)</td>
<td>1 (0–4)</td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td>Number of medications</td>
<td>2 (0–11)</td>
<td>2 (0–11)</td>
<td>1 (0–9)</td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td>Falls</td>
<td>1 (0–2)</td>
<td>1 (0–2)</td>
<td>0 (0–2)</td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td>Chronic pain, yes</td>
<td>195 (92.9)</td>
<td>125 (99.2)</td>
<td>70 (83.3)</td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td>SARC-F (0–10)</td>
<td>4 (0–10)</td>
<td>6 (4–10)</td>
<td>2 (0–3)</td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td>Geriatric pain measure</td>
<td>62 ± 22.7</td>
<td>73.9 ± 16.0</td>
<td>43.3 ± 18.6</td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td>Pain intensity today (0–10)</td>
<td>6 (0–10)</td>
<td>7 (0–10)</td>
<td>4 (0–10)</td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td>Pain intensity last 7 days (0–10)</td>
<td>6 (0–10)</td>
<td>6 (2–10)</td>
<td>4 (0–10)</td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td>Number of pain sites</td>
<td></td>
<td></td>
<td></td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td>0</td>
<td>15 (7.1)</td>
<td>1 (0.8)</td>
<td>14 (16.7)</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>46 (21.9)</td>
<td>16 (12.7)</td>
<td>30 (35.7)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>51 (24.3)</td>
<td>29 (23)</td>
<td>22 (26.2)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>35 (16.7)</td>
<td>25 (19.8)</td>
<td>10 (11.9)</td>
<td></td>
</tr>
<tr>
<td>4*</td>
<td>63 (30)</td>
<td>55 (43.7)</td>
<td>8 (9.6)</td>
<td></td>
</tr>
</tbody>
</table>

Values are presented as mean±standard deviation or number (%) or median (min–max).
SARC-F, strength, assistance with walking, rising from a chair, ascending stairs, and falls.
*p<0.05.

### Table 2. SARC-F: subgroup prevalence and item-response of indicators

<table>
<thead>
<tr>
<th>SARC-F</th>
<th>Response (%)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subgroup prevalence (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mild pain (0–29)</td>
<td>11.4</td>
<td></td>
</tr>
<tr>
<td>Moderate pain (30–69)</td>
<td>48.1</td>
<td></td>
</tr>
<tr>
<td>Severe pain (70–100)</td>
<td>40.5</td>
<td></td>
</tr>
<tr>
<td>Item-response</td>
<td></td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td>Strength-difficulty lifting and carrying 10 lb</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 (None)</td>
<td>58.3</td>
<td></td>
</tr>
<tr>
<td>1 (Some)</td>
<td>41.7</td>
<td></td>
</tr>
<tr>
<td>2 (A lot or unable)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Climb stairs-difficulty climbing a flight of 10 stairs</td>
<td></td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td>0 (None)</td>
<td>41.7</td>
<td></td>
</tr>
<tr>
<td>1 (Some)</td>
<td>58.3</td>
<td></td>
</tr>
<tr>
<td>2 (A lot or unable)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Assistance in walking-difficulty walking across a room</td>
<td></td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td>0 (None)</td>
<td>83.3</td>
<td></td>
</tr>
<tr>
<td>1 (Some)</td>
<td>16.7</td>
<td></td>
</tr>
<tr>
<td>2 (A lot or unable)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Rise from a chair-difficulty transferring from a chair or bed</td>
<td></td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td>0 (None)</td>
<td>70.8</td>
<td></td>
</tr>
<tr>
<td>1 (Some)</td>
<td>29.2</td>
<td></td>
</tr>
<tr>
<td>2 (A lot or unable without help)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Falls-times fallen in the past year</td>
<td></td>
<td>0.005*</td>
</tr>
<tr>
<td>0 (None)</td>
<td>70.8</td>
<td></td>
</tr>
<tr>
<td>1 (1–3 falls)</td>
<td>20.8</td>
<td></td>
</tr>
<tr>
<td>2 (≥ 4 falls)</td>
<td>8.3</td>
<td></td>
</tr>
<tr>
<td>SARC-F (total) ≥ 4</td>
<td></td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td>No</td>
<td>91.7</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>8.3</td>
<td></td>
</tr>
</tbody>
</table>

SARC-F, strength, assistance with walking, rising from a chair, ascending stairs, and falls.
*p<0.05.
Table 3. Correlations among sarcopenia risk and chronic pain intensity, multisite pain, and total score of GPM

<table>
<thead>
<tr>
<th></th>
<th>Multisite pain</th>
<th>Pain intensity today</th>
<th>Pain intensity last 7 days</th>
<th>GPM</th>
<th>SARC-F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multisite pain</td>
<td>-</td>
<td>0.436**</td>
<td>0.493**</td>
<td>0.547**</td>
<td>0.442**</td>
</tr>
<tr>
<td>Pain intensity today</td>
<td>0.436**</td>
<td>-</td>
<td>0.727**</td>
<td>0.847**</td>
<td>0.506**</td>
</tr>
<tr>
<td>Pain intensity last 7 days</td>
<td>0.493**</td>
<td>-</td>
<td>0.833**</td>
<td>-</td>
<td>0.584**</td>
</tr>
<tr>
<td>GPM</td>
<td>0.547**</td>
<td>0.847**</td>
<td>-</td>
<td>-</td>
<td>0.730**</td>
</tr>
<tr>
<td>SARC-F</td>
<td>0.442**</td>
<td>0.506**</td>
<td>0.584**</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

GPM, Geriatric Pain Measure; SARC-F, strength, assistance with walking, rising from a chair, ascending stairs, and falls.

**p<0.001.

Table 4. Logistic regression analysis between multisite pain, GPM score, and sarcopenia risk status

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>SE</th>
<th>Wald</th>
<th>df</th>
<th>Sig.</th>
<th>Exp(B)</th>
<th>OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>0.111</td>
<td>0.036</td>
<td>9.365</td>
<td>1</td>
<td>0.002*</td>
<td>1.117</td>
<td>1.041–1.199</td>
<td></td>
</tr>
<tr>
<td>BMI</td>
<td>0.118</td>
<td>0.046</td>
<td>6.526</td>
<td>1</td>
<td>0.011*</td>
<td>1.126</td>
<td>1.028–1.233</td>
<td></td>
</tr>
<tr>
<td>GPM</td>
<td>0.101</td>
<td>0.014</td>
<td>49.206</td>
<td>1</td>
<td>&lt;0.001*</td>
<td>1.106</td>
<td>1.075–1.138</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>-16.732</td>
<td>3.428</td>
<td>23.817</td>
<td>1</td>
<td>&lt;0.001</td>
<td>0.000</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

GPM, Geriatric Pain Measure; BMI, body mass index; SE, standard error; OR, odds ratio; CI, confidence interval.

Omnibus test (χ²=128.534, df=3, p<0.001), Hosmer–Lemeshow test (p>0.05), Nagelkerke R²=0.621.

*p<0.05.

Fig. 2. Distributions of pain site in older adults with and without sarcopenia risk.

those without sarcopenia.

In the present study, the risk of sarcopenia increased with advancing age and high BMI and was more prevalent in women than in men. Additionally, the mean age, BMI, and comorbidities were higher in older adults at risk for sarcopenia, in line with the literature. In previous research among older adults, these factors were also associated with an increased risk of sarcopenia. The possible explanations for these findings may be the significantly higher skeletal muscle mass, physical fitness, and muscle strength in men. In addition, muscle loss starts to increase at 70 years of age. The loss of muscle mass may be linked to a higher rate of disability, lower functional capacity, basal metabolic rate, and bone mineral density, which may have a detrimental impact on sarcopenia. Furthermore, aging and obesity induce fat infiltration into muscles.
Therefore, advanced age and high BMI may cause sarcopenia by impairing muscle quality and function. In addition to these factors, comorbidities such as diabetes and end-stage organ diseases are also associated with sarcopenia, as they cause losses of muscle mass and strength. These previous findings support our results related to female sex, age, BMI, and comorbidities.

We observed a prevalence of chronic pain of 92.9%, which is consistent with that reported in a previous study of 873 participants > 60 years of age. The previous study reported a prevalence of pain of 41.2% in women and 33.2% in men, with approximately 88% of patients aged 60–75 years of both sexes. In a one-year prospective cohort study, 64 (7.3%) older people who were followed for one year developed sarcopenia. Sarcopenia was more likely to occur in older adults who reported experiencing pain than in those who did not. Women and men with lower back pain, pain in more than one location, joint pain, and moderate-to-severe pain also had higher risks of sarcopenia, consistent with the results of the present study. Our findings regarding the relationship between chronic pain and sarcopenia risk are supported by the findings of previous studies that also reported associations between chronic pain and functional impairment. This relationship could be cyclic, where long-lasting pain leads to decreased activity, resulting in muscle weakening, further pain, and reduced activity. However, the exact duration for pain to prompt individuals to cease their physical activity and experience muscle loss remains undetermined; therefore, further research is warranted on this subject.

In this study, participants with severe pain had the highest prevalence of sarcopenia. Additionally, high pain severity was associated with an increased risk of sarcopenia. This could be because participants in the severe pain group were afraid of pain and did not want to perform maximal voluntary contractions. However, arthrogenous muscle inhibition is thought to occur because changes inafferent input from the affected joint cause decreased efferent motor neuron stimulation of nearby skeletal muscles to decrease. Furthermore, the etiology of pain, such as radiculopathy, diabetic polyneuropathy, and knee osteoarthritis, can affect muscular strength and mass.

In the present study, the knee was the most common site of pain. However, we did not collect data on the etiology of pain. In contrast, a previous study reported a significantly increased risk of osteoarthritis among older adults who were experiencing pain. Additionally, their prospective cohort study investigated the impact of osteoarthritic lower extremity pain on muscle strength and mass in the lower extremity. Scott et al. reported that knee and hip pain as well as more severe knee pain, stiffness, and dysfunction were predictive of a greater decline in lower extremity muscle strength and quality in older women. The primary finding of this study indicates that patient-reported osteoarthritis pain serves as a more accurate predictor of muscle wasting in older adults. This outcome aligns with the findings of a previous study. Foley et al. demonstrated that lower extremity joint pain, stiffness, and dysfunction (but not radiographic osteoarthritis) were associated with declines in muscle parameters over a period of nearly 3 years in women. The association of pain with decreased muscle strength, performance, and quality in these studies may explain the high prevalence of pain in older adults at risk of sarcopenia in our study.

In this study, upper and lower back pain were the most common complaints after knee pain in older adults at risk of sarcopenia. Reduced muscle mass and strength are typical symptoms of age-related skeletal muscle sarcopenia. Alterations in postural alignment often occur to compensate for decreased muscle strength in older adults. An incorrect body position negatively influences muscle function and can cause structural changes in overloaded parts of the spine, leading to pain, especially in older adults. Additionally, back muscle function influences thoracic spinal compressive loading, which may contribute to the development of upper back pain. Moreover, diminished trunk muscle strength and endurance are linked to lower back pain. These possible causes may partially explain the relationship between sarcopenia. However, additional studies examining these causal relationships are needed.

This study has several limitations. First, as we used SARC-F to assess sarcopenia risk, our results may differ from those of studies involving other populations using different sarcopenia criteria such as those proposed by the European Working Group on Sarcopenia in Older People. Although SARC-F appears to have limited screening capacity for excluding sarcopenia, it is simple, useful, feasible, and does not require sophisticated equipment; in addition, it has been extensively validated in the scientific literature. Tsuji et al. demonstrated the correlation of SARC-F scores with pain disability assessment scale scores, indicating pain-related disability. Second, the cross-sectional nature of this study made it difficult to establish a timeline for the development of sarcopenia and chronic pain. Further prospective cohort studies examining the association between sarcopenia, pain-related factors, and treatment outcomes in older community-dwelling adults with chronic musculoskeletal pain are required. Third, we did not collect information on the causes of pain or its treatment, which remains a key area for future research. Finally, we only included relatively young older adults. Therefore, further research on the association between pain and sarcopenia in older adults is required.

Our findings of a high rate of chronic pain in the older adult population, which was associated with a high risk of sarcopenia, warrant the development of systematic approaches to proactively identify older adults with these conditions. Many older adults ex-
perience multisite pain, in addition to high levels of chronic pain, making it especially important to consider this population when designing pain management strategies. Further studies are needed to determine the timing of sarcopenia and chronic musculoskeletal pain. The results of this study highlight the need for early pain interventions in the management of sarcopenia and the identification of vulnerable populations that might be experiencing pain.

ACKNOWLEDGMENTS
The authors thank all the study participants.

CONFLICT OF INTEREST
The researchers claim no conflicts of interest.

FUNDING
None.

AUTHOR CONTRIBUTIONS
Conceptualization, UKS; Data curation, UKS, AYS; Formal analysis, UKS, AYS; Investigation, UKS; Writing-original draft, UKS, AYS; Writing-review & editing, UKS, AYS.

REFERENCES
18. Türkiye Provincial District Neighborhood Village Population. General information of Söğütlu District population [Internet]. Ankara, Turkey: Türkiye Provincial District Neighborhood Village Population; 2022 [cited 2023 Sep 6]. Available from:


The Triglyceride-Glucose Index is Independently Associated with Chronic Kidney Disease in the Geriatric Population, Regardless of Obesity and Sex

Bokun Kim1,2, Gwon-Min Kim2,3, Kihoon Han4, Naoki Maki2,5, Keisuke Taniguchi2,5, Sechang Oh2,5

1Future Convergence Research Institute, Changwon National University, Changwon, Korea
2Human Community Renovation Research Center, R Professional University of Rehabilitation, Tsuchiura, Japan
3Medical Research Institute, Pusan National University, Busan, Korea
4Department of Physical Education, Pusan National University, Busan, Korea
5Faculty of Rehabilitation, R Professional University of Rehabilitation, Tsuchiura, Japan

Corresponding Author:
Sechang Oh, PhD
Division of Physical Therapy, Faculty of Rehabilitation, R Professional University of Rehabilitation, Tsuchiura, Ibaraki 300-0032, Japan
E-mail: osechang@u-a-ru.ac.jp
ORCID: https://orcid.org/0000-0002-7457-9305
Accepted: September 3, 2023
Revised: August 24, 2023
Received: July 6, 2023

INTRODUCTION

Chronic kidney disease (CKD) is a common condition in older adults. CKD increases the mortality rate and risk of conditions including myocardial infarction, hypertension, and type 2 diabetes in the geriatric population. From a pathophysiological perspective, these health concerns share a common pathway mediated by insulin resistance (IR). In 2017, CKD reportedly led to 1.2 million deaths globally. Owing to the aging of the global population, the prevalence and related mortality rate of CKD are expected to rise, with estimated CKD-related deaths increasing to 2.2 million or 4.0 million by 2040 in the best-case or worst-case scenarios, respectively. Therefore, developing effective strategies for CKD screening, detection, and management is essential to prevent or suppress the development of severe CKD, particularly in the geriatric population.

The association between obesity and CKD has been globally recognized for decades, and studies have evaluated the risk of CKD by broadly using body mass index (BMI) as the obesity index. However, Kim et al. reported that high fat and low muscle mass are more closely related to CKD than BMI-based obesity evaluation. Additionally, the limitation of BMI is apparent in the early screening and detection of high-risk older adults with CKD. The reason for these findings is that BMI does not precisely re-

Background: Insulin resistance (IR) negatively affects several risk factors of chronic kidney disease (CKD). This cross-sectional study investigated whether the triglyceride-glucose (TyG) index, which reflects IR, was independently associated with CKD in a geriatric population, regardless of obesity and sex. Methods: The analysis included 7,326 individuals (2,864 males and 4,462 females) aged ≥60 years. Non-obesity or obesity was evaluated using a body mass index cutoff of 25 kg/m². The TyG index was calculated as ln [triglyceride concentration (mg/dL)×fasting plasma glucose concentration (mg/dL)/2. All participants were categorized into three groups according to TyG tertiles. Moderate-to-severe CKD (≥50% CKD) was defined as an estimated glomerular filtration rate (eGFR) of <45.0 mL/min/1.73 m². Results: In males and females with or without obesity, a trend test showed a decreasing tendency in the eGFR from the lowest to highest TyG tertiles. Males without obesity and females with obesity in the middle and highest tertiles of the TyG index were 2.342 and 2.393, and were 2.313 and 3.516 times more likely to have ≥50% CKD, respectively. Those with or without obesity in the highest tertile of the TyG index were 1.736 and 2.374 times more likely to have ≥50% CKD, respectively. Conclusion: Geriatric populations with an increased TyG index have a high risk of ≥50% CKD regardless of obesity and sex. Our findings suggest that increased IR is associated with CKD in the geriatric population independent of obesity and sex.

Key Words: Body mass index, Insulin resistance, Metabolic syndrome, Aged, Renal insufficiency
flect overall adiposity and does not distinguish visceral fat, which induces the onset of IR.\textsuperscript{10,11} IR, rather than BMI-based obesity evaluation, is strongly associated with CKD because IR induces CKD risk factors, including glomerular hyperfiltration, sodium retention, defective tubular reabsorption, tissue inflammation, and fibrosis.\textsuperscript{12-14} Therefore, IR is more likely related to CKD than obesity.

The homeostasis model assessment of insulin resistance (HOMA-IR) has been widely used to examine insulin sensitivity for many years.\textsuperscript{15} The triglyceride-glucose (TyG) index was strongly related to hyperinsulinemic-euglycemic clamp data collected in Brazil, Mexico, and South Korea.\textsuperscript{16-19} Additionally, the TyG index is better than the HOMA-IR index for identifying various IR-related health concerns such as arterial stiffness, hypertension, and non-alcoholic steatohepatitis.\textsuperscript{18-21} Therefore, the TyG index is a reliable and valid indicator of IR that is superior to the HOMA-IR.

We hypothesized that IR is associated with CKD independent of obesity and sex and that an increased TyG index can be used for the early screening and detection of high-risk geriatric populations with CKD. Based on this hypothesis, we conducted a population-based cross-sectional study to examine the association of the TyG index with CKD in the geriatric population, regardless of obesity and sex.

**MATERIALS AND METHODS**

**Study Design and Subjects**

We analyzed data from a database of South Koreans’ general health, nutritional status, and lifestyle data from the Korea National Health and Nutritional Examination Survey (KNHANES) 2014–2018. The analysis included 7,326 participants (2,864 men and 4,462 women) among all participants aged ≥ 60 years from the 2014–2018 KNHANES. Fig. 1 shows a flowchart of participant recruitment. All participants provided written informed consent, and the study was conducted in accordance with the principles of the Declaration of Helsinki and approved by the Institutional Review Board of Silla University (No. 1041449-202203-HR-001).

This study complied the ethical guidelines for authorship and publishing in the *Annals of Geriatric Medicine and Research*.\textsuperscript{22}

**TyG Index and eGFR**

Blood samples were collected in the morning after a fast of at least 8 hours. Circulating glucose and triglyceride concentrations were measured by enzymatic methods using a Hitachi automatic analyzer 7600 (Hitachi, Tokyo, Japan). The TyG index was calculated as follows.\textsuperscript{17}

**In [triglyceride concentration (mg/dL) × fasting plasma glucose concentration (mg/dL)]/2.**

Creatinine concentrations were analyzed using the Jaffe rate-blanked creatinine assay and compensated at a certified laboratory (Seegene Medical Foundation, Seoul, Korea). The estimated glomerular filtration rate (eGFR) was calculated using the new Japanese-coefficient modified MDRD (Modification of Diet in Renal Disease) study equation as follows:\textsuperscript{8,23-25}

\[
eGFR \text{ (mL/min/1.73 m}^2\text{)} = 194 \times (\text{serum creatinine})^{-1.094} \times (\text{age})^{-0.287} \times (0.739 \text{ for females}).
\]

All participants were assigned into groups according to TyG tertiles. Moderate-to-severe CKD (\(\geq\)CKD) was defined as an eGFR < 45.0 mL/min/1.73 m\(^2\).\textsuperscript{23-25}

**Statistical Analysis**

All data are shown as mean ± standard deviation. Independent t-test or Mann–Whitney U tests were used to compare male and female variables. A one-way analysis of variance (ANOVA) was used to compare the anthropometric and biochemical characteristics of the three TyG index groups. The Bonferroni post-hoc test was applied when ANOVA showed significant differences (\(p < 0.05\)). The Mann–Whitney U test was used to analyze differences between groups with non-normal data distributions (\(p < 0.05\)). The Jonckheere–Terpstra test was used to compare the values between the three groups (two-tailed, \(p < 0.05\)). The Jonckheere–Terpstra test generates standardized statistics (SS) that point to the strength of tendencies in variables that increase or decline across groups.\textsuperscript{26-28} We applied logistic regression to evaluate the obesity- and sex-specific associations between the TyG index

---

**Fig. 1. Flowchart of the subjects. KNHANES, Korea National Health and Nutritional Examination Survey.**

---
and MS\textsubscript{CKD}. The fully adjusted model was adjusted for potential confounders such as education level, household income, smoking, drinking, handgrip strength, moderate-to-vigorous physical activity, total energy intake, and BMI, which are recognized or suspected factors associated with CKD. IBM SPSS Statistics for Windows, version 26.0 (IBM Corp, Armonk, NY, USA) was used to perform the statistical analyses. The optimal cutoff values for the TyG index in male and female participants with or without obesity to predict MS\textsubscript{CKD} were derived from receiver operating characteristic (ROC) curve analysis (area under the ROC curve [AUC] values). The sensitivity and specificity were also calculated. We used MedCalc for Windows version 9.1.0.1 (MedCalc, Ostend, Belgium).

RESULTS

Table 1 presents the participants’ characteristics. The mean age of the participants was 66.1 ± 10.5 years and was significantly higher in male participants than in females (p < 0.001). The mean TyG index and eGFR were 8.6 ± 0.6 and 62.8 ± 13.4 mL/min/1.73m\textsuperscript{2}, respectively. The eGFR in male participants was significantly lower than that in females (p < 0.001). The TyG index did not differ significantly between the sexes. Supplementary Table S1 provides more information on the subjects.

Table 2 displays the obesity- and sex-specific differences and tendencies based on the eGFR tertiles in male subjects. In subjects with and without obesity, the tendency test indicated a significant decrease in eGFR from the lowest to highest TyG tertiles (SS -5.61 and -3.59, respectively, relative to the lowest tertile of TyG index values). In the fully adjusted model, the middle and highest tertiles had odds ratios of 2.216 (95% CI, 1.361–3.606) and 3.141 (95% CI, 1.975–4.974), respectively, compared to the lowest tertile in MS\textsubscript{CKD}. In the fully adjusted model, the middle and highest tertiles showed odds ratios of 2.342 (95% CI, 1.464–3.747) and 2.393 (95% CI, 1.498–3.823), respectively, relative to the lowest tertile in MS\textsubscript{CKD}.

Regarding female participants without obesity, in the unadjusted model, the highest tertile displayed an odds ratio of 2.123, relative to the lowest tertile (95% CI, 1.411–3.194) for MS\textsubscript{CKD}. Among male subjects with obesity, in the unadjusted model, the middle and highest tertiles displayed odds ratios of 2.392 (95% confidence interval [CI], 1.522–3.760) and 2.439 (95% CI, 1.552–3.835), respectively, compared to the lowest tertile in MS\textsubscript{CKD}.

Table 4 compares the obesity- and sex-specific odds ratios for an association between the TyG index and MS\textsubscript{CKD}. Male and female participants with and without obesity were divided into tertiles based on TyG index values. For male participants without obesity, in the unadjusted model, the middle and highest tertiles displayed odds ratios of 2.392 (95% confidence interval [CI], 1.522–3.760) and 2.439 (95% CI, 1.552–3.835), respectively, compared to the lowest tertile in MS\textsubscript{CKD}. In the fully adjusted model, the middle and highest tertiles showed odds ratios of 2.342 (95% CI, 1.464–3.747) and 2.393 (95% CI, 1.498–3.823), respectively, relative to the lowest tertile in MS\textsubscript{CKD}.

Regarding female participants without obesity, in the unadjusted model, the highest tertile showed an odds ratio of 2.374 relative to the lowest tertile (95% CI, 1.539–3.662) of MS\textsubscript{CKD}. Among obese subjects with obesity, in the fully adjusted model, the highest tertile showed an odds ratio of 1.736 relative to the lowest tertile (95% CI, 1.053–2.863) for MS\textsubscript{CKD}. Among obese subjects without obesity, in the fully adjusted model, the middle and highest tertiles had odds ratios of 2.216 (95% CI, 1.361–3.606) and 3.141 (95% CI, 1.975–4.974), respectively, relative to the lowest tertile of MS\textsubscript{CKD}.

Table 1. Characteristics of the subjects

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Overall (n=7,326)</th>
<th>Male (n=2,864)</th>
<th>Female (n=4,462)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>66.1 ± 10.5</td>
<td>69.4 ± 6.1</td>
<td>64.0 ± 12.1</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>TyG index</td>
<td>8.6 ± 0.6</td>
<td>8.6 ± 0.5</td>
<td>8.6 ± 0.6</td>
<td>0.148</td>
</tr>
<tr>
<td>eGFR (mg/dL)</td>
<td>62.8 ± 13.4</td>
<td>60.6 ± 12.6</td>
<td>64.2 ± 13.7</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>158.9 ± 8.4</td>
<td>166.1 ± 5.8</td>
<td>154.3 ± 6.2</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Body mass (kg)</td>
<td>61.5 ± 9.2</td>
<td>67.4 ± 8.5</td>
<td>57.8 ± 7.4</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>24.3 ± 2.8</td>
<td>24.4 ± 2.5</td>
<td>24.3 ± 2.9</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Waist circumference (cm)</td>
<td>84.7 ± 8.7</td>
<td>88.1 ± 7.6</td>
<td>82.6 ± 8.7</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>FPG (mg/dL)</td>
<td>100.3 ± 20.2</td>
<td>100.3 ± 19.9</td>
<td>100.4 ± 20.3</td>
<td>0.868</td>
</tr>
<tr>
<td>HbA1c (%)</td>
<td>5.7 ± 0.7</td>
<td>5.7 ± 0.7</td>
<td>5.7 ± 0.7</td>
<td>0.385</td>
</tr>
<tr>
<td>Triglyceride (mg/dL)</td>
<td>124.5 ± 66.8</td>
<td>125.2 ± 65.0</td>
<td>124.0 ± 67.9</td>
<td>0.465</td>
</tr>
<tr>
<td>Creatinine (mg/dL)</td>
<td>0.85 ± 0.28</td>
<td>0.82 ± 0.29</td>
<td>0.85 ± 0.28</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Obesity status</td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Non-obese subjects</td>
<td>4,670 (63.7)</td>
<td>1,766 (61.7)</td>
<td>2,904 (65.1)</td>
<td></td>
</tr>
<tr>
<td>Obese subjects</td>
<td>2,656 (36.2)</td>
<td>1,098 (38.3)</td>
<td>1,558 (34.9)</td>
<td></td>
</tr>
</tbody>
</table>

Values are presented as mean±standard deviation or number (%).

eGFR, estimated glomerular filtration rate; FPG, fasting plasma glucose; TyG index, triglyceride-glucose index.

The Mann–Whitney U test was applied to assess differences between groups.
Table 2. Anthropometric data, the TyG index, and eGFR-related biochemical characteristics and trends according to TyG index tertiles in male subjects

<table>
<thead>
<tr>
<th>TyG index</th>
<th>eGFR (mg/dL)</th>
<th>Body mass index (kg/m²)</th>
<th>Age (y)</th>
<th>Height (cm)</th>
<th>Waist circumference (cm)</th>
<th>FPG (mg/dL)</th>
<th>Triglyceride (mg/dL)</th>
<th>Creatinine (mg/dL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (n=604)</td>
<td>B (n=590)</td>
<td>C (n=593)</td>
<td>A &lt; B &lt; C</td>
<td>A &gt; B, C</td>
<td>ns</td>
<td>A &lt; B, C</td>
<td>A &gt; B, C</td>
<td>ns</td>
</tr>
<tr>
<td>TyG index</td>
<td>8.00±0.24</td>
<td>8.59±0.15</td>
<td>9.22±0.27</td>
<td>22.9±1.3</td>
<td>42.8±2.3</td>
<td>60.4±12.4</td>
<td>60.6±12.6</td>
<td>22.8±1.3</td>
</tr>
<tr>
<td>eGFR</td>
<td>64.0±12.4</td>
<td>60.6±12.6</td>
<td>60.0±12.2</td>
<td>22.8±1.3</td>
<td>42.8±2.3</td>
<td>69.8±6.3</td>
<td>70.0±6.3</td>
<td>22.8±1.3</td>
</tr>
<tr>
<td>Body mass index</td>
<td>22.9±1.3</td>
<td>22.8±1.3</td>
<td>22.8±1.4</td>
<td>69.8±6.3</td>
<td>70.0±6.3</td>
<td>60.4±12.4</td>
<td>60.6±12.6</td>
<td>22.8±1.3</td>
</tr>
<tr>
<td>Age (y)</td>
<td>69.8±6.2</td>
<td>69.8±6.3</td>
<td>70.0±6.3</td>
<td>22.8±1.3</td>
<td>42.8±2.3</td>
<td>60.4±12.4</td>
<td>60.6±12.6</td>
<td>22.8±1.3</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>166.0±5.8</td>
<td>165.9±5.8</td>
<td>165.9±5.7</td>
<td>22.8±1.3</td>
<td>42.8±2.3</td>
<td>60.4±12.4</td>
<td>60.6±12.6</td>
<td>22.8±1.3</td>
</tr>
<tr>
<td>Waist circumference (cm)</td>
<td>84.5±2.6</td>
<td>84.2±2.5</td>
<td>84.3±2.8</td>
<td>22.8±1.3</td>
<td>42.8±2.3</td>
<td>60.4±12.4</td>
<td>60.6±12.6</td>
<td>22.8±1.3</td>
</tr>
<tr>
<td>FPG (mg/dL)</td>
<td>92.0±9.9</td>
<td>99.3±15.8</td>
<td>108.6±24.5</td>
<td>22.8±1.3</td>
<td>42.8±2.3</td>
<td>60.4±12.4</td>
<td>60.6±12.6</td>
<td>22.8±1.3</td>
</tr>
<tr>
<td>Triglyceride (mg/dL)</td>
<td>67.0±15.1</td>
<td>111.8±20.9</td>
<td>198.0±59.7</td>
<td>22.8±1.3</td>
<td>42.8±2.3</td>
<td>60.4±12.4</td>
<td>60.6±12.6</td>
<td>22.8±1.3</td>
</tr>
<tr>
<td>Creatinine (mg/dL)</td>
<td>0.82±0.16</td>
<td>0.86±0.18</td>
<td>0.88±0.18</td>
<td>22.8±1.3</td>
<td>42.8±2.3</td>
<td>60.4±12.4</td>
<td>60.6±12.6</td>
<td>22.8±1.3</td>
</tr>
</tbody>
</table>

Values are presented as means±standard deviation.
A group is lowest tertile; B, middle tertile; and C, highest tertile.
TyG index, triglyceride-glucose index; eGFR, estimated glomerular filtration rate; FPG, fasting plasma glucose; ss, standardized statistics; ns, not significant.

Table 3. Anthropometric data, the TyG index, and eGFR-related biochemical characteristics and trends according to TyG index tertiles in female subjects

<table>
<thead>
<tr>
<th>TyG index</th>
<th>eGFR (mg/dL)</th>
<th>Body mass index (kg/m²)</th>
<th>Age (y)</th>
<th>Height (cm)</th>
<th>Waist circumference (cm)</th>
<th>FPG (mg/dL)</th>
<th>Triglyceride (mg/dL)</th>
<th>Creatinine (mg/dL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (n=973)</td>
<td>B (n=988)</td>
<td>C (n=973)</td>
<td>A &lt; B &lt; C</td>
<td>A &gt; B, C</td>
<td>ns</td>
<td>A &lt; B, C</td>
<td>A &gt; B, C</td>
<td>ns</td>
</tr>
<tr>
<td>TyG index</td>
<td>7.95±0.25</td>
<td>8.57±0.15</td>
<td>9.22±0.28</td>
<td>22.6±1.4</td>
<td>42.6±2.3</td>
<td>60.4±13.5</td>
<td>60.6±13.6</td>
<td>22.6±1.4</td>
</tr>
<tr>
<td>eGFR</td>
<td>68.2±13.9</td>
<td>65.6±12.9</td>
<td>64.0±13.5</td>
<td>22.6±1.4</td>
<td>42.6±2.3</td>
<td>60.4±13.5</td>
<td>60.6±13.6</td>
<td>22.6±1.4</td>
</tr>
<tr>
<td>Body mass index</td>
<td>22.6±1.4</td>
<td>22.6±1.3</td>
<td>22.6±1.4</td>
<td>60.4±13.5</td>
<td>60.6±13.6</td>
<td>60.4±13.5</td>
<td>60.6±13.6</td>
<td>22.6±1.4</td>
</tr>
<tr>
<td>Age (y)</td>
<td>60.4±13.5</td>
<td>61.4±12.9</td>
<td>61.5±13.6</td>
<td>22.6±1.4</td>
<td>42.6±2.3</td>
<td>60.4±13.5</td>
<td>60.6±13.6</td>
<td>22.6±1.4</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>155.3±6.5</td>
<td>155.4±6.6</td>
<td>155.0±6.3</td>
<td>22.6±1.4</td>
<td>42.6±2.3</td>
<td>60.4±13.5</td>
<td>60.6±13.6</td>
<td>22.6±1.4</td>
</tr>
<tr>
<td>Waist circumference (cm)</td>
<td>78.2±6.0</td>
<td>78.5±6.0</td>
<td>78.1±6.0</td>
<td>22.6±1.4</td>
<td>42.6±2.3</td>
<td>60.4±13.5</td>
<td>60.6±13.6</td>
<td>22.6±1.4</td>
</tr>
<tr>
<td>FPG (mg/dL)</td>
<td>91.8±8.9</td>
<td>98.5±14.2</td>
<td>109.4±26.1</td>
<td>22.6±1.4</td>
<td>42.6±2.3</td>
<td>60.4±13.5</td>
<td>60.6±13.6</td>
<td>22.6±1.4</td>
</tr>
<tr>
<td>Triglyceride (mg/dL)</td>
<td>63.9±15.0</td>
<td>110.2±19.4</td>
<td>197.5±67.4</td>
<td>22.6±1.4</td>
<td>42.6±2.3</td>
<td>60.4±13.5</td>
<td>60.6±13.6</td>
<td>22.6±1.4</td>
</tr>
<tr>
<td>Creatinine (mg/dL)</td>
<td>0.80±0.45</td>
<td>0.83±0.28</td>
<td>0.88±0.27</td>
<td>22.6±1.4</td>
<td>42.6±2.3</td>
<td>60.4±13.5</td>
<td>60.6±13.6</td>
<td>22.6±1.4</td>
</tr>
</tbody>
</table>

Values are presented as means±standard deviation.
A group is lowest tertile; B, middle tertile; and C, highest tertile.
TyG index, triglyceride-glucose index; eGFR, estimated glomerular filtration rate; FPG, fasting plasma glucose; ss, standardized statistics; ns, not significant.

The Mann–Whitney U test was applied to assess differences between the three groups.
The Jonckheere–Terpstra test was used to assess the trend among the three groups.
justed model, the middle and highest tertiles showed odds ratios of 2.313 (95% CI, 1.397–3.828) and 3.516 (95% CI, 2.164–5.713), respectively, relative to the lowest tertile in MS CKD.

**DISCUSSION**

This study investigated whether the TyG index, which reflects IR, is associated with CKD in a geriatric population, independent of obesity and sex. The results showed that the TyG index was associated with CKD in the geriatric population, regardless of obesity. Additionally, the relationship between the TyG index and CKD was significant in both male and female participants. These findings suggested that IR is associated with CKD in the geriatric population independent of obesity and sex.

The long-standing consensus is that aging and obesity trigger a decline in kidney function. The effect of aging on CKD is undeniable due to the high global prevalence of CKD in the geriatric population. However, the association between obesity and CKD is increasing, mainly owing to the limitations of BMI. BMI is not an accurate indicator of overall adiposity and visceral fat, which induces the onset of IR. Recent studies published in 2019, 2020, and 2021 reported that IR was strongly related to a decline in kidney function rather than obesity per se. Our findings on IR also support these recent reports. In the present study, both male and female participants (Tables 2, 3) showed a stronger decreasing trend in eGFR in subjects without obesity than in those with obesity as the TyG index increased. If obesity causes a decline in kidney function, the decreasing trend in eGFR should be more pronounced in subjects with obesity than in those without. This suggests that the effect of IR on CKD is more significant than that on obesity.

We also found that male participants without obesity in the middle and highest tertiles of the TyG index were 2.342 and 2.393 times more likely to have MS CKD, respectively. Similarly, female participants without obesity in the highest tertile were 2.374 times more likely to develop MS CKD. Additionally, female subjects with obesity in the middle and highest tertiles of the TyG index were 2.313 and 3.516 times more likely to have MS CKD, respectively (Table 4). These findings suggest that increased IR is an independent risk factor for CKD in both men and women, regardless of obesity status. Therefore, IR is a primary pathophysiology that may be independently associated with CKD in geriatric populations regardless of obesity.

Several studies have reported a relationship between IR and CKD. Animal and human studies have reported that hyperinsulinemia leads to kidney vasodilatation, enhances sodium reabsorption, stimulates the renin-angiotensin system, and causes glomerular hyperfiltration, which increases the GFR. Increased filtration per nephron causes nephron loss and leads to glomerular hypertension, which causes glomerular sclerosis and a subsequent decline in kidney function.
Supplementary monitoring to suppress the progression of health concerns. In accordance with health issues and a TyG index value of ≥ 8.6 require careful consideration. However, these reports suggest that late middle-aged and older adults may be appropriate for clinical practice.

Studies have demonstrated the good performance of the TyG index in predicting or discriminating IR-related health concerns. However, specific cutoff values have not been confirmed, and few studies have suggested the potential value of the TyG index. Shin et al. studied 4,415 Korean adults aged 20–80 years and showed that a TyG index cutoff value of ≥ 8.81 discriminated individuals with IR with AUC of 0.894, sensitivity of 86.7%, and specificity of 80.1%. Endukuru et al. studied 150 Indian adults aged 18–65 years and found that a TyG index cutoff value for IR of ≥ 9.88 showed AUC of 0.836, sensitivity of 76.0%, and specificity of 88.0%. The value suggested by Endukuru et al. was derived from only 150 adults, and the AUC was relatively low compared with that suggested by Shin. In the present study, the potential cutoff value of the TyG index to distinguish individuals with CKD, was > 8.62 (AUC 0.584; sensitivity 59.34%; specificity 53.26%) (Supplementary Fig. S1). Considering the differences in population age, race, and number, the potential cutoff value in the present study cannot be directly compared with those obtained in the two previous studies. Additionally, the relatively low AUC, sensitivity, and specificity of the potential TyG index cutoff value in the present study suggest the need for re-examination using another sample of the geriatric population. However, as a geriatric population-specific cutoff value to distinguish CKD in high-risk individuals in the early stages, the potential TyG index cutoff value identified in the present study may be appropriate for clinical practice.

Previous studies in the Korean population have provided TyG index cutoff values to discriminate high-risk individuals with several health concerns. Kim et al. found that TyG index values of ≥ 8.72 and 8.67, respectively, were risk factors for sarcopenic obesity in men and women aged ≥ 60 years with health issues such as hypertension and hyperlipidemia. Kang et al. reported a TyG index value of ≥ 8.83 as a cutoff value for obstructive sleep apnea in men and women with health issues aged ≥ 55 years. Park et al. showed that a TyG index value of ≥ 8.44 was a cutoff value for coronary artery disease in men and women aged ≥ 65 years without health issues. Differences in age distribution, inconsistency in sex-specific populations, and differences in basic health status may be applied as a cutoff for early-stage prevention of health concerns.

The present study had several strengths and limitations. This study’s strength was the adjustment for potential covariates, such as demographic parameters and lifestyle factors that might affect the relationship between the TyG index and CKD. However, the study subjects were older Korean adults; thus, whether the findings of the present study can be applied to other ethnicities or nations is unclear. Further investigations in different races are needed to confirm the association between the TyG index and CKD.

In conclusion, the geriatric population with an increased TyG index has a high risk of CKD regardless of obesity and sex. This finding suggests that increased IR is associated with CKD in the geriatric population independent of obesity and sex.

ACKNOWLEDGMENTS
We thank Ellen Knapp, PhD, for editing a draft of this manuscript.

CONFLICT OF INTEREST
The researchers claim no conflicts of interest.

FUNDING
This study was supported in part by a National Research Foundation of Korea grant funded by the Ministry of Education (No. NRF-2022R1I1A1A01063664) and Grants-in-Aid for Scientific Research from the Ministry of Education, Culture, Sports, Science, and Technology, Japan (No. 21K17450 and 23H03273).

AUTHOR CONTRIBUTIONS
Conceptualization, BK, SO; Data curation, BK, GK; Funding acquisition, BK, NM; Investigation, BK, SO, KH; Methodology, NM, KT; Project administration, BK, KH; Supervision, BK, GK; Writing-original draft, BK; Writing-review & editing, BK, SO.

SUPPLEMENTARY MATERIALS
Supplementary materials can be found via https://doi.org/10.4235/agmr.23.0096.

REFERENCES
Netw Open 2021;4:e2131884.
Mucous Membrane Pemphigoid in a Nonagenarian: A Case Report

Océane Babin de Lignac1,2, Priscille Carvalho1,2, Marion Carrette3, Lucie Cellier4, Philippe Courville1, Billal Tedbirt1,2

1Department of Dermatology, CHU Rouen, Rouen, France
2French Reference Center for Autoimmune Bullous Diseases, Normandie University, Rouen, France
3Department of Immunology, CHU Rouen, Rouen, France
4Department of Pathology, CHU Rouen, Rouen, France

Corresponding Author:
Océane Babin de Lignac, MD
Department of Dermatology, CHU Rouen, 1 rue Germont, 76031 Rouen Cedex, France
E-mail: O.Babin-De-Lignac@chu-rouen.fr
ORCID: https://orcid.org/0000-0003-4807-9152

Received: March 7, 2023
Revised: June 8, 2023
Accepted: June 20, 2023

INTRODUCTION

Mucous membrane pemphigoids are a group of chronic autoimmune blistering diseases of the chorioepithelial or dermoepidermal junction, which are characterized by predominant or exclusive mucosal involvement.1,2 Mucous membrane pemphigoids primarily affect older patients, typically those aged 60–80 years.2 Mucosal involvement includes the oral, nasopharyngeal, laryngopharyngeal, genital, esophageal, tracheal, anal, and ocular mucosal membranes. Additionally, skin lesions may also be present, although they are typically mild and are observed in approximately 30% of patients.3 Mucous membrane pemphigoids are characterized by scarring resulting from initial inflammation, leading to significant morbidity, including pain, malnutrition, and corneal blindness. In nonagenarians, the management of mucous membrane pemphigoid becomes more complex owing to the age-related physiological changes, comorbidities, and potential polypharmacy interactions. Herein, we report a case of an old patient who presented with painful buccal erosions and was diagnosed with mucous membrane pemphigoid that was successfully treated with topical corticosteroids.

CASE REPORT

A 92-year-old male patient presented with a 6-month history of oral erosion that had resulted in feeding disorders and subsequent weight loss. His medical history included hypertension, atrial fibrillation, and dyslipidemia. Clinical examination revealed post-blistering erosions of the left buccal mucosa associated with palatal erosion (Fig. 1). The patient did not present any other mucosal or skin lesions. A skin biopsy revealed a cleavage between the epidermis and dermis with a few interstitial eosinophils present (Fig. 2). Direct cutaneous immunofluorescence of the biopsy revealed linear immunoglobulin G (IgG) and C3 deposits along the basement membrane. Laboratory test results were negative for antibodies against BP180, BP230, type VII collagen, and laminin 332. Immunoblotting studies of the skin extract and indirect immunofluorescence of salt-split skin yielded negative results. Clinical, histological, and immunological findings were consistent with a diagnosis of mild mucous membrane pemphigoid because the clinical involvement was limited to one site. As the Consensus Conference1 indicates that topical treatments can be introduced initially, the patient was prescribed clobetasol propionate cream. The lesions healed completely within 3 months of daily applica-
tion, allowing the resolution of pain and recovery of optimal oral feeding. No recurrence was observed after 1 year of follow-up.

**DISCUSSION**

The symptoms and complications of mucous membrane pemphigoid can substantially impact the quality of life of patients living with the disease and can cause difficulties in eating, ultimately leading to malnutrition in some cases, as observed in our patient. Scar formation is a characteristic feature of mucous membrane pemphigoid, which can result in major disabilities (e.g., blindness and esophageal, anal, and vaginal stenosis) and life-threatening situations (e.g., laryngeal stenosis leading to respiratory failure).

Mucous membrane pemphigoid is characterized by autoantibodies directed against various antigens of the dermoepidermal junction (i.e., BP180, laminin 332, type VII collagen, α6β4 integrin). Despite the recognition of multiple antigens targeted by autoantibodies and the use of various detection techniques (e.g., enzyme-linked immunosorbent assay [ELISA], immunoblot studies of skin extract, salt-split skin indirect immunofluorescence, and biochip technology), approximately one-third of the patients with mucous membrane pemphigoid do not have detectable autoanti-

---

**Fig. 1.** Clinical presentation: (A) atrophic plaque on the left cheek, with a post-blister erosion in the center associated with painful erosion located on the palate (B).

**Fig. 2.** The skin biopsy revealed a cleavage between the epidermis (A) and dermis with a few interstitial eosinophils (B) (hematoxylin-eosin saffron staining, original magnification ×20).
bodies, as in our patient. ¹ ³ ⁴ According to the Consensus Conference,¹ ³ a diagnosis of mucous membrane pemphigoid is established based on the clinical presentation along with the detection of anti-dermoepidermal junction autoantibodies on direct immunofluorescence, direct immunoelectron microscopy, or serological tests (e.g., ELISA, immunoblotting).² ⁵ Direct immunofluorescence is the major diagnostic test, which has the highest sensitivity for the diagnosis of mucous membrane pemphigoid.⁵

For mild/moderate mucous membrane pemphigoid, dapsone, methotrexate, tetracyclines, and/or topical corticosteroids are recommended as the first-line treatment.³ Considering the advanced age and potential frailty of our patient, we opted for a topical treatment. High-potency topical corticosteroids led to complete remission in our patient within 3 months, indicating that less invasive treatments can be more beneficial in geriatric patients with mild/moderate mucous membrane pemphigoid. Such a strategy limits the risk of potentially life-threatening adverse events associated with systemic therapies in patients of advanced age.

In conclusion, mucous membrane pemphigoid is a rare autoimmune disease that predominantly affects the mucous membrane and frequently affects the oral mucosa. Recognizing this condition is crucial due to its potential to reduce the quality of life (e.g., oral pain), especially among older patients.

ACKNOWLEDGMENTS

The authors are grateful to Nikki Sabourin-Gibbs, CHU Rouen, for her help in editing the manuscript.

CONFLICT OF INTEREST

The researchers claim no conflicts of interest.

FUNDING

None.

REFERENCES

**INTRODUCTION**

Tetanus is a non-communicable disease caused by the tetanospasmin neurotoxin produced by the gram-positive bacterium *Clostridium tetani*. The condition presents as spastic paralysis that spreads from the head and neck to the trunk and limbs.\(^1\) Global incidence and mortality depend on the barriers to care and availability of vaccines; however, even with proper care, mortality is up to 50% in adults.\(^1\)

Herein, we describe the tetanus sequelae in an 85-year-old survivor. Written informed consent was obtained from the patient for publishing this case report.

**CASE REPORT**

An 85-year-old man was transferred from the geriatric medicine unit of our tertiary hospital to our rehabilitation unit and underwent intensive treatment for the sequelae of *C. tetani* infection. He is a farmer leading an active lifestyle. His past medical history included atrial fibrillation (AF) and benign prostatic hypertrophy.

Two months prior, he was admitted to a local hospital because of trismus and hypertonia after injuring his leg while working on his farm. Since the clinical findings and medical history were strongly suggestive of *C. tetani* infection, he began immediate treatment with immunoglobulins, tetanus vaccination, and metronidazole for ten days (Fig. 1). He was transferred to our intensive care unit (ICU), where he underwent tracheostomy, mechanical ventilation, and vasoactive support owing to respiratory failure. The seizures were treated with baclofen, midazolam, and diazepam. Electroencephalography revealed severely slow cerebral activity. Due to worsening respiratory function, opacity on chest radiography, and peripheral leukocytosis due to possible ventilator-associated pneumonia (VAP), blood cultures and tracheal secretion samples were sent for laboratory analysis. The tracheal secretions tested positive for *Klebsiella pneumoniae* and methicillin-sensitive *Staphylococcus aureus* (MSSA); therefore, antibiotic therapy with piperacillin-tazobactam was prescribed (Fig. 1).
The patient was later moved to a geriatric unit in a coma and breathed spontaneously on 4 L/min of supplemental oxygen via a tracheal cannula. After three days, the antibiotic therapy was switched to linezolid (14 days) due to VAP exacerbation, and combined treatment with meropenem for 17 days was prescribed after septic shock occurred (Fig. 1). The patient gradually awoke, and the feeding tube was removed. He developed cholestasis and acute edematous pancreatitis; however, the endoscopic treatment got postponed due to spontaneous recovery. Urinary tract infection caused by the multidrug-resistant organisms (MDROs) *K. pneumoniae*, *Acinetobacter baumannii*, and *Enterococcus faecalis* was treated with colistin and amoxicillin-clavulanate for 1 week (Fig. 1). Eventually, his clinical condition improved, and he was considered eligible for rehabilitation.

In our unit, the patient was placed in MDRO isolation. He still required tracheal supplemental oxygen (1 L/min) and a bladder catheter and developed pressure ulcers on the right (unstageable) and left (stage II) heels, sacrum (stage II), and right elbow (stage III). He was sarcopenic and had low handgrip strength (9.9 kg) and appendicular skeletal mass (ASM, 16.9 kg). The rehabilitative evaluations are presented in Table 1.

On the first day, the patient underwent rehabilitation with good compliance. However, *Clostridioides difficile* infection occurred, and oral vancomycin was prescribed for 10 days. After 3 days, he presented with AF with a third-degree atrioventricular block (heart rate, 30 beats/min) without secondary bradycardia. The patient was transferred to our hospital’s cardiac ICU to undergo single-chamber pacemaker implantation and presented with hyperkinetic delirium during the postoperative course. Two days later, the patient was transferred to our hospital. *Pseudomonas aeruginosa* bloodstream infection was treated with ceftazidime-avibactam and amikacin for 1 week (Fig. 1). Meanwhile, on a routine nasopharyngeal swab, the patient tested positive for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The patient was treated with remdesivir for 3 days and placed on droplet isolation. The following day, a second recurrence of *C. difficile* occurred; therefore, he was transferred to a geriatric medicine unit. The infection was successfully treated with fidaxomicin for ten days.

Two days after completing treatment for the recurrence of *C. difficile*, he presented with bloodstream infection due to *Candida parapsilosis* (fluconazole-resistant), MSSA, and *Candida tropicalis* originating from the intravenous catheter; after replacing the infected catheter, it was treated with caspofungin and cefazolin for 17 days. After 10 days, the patient presented with a bloodstream infection caused by *P. aeruginosa*. Antibiotic treatment with piperacillin-tazobactam was prescribed and eventually shifted to aztreonam and ceftazidime-avibactam owing to evidence of antibiotic resistance from the antibiogram. After 4 days, owing to the improvement in clinical condition, the antibiotic was shifted to cefepime for 10 additional days (Fig. 1).

During the last months of hospitalization, tracheostomy closure was performed by an ear, nose, and throat (ENT) specialist and pulmonologist. Throughout the hospitalization, nutritional supplementation was prescribed to manage malnutrition and sarcopenia.
Table 1. Rehabilitative evaluation and objectives

<table>
<thead>
<tr>
<th>Physical evaluation</th>
<th>Logopedic evaluation</th>
<th>Functional evaluation</th>
<th>Short-term objectives</th>
<th>Mid-term objectives</th>
<th>Long-term objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performs isometric pelvic contraction and weak hip raising in supine position; Sits for a few minutes supported by upper limbs; No alterations in tactile, thermic, and pain sensitivity. Upper limbs - ROM preserved and pain-free beyond the middle degrees; GMS MRC 3/5. Lower limbs - PROM preserved until final degrees, pain on mobilization of left hip and knee; GMS MRC 2/5 on activating muscles of hip and knee and MRC 3/5 on activating muscles of tibiotarsus.</td>
<td>Cognitive - Not oriented in space, time, and self; - Impairment in executive functions, problem solving, working and episodic memory; - Ideomotor and buccofacial apraxia; - Successfully executes simple orders but fails to comprehend extended sentences due to early decline in working memory. Speech - Poor oral motor excursions; - Poor verbal communication; - Hypophonia (due to O₂-therapy).</td>
<td>Requires maximum assistance with dressing and personal hygiene; Requires modest help for posture changes; Requires bilateral support for bed-to-wheelchair transfers.</td>
<td>Discontinuing oxygen therapy; Closing the tracheostomy; Recovering swallowing, phonation, sitting, autonomy in postural transitions and transfers, and upright standing.</td>
<td>Improvement of functional independence in walking, balance, and ADL.</td>
<td>Recovering independence in ADL e IADL.</td>
</tr>
</tbody>
</table>

ROM, active range of motion; PROM, passive range of motion; GMS, global muscle strength; MRC, Medical Research Council scale; ADL, activities of daily living; IADL, instrumental activities of daily living.

...n. From the motor point of view, although intensive rehabilitation was compromised due to the large number of infectious (Fig. 1) and non-infectious complications, the patient continued to undergo short physiotherapy sessions according to the changes in his clinical condition.

At discharge, the patient was able to perform postural transition with assistance. Motor and respiratory reconditioning continued at discharge. From a motor point of view, postural transition training and aided transfers, axial stability, and balance improvement exercises, with the primary goal of achieving a standing position, were prescribed. From a respiratory perspective, breath-motion coordination exercises, thoracic expansion and girdle opening exercises, and inhalation-exhalation exercises were recommended. Wheelchairs and walkers were recommended for the current mobility deficit on short and medium trips and to facilitate safe postural transitions. Rehabilitation, ENT, and geriatric follow-up evaluations were recommended.

**DISCUSSION**

This report describes the sequelae of tetanus in a geriatric patient. Tetanus is an often-fatal disease accompanied by several complications and is even more severe in geriatric patients. Our patient developed respiratory failure, coma, VAP, septic shock, healthcare-associated infections (HAI), acute sarcopenia, life-threatening bradyarrhythmia, and pressure ulcers. The electroencephalogram and cognitive function assessment results (Table 1) raised the possibility of incident dementia, likely with vascular or mixed etiology. AF also plays a role in cognitive decline, and ICU admission may increase the risk of dementia. However, as no specific examinations were performed, this diagnosis cannot be validated. Furthermore, HAI, delirium, and sarcopenia were associated with adverse outcomes in hospitalized patients.

This case demonstrates the catastrophic effects of an otherwise preventable disease. In 2019, more than 73,000 new infections and 35,000 deaths due to tetanus occurred worldwide, with the highest incidence rates reported in Nepal, Eritrea, Pakistan, and Afghanistan.
Maternal and neonatal tetanus are public health concerns in developing countries; in higher-income countries, aged individuals are susceptible to both cases and death. Although vaccination does not affect the environmental distribution, serum antibody levels decrease with aging. Furthermore, the possibility that older adults may not have completed their primary vaccination cycle should not be overlooked. Vaccines have reduced tetanus incidence and mortality by up to 89% in the last century. The current state-of-the-art tetanus vaccination involves three vaccine doses at the 3rd, 5th, and 11th months of life; booster doses at 7 and 14 years of age; further booster doses every ten years. Diagnosis of C. tetani infection is based on clinical examination, medical history, and epidemiology. The differential diagnosis of trismus includes local oral or pharyngeal conditions, and the differential diagnosis of muscular spasms includes strychnine poisoning and iatrogenic causes. In the event of a risk of C. tetani infection, the procedure envisages the administration of a vaccine dose plus the simultaneous administration of immunoglobulins if the vaccine status is absent or uncertain or if 10 years have elapsed since the last booster vaccine was administered. If the last dose of vaccine was administered < 5 years prior, no further booster vaccine is required; on the contrary, after the 5th year of administration, a booster dose is recommended without simultaneous administration of immunoglobulins. Other steps for infection management include endotracheal intubation and early tracheostomy for airway protection, diazepam or midazolam administration to eliminate reflex spasms, surgical debridement of infected tissues, and antibiotic therapy with metronidazole or benzylpenicillin for 7–10 days.

The SARS-CoV-2 pandemic has deeply affected people’s lifestyles, especially those of older and frailer individuals. The coronavirus disease 2019 (COVID-19) has caused a dramatic decrease in compulsory vaccination among children. Although no studies have been conducted on vaccination shifts in older individuals, the effect of the pandemic on health service accessibility in older persons has been widely documented.

Therefore, this study is intended to be a strong call for tetanus vaccination, especially in geriatric patients. In addition, we hope that health can become a universal right.

ACKNOWLEDGMENTS

The authors would like to thank all the medical doctors, nurses, unlicensed assistive personnel, physical therapists, occupational therapists, speech therapists, and all the professionals who have been involved and are still involved in the management of this highly complex case. We also thank Fabio Zeoli, Rocco Mastromartino, Giacomo Piaser Guerrato, and the people of the Medical Research Opportunities Mentoring Program (Università Cattolica del Sacro Cuore, Rome, Italy) for allowing many undergraduate students into the world of medical research and guiding them through the writing of scientific articles.

CONFLICT OF INTEREST

The researchers claim no conflicts of interest.

FUNDING

None.

AUTHOR CONTRIBUTIONS

Conceptualization, SC, LG, EDA; Methodology, LG, LM; Validation, EDA, FL; Investigation, AP, FA, SC, RR, FI, FMP; Supervision: LG, LM, FL; Writing-original draft, AP, SC; Writing-review & editing, SC, EDA; Visualization, AP, SC.

REFERENCES

delirium among older adults. Innov Aging 2021;5(Supplement_1):581-582.


Association between Support after Dementia Diagnosis and Subsequent Decrease in Social Participation

Hiroshige Matsumoto¹, Shuji Tsuda², Shun Takehara³, Tomoyuki Yabuki⁴, Satoko Hotta⁵

¹Department of Community Health Nursing, Graduate School of Medicine, The University of Tokyo, Tokyo, Japan
²Research Team for Human Care, Tokyo Metropolitan Institute of Gerontology, Tokyo, Japan
³Department of Occupational Therapy, Faculty of Rehabilitation, Gunma Paz University, Takasaki, Japan
⁴Faculty of Social Welfare, University of Kochi, Kochi, Japan
⁵Graduate School of Health Management, Keio University, Fujisawa, Japan

Dear Editor,

We are writing this letter to accelerate research and discussion on the nature of post-diagnostic support for dementia. Accurate diagnosis of dementia provides a gateway to care and support for people living with dementia and their relatives.¹ The reasons for recommending early diagnosis is that cognitive rehabilitation in the milder stages of dementia was suggested to be effective in preventing further impairment.² National plans focused on early diagnosis of dementia have been initiated in many countries.³ However, the stigma and anxiety associated with diagnosis of dementia without care and support may reduce social participation.⁴ Also, post-diagnostic support is supposed to moderate the negative impact, but little is known about the delivery and effectiveness of the support. Therefore, we have analyzed the association between post-diagnosis support and subsequent changes in social participation using data from an online survey.

In this survey conducted in December 2021, the respondents were family caregivers of people living at home with early phase dementia and were recruited from a commercial panel.⁵ Family caregivers of those diagnosed with dementia or mild cognitive impairment for more than three months prior to the survey were included. The outcome variable was the number of categories of social participation that decreased after diagnosis (range 0–3) measured retrospectively. Social participation was categorized into three groups based on Levasseur et al.’s taxonomy⁶: (1) activities with others around but not including a specific activity with them; (2) activities in collaboration with others to reach a common goal; and (3) activities helping others or contributing to the community. For example, walking, shopping, and eating out were examples of the first group; visiting friends’ homes, peer meetings, and group exercises were examples of the second group; and doing volunteer work and involving in community organization activities would be categorized in the third group. In addition, social participation was stratified as people living with dementia alone (unaccompanied) and those with living with family members (accompanied). As an independent variable, the respondents were asked to choose the sources of support they consulted immediately after the diagnosis of dementia. The sources of support included the informal sector (family members/relatives, friends, other people living with dementia), the medical sector (primary care physician, memory clinic, medical center for dementia), and the long-term care sector (care manager, long-term care facility, community general support center). These sources were multiple-response items, and participants selecting each item were compared with those who did not.

Finally, 355 respondents were included in the analysis. The mean age of care recipients was 77.2 ± 12.0 years and the mean score of the Dementia Assessment Sheet for Community-Based Integrated Care System 8-item (DASC-8)⁷ was 12.8 ± 2.7. Majority of them (n = 309; 87.0%) lived with their family members and 197 participants (55.5%) had a level of care need certification. For the respondents of family caregivers, the mean age was 50.0 ± 12.9 years. Of the respondents, 161 (45.4%) were children of the participants, 63 (17.7%) were spouses, 120 (59.7%) lived with the participants.

Primary care doctors were the most common post-diagnosis source of support (35.8%), followed by family members/relatives (20.0%) and care managers (15.2%). Moreover, 93 participants (14.6%) did not receive any support. After diagnosis, unaccompanied social participation decreased by 0.95 ± 1.11, while accompa-
nied social participation decreased by 0.78 ± 1.06.

Fig. 1 presents a summary of linear regression analyses with the source of support as the independent variable, the decreased number of social participations as the dependent variable, and age, sex, DASC-8 score, living arrangement, and care needs level as the adjusted variables. Positive regression coefficients indicate a greater decrease in social participation. Support from the informal sector tended to be associated with a decrease in social participation, while support from the medical sector resulted in an opposite trend. In particular, support from friends was significantly associated with greater decrease in social participation (unaccompanied: β = 0.561, p = 0.015). Support from memory clinic (accompanied: β = -0.417, p = 0.038) and dementia medical centers was associated with a smaller decrease (unaccompanied: β = -0.406, p = 0.096). Support from care managers was associated with decreased social participation (unaccompanied: β = 0.346, p = 0.057). Absence of support was not significantly associated with changes in social participation.

Although the present survey is limited by its retrospective nature and small sample size, the implications of the findings are important. The study suggested that social participation decrease depends on the source of support rather than its presence or absence of support. Support from the medical sector, especially memory clinic and Medical Centers for Dementia, had a protective effect against a decline in social participation. It is specified that Medical Centers for Dementia are to be staffed by professionals, including mental health social workers, and a previous study reported that 72.6% of the centers offered post-consultation support and 21.5% offered peer support. This study suggested the importance of assigning personnel to provide post-diagnostic support to medical institutions that play a central role in dementia in the community.

The association between support from friends and decreased social participation might be due to negative or overprotective attitudes toward social participation of people with dementia. Stigma and misinformation on dementia among the general public have been extensively reported. Although support from care managers was common, it was associated with a decrease in social participation. Participants supported by care managers may have already had problems related to social participation and sought support for access to long-term care insurance services. In addition, unaccompanied social participation tended to be affected more by support than accompanied participation.

Future research should investigate the kind of support received by people diagnosed with dementia. The present survey did not identify the detailed nature of this support. Even if unintentional, an overprotectiveness implies restrictions on the activities of people with dementia. Improving the quality of post-diagnostic support will contribute to a better living with dementia.

---

**Fig. 1.** Decreased number of social participations after dementia diagnosis by source of support. LTC, long-term care; CGSC, community general support center; un., unaccompanied; ac., accompanied; CI, confidence interval. Adjusted for age, sex, living arrangement, months from diagnosis, DASC8 (Dementia Assessment Sheet for Community-based Integrated Care System 8-item) score, care needs level.
ACKNOWLEDGMENTS

CONFLICT OF INTEREST
The authors claim no conflicts of interest.

FUNDING
None.

AUTHOR CONTRIBUTIONS
Conceptualization: STsuda, STakehara, TY, SH; Formal analysis: HM, STsuda; Funding acquisition: SH; Supervision: SH, STsuda; Writing-original draft: HM; Writing-review & editing: HM, STsuda, STakehara, TY, SH.

REFERENCES

Courses and Conferences

Upcoming academic events in 2023 of the Korean Geriatrics Society.
We would like to invite members of the Korean Geriatric Society and anyone who are interested.

[The 72th Annual Meeting of the Korean Geriatrics Society]
November 25-26, 2023
GECE Convention
1, Gwanak-ro, Gwanak-gu, Seoul, Republic of Korea 08826, Republic of Korea.
For more information please contact kgskorea1968@gmail.com

Membership Fee Information

Membership Fee

- Regular member (Certified by the Korean Geriatrics Society): KRW 20,000
- Other member: KRW 30,000

Payment account information
KEB Hana Bank: 630-007115-767
대한노인병학회
- Please remark the name of the sender when making bank transfer.

Information on Geriatric Medicine Certification

Examination date
The examination is held once a year in August.

Eligibility for examination
a. Should be a member of the Korean Geriatrics Society.
b. Should have more than 200 points recognized by the Korean Geriatrics Society.

Benefits of Certification
a. Discounted annual membership fee of KRW 20,000 (KRW 30,000 for general members).
b. Discount on registration fee for the Korean Geriatrics Society Meetings.

guideline on Geriatric Medicine Certification
a. Qualifications: Those who passed the Geriatric Medicine Certification Exam
b. Those who had a medical license for over 5 years.
c. Certification fee: KRW 200,000

c. Procedure: Confirmation of acceptance → Confirmation of mailing address → Transfer certification fee to AGMR → Certificate is sent by mail
Expiration policy: Valid for 5 years after acquisition
Ex. September 1, 2015 - August 31, 2020

* For doctors of earlier career with less than 5 years from acquiring license from Korean Medical Association, we encourage to take the examination for the geriatric certification. However, the geriatric certification will be valid only after 5 years since the license acquisition.

Renewal of Certification
a. Qualification: Those who earned 250 points or more within the validity period (5 years)

(The changes have been made to the article 8 of the Regulation on the Management in that one needs to earn 250 points and not 500 points for renewing the certificate.)
b. Certification renewal fee: KRW 50,000
c. Procedure: Acquisition of 250 points (check on "My Page" at the website)

→ Check mailing address
→ Send the certification renewal fee to the Korean Geriatrics Society
→ Certificate issued and sent by mail
d. Expiration policy: Valid for 5 years after renewal
Ex. September 1, 2015 - August 31, 2020

Account information
KEB Hana Bank: 630-007115-767
대한노인병학회
- Please remark the name of the sender when making bank transfer.
The Korean Geriatrics Society [Geriatric Disease] has become an English-language journal named Annals of Geriatric Medicine and Research (Ann Geriatr Med Res, AGMR). As a non-profit emerging global peer-reviewed journal based on Korea, we highly encourage our members to submit articles to AGMR.

**Submission Method**

1. Journal website  
   Log-In (http://www.e-agmr.org)

2. Manuscript revision according to submission guidelines  
   (file format: MS word)

3. Log in → Author → Article (new) Submission  
   → Confirmation e-mail sent (Author)

4. Copyright agreement via web submission system  
   (Form available on our website or journal)

5. Submission Completed

**Provide the Evaluation of the Society when Contributing Articles**

If your article is published in the AGMR, 100 points will be given to the first author and corresponding author. Therefore, you must fill out medical licence number. Submission is always welcome as there is no limit in earning points.

**Journal Subscription Guide**

**Subscription fees**

- Subscription fee: KRW 20,000  
  (Journal mailed 4 times a year at the end of March, June, September, December)

* If you wish to receive journal by mail, please send a yearly subscription fee of KRW 20,000. Members who pay the annual fee will receive a journal letter.

**Payment account information**

- KEB Hana Bank: 630-007115-767  
  대한노인병원제

Please remark the name of the sender when making bank transfer, and include the comment “구독료/subcription fee” to specify that the transfer is for journal subscription. If you do not receive your mail even after transferring the payment, please confirm and correct the mailing address on “My page” after logging in.
Annals of Geriatric Medicine and Research (Ann Geriatr Med Res, AGMR) is the official journal of the Korean Geriatrics Society (http://www.geriatrics.or.kr/eng/) and the Korean Society for Gerontology (http://www.korea-biogerontology.co.kr). It is a peer-reviewed English journal that aims to introduce new knowledge related to geriatric medicine and to provide a forum for the analysis of gerontology, broadly defined. As a leading journal of geriatrics and gerontology in Korea, one of the fastest aging countries, AGMR offers future perspectives on clinical and biological science and issues on policymaking for older adults especially for Asian emerging countries.

Manuscripts on geriatrics and gerontology, including clinical research, aging-related basic research, and policy research related to senior health and welfare will be considered for publication. Researchers from a wide range of geriatric specialties, multidisciplinary areas, and related disciplines of gerontology are encouraged to submit manuscripts for publication. AGMR is published quarterly on the last days of March, June, September, and December. The official website of AGMR is https://www.e-agmr.org/.

Manuscripts submitted to AGMR should be prepared according to the instructions below. For issues not addressed in these instructions, the author should refer to the Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly Work in Medical Journals (http://www.icmje.org/icmje-recommendations.pdf) from the International Committee of Medical Journal Editors (ICMJE).

Contact Us
Editor-in-Chief: Jae-Young Lim, MD, PhD
Department of Rehabilitation Medicine, Seoul National University College of Medicine, Seoul National University Bundang Hospital, 82 Gumi-ro 173 beon-gil, Bundang-gu, Seongnam 13620, Korea
Tel: +82-31-787-7732, Fax: +82-31-787-4056
E-mail: drlim1@snu.ac.kr

Editorial Office: Korean Geriatrics Society
401 Yuksam Hyundai Venturetel, 20 Teheran-ro 25-gil, Gangnamgu, Seoul 06132, Korea
Tel: +82-2-2269-1039, Fax: +82-2-2269-1040
E-mail: agmr.editorial@gmail.com

RESEARCH AND PUBLICATION ETHICS

The journal adheres to the guidelines and best practices published by professional organizations, including International Standards for Editors and Authors (https://publicationethics.org/node/11184), ICMJE Recommendations, and the Principles of Transparency and Best Practice in Scholarly Publishing (joint statement by the Committee on Publication Ethics [COPE], Directory of Open Access Journals [DOAJ], World Association of Medical Editors [WAME], and Open Access Scholarly Publishers Association [OASPA]; https://doaj.org/bestpractice). Further, all processes of handling research and publication misconduct shall follow the applicable COPE flowchart (https://publicationethics.org/resources/flowcharts).

Statement of Human and Animal Rights
Clinical research should be conducted in accordance with the World Medical Association’s Declaration of Helsinki (https://www.wma.net/policies-post/wma-declaration-of-helsinki-ethical-principles-for-medical-research-involving-human-subjects/). Clinical studies that do not meet the Helsinki Declaration will not be considered for publication. For human subjects, identifiable information, such as patients’ names, initials, hospital numbers, dates of birth, and other protected health care information, should not be disclosed. For animal subjects, research should be performed based on the National or Institutional Guide for the Care and Use of Laboratory Animals. The ethical treatment of all experimental animals should be maintained.

Statement of Informed Consent and Institutional Approval
Copies of written informed consent should be kept for studies on human subjects. Clinical studies with human subjects should provide a certificate, an agreement, or the approval by the Institutional Review Board (IRB) of the author’s affiliated institution. For research with animal subjects, studies should be approved by an Institutional Animal Care and Use Committee (IACUC). If necessary, the editor or reviewers may request copies of these documents to resolve questions regarding IRB/IACUC approval and study conduct.
Conflict of Interest Statement

The corresponding author of an article is asked to inform the Editor of the authors’ potential conflicts of interest possibly influencing their interpretation of data. Examples of potential conflicts of interest include employment, consultancies, stock ownership, honoraria, paid expert testimony, patent applications/registrations, and grants or other funding. A potential conflict of interest should be disclosed in the manuscript even when the authors are confident that their judgments have not been influenced in preparing the manuscript. The disclosure form should be the same as the ICMJE Form for Disclosure of Potential Conflicts of Interest (http://www.icmje.org/conflicts-of-interest/).

Originality, Plagiarism, and Duplicate Publication

Redundant or duplicate publication refers to the publication of a paper that overlaps substantially with one already published. Upon receipt, submitted manuscripts are screened for possible plagiarism or duplicate publication using Crossref Similarity Check. If a paper that might be regarded as duplicate or redundant had already been published in another journal or submitted for publication, the author should notify the fact in advance at the time of submission. Under these conditions, any such work should be referred to and referenced in the new paper. The new manuscript should be submitted together with copies of the duplicate or redundant material to the editorial committee. If redundant or duplicate publication is attempted or occurs without such notification, the submitted manuscript will be rejected immediately. If the editor was not aware of the violations and of the fact that the article had already been published, the editor will announce in the journal that the submitted manuscript had already been published in a duplicate or redundant manner, without seeking the author’s explanation or approval.

Secondary Publication

It is possible to republish manuscripts if the manuscripts satisfy the conditions for secondary publication of the ICMJE Recommendations (http://www.icmje.org/icmje-recommendations.pdf).

Authorship and Author’s Responsibility

Authorship credit should be based on (1) substantial contributions to conception and design, acquisition of data, and analysis and interpretation of data; (2) drafting the article or revising it critically for important intellectual content; (3) final approval of the version to be published; and (4) agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. Authors should meet these four conditions.

- A list of each author’s role should accompany the submitted paper.
- Correction of authorship: Any requests for such changes in authorship (adding author(s), removing author(s), or re-arranging the order of authors) after the initial manuscript submission and before publication should be explained in writing to the editor in a letter or e-mail from all authors. This letter must be signed by all authors of the paper. A copyright assignment must be completed by every author.
- Role of corresponding author: The corresponding author takes primary responsibility for communication with the journal during the manuscript submission, peer review, and publication process. The corresponding author typically ensures that all of the journal’s administrative requirements, such as providing the details of authorship, ethics committee approval, clinical trial registration documentation, and conflict of interest forms and statements, are properly completed, although these duties may be delegated to one or more coauthors. The corresponding author should be available throughout the submission and peer review process to respond to editorial queries in a timely manner, and after publication, should be available to respond to critiques of the work and cooperate with any requests from the journal for data or additional information or questions about the article.
- All authors of a manuscript must have agreed to its submission and are responsible for its content, including appropriate citations and acknowledgements; they must also have agreed that the corresponding author has the authority to act on their behalf on all matters pertaining to the publication of the paper.
- Description of co-first authors or co-corresponding authors is also accepted if corresponding author believes that their roles are equally contributed.
- Contributors: Any researcher who does not meet all four ICMJE criteria for authorship discussed above but contribute substantively to the study in terms of idea development, manuscript writing, conducting research, data analysis, and financial support should have their contributions listed in the Acknowledgments section of the article.

Process for Managing Research and Publication Misconduct

When the journal faces suspected cases of research and publication misconduct, such as redundant (duplicate) publication, plagiarism, fraudulent or fabricated data, changes in authorship, undisclosed conflict of interest, ethical problems with a submitted manuscript, appropriation by a reviewer of an author’s idea or data, and complaints against editors, the resolution process will follow the flowchart provided by COPE (http://publicationethics.org/
resources/flowcharts). The discussion and decision on the suspected cases are carried out by the Editorial Board.

Editorial Responsibilities
The Editorial Board will continuously work to monitor and safeguard publication ethics: guidelines for retracting articles; maintenance of the integrity of academic records; preclusion of business needs from compromising intellectual and ethical standards; publishing corrections, clarifications, retractions, and apologies when needed; and excluding plagiarized and fraudulent data. The editors maintain the following responsibilities: responsibility and authority to reject and accept articles; avoid any conflict of interest with respect to articles they reject or accept; promote the publication of corrections or retractions when errors are found; and preserve the anonymity of reviewers.

EDITORIAL POLICY

Copyright
Copyright in all published material is owned by the Korean Geriatrics Society. Authors must agree to transfer copyright (https://www.e-agmr.org/authors/copyright_transfer_agreement.php) during the submission process. The corresponding author is responsible for submitting the copyright transfer agreement to the publisher.

Open Access Policy
AGMR is an open-access journal. Articles are distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by-nc/4.0/), which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited. Author(s) do not need to permission to use tables or figures published in AGMR in other journals, books, or media for scholarly and educational purposes. This policy is in accordance with the Budapest Open Access Initiative definition of open access.

Registration of Clinical Trial Research
It is recommended that any research dealing with a clinical trial be registered with a primary national clinical trial registration site such as Clinical Research Information Service (http://cris.cdc.go.kr/), or other sites accredited by the World Health Organization ICTRP (http://www.who.int/ictrp/en) and ClinicalTrials.gov (http://clinicaltrials.gov/), a service of the United States National Institutes of Health.

Data Sharing
AGMR encourages data sharing wherever possible, unless this is prevented by ethical, privacy, or confidentiality matters. Authors wishing to do so may deposit their data in a publicly accessible repository and include a link to the DOI within the text of the manuscript.

Archiving and Posting Policy
AGMR provides electronic archiving and preservation of access to the journal content in the event the journal is no longer published, by archiving in the National Library of Korea. According to the deposit policy (self-archiving policy) of Sherpa/Romeo (http://www.sherpa.ac.uk/), authors cannot archive pre-print (i.e., pre-refereeing) but they can archive post-print (i.e., final draft post-refereeing). Authors can archive the publisher’s version/PDF.

Correction
If correction is needed, it will follow the ICMJE Recommendation for Corrections, Retractions, Republications and Version Control available from: http://www.icmje.org/recommendations/browse/publishing-and-editorial-issues/corrections-and-version-control.html as follows:
Honest errors are a part of science and publishing and require publication of a correction when they are detected. Corrections are needed for errors of fact. Minimum standards are as follows:
First, it shall publish a correction notice as soon as possible, detailing changes from and citing the original publication on both an electronic and numbered print page that is included in an electronic or a print Table of Contents to ensure proper indexing;
Second, it shall post a new article version with details of the changes from the original version and the date(s) on which the changes were made through CrossMark;
Third, it shall archive all prior versions of the article. This archive can be either directly accessible to readers; and Fourth, previous electronic versions shall prominently note that there are more recent versions of the article via CrossMark.

SUBMISSION & PEER REVIEW PROCESS

Submission
All manuscripts should be submitted online via the journal’s website (http://submit.e-agmr.org/submission/) by the corresponding author. Once you have logged into your account, the online
system will lead you through the submission process in a stepwise orderly process. Submission instructions are available at the website. All articles submitted to the journal must comply with these instructions. Failure to do so will result in the return of the manuscript and possible delay in publication.

Peer-Review Process

- A submitted manuscript will be evaluated by editors and reviewers. All manuscripts submitted to AGMR undergo screening by the Editorial Board, who then determines whether a manuscript undergoes external review.
- The journal uses a double-blind peer review process: the reviewers are not aware of the identity of the authors, and vice versa. They are peer reviewed by at least 3 anonymous reviewers selected by the editor. We neither guarantee the acceptance without reviewing process nor very short peer review times for unsolicited manuscripts. Commissioned manuscripts will also be reviewed before publication.
- The average time interval for an initial review process that involves both editorial and peer reviews is approximately 1 month; occasionally, there are unavoidable delays, usually because a manuscript needs multiple reviews or several revisions.
- The corresponding author will be notified as soon as possible of the editor’s decision to accept, reject, or ask for revisions. When manuscripts are returned for a revision, a cover letter from the editor provides directions that should be followed carefully. When submitting the revised manuscript, authors should include a Response Letter, which describes how the manuscript has been revised. A point-by-point response to the editor should be included with the revised manuscript. Authors who plan to resubmit but cannot meet this deadline should contact the Editorial Office. Manuscripts held for revision will be retained for a maximum of 90 days. The revised manuscript and the author’s comments will be reviewed again. If a manuscript is completely acceptable according to the criteria set forth in these instructions, it is scheduled for publication in the next available issue.

Appeals of Decisions

Any appeal against an editorial decision must be made within 2 weeks of the date of the decision letter. Authors who wish to appeal a decision should contact the Editor-in-Chief, explaining in detail the reasons for the appeal. All appeals will be discussed with at least one other associate editor. If consensus cannot be reached thereby, an appeal will be discussed at a full editorial meeting. The process of handling complaints and appeals follows the guidelines of COPE available from https://publicationethics.org/appeals.

AGMR does not consider second appeals.

MANUSCRIPT PREPARATION

AGMR focuses on clinical and experimental studies, reviews, case reports, editorials and letters in geriatric medicine and gerontology. Any researcher throughout the world can submit a manuscript if the scope of the manuscript is appropriate.

General Requirements

- The manuscript must be written using Microsoft Word and saved as “.doc” or “.docx” file format. The font size must be 11 points. The body text must be left aligned, double spaced, and presented in one column. The left, right, and bottom margins must be 3 cm, but the top margin must be 3.5 cm.
- Page numbers must be indicated in Arabic numerals in the middle of the bottom margin, starting from the abstract page.
- A complete title page should be submitted separately from the main document file, and the latter should contain no information that identifies the author or the author’s institutional affiliation.
- All manuscripts must be written in clearly understandable English. Authors whose first language is not English are requested to have their manuscripts checked for grammatical and linguistic correctness before submission. Correct medical terminology should be used, and jargon should be avoided.
- The use of abbreviations should be minimized and restricted to those that are generally recognized. When using an abbreviated word, it should be spelled out in full on first usage in the manuscript, followed by the abbreviation in parentheses.
- Numbers should be written in Arabic numerals, but must be spelled out when placed at the beginning of a sentence.
- Drugs and chemicals should be referred to using standard chemical or generic terms. The names and locations (city, state, and country only) of manufacturers of equipment and non-generic drugs should be given.
- Measurements should be described using the metric system, and hematologic and biochemical markers using the International System of Units. All units must be preceded by one space, except for the following symbols: percentage (%), temperature (°C), and degree (°).

All authors of a manuscript must have agreed to its submission and are responsible for its content, including appropriate citations and acknowledgements; they must also have agreed that the corresponding author has the authority to act on their behalf on all matters pertaining to the publication of the paper. By publishing in this journal, the authors agree that the Korean Geriatrics Society
has the right to protect the manuscript from misappropriation. Illustrations in published articles will not be returned to the authors.

**Reporting Guidelines for Specific Study Designs**

For specific study designs, such as randomized control studies, studies of diagnostic accuracy, meta-analyses, observational studies, and non-randomized studies, authors are encouraged to consult the reporting guidelines relevant to their specific research design. A good source of reporting guidelines is the EQUATOR Network (https://www.equator-network.org/) and NLM (https://www.nlm.nih.gov/services/research_report_guide.html).

**Composition of Manuscripts**

The manuscript sections should be presented in the following order: Cover Letter, Title Page, Abstract and Keywords, Introduction, Materials and Methods, Results, Discussion, Acknowledgements, References, Tables, and Figure Legends. Provide only one table or figure per page. Table 1 shows the recommended maximums of manuscripts according to publication type; however, these requirements are negotiable with the editor.

**Table 1. Recommended maximums for articles submitted to AGMR**

<table>
<thead>
<tr>
<th>Type of article</th>
<th>Abstract (word)</th>
<th>Text (word)</th>
<th>Reference</th>
<th>Table &amp; figure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original article</td>
<td>Structured b)</td>
<td>3,500</td>
<td>50</td>
<td>7</td>
</tr>
<tr>
<td>Review</td>
<td>150</td>
<td>6,000</td>
<td>unlimited</td>
<td>7</td>
</tr>
<tr>
<td>Case report</td>
<td>150</td>
<td>1,500</td>
<td>20</td>
<td>7</td>
</tr>
<tr>
<td>Editorial</td>
<td>No</td>
<td>1,200</td>
<td>15</td>
<td>7</td>
</tr>
<tr>
<td>Letter to the editor</td>
<td>No</td>
<td>1,200</td>
<td>15</td>
<td>1</td>
</tr>
</tbody>
</table>

AGMR, Annals of Geriatric Medicine and Research.

a) Maximum number of words is exclusive of the abstract, references, tables, and figure legends.

b) Background, methods, results, and conclusion.

**Title Page**

The Title Page should include only the following information:

- **Title**: The title and the running title should be 25 or less and 10 or less words, respectively. Please consider the title very carefully, as these are often used in information-retrieval systems. Please use a concise and informative title (avoiding abbreviations where possible). The title should be written in sentence case (capitalize only the first word of the title and proper nouns).

- **Author names and affiliations in the correct order**: Where the family name may be ambiguous (e.g., a double name), please indicate this clearly. Present the authors’ affiliation (where the actual work was done) below the names. Indicate all institutional affiliations, including the city and country, using lower-case superscript letters immediately after the author’s name and in front of the appropriate address.

- **Corresponding author**: Clearly indicate who will handle correspondence at all stages of the refereeing and publication process and after publication. Provide the full postal address, including the city and country and, if available, the e-mail address of each author. When stating the author's degree, do not place periods within “MD” and “PhD”. The e-mail address and ORCID of the corresponding author should be placed in the title page. Contact details must be kept up-to-date by the corresponding author. ORCID (Open Researcher and Contributor ID) identifier must be also addressed. If the corresponding author does not have an ORCID identifier, it can be obtained through the ORCID website (https://orcid.org).

- **Acknowledgments**: This section is for the Conflicts of Interest, Funding, Author Contributions, ORCID, Additional Contributions, and Previous Presentations.
  - **Conflicts of Interest Disclosures**: Please include the authors’ potential conflicts of interest that could possibly influence their interpretation of data. If no conflict exists, please state the following: “The researcher(s) claim(s) no conflicts of interest.”
  - **Funding**: For each source of funds, both the research funder and the grant number should be listed in this section.
  - **Author Contributions**: The contributions of all authors must be described using the CRedit (https://www.casrai.org/credit.html) Taxonomy of author roles. Sample:
    - Conceptualization, GDH; Data curation, JHK; Funding acquisition, GDH; Investigation, JHK, SSL; Methodology, AGK; Project administration, GDH; Supervision, GDH; Writing—original draft, JHK, SSL; Writing—review & editing, GDH, AGK
  - **ORCID**: We recommend that the open researcher and contributor ID (ORCID) of all authors be provided. In order to obtain an ORCID, authors should register in the ORCID website: http://orcid.org/. Registration is free to every researcher in the world.
  - **Additional Contributions**: All persons who have made substantial contributions, but who have not met the criteria for authorship, are acknowledged here.
  - **Previous Presentation**: Please inform any previous presentation of the material. Provide the exact data and location of the meeting.
**Abstract & Keywords**

A concise and factual abstract is required. The abstract should not be more than 250 words (150 words for case reports and reviews). Abstracts should include the following headings: Background, Methods, Results, and Conclusion. Author(s) should specify the number of study participants. The abstract’s conclusion should emphasize clinical relevance. Do not use vague phrases such as “We believe that …” or “We suppose that …”. Non-standard or uncommon abbreviations should be avoided, but if essential, must be defined the first time they are mentioned in the abstract. After the abstract, list 3-5 keywords to be used for indexing. The keywords are from medical subject headings (MeSH; [https://www.ncbi.nlm.nih.gov/mesh](https://www.ncbi.nlm.nih.gov/mesh)). Editorials and Letters to the editor do not require an abstract. An abstract is often presented separately from the article, and therefore must be able to stand alone.

**Guidelines for the Main Body**

- **Introduction**: State the objectives of the work and provide adequate background, avoiding a detailed literature survey or summary of the results.
- **Materials and Methods**: Authors of empirical papers are expected to provide full details of the research methods used, including study location(s), sampling procedures, date(s) of data collection, research instruments, and data analysis techniques. Methods already published should be indicated in a reference; only relevant modifications should be described. For Case Reports, the case history or case description replaces the Methods section, as well as the Results section. Any study using human subjects or materials should be approved by the Institutional Review Board, as well through patient consent. Affiliation name of Institutional Review Board and approval number must be clearly stated as the following: “This study was approved by the Institutional Review Board of [Name of Affiliation] (Approval Number)”. Any study using animals should state the Institutional Animal Care approval and number. Any other ethics approvals should also be listed. If no ethical approvals were achieved or required, please state the reason (e.g., “In this study, the Institutional Review Board of [Name of Affiliation] approved the exemption and allowed authors to review the patient’s records with no need for the informed consents.”). Ensure correct use of the terms sex (when reporting biological factors) and gender (identity, psychosocial or cultural factors), and, unless inappropriate, report the sex and/or gender of study participants, the sex of animals or cells, and describe the methods used to determine sex and gender. If the study was done involving an exclusive population, for example in only one sex, authors should justify why, except in obvious cases (e.g., prostate cancer).
- **Results**: Results should be clear and concise. Excessive repetition of table or figure content should be avoided.
- **Discussion**: This should explore the significance of the findings, rather than repeating them. Avoid extensive citations or a discussion of published literature. The main conclusions of the study may be presented in a short Conclusion section, which may stand alone or form a subsection of the Discussion section.

**References**

The citation of references in the text should be made using consecutive numbers in parentheses (Vancouver style). They should be listed in the text in the order of citation, with consecutive numbering in this separate section. The style for papers in periodicals is as follows: the name and initials of all authors, the full title of article, the journal name abbreviated in accordance with Index Medicus, the year and volume, and the first and last page numbers. If there are more than 7 authors, write the names of the first 6 authors, followed by “et al.” The style for a book chapter is as follows: author and title of the chapter, editor of the book, title of the book, edition, volume, place, publisher, year, and first and last page numbers. The style for a book is as follows: author, title of the book, edition, place of publication, publisher, and year of publication. The style for a website is as follows: title of the website, the book, edition, volume, place, publisher, and year of publication. Place of publication, publisher, year of copyright, and Internet address. Other types of references not described below should follow ICMJE Recommendations ([https://www.nlm.nih.gov/bsd/uniform_requirements.html](https://www.nlm.nih.gov/bsd/uniform_requirements.html)). Authors are responsible for the accuracy and completeness of their references and for ensuring that their text citations are correct. Papers still in press may be listed among the references using the journal name and a tentative year of publication. Unpublished data and personal communications may be listed only with the author’s written permission.

**Reference Style**

- **Journal article**:
- **Book**:
- **Book chapter**:
Table: Please submit tables as editable text and not as images. Avoid using vertical rules. Tables should be simple and should not duplicate information already presented in figures. Title all tables and number them using Arabic numerals in the order of their citation. Tables should be double-spaced, with each table on a separate sheet. Describe all abbreviations using footnotes. Footnotes are followed by the source notes, other general notes, abbreviation, notes on specific parts of the table (a), (b), (c), d)..., and notes on level of probability (*, **, *** for p-values). Each column and row should have an appropriate heading. The first letter of the first word in each column and row should be capitalized. Use Arabic numerals after “Table” in accordance with the order of citation, with a space between “Table” and the Arabic number. Mean and standard deviation (mean ± SD) and numbers of subjects are included and the significance of results is indicated through appropriate statistical analysis. The p-value should be provided to 3 decimal places and the letter “p” in “p-value” written in lower case. Table footnotes should be indicated with superscript markings. All units of measurement and concentration should be designated. Exponential terminology is discouraged. The table should be drawn in MS word and not as an image file (JPG, GIF, TIFF, etc.).

Figure: Electronic art should be created/scanned and saved and submitted as either a TIFF (tagged image file format) or an EPS (encapsulated postscript) file. Figures must be cited in the text and numbered in order of first mention. Make sure to mark the figure number clearly on the figure or part of the electronic file name (i.e., Figure 1.tif). Line art must have a resolution of at least 1,200 dpi (dots per inch), and electronic photographs, radiographs, CT scans, and scanned images must have a resolution of at least 300 dpi. Images should be supplied at a size that approximates the final figure size in the print journal. If fonts are used in the artwork, they must be converted to paths or outlines, or embedded in the files. Color images must be created/scanned, saved, and then submitted as CMYK files. Please note that artwork generated using office suite programs such as Corel Draw or MS Word, as well as artwork downloaded from the Internet (JPEG or GIFF files), cannot be used. Color photographs will be published if the editor considers them absolutely necessary. The expense of reproducing color photographs/designs will be passed on to the author. The author is responsible for submitting prints that are of sufficient quality to permit accurate reproduction, and for approving the final color galley proof.

Figure legend: All of the figure legends should be typewritten and double-spaced. Use a separate sheet for each legend. Figure legends should describe briefly the data shown, explain any abbreviations or reference points in the photographs, and identify all units, mathematical expressions, abscissas, ordinates, and symbols.

Other Manuscript Formats
General guidelines are same as for original articles.

Case Reports
- Case reports are considered for publication only if they report rare conditions, atypical symptoms and signs, or novel diagnostic or therapeutic approaches. The manuscript is structured in the following order: Title Page, Abstract, Introduction, Case Report, Discussion, References, Tables, and Figures. The abstract should be unstructured and should be no more than 150 words, with no more than 3 keywords attached. The introduction should briefly state the background and significance of the case. The actual case report should describe the clinical presentation and the diagnostic and therapeutic measures taken. The discussion should focus on the uniqueness of the case and should not contain an extensive review of the disease or disorder. The number of references is limited to 20. The maximum word count is 1,500 words, except references, figure legends, and tables.

- A case report is an academic/educational activity that does not meet the definition of “research”, which is: “a systematic investigation, including research development, testing and evaluation, designed to develop or contribute to generalizable knowledge.” Therefore, the activity does not necessarily need to be reviewed by an Institutional Review Board. However, patients have a right to privacy that should not be infringed without an informed consent. Identifying information, including patients’ names, initials, or hospital numbers, should
not be published in written descriptions, photographs, and pedigrees unless the information is essential for scientific purposes and the patient (or parent or guardian) gives written informed consent for publication. Informed consent for this purpose requires that a patient who is identifiable be shown the manuscript to be published. Complete anonymity is difficult to achieve, however, an informed consent should be obtained if there is any doubt. For example, masking the eye region in photographs of patients is inadequate protection of anonymity. If identifying characteristics are altered to protect anonymity, such as in genetic pedigrees, authors should provide assurance that alterations do not distort scientific meaning and editors should so note.

- Editorials are an invited comment on a recently published manuscript. Editorial offers broader view of raised issues, balanced interpretation, and a link to further questions. Manuscript limitations are 1,200 words and 15 references.
- Letters to the editor: Letters to the editor comment on papers published in this journal or on other relevant matters and do not require an abstract. Manuscripts may be no longer than 1,200 words, with 15 or less references and may include only 1 figure or table. Subtitles should not be used, and any acknowledgements should be included in the body of the letter. Writing a letter is an academic/educational activity that does not meet the definition of “research”, which is: “a systematic investigation, including research development, testing and evaluation, designed to develop or contribute to generalizable knowledge.” Therefore, the activity does not necessarily need to be reviewed by an Institutional Review Board.

Supplemental Data
Additional data, including Methods, Results, References, Tables, Figures, and video, that are difficult to be inserted in the main body can be submitted in the form of Supplemental Data. Supplemental Data submitted by the author will be published online together with the main body without going through a separate editing procedure. All supplemental data, except video materials, are to be submitted in a single file, and the manuscript title, authors’ name, organization, and corresponding author’s contact information must be specified in the first page.

FINAL PREPARATION FOR PUBLICATION

Final Version
After the paper has been accepted for publication, the author(s) should submit the final version of the manuscript. The names and affiliations of the authors should be double-checked, and if the originally submitted image files were of poor resolution, higher resolution image files should be submitted at this time. Symbols (e.g., circles, triangles, squares), letters (e.g., words, abbreviations), and numbers should be large enough to be legible on reduction to the journal’s column widths. All symbols must be defined in the figure caption. If references, tables, or figures are moved, added, or deleted during the revision process, renumber them to reflect such changes so that all tables, references, and figures are cited in numeric order.

Manuscript Corrections
Before publication, the manuscript editor will correct the manuscript such that it meets the standard publication format. The author(s) must respond within 2 days when the manuscript editor contacts the corresponding author for revisions. If the response is delayed, the manuscript’s publication may be postponed to the next issue.

Gallery Proof
The author(s) will receive the final version of the manuscript as a PDF file. Upon receipt, the author(s) must notify the Editorial Office (or printing office) of any errors found in the file within 2 days. Any errors found after this time are the responsibility of the author(s) and will have to be corrected as an erratum.

Errata and Corrigenda
To correct errors in published articles, the corresponding author should contact the journal’s Editorial Office with a detailed description of the proposed correction. Corrections that profoundly affect the interpretation or conclusions of the article will be reviewed by the editors. Corrections will be published as corrigenda (corrections of the author’s errors) or errata (corrections of the publisher’s errors) in a later issue of the journal.

ARTICLE PROCESSING CHARGES
There are no article submission charges or article processing charges for AGMR. Only reprinting cost will be charged to the authors. Reprints may be ordered directly from the publisher. An order form for reprints will be sent with the proofs to the corresponding author. Reprints are available in quantities of 50.
Before submitting the manuscript, please complete the author’s checklist below and send it to the editorial office using online submission system (http://www.e-agmr.org).

General Guideline
☐ The content of the manuscript is original.
☐ The contact information (address, ORCID, e-mail address) of the corresponding author is indicated.

Abstract and Keywords
☐ The abstract is 250 words or less.
☐ The abstract is presented in the order of background, methods, results, and conclusion.
☐ The keywords are from medical subject headings (MeSH) (see https://www.ncbi.nlm.nih.gov/mesh).

References
☐ References are listed in accordance with the “submission guidelines”.
☐ The number of references is appropriate.
☐ One or more articles are cited from the “Annals of Geriatric Medicine and Research”.

Tables and Figures
☐ No more than 7 tables and figures in total.
☐ The title and legends of tables and figures are clear and concise.

Corresponding Author
Print Name
Signiture

www.e-agmr.org
Copyright transfer form

*Must be signed and returned to the editor-in-chief of the journal before the manuscript can be considered for publication

YOUR STATUS
I am the author signing on behalf of all co-authors of the manuscript
Name/Title/Institution/Signature: _______________________________________________________________
E-mail address: _________________________________________________________________________

I have read and agree to the terms of the License Agreement [     ]

Author(s) hereby certify that:
1. The Author(s) are the sole authors of and sole owners of the copyright in the Contribution.
2. If the Contribution includes materials of others, the Author(s) certify that they have obtained written permission for the use of text, tables, and/or illustrations from any copyrighted source(s), and agree to supply such written permission(s) to the Korean Geriatrics Society (KGS) upon request.
3. In consideration of publication of the Contribution in the Annals of Geriatric Medicine and Research (AGMR), the Author(s) hereby grants to KGS for the full term of copyright and any extensions thereto the sole and exclusive, irrevocable license to publish, reproduce, distribute, transmit, display, store, translate, create derivative works from and otherwise use the Work in any language or in any form, manner, format, or medium now known or hereafter developed without limitation throughout the world, and to permit and/or license others to do any or all of the above. In the event that AGMR decides not to publish the Contribution, this license shall be terminated and all rights revert to the author(s). And I agree to the AGMR Open Access license agreement: Creative Commons Attribution Noncommercial license.

AUTHORS RIGHTS

Ownership of copyright remains with the Authors, and provided that, when reproducing the Contribution or extracts from it, they acknowledge first and reference publication in the Journal. Authors also retain the following nonexclusive rights:
* To reproduce the Contribution in whole or in part in any printed volume (book or thesis) of which they are the author(s).
* They and any academic institution where they work at the time may reproduce the Contribution for the purpose of course teaching.
* To post a copy of the Contribution as accepted for publication after peer review (in Word or Text format) on the Authors’ own web site or institutional repository or the Author’s funding body’s archive, after publication of the printed or online edition of the Journal, provided that they also give a hyperlink from the Contribution to the Journal’s web site.
* To reuse figures or tables created by them and contained in the Contribution in other works created by them.

USERS RIGHTS: SUMMARY OF CREATIVE COMMONS LICENCES

CREATIVE COMMONS ATTRIBUTION-NON-COMMERCIAL LICENCE
Users are free to share (copy, distribute and transmit) and remix (adapt) the contribution under the following conditions (read full legal code at https://creativecommons.org/licenses/by-nc/4.0/legalcode):
* Attribution: Users must attribute the contribution in the manner specified by the author or licensor (but not in any way that suggests that they or their use of the contribution is endorsed by the author or licensor).
* Noncommercial: Users may not use this work for commercial purposes.
* For any reuse or distribution, users must make clear to others the license terms of this work, preferably using a link to the Creative commons webpage (http://creativecommons.org/licenses/)
* Any of the above conditions can be waived if users get permission from the copyright holder.

www.e-agmr.org
AUTHOR REPRESENTATIONS / ETHICS AND DISCLOSURE

I affirm the Author Representations noted below, and confirm that I have reviewed and complied with the relevant Instructions to Authors.

Author representations
The Article I have submitted to the journal for review is original, has been written by the stated authors and has not been previously published.
The Article was not submitted for review to another journal while under review by this journal and will not be submitted to any other journal.
The Article and the Supplemental Materials do not infringe any copyright, violate any other intellectual property, privacy or other rights of any person or entity, or contain any libelous or other unlawful matter.
I have obtained written permission from copyright owners for any excerpts from copyrighted works that are included and have credited the sources in the Article or the Supplemental Materials. Except as expressly set out in this License Agreement, the Article is not subject to any prior rights or licenses and, if my or any of my co-authors’ institution has a policy that might restrict my ability to grant the rights required by this License Agreement (taking into account the Author Rights permitted hereunder, including Internal Institutional Use), a written waiver of that policy has been obtained.
If I am using any personal details or images of patients, research subjects or other individuals, I have obtained all consents required by applicable law and complied with the publisher’s policies relating to the use of such images or personal information. If the Article or any of the Supplemental Materials were prepared jointly with other authors, I have informed the coauthor(s) of the terms of this License Agreement and that I am signing on their behalf as their agent, and I am authorized to do so.
The Korean Geriatrics Society Board of Trustees

Jan 2022–Dec 2023

President
Yong Kyun Roh, Hallym University

Chairperson
Seok Yeon Kim, Seoul Medical Center

Honorary Committee
Haeng Il Koh, Mirae ING
In Soon Kwon, Korea Medical Dispute Mediation and Arbitration Agency
Cheol Ho Kim, Seoul National University
Jong Chun Park, Chonnam National University
Hyun Wook Baik, Bundang Jesaeng Hospital
Seok Whan Shin, Health Insurance Review & Assessment Service (Inchon)
Jun Hyun Yoo, Sungkyunkwan University
Hyung Joon Yoo, CM Hospital
Sang Yun Kim, Seoul National University
Young-Soo Lee, Ulsan University
Jung Ae Rhee, Chonnam National University
Hong Soon Lee, Inje University
Hak Chul Jang, Seoul National University
Kyung Hwan Cho, Korea University
Young Soo Jin, Honorary professor, Ulsan University
Hyun Rim Choi, Good Morning Hospital
Chang Won Won, Kyung Hee University
Il Woo Han, Yong-in Hyoja Geriatric Hospital

Vice-President
Kang Seo Park, Eulji University
Min Ho Chun, Ulsan University

Secretary General
Young Jung Cho, National Medical Center

Treasurer
Su Hyun Kim, Seoul Medical Center

Director, Academic Affairs
Kwang-Il Kim, Seoul National University

Director, Board Exam Committee
Eun Ju Lee, Ulsan University

Director, Publication Committee, Editor-in-chief
Jae-Young Lim, Seoul National University

Director, Scientific Committee
Ki Young Son, Ulsan University

Director, Big Data Research TFT
Cheol Min Shin, Seoul National University

Director, Ethics Committee
Nam-Jong Bail, Seoul National University

Director, Committee of Strategic Planning
Young Deuk Jeon, National Medical Center
Yong Kyun Roh, Hallym University

Director, Medical Policy Planning Committee
Dong-Woo Lee, Inje University
Jae Kyung Choi, Konkuk University

Director, Training Committee
Chang-Oh Kim, Yonsei University

Director, Education Committee
Dae Yul Kim, Ulsan University

Director, Public Relations and Informational Committee
Heewon Jung, Ulsan University

Director, Collaborative Policy Committee of Geriatric Long-term Care Hospital
Hang Suk Cho, Yonsei Noble Hospital

Director, External Cooperation Committee
Il-Young Jang, Ulsan University

Director, Medical Insurance Policy
Hyuk Ga, Incheon Eun-Hye Hospital

Director, Legislation Committee
Be Long Cho, Seoul National University

Director, Nursing and community care TFT
Yong Kyun Roh, Hallym University

Director, Age Friendly Hospital TFT
Jong Min Lee, Konkuk University

Director, Smart Healthcare TFT
Chul Jun Kim, Daejeon Wellness Hospital

Director, International Cooperation Committee
Chang Won Won, Kyung Hee University

Auditor
Sung Hee Hwang, Hallym University
Hwan Sik Hwang, Hanyang University

Special Appointment Director
Young-Kyu Park, DMC Bundang Jesaeng Hospital
Jae Won Ri, Gwanggye Hospital
Yong-Chan Ha, Seoul Bumin Hospital
Yu Hea-Min, Eulji University
Yoon-Ho Choi, Sungkyunkwan University
Doo Soo Jeon, Catholic University of Korea
Yun Hwan Lee, Aju University
Jae-Geun Lee, Jeju Hospital
Hyeng Kue Park, Chonnam National University