The Ewha Medical Journal

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Aims & Scope

Aims: The Ewha Medical Journal aims to provide medical professionals with essential healthcare information and fundamental medical knowledge. The journal will contribute to improving and serving human society based on the Christian values of education, truth, goodness, and beauty. Additionally, the journal strives to nurture young editors, enabling them to demonstrate exceptional women's editorial leadership and provide innovative learning methods.

Scope: Its scope includes:

Up-to-date medical knowledge and skills essential for patient care
Preparing for the future of medicine
Effective interprofessional communication
Ensuring gender equity and diversity
Medical education materials
Sharing data and protocols

Regional scope: The journal primarily focuses on Korea but welcomes submissions from researchers worldwide.

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How a medical journal can survive the freezing era of article production in Korea, and highlights in this issue of the *Ewha Medical Journal*

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After the resignation of medical residents from their training hospitals in February 2024 [1], the number of submissions to medical journals reportedly decreased. For the Journal of Korean Medical Science, domestic submissions in 2024 began higher than the 15-year average in January (92 vs. 68). However, they gradually declined throughout the year, hitting a low of 56 in September before rebounding to 92 in October [2]. This decrease in manuscript submissions stemmed from the increased workload on clinical faculty members after the residents' resignations. Although submission levels in 2024 remained sustainable, the situation in 2025 may worsen due to reduced research activities by clinical faculty members in 2024. Fortunately, the Ewha Medical Journal published 74 articles in 2024, more than double the 34 publications in 2023. This remarkable achievement was made possible by the commitment of clinical faculty members in Korea to the journal. However, we remain concerned about the number of submissions in 2025, because the environment for patient care in university hospitals continues to deteriorate. Unfortunately, the current conflict between the Korean government and the medical association remains unresolved following a Korean presidential emergency briefing announcing martial law, which threatened punishment under martial law if medical residents did not "return to work" within 48 hours [3]. We have no choice but to wait for an evidence-based resolution by the Korean government. This situation can be described as a freezing era of article production. How can the Ewha Medical Journal survive in this challenging environment? The editors and editorial office plan to review manuscripts as quickly as possible and publish them with the highest editorial quality. We will also seek out helpful topics for clinicians and medical educators. Maintaining the highest editorial quality may help sustain researchers' commitment.

In this January issue, we are pleased to publish two editorials, two special topics, composed of nine narrative reviews, five reviews, three original articles, one case report, and one correspondence. The special topics focus on recent clinical approaches to shoulder diseases in older adults and the role of institutes and enterprises in addressing occupational and environmental diseases in Korea.

Special topics on clinical approaches to shoulder diseases in older adults

Five narrative review articles comprehensively address various topics related to shoulder

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diseases in older adults. Kang and Kang [4] present fundamental physical examination procedures for diagnosing shoulder pain. They also provide video files demonstrating physical examinations, including range-of-motion assessment, the full can and empty can tests for supraspinatus, the external lag sign, the Hornblower sign for infraspinatus, the lift-off and internal lag sign for subscapularis, the belly-press test for subscapularis, and impingement tests. These video files will be beneficial for any physician conducting shoulder joint examinations. Lee and Kim [5] review the classification, epidemiology, pathophysiology, clinical presentation, and management strategies of shoulder diseases in older adults. They categorize four major conditions—rotator cuff disease, frozen shoulder (adhesive capsulitis), osteoarthritis, and shoulder instability—in a table that outlines their pathophysiology, risk factors, clinical presentation, diagnostic approaches, and treatment strategies at a glance. Kim and Jung [6] discuss the radiological characteristics of shoulder diseases in older adults, including adhesive capsulitis, rotator cuff tears, and osteoarthritis of the glenohumeral joint. They also provide various clinical images illustrating these conditions. Furthermore, Kim and Jeong [7] present a detailed guide for managing shoulder diseases in older adults. They recommend nonsurgical interventions—such as exercise, manual therapy, and modifications to daily activities—as the primary treatment approach. Pharmacological strategies include nonsteroidal anti-inflammatory drugs, corticosteroid injections, and medications targeting neuropathic pain. Although steroid injections can offer short-term relief, repeated administration may compromise the integrity of surrounding tissues.

Another notable review explores the application of cutting-edge deep learning technology for diagnosing shoulder diseases [8]. This narrative review describes how deep learning addresses diagnostic challenges in shoulder care by automating image analysis, disease detection, and motion assessment. Convolutional neural networks match or surpass human accuracy in identifying rotator cuff tears, fractures, and joint conditions, while pose estimation refines range-of-motion evaluations. Deep learning also classifies local osteoporosis and enables personalized treatments. Such technologies are already being integrated into patient care for shoulder diseases. The aforementioned five reviews offer a comprehensive framework for understanding and addressing the unique challenges associated with shoulder diseases in older adults.

Special topic on the role of institutes related to occupational and environmental diseases in Korea

These papers discuss the role of institutes that deal with occupational and environmental diseases in Korea. First, the Korea Occupational Disease Surveillance Center [9] is not a single institution, but rather a comprehensive nationwide system designed to gather, analyze, and interpret data on occupational diseases through a network of regional centers. Established in 2022, it had 10 operational regional centers by 2024 in line with regional Ministry of Employment and Labor offices. Despite its recent inception, the Korea Occupational Disease Surveillance Center has already uncovered unrecognized occupational diseases, including acute poisoning cases requiring urgent workplace intervention, thus informing national prevention policies. Generating relevant data supports the development and execution of targeted interventions, enhancing occupational health services, and facilitating national interventions for workers across the country.

Second, regional Environmental Health Centers in Korea [10] have undergone continuous transformation since their inception in May 2007, when 10 regional centers were established.



During the initial phase (May 2007–February 2009), these centers focused on research-driven activities. In the second phase (March 2009–2015), six additional centers were established, broadening their scope to address national environmental health issues. The third phase (2015–2019) introduced Ko-CHENS, a 20-year national cohort project aimed at informing environmental health policy through the integration of research findings into policy frameworks. The fourth phase (2020–present) has been characterized by a decentralization of authority, empowering local governments and redefining the centers' roles to address regional environmental health challenges. The text precisely describes these evolving roles.

Third, Workers' Health Centers, established in 2011 [11], serve as a representative public organization providing occupational health services to micro and small enterprises in Korea. As of 2024, there are 24 WHCs, 22 branch offices, and 23 trauma counseling centers for workers. Managed by the Korea Occupational Safety and Health Agency but operated by private entities, each Workers' Health Center employs around 13 staff members across four teams: cardiovascular disease prevention, environmental improvement, musculoskeletal disease prevention, and stress management. Serving 203,877 users in 2023—88.5% of whom were from micro and small enterprises—Workers' Health Centers offer both basic and specialized programs, acting as crucial case managers that connect micro and small enterprises to necessary resources through flexible, problem-solving approaches.

Fourth, as of 2024, 23 Occupational Trauma Centers were operating within Workers' Health Centers across Korea [12]. Each trauma center is staffed by two counseling psychologists and equipped with private consultation rooms to foster psychological safety. These Centers aim to address psychological distress following workplace injuries. Despite a decreasing trend in fatal injuries, Korea continues to report elevated rates compared to other industrialized nations, underscoring the need for effective mental health interventions. The Occupational Trauma Management Program focuses on early crisis intervention, multi-phased counseling, and ongoing monitoring to stabilize affected workers and support their return to work.

These four reviews collectively highlight the significant progress made by institutes that address occupational and environmental health challenges in Korea.

Ju et al. investigated the health rights of inmates in correctional facilities and highlighted their conditions [13]. Although conducted in 2016, this is a unique survey because no other similar study exists. The authors propose strategies to improve inmates' health rights, including establishing a primary healthcare system, enhancing governance, alleviating overcrowding, and introducing mental health programs. If any follow-up studies are conducted, they may confirm an improved environment for inmates.

We welcome high-quality articles covering a wide range of topics in medicine and healthcare. While the journal primarily focuses on Korea, we also encourage submissions from researchers worldwide.

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Authors' contributions

All work was done by Ji Yeon Byun.

Conflict of interest

Ji Yeon Byun has been the associate editor of the Ewha Medical Journal since 2018. However,



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References -

- Huh S. Unresolved policy on the new placement of 2,000 entrants at Korean medical schools and this issue of *Ewha Medical Journal*. *Ewha Med J* 2024;47(3):e32. https://doi.org/10.12771/emj.2024.e32
- Jung J, Jang Y, Radnaabaatar M, Jo DS, Kim JM, Yoo JH. Insights into JKMS submissions and medical journal publications in Korea. *J Korean Med Sci* 2025;40(1):e76. https://doi.org/10.3346/jkms.2025.40.e76
- 3. Huh S. Halted medical education and medical residents' training in Korea, journal metrics, and appreciation to reviewers and volunteers. *J Educ Eval Health Prof* 2025;22:1. https://doi.org/10.3352/jeehp.2025.22.1
- 4. Kang S, Kang SW. Physical examinations for older adults with shoulder pain: a narrative review. *Ewha Med J* 2025;48(1):e8. https://doi.org/10.12771/emj.2025.e8
- 5. Lee HJ, Kim JH. Classification of shoulder diseases in older adult patients: a narrative review. *Ewha Med J* 2025;48(1):e5.
 - https://doi.org/10.12771/emj.2025.e5
- 6. Kim MS, Jung TH. Radiological characteristics of shoulder diseases in older adults, including adhesive capsulitis, rotator cuff tear, and osteoarthritis of the glenohumeral joint: a narrative review. *Ewha Med J* 2025;48(1):e10.
 - https://doi.org/10.12771/emj.2025.e10
- 7. Kim KJ, Jeong HS. Conservative treatment of older adult patients with shoulder diseases: a narrative review. *Ewha Med J* 2025;48(1):e1.
 - https://doi.org/10.12771/emj.2025.e1
- 8. Rhee SM. Application of deep learning for diagnosis of shoulder diseases in older adults: a narrative review. *Ewha Med J* 2025;48(1):e6.
 - https://doi.org/10.12771/emj.2025.e6
- 9. Lee DW, Kim I, Hwang J, Choi S, Jang TW, Chung I, et al. Occupational disease monitoring by the Korea Occupational Disease Surveillance Center: a narrative review. *Ewha Med J* 2025;48(1):e9.
 - https://doi.org/10.12771/emj.2025.e9



- 10. Park MS, Kim HC. Environmental disease monitoring by regional Environmental Health Centers in Korea: a narrative review. Ewha Med J 2025;48(1):e3. https://doi.org/10.12771/emj.2025.e3
- 11. Kong JO, Choi Y, Yang S, Jung-Choi K. Challenges from 14 years of experience at Workers' Health Centers in basic occupational health services for micro and small enterprises in Korea: a narrative review. Ewha Med J 2025;48(1):e7. https://doi.org/10.12771/emj.2025.e7
- 12. Kim CS, Kong JO, Koo JW. Trauma counseling centers for psychological support to manage trauma from workplace injuries in Korea: a narrative review. Ewha Med J 2025;48(1):e12. https://doi.org/10.12771/emj.2025.e12
- 13. Ju YS, Kim M, Yim J, Choung M. Health rights of inmates in correctional facilities in Korea as of 2016: a cross-sectional study. Ewha Med J 2025;48(1):e75. https://doi.org/10.12771/emj.2024.e75

Editorial



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A creative and innovative platform leading a sustainable society by the 150th anniversary of Ewha Womans University: a presidential farewell address

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In 2024, the medical community in Korea encountered significant challenges stemming from increased medical school enrollment quotas [1]. Regrettably, these issues remain unresolved as of February 2025. I sincerely hope for a prompt return to normalcy in both the healthcare system and medical education. Throughout this process, the *Ewha Medical Journal* and its readers, who have consistently contributed research on global and local healthcare issues, are expected to play a crucial role.

In March 2021, I was inaugurated as the 17th President of Ewha Womans University. Serving as the President of my alma mater for the past four years has been an incredibly honorable and meaningful experience [2]. Later that year, during the 135th Anniversary Founding Ceremony, I announced Ewha Vision 2030+, reaffirming our commitment to building a "creative and innovative platform leading a sustainable society" and propelling Ewha to become a university with top-tier competitiveness. Amid a period of rapid global transformations, including the Fourth Industrial Revolution, the rapid advancement of artificial intelligence, climate change, and various crises, as well as the domestic challenge of declining school-age populations, we established three core values—Inspiring Ewha (Creativity and Challenge), Interacting Ewha (Communication and Innovation), and Integrating Ewha (Empathy and Inclusion). Along with these values, we identified five key goals and have systematically implemented 100 major initiatives to achieve them. The specific content of the five key goals is as follows:

First, a top-tier research-oriented university

We have reached community alignment on the importance of establishing Ewha as a world-class research university that will lead the way for the next 30 to 50 years. To achieve this, we launched the Ewha Frontier 10-10 Initiative, aimed at fostering a creative research ecosystem capable of delivering world-class achievements. This initiative has led to the selection and support of five globally competitive leading research fields and ten promising future-oriented research areas. As a result of these efforts, 39 Ewha researchers have been recognized among the "Top 2% Researchers Worldwide." We have also achieved notable successes, including an increase in publications in high-impact international journals, higher citation counts, and the

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selection of key research and industry-academic collaboration projects. These accomplishments have significantly enhanced Ewha's reputation as a research-focused university. Furthermore, we have intensified our joint research efforts through partnerships, including a climate technology entrepreneurship program with the Asan Nanum Foundation and a global industry collaboration MOU with Syensgo (formerly Solvay).

Second, an educational response to artificial intelligence and big data

In the era of digital transformation driven by the Fourth Industrial Revolution, Ewha has focused on creating an educational innovation platform that addresses digital needs, strengthens our capabilities in advanced fields, and puts them into practice. Since the beginning of my term, we have established the College of Artificial Intelligence and the Graduate School of Data Science to nurture key talent for the advanced industrial era. We also developed Ewha's signature teaching and learning model, THE BEST Educational Model, and created a hybrid learning environment to lead next-generation education. In addition, we launched the Global Division within the HOKMA College of General Education as a pilot program designed for international students. This initiative is spearheading the internationalization of education and enhancing Ewha's global brand value.

Third, restructuring campus environment for students

We have introduced a big data-based intelligent academic support system to reinforce students' future planning and improve the campus environment. Additionally, we partially rebuilt and remodeled the Main Hall, which was originally constructed in 1964, into a 21st-century learning space. Most notably, we transformed Helen Hall, Ewha's first library, into the Ewha Advanced Library, a future-oriented, smart academic information center and multimedia cultural space integrating new media. We have also initiated projects aligned with Ewha's 150th-anniversary vision, including the creation of Ewha West Campus (63,000 square meters) to replace the Life Environment Hall built in 1972. The Ewha West Campus is envisioned as a dynamic, future-oriented site where the university transcends the confines of the ivory tower, fostering creativity and innovation through active communication, coexistence, and collaboration with society. This transformation reflects Ewha's vision of becoming an institution that flourishes as an integral, interactive part of the broader community.

Fourth, innovation of administrative infrastructure

We have undertaken structural reforms to increase administrative efficiency and financial soundness. These include elevating the roles of vice presidents to strengthen industry-academic cooperation and research functions, reorganizing the Office of Academic Affairs to actively formulate education policies, and establishing the Graduate School Innovation Center to promote graduate-level innovation projects more effectively. In addition, we have improved our administrative infrastructure by formulating an ICT Master Plan, upgrading outdated information and communication hardware, and enhancing ICT facilities to streamline processes and boost operational efficiency.



Fifth, Ewha's empathy and inclusion

To cultivate "Ewha's uniqueness in empathy and care," we have focused on reinvigorating community-based social welfare center programs, fostering shared innovation projects in partnership with local governments and universities, and disseminating Ewha's values through endeavors such as the Pear Blossom Sharing Corps. We have also expanded global scholarship programs, including the Ewha-KOICA Program and the EGPP (Ewha Global Partnership Program). In 2024, the College of Music hosted its first New Year's Concert at the Main Auditorium, inviting residents of Seodaemun District. Approximately 2,800 attendees filled the auditorium, creating a warm community gathering. Furthermore, I-Soo Management, a subsidiary of Ewha Haktang, has employed individuals with developmental disabilities to establish inclusive workspaces on Ewha's Sinchon Campus and within Ewha Medical Center, exemplifying Ewha's commitment to coexistence and its core values of empathy and care.

Network among three campuses

Ewha originated from Ewha Hakdang in 1886 and Bogunyeogwan in 1887, both established in Jeong-dong. The institution's core pillars rest on two principles: Christian values and education focused on women's empowerment and women's health. These principles form the basis of Ewha's mission. The Ewha History Museum on the Sinchon Campus serves to restore the legacy of Ewha Hakdang, safeguarding our historical roots. Similarly, the restored Bogunyeogwan at Ewha Seoul Hospital symbolizes respect for both Ewha's longstanding dedication to women's education and its emphasis on women's health, reflecting the essence of our institution's founding values.

At Ewha Medical Center, we have made remarkable strides by developing specialized clinical areas in alignment with the Bogunyeogwan spirit—Korea's first women's hospital, established in 1887 [3]. Notable achievements include specialized facilities such as the Ewha Cancer Center for Women, Ewha Urology Institute, Ewha Cardio-Cerebrovascular Center, Ewha Aortic Center, and Ewha Mother and Baby Center, all geared toward providing high-quality, specialized care. These accomplishments underscore Ewha Medical Center's emergence as a leading healthcare institution.

During my term, one of my foremost objectives was to foster organic and robust collaboration among the Sinchon Campus, Ewha Mokdong Hospital, and Ewha Seoul Hospital, thereby creating a thriving, mutually beneficial community. A significant milestone here was the formation of the Ewha Advanced Convergence Med-Tech Healthcare Cluster, where these three entities united to forge an integrated industry-academia-research-hospital ecosystem. This initiative has stimulated collaborative research and entrepreneurship in the biomedical and healthcare fields and marks a crucial first success. Moving forward, I hope the faculty, students, researchers, and staff at the Sinchon Campus, Ewha Mokdong Hospital, and Ewha Seoul Hospital will continue to deepen their shared research, practice, entrepreneurship, service, and collaboration, expanding this communal ecosystem with love and dedication.

In 2025, Ewha will continue to reinforce its standing as a premier institution, proactively preparing for the future and leading in the spheres of research, education, and global engagement. We aspire to rank among the world's top universities. The *Ewha Medical Journal* will act as a trailblazer in realizing this vision, playing an essential role in disseminating outstanding research and sharing the fruits of our collective endeavors.



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All work was done by Eun Mee Kim.

Conflict of interest

Eun Mee Kim has been the 17th President of the Ewha Womans University. However, she was not involved in the decision process. Otherwise, no potential conflict of interest relevant to this article was reported.

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References

- Huh S. The new placement of 2,000 entrants at Korean medical schools in 2025: is the government's policy evidence-based? *Ewha Med J* 2024;47(2):e13. https://doi.org/10.12771/emj.2024.e13
- Kim EM. Vision of Ewha in the COVID-19 pandemic era: a note from the President. Ewha Med J 2021;44(2):34-36.
 - https://doi.org/10.12771/emj.2021.44.2.34
- 3. Lee H, Kang M, Kwon I. A study on the name of "Po Goo Nyo Goan" and its marking. *Korean J Med Hist* 2019;28(3):685-720.
 - https://doi.org/10.13081/kjmh.2019.28.685

Review



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Physical examinations for older adults with shoulder pain: a narrative review

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Shoulder pain is a common complaint in primary care settings. The prevalence of shoulder pain is on the rise, especially in societies with aging populations. Like other joint-related conditions, shoulder pain is predominantly caused by degenerative diseases. These degenerative changes typically affect bones, tendons, and cartilage, with common conditions including degenerative rotator cuff tears, impingement syndrome, and osteoarthritis. Diagnosing these degenerative diseases in older adults requires a thorough understanding of basic anatomy, general physical examination techniques, and specific diagnostic tests. This review aims to outline the fundamental physical examination methods for diagnosing shoulder pain in older adult patients in primary care. The shoulder's complex anatomy and its broad range of motion underscore the need for a systematic approach to evaluation. Routine inspection and palpation can identify signs such as muscle atrophy, bony protrusions, or indications of degenerative changes. Assessing range of motion, and distinguishing between active and passive deficits, is crucial for differentiating conditions like frozen shoulder from rotator cuff tears. Targeted strength tests, such as the empty can, external rotation lag, liftoff, and belly press tests, are instrumental in isolating specific rotator cuff muscles. Additionally, impingement tests, including Neer's and Hawkins' signs, are useful for detecting subacromial impingement. A comprehensive understanding of shoulder anatomy and a systematic physical examination are vital for accurately diagnosing shoulder pain in older adults. When properly executed and interpreted in the clinical context, these maneuvers help differentiate between various conditions, ranging from degenerative changes to rotator cuff pathology.

Introduction

Background

Shoulder pain is the third most common musculoskeletal complaint, following back and knee pain [1]. A systematic review revealed that the prevalence of shoulder pain in the community varies widely, with a median of 16% (ranging from 0.67% to 55.2%). In primary care settings, prevalence estimates range from 1.01% to 4.84%, with a median of 2.36%. The incidence of shoulder pain varies from 7.7 to 62 per 1,000 persons annually, with a median of 37.8 per 1,000 persons per year [2]. The prevalence of shoulder pain differs across age groups, with significant increases noted in older populations. A systematic review that focused on occupational groups

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found that 16 out of 21 studies reported higher prevalence estimates or odds ratios for shoulder pain in individuals over the age of 50. This trend was more evident in physically demanding occupations, where 14 out of 18 samples indicated an increased prevalence in those over 50 years old, compared to only two out of four in sedentary occupations [3].

In South Korea, data from 2011 to 2020 indicated a significant increase in shoulder lesions among individuals aged 60-69 years, underscoring the rising prevalence of shoulder pain within this demographic [4]. Kim et al. [5] recently carried out a study involving participants aged 40 years or older from a specific city. Their findings from a survey of 30 bilateral shoulders revealed that about 65% of individuals aged 60 years or older reported experiencing shoulder pain. Furthermore, the incidence of associated rotator cuff disease was significantly higher in this age group compared to those under 60 years (P=0.006).

Age is a critical demographic factor in the context of shoulder pain. Younger individuals exhibit a higher prevalence of traumatic dislocations and labral injuries, whereas older adults more frequently experience degenerative wear of the shoulder joint, along with tears in the rotator cuff tendons [6-8].

Objectives

The purpose of this review was to examine the basic approaches for diagnosing shoulder pain in older adult patients. It assessed the physical examination techniques used to evaluate shoulder pain.

Ethics statement -

As this study is a literature review, it did not require institutional review board approval or individual consent. Supplementary video files were provided by the authors as examinee and examiner

Anatomy -

To understand shoulder disorders, it is essential to have a basic knowledge of shoulder anatomy. The shoulder is one of the most complex joints in the human body and enables a wide range of movements that are crucial for everyday activities.

The shoulder comprises three bones: the clavicle, scapula, and humeral head. Together, these bones form the glenohumeral, sternoclavicular, acromioclavicular, and scapulothoracic joints. The primary shoulder joint, the glenohumeral joint, is a ball-and-socket type located between the humeral head and the glenoid cavity. However, only 25% of the humeral head articulates with the glenoid cavity [9]. This joint is inherently unstable yet allows for a broad range of motion (ROM). Adding stability to the shoulder, the labrum—a layer of fibrocartilage—envelops the glenoid rim [10].

The shoulder is surrounded by several key muscles that not only contribute to its extensive ROM but also provide stability to the joints. These muscles include the deltoid, trapezius, pectoralis major, latissimus dorsi, biceps, triceps, and rotator cuff. They work in concert to facilitate a wide range of movements and stabilize this highly mobile joint, thus protecting the shoulder from injury [11]. The rotator cuff muscles, comprising the supraspinatus, infraspinatus, teres minor, and subscapularis, are crucial for normal shoulder function. Injuries to these muscles or their tendons can severely impair movement and cause significant pain. These muscles are



interconnected by tendons that merge to form the rotator cuff tendon. This tendon complex encircles the head of the humerus, enabling the arm to perform a wide range of movements across various planes while maintaining the stability of the shoulder joint [12]. The supraspinatus muscle, originating from the supraspinatus fossa of the scapula, inserts into the greater tubercle of the humerus. Its primary functions are to initiate arm abduction and stabilize the humeral head within the glenoid cavity. The infraspinatus muscle arises from the infraspinous fossa of the scapula and also attaches to the greater tubercle of the humerus. Positioned just below the infraspinatus, the teres minor muscle originates from the lateral border of the scapula and inserts near the infraspinatus on the greater tubercle of the humerus. Both the infraspinatus and teres minor muscles aid in the external rotation of the arm. The subscapularis muscle, located on the anterior side of the scapula, occupies the subscapular fossa and attaches to the lesser tubercle of the humerus. This muscle facilitates the internal rotation of the arm [13].

Physical examination

The physical examination of the shoulder starts with taking the patient's history, followed by inspection, palpation, assessment of ROM, muscle strength testing, and provocative tests for specific conditions. It is essential to obtain a detailed medical history to guide further testing and imaging. Typically, inquiries should cover the patient's age, the duration and quality of the pain, associated symptoms, and factors that aggravate or relieve the pain [14].

Shoulder pain is frequently associated with occupational factors; thus, the duration of employment, working posture, and hours worked are significant considerations. With the growing interest in leisure sports among older adults, it is crucial to gather a detailed history that includes the types of sports they engage in and whether they experience pain during these activities. Furthermore, for older patients, it is equally important to document a treatment history for concurrent conditions like diabetes, chronic kidney disease, and rheumatic diseases, which can contribute to shoulder pain [15].

Inspection

Patient inspection should be conducted with both the affected and unaffected extremities fully exposed. The examination should encompass both anterior and posterior views to detect any muscle asymmetry or abnormal bony prominences. Bilateral examination of the deltoid, supraspinatus, and infraspinatus fossae for atrophy is essential [16]. If muscle atrophy is significant, further evaluation should be undertaken, including an assessment for shoulder pathology, to ascertain the presence of any neurological issues [17,18].

Rupture of the long head of the biceps tendon (LHBT) can occur either traumatically or spontaneously in older adults, often resulting in a noticeable bulge in the upper arm, known as the Pop eye sign [19].

Degenerative arthritis commonly affects the sternoclavicular and acromioclavicular joints in the shoulders of older adults, often resulting in bony protrusions [20,21]. Additionally, patients with massive rotator cuff tears may experience anterior protrusion of the humeral head into the shoulder joints [22]. The position of the scapula was observed from the patient's back. The differential diagnosis should consider both the static position and the dynamic motion of the scapula [23].

Palpation

Palpation, combined with visual inspection, plays a crucial role in the initial physical



examination. It is essential to accurately identify the specific location of any local tenderness. This helps in predicting the disease based on its anatomical location and facilitates preparation for further evaluation.

In degenerative arthritis of the sternoclavicular and glenohumeral joints, it is essential to palpate the articular processes to assess tenderness, bony prominences, and swelling [20,21]. Rotator cuff disease is the most prevalent condition among shoulder diseases, with the supraspinatus tendon frequently affected, especially in cases of rotator cuff pathology. Precise palpation is key for diagnosing issues such as tendinitis, tears, or impingement [24]. To palpate the supraspinatus tendon, one must identify the attachment site and the greater tuberosity area. The patient's arm should be placed in slight extension (moving the arm slightly behind the body) and internal rotation (turning the hand toward the body), which moves the supraspinatus tendon anteriorly. The supraspinatus tendon and greater tuberosity can then be palpated just anterior and slightly lateral to the acromion [25]. The subscapularis tendon, part of the rotator cuff, is located on the anterior aspect of the shoulder. To palpate the subscapularis and its attachment site (the lesser tuberosity), the patient's arm should be externally rotated with the elbow flexed at 90°. This maneuver lengthens the subscapularis tendon and brings it to a more superficial position [26]. The LHBT runs through the bicipital groove on the anterior aspect of the humerus and is commonly affected by tendinitis, instability, or rupture. The biceps groove, housing the LHBT, is situated between the greater and lesser tubercles of the humerus. To palpate the bicep groove, place the patient's arm in neutral rotation with the elbow flexed to 90°. Slightly outward rotation of the arm (turning the forearm outward) will better expose the tendon. The bicep groove can be palpated 2–3 cm inferior to the anterior border of the acromion [27].

Range of motion assessment

As a ball-and-socket joint, the shoulder facilitates an extensive ROM across multiple planes [9,10]. Proper evaluation of ROM is essential for assessing function, identifying limitations, and diagnosing various conditions. Typically, ROM measurements include forward flexion, extension, abduction, external rotation, and internal rotation. These measurements can be taken while the patient is sitting, standing, or lying supine. The sitting position is particularly convenient for simultaneously conducting other muscle tests and provocative tests. However, it is crucial to stabilize the scapula to accurately measure the true ROM of the glenohumeral joint. Additionally, ROM measurements should be compared with those of the unaffected side, as the normal range varies from person to person and with age [28]. Assessment of shoulder ROM should encompass both active (unassisted) and passive (assisted by the examiner) movements. A loss of both may indicate a stiff shoulder, such as frozen shoulder or secondary stiff shoulder, whereas a loss of active ROM alone suggests shoulder weakness, potentially due to a rotator cuff tear or neurologic dysfunction. Disease-specific tests and imaging evaluations should be tailored to each specific symptom [29]. A video of the ROM assessment of shoulder joints is available in Supplement 1.

Muscle strength testing and provocative tests

Shoulder strength assessment is a crucial part of physical examinations, offering insights into muscle function that can assist in diagnosing rotator cuff disorders [22]. It is essential to understand the function of each tendon in the rotator cuff and to conduct muscle strength and provocation tests accordingly. These muscle tests should be carried out on both the affected and unaffected sides.



Supraspinatus

The supraspinatus is assessed using both the empty can test (Jobe's test) and the full can test [30]. The empty can test involved abducting the arm to 90°, internally rotating the forearm, and orienting the thumb downward. A positive result, indicating pain or weakness, is noted when the examiner exerted downward pressure on the arm. Conversely, the full can test is conducted in a similar arm position but with the forearm externally rotated and the thumb pointing upward, while the examiner applied force. The tests demonstrate the highest accuracy in detecting a torn supraspinatus tendon when muscle weakness is present, with the full can test showing 75% accuracy and the empty can test showing 70% accuracy [30]. Both tests have proven to be highly sensitive and specific, making them suitable for both screening and confirming rotator cuff tears that involve the supraspinatus. A video of the empty can test (Jobe's test), and the full can test for supraspinatus muscle strength is available in Supplement 2.

Infraspinatus and teres minor

The infraspinatus and teres minor muscles serve as external rotators of the arm. To assess external rotational strength, the patient holds their arm at their side with the elbow bent at 90°. The examiner then applies inward pressure as the patient resists by rotating the arm externally [31]. The external rotation lag sign is a diagnostic test for the shoulder, useful in identifying tears in the infraspinatus and supraspinatus tendons. This sign is considered positive if, after the examiner maximally externally rotates the arm—with the shoulder flexed at 20° and the elbow at 90°—the patient is unable to keep the arm in this position. With a specificity of 94%, a positive external rotation lag sign reliably indicates full-thickness tears of both the supraspinatus and infraspinatus tendons [32]. The Hornblower test is another clinical examination that evaluates the function and strength of the infraspinatus and teres minor muscles. During this test, the patient's arm is passively abducted and supported by the examiner with the elbow flexed at 90°. A positive result occurs if the patient cannot maintain external rotation of the arm. Given that both the infraspinatus and teres minor contribute to external rotation of the humerus, identifying weakness in these muscles can be challenging through physical examination alone [17]. A video of the external rotation lag sign and Hornblower test is available in Supplement 3.

Subscapularis

The subscapularis tendon plays a crucial role in the internal rotation of the shoulder. To assess its integrity, strength, and function, four clinical tests are conducted. Initially, the liftoff test (Gerber test) is performed. This involves the patient flexing their elbow, internally rotating their arm, and placing their hand on the lumbar spine. A positive result is indicated by the patient's inability to lift the back of their hand away from the body. Next, the belly press test (Napoleon sign) is administered. For this test, the patient places their hand on their abdomen with the arm internally rotated and the elbow flexed, keeping the wrist in a neutral position. A positive result is noted if the patient cannot maintain the elbow in a forward position or keep the wrist neutral while pressing against the abdomen. The third test conducted is the bear-hug test. The patient positions their elbow at shoulder height and places their hands on the opposite shoulder. The examiner then attempts to pull the patient's hand away from the shoulder while the patient resists. A positive result is recorded if the patient cannot maintain their hand on the shoulder. The fourth assessment is the internal rotation lag sign. In this test, the examiner positions the patient's arm behind their back in internal rotation and lifts their hand off the back. If the patient is unable to hold the position and the hand falls back, it suggests weakness or a



tear in the subscapularis [32-34]. Videos demonstrating the liftoff test (Gerber test) and the internal rotation lag sign, which assess the strength of the subscapularis tendon, are available in Supplement 4. Additionally, a video of the belly press test (Napoleon sign) for evaluating the strength of the subscapularis tendon can be found in Supplement 5.

Impingement test

Impingement occurs when the soft tissues—specifically the subacromial bursa, supraspinatus tendon, and biceps tendon—within the subacromial space become chronically trapped between the humeral head and the acromion [35]. This condition leads to progressive degenerative changes in the hypovascular region of the rotator cuff. A thorough medical history and physical examination are crucial for diagnosing shoulder impingement syndrome. Patients typically report pain or discomfort when lifting the arm or at specific points of impingement. Special tests are integral to the physical examination process. Initially, the Hawkins test is conducted by passively internally rotating the patient's arm, flexing the shoulder to 90 degrees forward, and flexing the elbow. The presence of acromial pain indicates subacromial impingement [36]. Next, the Neer sign test involves fixing the scapula in a depressed position and having the examiner maximally flex the patient's arm forward (passive ROM testing). Pain localized to the anterior aspect of the shoulder suggests impingement syndrome [36]. Additionally, the Painful arc sign is identified by pain occurring as the elbow is fully extended and abducted between 60° and 120° in the scapular plane, which indicates a pathology in the subacromial space [37]. Lastly, the Jobe test, also known as the empty-can test, is positive for impingement syndrome and supraspinatus lesions [37]. Although these tests individually have low sensitivity and specificity, when used collectively, they can provide a more comprehensive assessment of shoulder impingement syndrome. A video file of the Neer sign test and Hawkins test for checking impingement of the shoulder joint is available in Supplement 6.

Osteoarthritis of the glenohumeral joint

Osteoarthritis is a degenerative disease whose prevalence increases with age. It is a significant cause of physical disability and often severely impairs the quality of life in older adults [38]. In a study of a Korean population, Cho [39] reported that approximately 5% of patients over 65 years of age had shoulder arthritis of Kellgren-Lawrence grade 2 or higher. In addition, Oh [8] reported prevalence rates of 11.3% for Samilson-Prieto grade 1, 3.4% for grade 2, and 1.3% for grade 3. In general, patients with glenohumeral joint osteoarthritis present with decreased ROM accompanied by crepitus as their main symptom. Osteoarthritis often manifests as a secondary stiff shoulder, characterized by reduced passive and active ranges of motion. Assessment of tenderness is conducted along the joint line, and palpation is used to check for swelling and effusion along the joint surface [40].

Acromioclavicular joint disease

Acromioclavicular (AC) joint disease encompasses a range of conditions affecting the joint between the clavicle and the acromion of the scapula. These conditions include degenerative changes such as osteoarthritis and traumatic injuries like dislocation or separation. AC joint arthritis is the predominant cause of shoulder pain in middle-aged individuals, primarily due to the degeneration of cartilage and the intraarticular disc [41]. Primary osteoarthritis of the AC joint appears to be associated with normal age-related damage and subsequent loss of protective cartilage, causing painful bone-on-bone contact [42]. Although most patients do



not exhibit symptoms, some may experience pain around the AC joint during daily activities, particularly during overhead or crossbody movements [43]. The physical examination for AC joint disease starts with observing any joint asymmetry through palpation and assessing the area for tenderness. The cross-body adduction test is highly effective for diagnosing AC joint pathology. During this test, the examiner stands in front of the patient, lifts the patient's arm to 90 degrees forward, holds the elbow, and adducts the shoulder across the body. This maneuver typically provokes pain around the AC joint, indicating potential pathology [42]. Another diagnostic tool is the O'Brien active compression test, where the examiner stands behind the patient. The patient flexes their arm forward to 90 degrees with the elbow fully extended, then adducts the arm 10° to 15° with internal rotation, thumb pointing downward. The examiner applies a downward force against the patient's resistance. The test is repeated with the palms fully supinated. A positive result—pain during the first maneuver that disappears in the second—confirms the diagnosis if the pain is localized to the AC joint [44]. Tenderness on palpation of the AC joint, which seems to be the easiest and most effective method, has been recommended as a screening test for AC joint disease due to its high sensitivity (96%) [45,46].

Conclusion

The shoulder is a crucial joint that facilitates a broad spectrum of activities due to its extensive ROM. Shoulder pain can originate from various anatomical structures, including cartilage, ligaments, tendons, and bones. A deep understanding of these structures is essential for conducting precise physical examinations of the shoulder. By performing a comprehensive physical examination and utilizing appropriate imaging studies, the underlying causes of shoulder pain can be effectively analyzed.

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Conflict of interest

No potential conflict of interest relevant to this article was reported.

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Data availability

Not applicable.



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Not applicable.

Supplementary materials

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Supplement 1. ROM assessment

Supplement 2. Supraspinatus muscle examination (full can, empty can test)

Supplement 3. Infraspinatus muscle examination (external lag sign, Hornblower sign)

Supplement 4. Subscapularis tendon examinnation (liftoff, internal lag sign)

Supplement 5. Subscapularis tendon examination (belly press test)

Supplement 6. Impingement test

References -

- 1. Urwin M, Symmons D, Allison T, Brammah T, Busby H, Roxby M, et al. Estimating the burden of musculoskeletal disorders in the community: the comparative prevalence of symptoms at different anatomical sites, and the relation to social deprivation. Ann Rheum Dis 1998;57(11):649-655.
 - https://doi.org/10.1136/ard.57.11.649
- 2. Lucas J. van Doorn P. Hegedus E. Lewis J. van der Windt D. A systematic review of the global prevalence and incidence of shoulder pain. BMC Musculoskelet Disord 2022;23(1):1073. https://doi.org/10.1186/s12891-022-05973-8
- 3. Hodgetts CJ, Leboeuf-Yde C, Beynon A, Walker BF. Shoulder pain prevalence by age and within occupational groups: a systematic review. Arch Physiother 2021;11(1):24. https://doi.org/10.1186/s40945-021-00119-w
- 4. Jung J, Shon MS. Epidemiology and etiology of shoulder pain based on health statistics data from Healthcare Bigdata Hub in Korea. J Korean Med Assoc 2022;65(11):687-698. https://doi.org/10.5124/jkma.2022.65.11.687
- 5. Kim DY, Hwang JT, Lee SS, Lee JH, Cho MS. Prevalence of rotator cuff diseases in adults older than 40 years in or near Chuncheon city, Korea. Clin Shoulder Elb 2020;23(3):125-130. https://doi.org/10.5397/cise.2020.00178
- 6. McLaughlin HL, MacLellan DI. Recurrent anterior dislocation of the shoulder. II. A comparative study. J Trauma Acute Care Surg 1967;7(2):191-201. https://doi.org/10.1097/00005373-196703000-00002
- 7. Kim JH, Jung SH, Park DH, Kwon YU, Lee HY. Factors associated with patient satisfaction after arthroscopic rotator cuff repair: do they differ by age? Clin Shoulder Elb 2024;27(3):345-352.
 - https://doi.org/10.5397/cise.2024.00283
- 8. Oh JH, Chung SW, Oh CH, Kim SH, Park SJ, Kim KW, et al. The prevalence of shoulder osteoarthritis in the elderly Korean population: association with risk factors and function. J Shoulder Elb Surg 2011;20(5):756-763. https://doi.org/10.1016/j.jse.2011.01.021
- 9. Halder AM, Kuhl SG, Zobitz ME, Larson D, An KN. Effects of the glenoid labrum and glenohumeral abduction on stability of the shoulder joint through concavity-compression: an in vitro study. J Bone Joint Surg Am 2001;83(7):1062-1069.



- https://doi.org/10.2106/00004623-200107000-00013
- 10. Cooper DE, Arnoczky SP, O'Brien SJ, Warren RF, DiCarlo E, Allen AA. Anatomy, histology, and vascularity of the glenoid labrum. An anatomical study. J Bone Joint Surg Am 1992;74(1):46-52.
 - https://doi.org/10.2106/00004623-199274010-00007
- 11. Veeger HEJ, van der Helm FCT. Shoulder function: the perfect compromise between mobility and stability. J Biomech 2007;40(10):2119-2129.
 - https://doi.org/10.1016/j.jbiomech.2006.10.016
- 12. Clark JM, Harryman DT 2nd. Tendons, ligaments, and capsule of the rotator cuff. Gross and microscopic anatomy. J Bone Joint Surg Am 1992;74(5):713-725. https://doi.org/10.2106/00004623-199274050-00010
- 13. Kim SC, Yoo SJ, Jo JH, Lee JH, Baek E, Lee SM, et al. The impact of supraspinatus tear on subscapularis muscle atrophy and fatty infiltration. Clin Shoulder Elb 2024;27(4):437-446. https://doi.org/10.5397/cise.2024.00521
- 14. House J, Mooradian A. Evaluation and management of shoulder pain in primary care clinics. South Med J 2010;103(11):1129-1135.
 - https://doi.org/10.1097/SMJ.0b013e3181f5e85f
- 15. Lee JS, Suh KT, Shin WC, Bae JY, Goh TS, Jung SW, et al. Socioeconomic and other risk factors for retear after arthroscopic surgery for nontraumatic rotator cuff tear. Medicina 2024;60(4):640.
 - https://doi.org/10.3390/medicina60040640
- 16. Tobola A, Cassas K, Sease F. Identifying shoulder pain in older patients: the history, physical examination, and testing. J Musculoskeletal Med 2009;26(6):216-221.
- 17. Wilson L, Sundaram M, Piraino DW, Hakan I, Michael R. Isolated teres minor atrophy: manifestation of quadrilateral space syndrome or traction injury to the axillary nerve? Orthopedics 2006;29(5):447-450.
 - https://doi.org/10.3928/01477447-20060501-09
- 18. Friend J, Francis S, McCulloch J, Ecker J, Breidahl W, McMenamin P. Teres minor innervation in the context of isolated muscle atrophy. Surg Radiol Anat 2010;32(3):243-249. https://doi.org/10.1007/s00276-009-0605-9
- 19. Pagnani MJ, Deng XH, Warren RF, Torzilli PA, O'Brien SJ. Role of the long head of the biceps brachii in glenohumeral stability: a biomechanical study in cadavera. J Shoulder Elb Surg 1996;5(4):255-262.
 - https://doi.org/10.1016/S1058-2746(96)80051-6
- 20. Mall NA, Foley E, Caalmers PN, Cole BJ, Romeo AA, Bach BR. Degenerative joint disease of the acromioclavicular joint: a review. Am J Sports Med. 2013;41(11):2684-2692. https://doi.org/10.1177/0363546513485359
- 21. Rockwood CA Jr, Matsen FA 3rd. Osteoarthritis of the sternoclavicular joint. In: Rockwood CA, editor. The shoulder. 2nd ed. Philadelphia: WB Saunders; 1998. p.1055-1066.
- 22. Bishay V, Gallo RA. The evaluation and treatment of rotator cuff pathology. Prim Care Clin Office Pract 2013;40(4):889-910.
 - https://doi.org/10.1016/j.pop.2013.08.006
- 23. Kibler WB, Sciascia A, Wilkes T. Current concepts: scapular dyskinesis. Br J Sports Med 2010;44(5):350-355.
 - https://doi.org/10.1136/bjsm.2009.058834
- 24. Radhakrishnan R, Goh J, Tan AHC. Partial-thickness rotator cuff tears: a review of current



- literature on evaluation and management. Clin Shoulder Elb 2024;27(1):79-87. https://doi.org/10.5397/cise.2022.01417
- 25. Jacobson JA. Shoulder US: anatomy, technique, and scanning pitfalls. Radiology 2011;260(1):6-16.
 - https://doi.org/10.1148/radiol.11101082
- 26. Lyons RP, Green A. Subscapularis tendon tears. J Am Acad Orthop Surg 2005;13(5):353
 - https://doi.org/10.5435/00124635-200509000-00009
- 27. McDevitt AW, Cleland JA, Strickland C, Mintken P, Leibold MB, Borg M, et al. Accuracy of long head of the biceps tendon palpation by physical therapists; an ultrasonographic study. J Phys Ther Sci 2020;32(11):760-767.
 - https://doi.org/10.1589/jpts.32.760
- 28. Lee SH, Yoon C, Chung SG, Kim HC, Kwak Y, Park H, et al. Measurement of shoulder range of motion in patients with adhesive capsulitis using a Kinect. PLoS One 2015;10(6):e0129398. https://doi.org/10.1371/journal.pone.0129398
- 29. Yang S, Kim TU, Kim DH, Chang MC. Understanding the physical examination of the shoulder: a narrative review. Ann Palliat Med 2021;10(2):2293-2303. https://doi.org/10.21037/apm-20-1808
- 30. Itoi E, Kido T, Sano A, Urayama M, Sato K. Which is more useful, the "full can test" or the "empty can test," in detecting the torn supraspinatus tendon? Am J Sports Med 1999:27(1):65-68.
 - https://doi.org/10.1177/03635465990270011901
- 31. Kim KC, Rhee KJ, Shin HD, Byun KY. Physical examinations of rotator cuff tear. Clin Shoulder Elb 2008;11(1):13-18.
 - https://doi.org/10.5397/CiSE.2008.11.1.013
- 32. Hertel R, Ballmer FT, Lambert SM, Gerber C. Lag signs in the diagnosis of rotator cuff rupture. J Shoulder Elb Surg 1996;5(4):307-313. https://doi.org/10.1016/S1058-2746(96)80058-9
- 33. Barth JRH, Burkhart SS, De Beer JF. The bear-hug test: a new and sensitive test for diagnosing a subscapularis tear. Arthroscopy 2006;22(10):1076-1084. https://doi.org/10.1016/j.arthro.2006.05.005
- 34. Hegedus EJ, Goode AP, Cook CE, Michener L, Myer CA, Myer DM, et al. Which physical examination tests provide clinicians with the most value when examining the shoulder? Update of a systematic review with meta-analysis of individual tests. Br J Sports Med 2012;46(14):964-978.
 - https://doi.org/10.1136/bjsports-2012-091066
- 35. Creech JA, Silver S. Shoulder impingement syndrome [Internet]. Treasure Island (FL): StatPearls; c2023 [cited 2024 Dec 20]. Available from: https://www.ncbi.nlm.nih.gov/books/ NBK554518/
- 36. Cools AM, Cambier D, Witvrouw EE. Screening the athlete's shoulder for impingement symptoms: a clinical reasoning algorithm for early detection of shoulder pathology. Br J Sports Med 2008;42(8):628-635.
 - https://doi.org/10.1136/bjsm.2008.048074
- 37. Garving C, Jakob S, Bauer I, Nadjar R, Brunner UH. Impingement syndrome of the shoulder. Dtsch Arztebl Int 2017;114(45):765-776. https://doi.org/10.3238/arztebl.2017.0765



- 38. Cornoni-Huntley JC, Foley DJ, White LR, Suzman R, Berkman LF, Evans DA, et al. Epidemiology of disability in the oldest old: methodologic issues and preliminary findings. Milbank Mem Fund Q Health Soc 1985;63(2):350-376. https://doi.org/10.2307/3349884
- 39. Cho HJ, Morey V, Kang JY, Kim KW, Kim TK. Prevalence and risk factors of spine, shoulder, hand, hip, and knee osteoarthritis in community-dwelling Koreans older than age 65 years. Clin Orthop Relat Res 2015;473(10):3307-3314. https://doi.org/10.1007/s11999-015-4450-3
- 40. Choi YY, Lee JY, Yang SH, Lee TG, Oh DY, Kim DW, et al. Inpatients with shoulder osteoarthritis who received integrative Korean medicine treatment: long-term follow-up of an observation study. Medicine 2022;101(45):e31431. https://doi.org/10.1097/MD.000000000031431
- 41. Vaishya R, Damor V, Agarwal AK, Vijay V. Acromioclavicular arthritis: a review. J Arthrosc Jt Surg 2018;5(2):133-138.
 - https://doi.org/10.1016/j.jajs.2018.05.001
- 42. Yi JW. Isolated acromioclavicular osteoarthritis and steroid injection. Clin Shoulder Elb 2023;26(2):107-108.
 - https://doi.org/10.5397/cise.2023.00311
- 43. Mazzocca AD, Arciero RA, Bicos J. Evaluation and treatment of acromioclavicular joint injuries. Am J Sports Med 2007;35(2):316-329. https://doi.org/10.1177/0363546506298022
- 44. Chronopoulos E, Kim TK, Park HB, Ashenbrenner D, McFarland EG. Diagnostic value of physical tests for isolated chronic acromioclavicular lesions. Am J Sports Med 2004;32(3):655-661.
 - https://doi.org/10.1177/0363546503261723
- 45. Hughes PC, Taylor NF, Green RA. Most clinical tests cannot accurately diagnose rotator cuff pathology: a systematic review. *Aust J Physiother* 2008;54(3):159-170. https://doi.org/10.1016/S0004-9514(08)70022-9
- 46. Walton J, Mahajan S, Paxinos A, Marshall J, Bryant C, Shnier R, et al. Diagnostic values of tests for acromioclavicular joint pain. J Bone Joint Surg Am 2004;86(4):807-812. https://doi.org/10.2106/00004623-200404000-00021

Review



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Classification of shoulder diseases in older adult patients: a narrative review

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Bursitis; Osteoarthritis; Pain; Rotator cuff iniuries: Shoulder



This review classifies and summarizes the major shoulder diseases affecting older adults, focusing on rotator cuff disease, frozen shoulder, osteoarthritis, and shoulder instability. It explores each condition's pathophysiology, risk factors, clinical presentation, diagnostic approaches, and treatment strategies to guide clinicians in optimizing patient outcomes and enhancing guality of life. Age-related degenerative changes, comorbidities, and distinct etiological factors contribute to the presentation of shoulder disorders in older adults. Rotator cuff disease ranges from tendinopathy to full-thickness tears and is influenced by genetic predispositions, inflammatory cytokines, and muscle quality. Frozen shoulder results from fibroproliferative changes in the capsule, leading to significant pain and restricted motion. Osteoarthritis involves cartilage degeneration and bony remodeling, often necessitating surgical interventions such as arthroplasty. Shoulder instability, though less frequent, is complicated by associated injuries like rotator cuff tears and fractures, requiring tailored management strategies. Advances in imaging techniques, biologic treatments, and surgical procedures, particularly arthroscopic and arthroplasty options, have improved diagnostic accuracy and therapeutic outcomes. A thorough classification of shoulder diseases in older adult patients highlights the complexity of managing these conditions. Effective treatment requires individualized approaches that integrate conservative measures with emerging biologic or surgical therapies. Future research should focus on targeted interventions, standardized diagnostic criteria, and multidisciplinary collaboration to minimize disability, optimize function, and improve overall quality of life in this growing patient population. Multimodal strategies, including patient education, structured rehabilitation, and psychosocial support, further enhance long-term adherence and outcomes. Ongoing vigilance for comorbidities, such as osteoporosis or metabolic disorders, is necessary for comprehensive care.

Introduction

Background

The shoulder joint is crucial for performing daily activities and maintaining independence, especially among older adults. Its extensive range of motion renders it vulnerable to injuries and degenerative diseases, which are more common as people age [1]. Aging leads to structural changes in the musculoskeletal system, including decreased bone density, reduced tendon elasticity, and diminished joint lubrication [2]. These factors predispose older adults to conditions

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such as rotator cuff tears, osteoarthritis, frozen shoulder, and instability [1,3,4].

Objectives

This review aims to provide a detailed classification of shoulder diseases, focusing on their pathophysiology, risk factors, clinical presentation, diagnostic approaches, and treatment strategies. By tailoring management to the specific needs of older adult patients, clinicians can improve outcomes and enhance the quality of life for this vulnerable population.

Ethics statement -

As this study is a literature review, it did not require approval from the institutional review board or individual consent.

Rotator cuff diseases

Rotator cuff diseases are a common condition affecting the upper extremity, with manifestations ranging from mild tendinopathy to full-thickness tears accompanied by arthritis [2-4]. These injuries compromise the functionality of the shoulder, leading to pain, restricted mobility, and weakness [5]. The rotator cuff consists of four muscles—the supraspinatus, infraspinatus, subscapularis, and teres minor—which stabilize the shoulder and enable movement. Rotator cuff tears often occur due to a combination of traumatic events and degenerative changes, particularly affecting the supraspinatus tendon, which is especially susceptible due to its hypovascular nature.

The epidemiology of rotator cuff tears shows that their prevalence increases with age. Research indicates a strong correlation between aging and the development of these tears, with about 62% of individuals over the age of 80 experiencing such injuries [6]. Genetics also contribute to the risk, as familial predispositions and genetic markers associated with inflammation and tissue remodeling can heighten susceptibility. Additional risk factors are diabetes, obesity, smoking, and repetitive physical activity [7].

The pathophysiology of rotator cuff tears involves a complex interplay among tendon degeneration, inflammation, and muscle quality [7]. Tendon injuries typically start with microtrauma, which leads to tendinopathy and may eventually progress to partial or fullthickness tears. Inflammatory cytokines, including IL-6 and IL-1B, significantly contribute to tendon degeneration. Additionally, muscle atrophy and fatty infiltration are known to adversely affect surgical outcomes and impede tendon healing [8]. Advanced imaging techniques, such as MRI and ultrasound, are crucial for diagnosing these conditions by enabling the assessment of tear size, muscle quality, and tendon retraction.

Diagnosis involves a combination of clinical evaluation and imaging. Patients typically present with shoulder pain, especially at night, difficulty performing overhead activities, and weakness [9,10]. Physical examination tests, including the Neer, Jobe, and Hawkins-Kennedy tests, are used to assess muscle strength and functionality. Imaging techniques such as X-rays, MRI, and ultrasound help confirm the diagnosis, assess the size of the tear, and evaluate the quality of the muscle. However, standardizing the diagnostic approach is challenging due to the variability in tear progression and symptoms [10].

Management strategies for rotator cuff tears are customized based on the patient's symptoms, the size of the tear, and their activity levels [9]. Non-operative treatments, which



include physical therapy, pharmacotherapy, and corticosteroid injections, prove effective for the majority of patients. Physical therapy aims to restore shoulder mobility, muscle strength, and scapular stability [11]. Pharmacological treatments, such as NSAIDs and corticosteroids, offer short-term relief from pain. Additionally, emerging therapies like platelet-rich plasma and mesenchymal stem cell injections are currently under investigation for their potential to promote healing, although their long-term effectiveness is still unclear [12].

Surgical interventions are typically reserved for cases where non-operative treatments are unsuccessful or for patients with acute, traumatic tears [5,9]. Arthroscopic rotator cuff repair is considered the standard surgical method, offering a less invasive option with improved recovery times [13]. However, the rates of retear are still high, especially in patients with poor muscle quality or large tears. Advanced techniques such as double-row suture bridge repair and biologic augmentation with mesenchymal stem cells or platelet-rich plasma are employed to enhance tendon-to-bone healing and reduce the likelihood of retears [14]. In situations involving irreparable tears, alternative strategies like tendon transfer or reverse shoulder arthroplasty might be considered, particularly for older patients [15–17].

The natural history of rotator cuff tears is unpredictable. While many tears remain asymptomatic, others may progress, resulting in increased pain and functional limitations. Factors such as age, tear size, and comorbidities influence the progression of these tears. It is important to note that symptomatic degenerative tears rarely heal on their own and necessitate careful monitoring and management to prevent further complications [18].

Quality of life for individuals with rotator cuff tears can be significantly impacted. Pain, reduced mobility, and sleep disturbances contribute to decreased physical and emotional well-being [19]. Patient education and timely interventions are crucial for improving outcomes and restoring functionality. Future research aims to identify novel therapeutic targets, optimize treatment protocols, and enhance tendon-to-bone healing processes. Rotator cuff tears represent a complex and multifaceted condition, characterized by a broad spectrum of presentations and management options. While non-operative treatments suffice for most patients, advanced surgical techniques and emerging therapies offer hope for improved outcomes in severe cases. Continued research and personalized care approaches are essential for addressing the challenges associated with this condition.

Frozen shoulder -

Frozen shoulder, or adhesive capsulitis, is a debilitating condition characterized by pain and a progressive loss of shoulder mobility [20]. It is typically divided into primary and secondary forms; primary cases arise without a clear cause, while secondary cases are linked to trauma, surgery, or underlying medical conditions [21]. The condition generally evolves through three overlapping phases: the painful "freezing" stage, the stiff "frozen" stage, and the "thawing" stage, where gradual improvement occurs [22]. However, many patients continue to experience symptoms beyond these stages. Frozen shoulder is characterized by fibroproliferative tissue fibrosis, in which fibroblasts and myofibroblasts overproduce collagen. This leads to inflammation, neoangiogenesis, and capsule contracture, ultimately resulting in restricted shoulder movement and pain [21,22]. The condition most commonly affects individuals in their 50s and has a lifetime prevalence of 2%-5%. Risk factors include diabetes, cardiovascular disease, thyroid disorders, autoimmune diseases, obesity, smoking, and low levels of physical activity. Notably, up to 60% of individuals with diabetes may develop frozen shoulder, and the presence of comorbidities



such as Dupuytren's disease also increases the risk [20–24].

The pathophysiology of frozen shoulder involves inflammation, vascular and neural changes, and excessive extracellular matrix remodeling [20-22]. Chronic unresolved inflammation is a central feature, with immune cells such as T cells and macrophages playing significant roles. Pro-inflammatory cytokines, including IL-1, IL-6, and transforming growth factor-β, are crucial in promoting fibrosis and inflammation. Fibroblast activation is also key, as these cells produce abnormal amounts of collagen and matrix proteins, which contribute to increased stiffness [25]. Additionally, neural changes, such as heightened nerve sensitivity and an increased expression of pain-related receptors, contribute to the severe pain experienced with this condition, especially at night. Furthermore, advanced glycation end products, which are often elevated in individuals with diabetes, exacerbate fibrosis and inflammation by altering tissue remodeling processes [26].

The diagnosis of frozen shoulder primarily relies on clinical assessment, which includes evaluating pain and the restriction of both active and passive shoulder movement. Imaging modalities like X-rays, MRI, and ultrasound are useful for distinguishing this condition from other pathologies, although routine imaging is not always necessary. The lack of standardized diagnostic criteria presents challenges, and differentiating frozen shoulder from other conditions, such as rotator cuff tendinopathy or joint arthrosis, can be difficult in the early stages [21].

Management of frozen shoulder presents a significant challenge, as the condition often resolves spontaneously within 1-2 years. However, symptoms persist in a considerable number of patients [27,28]. Non-operative treatments, which are the initial approach to management, include patient education, physiotherapy, pharmacotherapy, and corticosteroid injections. Patient education is aimed at explaining the natural history of the condition, reducing anxiety, and setting realistic expectations for recovery. Physiotherapy involves mobility exercises that are customized according to the stage of the disease and the severity of pain, incorporating techniques such as stretching and joint mobilization. Nonetheless, the long-term benefits of physiotherapy remain uncertain, and excessive intensity during the inflammatory stage may exacerbate symptoms.

Pharmacological options for treatment include NSAIDs, acetaminophen, and corticosteroids. Intra-articular corticosteroid injections have been shown to effectively reduce pain and inflammation in the early stages, although their benefits tend to be short-lived [29]. Alternative interventions, such as injections of sodium hyaluronate, suprascapular nerve blocks, and hydrodilatation (capsular distension with saline or corticosteroids), are promising but still require more research. Hydrodilatation, in particular, is becoming increasingly popular due to its potential to enhance range of motion and alleviate pain. Additionally, emerging therapies like collagenase injections and botulinum toxin are under investigation, with preliminary evidence supporting their effectiveness in certain scenarios [30,31].

For patients who do not respond to non-operative treatments, surgical options are considered. Manipulation under anesthesia involves forcibly stretching the joint to break adhesions. In contrast, arthroscopic capsular release (ACR) provides direct visualization and surgical removal of fibrotic tissue. Both methods enhance range of motion and alleviate pain; however, ACR is more invasive and costly. The decision between surgical and non-surgical options is influenced by the severity of the disease, patient preference, and access to healthcare. Research, including the UK FROST trial, indicates that all approaches significantly improve patient outcomes, with ACR showing the most consistent results in refractory cases [32].

Quality of life is significantly impacted by frozen shoulders, which cause severe pain, functional limitations, and sleep disturbances. This condition often leads to anxiety and depression, further exacerbating the overall burden. Patients frequently express frustration over delayed diagnoses



and unclear management pathways [33]. These issues underscore the importance of patientcentered care, timely diagnosis, and clear communication regarding treatment options.

Advancements in research are revealing the intricate mechanisms behind frozen shoulder, which include the roles of inflammation, fibrosis, angiogenesis, and neural sensitization. Translational studies are investigating new therapeutic targets, such as anti-inflammatory agents, gene silencing of fibrotic pathways, and alarmin inhibitors [34,35]. Although these emerging therapies are promising, challenges persist in standardizing clinical trials and managing the diverse characteristics of the patient population. Future efforts will focus on developing personalized treatment strategies and incorporating basic science findings into clinical practice.

In conclusion, frozen shoulder is a complex condition that significantly impacts both clinical and psychological aspects of health. Although it is self-limiting, many patients experience prolonged symptoms that disrupt daily activities and overall well-being. Current management strategies primarily aim to control symptoms and enhance functionality. However, there is an urgent need for more effective, evidence-based interventions. Enhancing our knowledge of the disease's pathophysiology and risk factors is crucial for developing targeted therapies and achieving better outcomes for those affected by this debilitating condition.

Osteoarthritis ·

Shoulder osteoarthritis is a prevalent chronic condition that significantly impacts quality of life by causing pain and disability [36]. It commonly affects older adults, particularly women and individuals who are obese. The shoulder joint, known for its complex structure and extensive range of motion, ranks as the third most frequent site of musculoskeletal pain, following the lower back and knee. This condition targets the synovial joint, resulting in cartilage degeneration, abnormal bone remodeling, osteophyte formation, and inflammation. The development of osteoarthritis is influenced by both mechanical wear and inflammatory processes, which are driven by cytokines, degradative enzymes, and immune system pathways [37].

The primary contributors to shoulder osteoarthritis include aging, genetic predisposition, and obesity, along with trauma, rotator cuff tears, and joint instability [36,38]. Traumatic injuries, whether acute or repetitive, can lead to posttraumatic arthritis, which accounts for approximately 12% of osteoarthritis cases. Chronic rotator cuff tears often result in a specific pattern of osteoarthritis known as cuff tear arthropathy, characterized by upward migration of the humeral head, which alters the joint structure. Additionally, glenoid dysplasia and chronic glenohumeral instability predispose individuals to shoulder osteoarthritis [36,38].

The diagnosis of shoulder osteoarthritis typically involves a clinical evaluation complemented by imaging studies. Radiographs serve as the primary imaging modality and are frequently augmented by MRI, CT, or ultrasound to provide more detailed assessments. Classic signs observed in radiographs include joint space narrowing, subchondral sclerosis, cyst formation, and osteophyte growth. Advanced imaging plays a crucial role in evaluating associated pathologies such as rotator cuff or glenoid issues, and in assessing the thickness of cartilage and the quality of bone [39].

Management of shoulder osteoarthritis depends on the severity of symptoms and the extent of joint damage. Non-surgical treatments include physical therapy, pharmacological interventions like NSAIDs, and corticosteroid injections to alleviate pain and inflammation [39]. In more severe cases, surgical interventions are considered, particularly shoulder arthroplasty. There are three main types of shoulder arthroplasty: partial shoulder replacement, anatomic



total shoulder arthroplasty, and reverse total shoulder arthroplasty [40,41].

Partial shoulder replacement, which includes humeral head resurfacing arthroplasty and humeral hemiarthroplasty, targets pathology on the humeral side, preserves bone stock, and maintains native anatomy [42]. Anatomic total shoulder arthroplasty treats both the humeral and glenoid surfaces and depends on a functional rotator cuff for successful outcomes. Reverse total shoulder arthroplasty, specifically designed for patients with rotator cuff tears, alters the normal ball-and-socket joint configuration to restore function via deltoid muscle tension [40,41].

Each type of arthroplasty comes with its own set of indications and postoperative challenges. Common complications include component loosening, glenohumeral instability, periprosthetic fractures, rotator cuff tears, infection, and nerve injury. The most frequent complication is component loosening, particularly of the glenoid component, often due to wear and instability. Glenohumeral instability typically presents as anterior or superior displacement, generally resulting from rotator cuff failure or incorrect positioning of the prosthetic components. Periprosthetic fractures may occur during surgery due to the techniques used, or postoperatively as a result of trauma. Although infections are relatively rare, they are serious complications that frequently necessitate revision surgery [40,41].

Reverse total shoulder arthroplasty is associated with unique complications, including anterosuperior instability resulting from unopposed deltoid contraction and scapular notching due to mechanical impingement. Other concerns include fractures of the acromial or scapular spine and mechanical failure of the prosthetic components, such as dislodgment of the glenosphere [40].

Preoperative imaging is essential in planning for arthroplasty, as it allows for the assessment of rotator cuff integrity and glenoid morphology, which are key factors in determining the appropriate surgical procedure. An intact rotator cuff is essential for successful anatomic total shoulder arthroplasty, whereas reverse total shoulder arthroplasty is more appropriate for patients with rotator cuff deficiencies. Advanced imaging techniques are used to evaluate glenoid morphology and bone stock, employing classifications such as the modified Walch criteria to facilitate surgical planning. Challenges such as posterior glenoid wear or retroversion are addressed through techniques like asymmetric glenoid reaming, bone grafting, and the use of augmented components [41].

In summary, shoulder osteoarthritis significantly contributes to pain and disability, especially among the elderly. The complexity of the condition, its variable progression, and its profound impact on quality of life underscore the need for customized management strategies. Ongoing advancements in imaging, surgical methods, and prosthetic designs have enhanced outcomes for patients undergoing shoulder arthroplasty. Radiologists are crucial in diagnosing osteoarthritis, assessing preoperative findings, and detecting postoperative complications, thereby playing a key role in patient care.

Shoulder instability -

Shoulder instability in older patients is characterized by a lower recurrence rate than in younger populations, yet it is frequently accompanied by a higher incidence of complications such as rotator cuff tears, fractures, and neurologic injuries [43]. In older adults, acute dislocations typically occur due to traumatic events that compromise the shoulder's stabilizing structures, including the anterior capsule, glenohumeral ligaments, and labrum. Additionally, age-related degeneration and comorbidities such as osteoporosis and rotator cuff degeneration present unique challenges in the management of shoulder instability in this age group [43,44].



The incidence of shoulder instability increases with age, peaking in women over 80 years, with traumatic anterior dislocations being the most common form [44]. Although older adults have lower recurrence rates compared to younger individuals, they frequently suffer from associated injuries. Up to 86% of patients older than 40 years experience rotator cuff tears following an anterior dislocation. These tears can range from small lesions to massive tears involving the posterosuperior or anterosuperior rotator cuff. Additionally, fractures such as Hill-Sachs lesions, greater tuberosity fractures, and glenoid fractures occur more frequently in this age group due to osteoporotic bone. Neurologic injuries, including axillary nerve or brachial plexus lesions, are also more common and severe in older adults, with recovery being less predictable than in younger patients [43,44].

The mechanisms underlying shoulder instability vary with age. In younger individuals, anterior dislocations are frequently associated with Bankart lesions, which involve the labrum and capsuloligamentous structures. In contrast, older patients more commonly experience capsular ruptures and rotator cuff tears, indicative of age-related tissue weakening. Although less common, posterior instability is often related to rotator cuff deficiency or low-energy trauma, and chronic dislocations can present significant diagnostic challenges.

The management of shoulder instability in older patients is tailored to the specific injury pattern and the patient's overall health. For acute anterior dislocations, the initial treatment typically involves a gentle closed reduction, followed by imaging studies such as X-rays or CT scans to evaluate any associated injuries [45]. Conservative management, which includes sling immobilization, physical therapy, and gradual strengthening exercises, is suitable for first-time dislocations or stable reductions that do not involve significant tears or fractures. However, surgical intervention may be required in cases of recurrent instability, large rotator cuff tears, or significant bone deficiencies [45,46].

Surgical options vary depending on the specific pathology. Rotator cuff repairs are recommended for large or massive tears, especially when they are associated with functional deficits or nerve injuries. Bankart repairs, which are often performed alongside rotator cuff repairs, are indicated in cases of recurrent instability when there is no significant bone loss [47,48]. Severe deficiencies in the glenoid or humerus may require reconstructive procedures, such as glenoid augmentation with grafts or reverse total shoulder arthroplasty. The latter is particularly advantageous for patients with irreparable rotator cuff tears, chronic dislocations, or complex fractures [46,49].

The complications of shoulder instability in older patients include stiffness, persistent pain, and functional limitations [44]. It is crucial to address all components of the injury, such as rotator cuff pathology, osseous defects, and ligamentous damage, to optimize outcomes. However, maintaining a balance between achieving stability and preserving motion continues to be a challenge. In cases of chronic anterior dislocations, extensive releases, including pectoralis major release, may be necessary to achieve reduction. However, these procedures carry significant risks, such as vascular injury or residual instability [43].

Posterior shoulder instability, while less common, requires careful evaluation due to its frequent association with undiagnosed chronic dislocations [50]. Radiographic assessments in orthogonal planes and advanced imaging like CT are critical for identifying reverse Hill-Sachs lesions or posterior glenoid fractures. Treatment involves reduction techniques tailored to the chronicity and severity of the dislocation, with arthroplasty often being the preferred option for severe cases with substantial bone or soft tissue loss [50].

In summary, shoulder instability in older patients poses unique diagnostic and management



challenges due to age-related degenerative changes, associated injuries, and diminished tissue healing capacity. Although this condition has a lower recurrence rate in older individuals compared to younger ones, it is complicated by the presence of associated injuries such as rotator cuff tears, fractures, and neurologic injuries. Tailored treatment strategies that combine conservative management with advanced surgical interventions when necessary are essential for enhancing outcomes and restoring function in this demographic. Continued research and advancements in surgical methods and prosthetic designs are promising for overcoming the challenges associated with shoulder instability in older adults.

Table 1 shows a comparative overview of four major shoulder diseases in older adults.

Table 1 Comparative clinical characteristics of four major shoulder diseases in older adults

Condition	Pathophysiology	Risk factors	Clinical presentation	Diagnostic approaches	Treatment strategies
Rotator cuff disease	Tendon degeneration, inflammation, and microtrauma leading to tendinopathy or tears. Involves cytokines (IL-6, IL-1β), muscle atrophy, and fatty infiltration.	Age (higher prevalence in those >80 years), genetics, diabetes, obesity, smoking, repetitive physical activity	Pain (often nocturnal), limited mobility, weakness, difficulty with overhead activities	Clinical exam (Neer, Jobe, Hawkins–Kennedy tests), X-rays, MRI, ultrasound to assess tear size, tendon retraction, and muscle quality	Non-operative (physical therapy, NSAIDs, corticosteroid injections, emerging biologics) or surgical repair (arthroscopic rotator cuff repair, tendon transfer, reverse arthroplasty for irreparable tears)
Frozen shoulder (adhesive capsulitis)	Fibroproliferative capsular fibrosis with inflammation, neo-angiogenesis, and excess collagen deposition, causing restricted joint motion and pain.	Diabetes, thyroid disease, cardiovascular disease, obesity, smoking, low physical activity, Dupuytren's disease	Severe pain, progressive loss of both active and passive range of motion; often goes through freezing, frozen, and thawing stages	Primarily clinical diagnosis (painful loss of motion), imaging (X-rays, MRI, ultrasound) to exclude other pathologies	Non-operative (patient education, physiotherapy, NSAIDs, corticosteroids, hydrodilatation) or operative (manipulation under anesthesia, arthroscopic capsular release)
Osteoarthritis	Progressive cartilage loss, osteophyte formation, subchondral sclerosis, and joint inflammation. Mechanical wear plus cytokinedriven inflammatory processes.	Aging, genetic predisposition, obesity, trauma, rotator cuff tears, chronic instability	Pain, stiffness, crepitus, functional limitations, often worsened by activity	X-rays (joint space narrowing, osteophytes), MRI or CT (assess rotator cuff, glenoid wear, bone quality), ultrasound (soft tissue evaluation)	Conservative (physical therapy, NSAIDs, corticosteroid injections) or surgical (arthroplasty: partial/hemi-arthroplasty, anatomic total shoulder, reverse total shoulder arthroplasty) based on cuff integrity and severity of damage
Shoulder instability	Disruption of stabilizing structures (capsule, ligaments, labrum) due to traumatic events or degenerative changes. Often complicated by rotator cuff tears, fractures, or neurologic injuries in older patients.	Advancing age, osteoporosis, rotator cuff degeneration, comorbidities (e.g., diabetes), history of dislocation	Acute or chronic dislocation, pain, inability to move the arm, associated rotator cuff or bony injuries	Radiographs or CT for fracture assessment, MRI for soft tissue lesions, clinical exam to assess stability	Closed reduction, immobilization, and rehabilitation if stable; surgical repair (rotator cuff, Bankart, arthroplasty) if there is recurrent instability, large tears, or osseous deficiencies



Conclusion

Shoulder diseases in older adults, including rotator cuff disease, frozen shoulder, osteoarthritis, and instability, pose significant challenges due to age-related degeneration and comorbidities. Effective management necessitates an accurate diagnosis, individualized treatment, and an appropriate balance between conservative and surgical approaches. Advances in surgical techniques, biologic therapies, and imaging have improved outcomes, but careful patient selection and multidisciplinary care remain critical. Future research should focus on optimizing therapeutic strategies and addressing the broader impacts of these conditions on quality of life. A patient-centered, evidence-based approach is essential to improving outcomes and improving the well-being of this vulnerable population.

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References

- 1. Chard MD, Hazleman R, Hazleman BL, King RH, Reiss BB. Shoulder disorders in the elderly: a community survey. Arthritis Rheum 1991;34(6):766-769. https://doi.org/10.1002/art.1780340619
- 2. Kim JH, Jung SH, Park DH, Kwon YU, Lee HY. Factors associated with patient satisfaction after arthroscopic rotator cuff repair: do they differ by age? Clin Shoulder Elb 2024;27(3):345-



352.

- https://doi.org/10.5397/cise.2024.00283
- 3. Kim SC, Yoo SJ, Jo JH, Lee JH, Baek E, Lee SM, et al. The impact of supraspinatus tear on subscapularis muscle atrophy and fatty infiltration. *Clin Shoulder Elb* 2024;27(4):437-446. https://doi.org/10.5397/cise.2024.00521
- 4. Gumina S, Kim H, Jung Y, Song HS. Rotator cuff degeneration and healing after rotator cuff repair. *Clin Shoulder Elb* 2023;26(3):323-329.
 - https://doi.org/10.5397/cise.2023.00430
- Dang A, Davies M. Rotator cuff disease: treatment options and considerations. Sports Med Arthrosc Rev 2018;26(3):129-133.
 - https://doi.org/10.1097/JSA.0000000000000207
- 6. Geary MB, Elfar JC. Rotator cuff tears in the elderly patients. *Geriatr Orthop Surg Rehabil* 2015;6(3):220-224.
 - https://doi.org/10.1177/2151458515583895
- 7. Yamamoto A, Takagishi K, Osawa T, Yanagawa T, Nakajima D, Shitara H, et al. Prevalence and risk factors of a rotator cuff tear in the general population. *J Shoulder Elb Surg* 2010;19(1):116-120.
 - https://doi.org/10.1016/j.jse.2009.04.006
- 8. Zumstein MA, Künzler M, Hatta T, Galatz LM, Itoi E. Rotator cuff pathology: state of the art. *J ISAKOS* 2017;2(4):213-221.
 - https://doi.org/10.1136/jisakos-2016-000074
- 9. Moran TE, Werner BC. Surgery and rotator cuff disease: a review of the natural history, indications, and outcomes of nonoperative and operative treatment of rotator cuff tears. *Clin Sports Med* 2023;42(1):1-24.
 - https://doi.org/10.1016/j.csm.2022.08.001
- 10. Itoi E. Rotator cuff tear: physical examination and conservative treatment. *J Orthop Sci* 2013;18(2):197-204.
 - https://doi.org/10.1007/s00776-012-0345-2
- 11. Karasuyama M, Gotoh M, Tahara K, Kawakami J, Madokoro K, Nagamatsu T, et al. Clinical results of conservative management in patients with full-thickness rotator cuff tear: a meta-analysis. *Clin Shoulder Elb* 2020;23(2):86-93.
 - https://doi.org/10.5397/cise.2020.00031
- 12. Choi S. Will platelet rich plasma open new era for treatment of rotator cuff tear? *Clin Shoulder Elb* 2018;21(1):1-2.
 - https://doi.org/10.5397/cise.2018.21.1.1
- 13. Lee GW, Kim JY, Lee HW, Yoon JH, Noh KC. Clinical and anatomical outcomes of arthroscopic repair of large rotator cuff tears with allograft patch augmentation: a prospective, single-blinded, randomized controlled trial with a long-term follow-up. *Clin Orthop Surg* 2022;14(2):263-271.
 - https://doi.org/10.4055/cios21135
- 14. Xu W, Xue Q. Application of platelet-rich plasma in arthroscopic rotator cuff repair: a systematic review and meta-analysis. *Orthop J Sports Med* 2021;9(7):23259671211016847. https://doi.org/10.1177/23259671211016847
- 15. Baek CH, Kim BT, Kim JG, Kim SJ. Comparison of clinical outcomes of anterior combined latissimus dorsi and teres major tendon transfer for anterior superior irreparable rotator cuff tear between young and elderly patients. *Clin Shoulder Elb* 2024;27(3):327-337.



- https://doi.org/10.5397/cise.2024.00248
- 16. Hones KM, Gutowski CT, Rakauskas TR, Bindi VE, Simcox T, Wright JO, et al. Outcomes of lateralized reverse total shoulder arthroplasty versus latissimus dorsi transfer for external rotation deficit: a systematic review and meta-analysis. *Clin Shoulder Elb* 2024;27(4):464-478.
 - https://doi.org/10.5397/cise.2024.00304
- 17. Kim JH, Lee HJ, Park TY, Lee JU, Kim YS. Preliminary outcomes of arthroscopic biceps rerouting for the treatment of large to massive rotator cuff tears. *J Shoulder Elbow Surg* 2021;30(6):1384-1392.
 - https://doi.org/10.1016/j.jse.2020.08.023
- Kim YS, Kim SE, Bae SH, Lee HJ, Jee WH, Park CK. Tear progression of symptomatic full-thickness and partial-thickness rotator cuff tears as measured by repeated MRI. Knee Surg Sports Traumatol Arthrosc 2017;25(7):2073-2080.
 - https://doi.org/10.1007/s00167-016-4388-3
- Rohrback M, Ramtin S, Abdelaziz A, Matkin L, Ring D, Crijns TJ, et al. Rotator cuff tendinopathy: magnitude of incapability is associated with greater symptoms of depression rather than pathology severity. *J Shoulder Elbow Surg* 2022;31(10):2134-2139. https://doi.org/10.1016/j.jse.2022.03.007
- 20. Tamai K, Hamada J, Nagase Y, Morishige M, Naito M, Asai H, et al. Frozen shoulder. An overview of pathology and biology with hopes to novel drug therapies. *Mod Rheumatol* 2023;34(3):439-443.
 - https://doi.org/10.1093/mr/road087
- 21. Rangan A, Goodchild L, Gibson J, Brownson P, Thomas M, Rees J, et al. Frozen shoulder. *Shoulder Elb* 2015;7(4):299-307.
 - https://doi.org/10.1177/1758573215601779
- 22. Ryan V, Brown H, Minns Lowe CJ, Lewis JS. The pathophysiology associated with primary (idiopathic) frozen shoulder: a systematic review. *BMC Musculoskelet Disord* 2016;17(1):340. https://doi.org/10.1186/s12891-016-1190-9
- 23. Kim JH, Kim BS, Han K, Kwon HS. The risk of shoulder adhesive capsulitis in individuals with prediabetes and type 2 diabetes mellitus: a longitudinal nationwide population-based study. *Diabetes Metab J* 2023;47(6):869-878.
 - https://doi.org/10.4093/dmj.2022.0275
- 24. Kim JH, Baek JY, Han KD, Kim BS, Kwon HS. Higher body mass index increases the risk of shoulder adhesive capsulitis in young adults: a nationwide cohort study. *J Shoulder Elbow Surg* 2025;34(1):26-32.
 - https://doi.org/10.1016/j.jse.2024.03.063
- Lee HJ, Hong OK, Kwak DH, Kim YS. Metabolic profiling of serum and tissue from the rotator interval and anterior capsule in shoulder stiffness: a preliminary study. *BMC Musculoskelet Disord* 2019;20(1):364.
 - https://doi.org/10.1186/s12891-019-2709-7
- 26. Kim YS, Lee YG, Park HS, Cho RK, Lee HJ. Comparison of gene expression of inflammation- and fibrosis-related factors between the anterior and posterior capsule in patients with rotator cuff tear and shoulder stiffness. *Orthop J Sports Med* 2021;9(10):23259671211032543.
 - https://doi.org/10.1177/23259671211032543
- 27. Neviaser AS, Neviaser RJ. Adhesive capsulitis of the shoulder. J Am Acad Orthop Surg



- 2011;19(9):536-542.
- https://doi.org/10.5435/00124635-201109000-00004
- 28. Redler LH, Dennis ER. Treatment of adhesive capsulitis of the shoulder. *J Am Acad Orthop Surg* 2019;27(12):e544-e554.
 - https://doi.org/10.5435/JAAOS-D-17-00606
- 29. Challoumas D, Biddle M, McLean M, Millar NL. Comparison of treatments for frozen shoulder: a systematic review and meta-analysis. *JAMA Netw Open* 2020;3(12):e2029581. https://doi.org/10.1001/jamanetworkopen.2020.29581
- 30. Lädermann A, Piotton S, Abrassart S, Mazzolari A, Ibrahim M, Stirling P. Hydrodilatation with corticosteroids is the most effective conservative management for frozen shoulder. *Knee Surg Sports Traumatol Arthrosc* 2021;29(8):2553-2563. https://doi.org/10.1007/s00167-020-06390-x
- 31. Rymaruk S, Peach C. Indications for hydrodilatation for frozen shoulder. *EFORT Open Rev* 2017;2(11):462-468.
 - https://doi.org/10.1302/2058-5241.2.160061
- 32. Rangan A, Brealey SD, Keding A, Corbacho B, Northgraves M, Kottam L, et al. Management of adults with primary frozen shoulder in secondary care (UK FROST): a multicentre, pragmatic, three-arm, superiority randomised clinical trial. *Lancet* 2020;396(10256):977-989.
 - https://doi.org/10.1016/S0140-6736(20)31965-6
- 33. Brindisino F, Silvestri E, Gallo C, Venturin D, Di Giacomo G, Peebles AM, et al. Depression and anxiety are associated with worse subjective and functional baseline scores in patients with frozen shoulder contracture syndrome: a systematic review. *Arthrosc Sports Med Rehabil* 2022;4(3):E1219-E1234.
 - https://doi.org/10.1016/j.asmr.2022.04.001
- 34. Hopewell S, Kenealy N, Knight R, Rangan A, Dutton S, Srikesavan C, et al. Anti-TNF (adalimumab) injection for the treatment of adults with frozen shoulder during the pain predominant stage protocol for a multi-centre, randomised, double blind, parallel group, feasibility trial. NIHR Open Res 2022;2:28.
 - https://doi.org/10.3310/nihropenres.13275.2
- 35. Hopewell S, Srikesavan C, Evans A, Er F, Rangan A, Preece J, et al. Anti-TNF (adalimumab) injection for the treatment of pain-predominant early-stage frozen shoulder: the anti-freaze-feasibility randomised controlled trial. *BMJ Open* 2024;14(5):e078273. https://doi.org/10.1136/bmjopen-2023-078273
- 36. Stanborough RO, Bestic JM, Peterson JJ. Shoulder osteoarthritis. *Radiol Clin North Am* 2022;60(4):593-603.
 - https://doi.org/10.1016/j.rcl.2022.03.003
- 37. Voss A, Beitzel K. Shoulder osteoarthritis across the lifespan. *J ISAKOS* 2023;8(6):396-397. https://doi.org/10.1016/j.jisako.2023.10.012
- 38. Yamamoto N, Szymski D, Voss A, Ishikawa H, Muraki T, Cunha RA, et al. Non-operative management of shoulder osteoarthritis: current concepts. *J ISAKOS* 2023;8(5):289-295. https://doi.org/10.1016/j.jisako.2023.06.002
- 39. Vocelle AR, Weidig G, Bush TR. Shoulder structure and function: the impact of osteoarthritis and rehabilitation strategies. *J Hand Ther* 2022;35(3):377-387. https://doi.org/10.1016/j.jht.2022.06.008
- 40. Heifner JJ, Kumar AD, Wagner ER. Glenohumeral osteoarthritis with intact rotator cuff



- treated with reverse shoulder arthroplasty: a systematic review. *J Shoulder Elbow Surg* 2021;30(12):2895-2903.
- https://doi.org/10.1016/j.jse.2021.06.010
- 41. Jensen AR, Tangtiphaiboontana J, Marigi E, Mallett KE, Sperling JW, Sanchez-Sotelo J. Anatomic total shoulder arthroplasty for primary glenohumeral osteoarthritis is associated with excellent outcomes and low revision rates in the elderly. *J Shoulder Elbow Surg* 2021;30(7s):S131-S139.
 - https://doi.org/10.1016/j.jse.2020.11.030
- 42. Miettinen SSA, Liu Y, Kröger H. Long-term survival of resurfacing humeral hemiarthroplasty. *Eur J Orthop Surg Traumatol* 2024;34(6):2925-2932.
 - https://doi.org/10.1007/s00590-024-04010-9
- 43. Gombera MM, Sekiya JK. Rotator cuff tear and glenohumeral instability: a systematic review. *Clin Orthop Relat Res* 2014;472(8):2448-2456.
 - https://doi.org/10.1007/s11999-013-3290-2
- 44. Paxton ES, Dodson CC, Lazarus MD. Shoulder instability in older patients. *Orthop Clin North Am* 2014;45(3):377-385.
 - https://doi.org/10.1016/j.ocl.2014.04.002
- 45. Hurley ET, Matache BA, Wong I, Itoi E, Strauss EJ, Delaney RA, et al. Anterior shoulder instability part I: diagnosis, nonoperative management, and Bankart repair: an international consensus statement. *Arthroscopy J Arthrosc Relat Surg* 2022;38(2):214-223.E7. https://doi.org/10.1016/i.arthro.2021.07.022
- 46. Arner JW, Peebles LA, Bradley JP, Provencher MT. Anterior shoulder instability management: indications, techniques, and outcomes. *Arthroscopy* 2020;36(11):2791-2793. https://doi.org/10.1016/j.arthro.2020.09.024
- 47. Brown L, Rothermel S, Joshi R, Dhawan A. Recurrent instability after arthroscopic Bankart reconstruction: a systematic review of surgical technical factors. *Arthroscopy* 2017;33(11):2081-2092.
 - https://doi.org/10.1016/j.arthro.2017.06.038
- 48. Olds M, Ellis R, Donaldson K, Parmar P, Kersten P. Risk factors which predispose first-time traumatic anterior shoulder dislocations to recurrent instability in adults: a systematic review and meta-analysis. *Br J Sports Med* 2015;49(14):913-923.
 - https://doi.org/10.1136/bjsports-2014-094342
- 49. Chae J, Siljander M, Wiater JM. Instability in reverse total shoulder arthroplasty. *J Am Acad Orthop Surg* 2018;26(17):587-596.
 - https://doi.org/10.5435/JAAOS-D-16-00408
- 50. DeLong JM, Jiang K, Bradley JP. Posterior instability of the shoulder: a systematic review and meta-analysis of clinical outcomes. *Am J Sports Med* 2015;43(7):1805-1817. https://doi.org/10.1177/0363546515577622

Review



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Radiological characteristics of shoulder diseases in older adults, including adhesive capsulitis, rotator cuff tear, and osteoarthritis of the glenohumeral joint: a narrative review

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Keywords

Magnetic resonance imaging; Osteoarthritis; Rotator cuff injuries; Shoulder joint; X-Ray computed tomography



Shoulder diseases, including adhesive capsulitis, rotator cuff tear, and osteoarthritis of the glenohumeral joint, can significantly impair daily activities in older adult patients. This review aims to examine the radiologic findings associated with these shoulder conditions in older patients, providing insights for accurate diagnosis and effective treatment. Adhesive capsulitis, commonly known as frozen shoulder, leads to pain and restricted movement, thereby causing shoulder dysfunction. Recent advances in diagnostic technology have greatly enhanced the sensitivity and accuracy of diagnosing this condition through radiologic evaluations, including MRI, magnetic resonance arthrography (MRA), and high-resolution ultrasound. Rotator cuff disease is another frequent issue in older adults, with fullthickness tears occurring in 50%-80% of cases. Both MRI and MRA are highly sensitive and specific in identifying rotator cuff tears. Additionally, ultrasonography is recognized for its high sensitivity and specificity in detecting tears of the supraspinatus tendon. Although osteoarthritis of the glenohumeral joint is less commonly prevalent, its advanced stages can severely affect the function of the upper extremity. Plain radiography is typically the first imaging technique used to assess this type of osteoarthritis. As the condition worsens, CT is utilized to measure glenoid bone loss, glenoid version, and inclination, which are crucial for accurate surgical planning. Each imaging modality provides distinct benefits: plain radiographs for initial structural assessment, ultrasonography for real-time evaluation of soft tissues, MRI/MRA for detailed visualization of capsular and tendinous lesions, and CT for precise bony analysis.

Introduction

Background

Previous studies have indicated that shoulder pain affects approximately 20% of individuals over the age of 65, ranking it as the third most common source of pain following back and knee pain [1]. Common conditions associated with shoulder pain include adhesive capsulitis, rotator cuff tears, and osteoarthritis of the glenohumeral joint [2,3]. Without proper diagnosis and treatment, these shoulder pathologies may progress, leading to pain and functional impairment

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that complicates daily activities [4-8]. Advances in diagnostic techniques now allow for the identification of diseases causing shoulder pain with high sensitivity and accuracy through the use of MRI, magnetic resonance arthrography (MRA), and ultrasonography [9]. For glenohumeral joint arthritis, surgical planning can be facilitated by radiography and CT [10]. Therefore, it is essential for healthcare providers to be well-versed in the radiologic characteristics of common shoulder pathologies in older adults.

Objectives

This article reviews the radiologic findings associated with shoulder diseases in older adults, offering insights for accurate diagnosis and effective treatment.

Ethics statement

As this study was a literature review, it did not require approval from the institutional review board or individual consent

Adhesive capsulitis

Plain radiography

Plain radiography typically shows no significant findings in patients with adhesive capsulitis [11]. Its primary utility is to differentiate diseases such as calcific tendinitis or osteoarthritis that may cause shoulder pain [12].

Ultrasonography

As technological advances in ultrasound have improved the accurate visualization of shoulder joint structures, it is increasingly being used to examine patients with adhesive capsulitis, leveraging its dynamic and non-invasive advantages [13]. The radiological characteristics observable in patients with adhesive capsulitis via ultrasound include the following.

- Coracohumeral ligament, inferior glenohumeral capsule thickening, and rotator interval abnormality (88% sensitivity and 96% specificity; Figs. 1, 2) [5,9,14,15]
- Thickening of the axillary pouch, as illustrated in Fig. 3, is a notable finding [16,17]
- Increased vascularity in the rotator interval [18]

Recently, a protocol for diagnosing adhesive capsulitis using ultrasonographic findings has been proposed. Ultrasonography is reported to be a valuable diagnostic tool for patients with

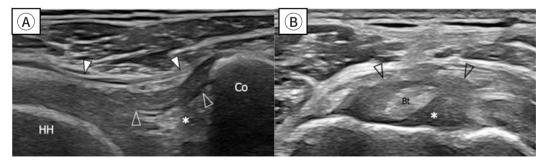


Fig. 1. Ultrasonography. Thickened coracohumeral ligament, oblique transverse image (A), short axis image (B). Adapted from Picasso et al. [5] with CC-BY.



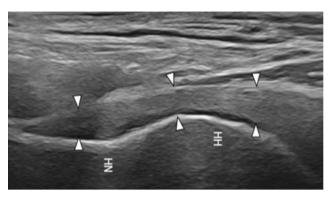


Fig. 2. Ultrasonography. Thickened inferior glenohumeral capsule, longitudinal image. Adapted from Picasso et al. [5] with CC-BY.

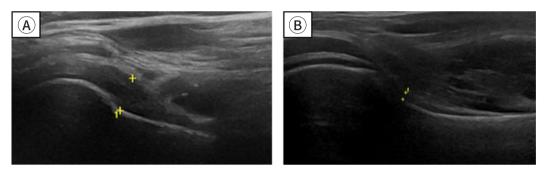


Fig. 3. Ultrasonography, oblique axial section. Thickened axillary pouch (A), normal axillary pouch (B). Adapted from Tue et al. [17] with CC-BY.

adhesive capsulitis (Fig. 4) [5].

MRI and magnetic resonance arthrography

MRI is considered the gold standard for assessing the entire glenohumeral capsule and pericapsular soft tissue in cases of adhesive capsulitis [5]. A recent systematic review and metaanalysis of MRI radiological characteristics in adhesive capsulitis identified six significant findings (Fig. 5) [5,19].

- Coracohumeral ligament thickening and fat obliteration of the rotator interval [5,20]
- Inferior glenohumeral ligament hyperintensity and thickening (85.3%-88.2% sensitivity and 88.2% specificity) [21]
- Obliteration of the subcoracoid fat triangle by hypointense synovium
- Contrast enhancement of the axillary joint capsule and the rotator interval [22]

MRI and MRA are crucial diagnostic tools for identifying specific radiologic characteristics of adhesive capsulitis, thereby playing a significant role in understanding the disease's nature [11].

Rotator cuff tear

Plain radiography

Plain radiography is typically the first step in assessment due to its speed, low cost, and broad availability [23]. While it does not allow for direct evaluation of the rotator cuff, it can reveal



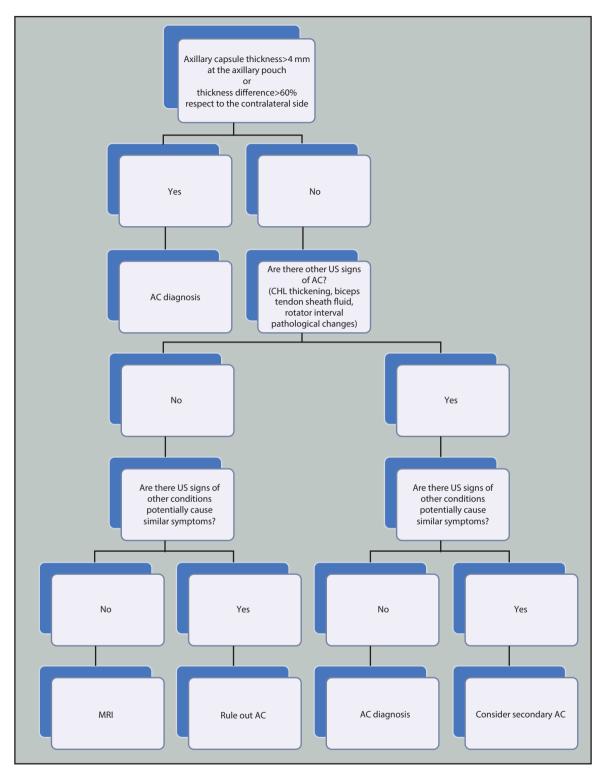


Fig. 4. Protocol for imaging evaluation using ultrasonography in patients with adhesive capsulitis. Adapted from Picasso et al. [5] with CC-BY.

osseous abnormalities linked to impingement. Anteroposterior, outlet, and axillary views are taken, and certain findings indicative of chronic rotator cuff tears can be observed on these radiographs (Fig. 6) [24].



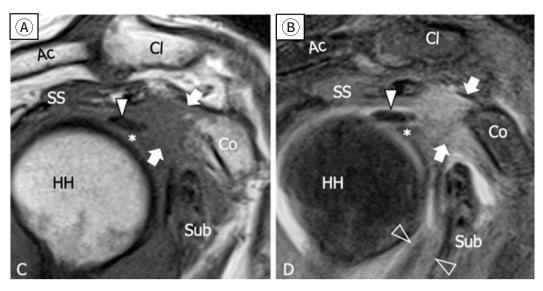


Fig. 5. Sagittal T1 and T2-weighted MRI scan. Fat obliteration (arrow), thickened and hyperintensity of the anteroinferior capsule (outlined arrowhead; A,B). Adapted from Picasso et al. [5] with CC-BY. SS, supraspinatus; Ac, acromion; CI, clavicle; Co, coracoid process; Sub, subscapularis; HH, humeral head.

- Anteroposterior view: reduction of subacromial space, subacromial enthesophyte, and cystic change with sclerosis of the acromion and greater tuberosity [25]
- Outlet view: coracoacromial arch and the morphology of the anterior acromion (flat, curved, or hooked)
- Axillary view: Details of the glenoid, glenohumeral alignment, coracohumeral interval, and os acromiale [24]

Ultrasonography

Ultrasound is a crucial diagnostic tool with sensitivity and specificity comparable to 1.5T MRI, particularly effective in diagnosing full-thickness rotator cuff tears [26]. In cases of full-thickness rotator cuff tendon tears, the defect in the cuff typically appears hypoechoic or anechoic. This is accompanied by irregularities in the greater tuberosity and pitting caused by the tear (Fig. 7) [24,27].

MRI and magnetic resonance arthrography

MRI is effective in evaluating both bone and soft tissue, establishing it as a precise diagnostic tool for confirming rotator cuff pathology. MRA, on the other hand, shows almost perfect sensitivity and specificity in detecting full-thickness rotator cuff tears, with values nearing 100% [28].

Rotator cuff tendinopathy, two hallmarks (Fig. 8) [29,30]

- Abnormal increased signal within the substance of the cuff (without extension to the articular or bursal side)
- Swelling or increased thickness of the tendon

Rotator cuff tear

- Supraspinatus



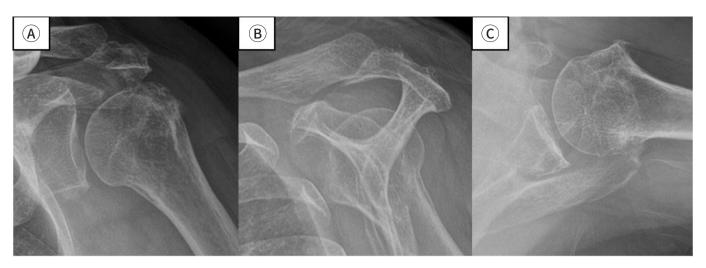


Fig. 6. Plain image. True anteroposterior view (A), outlet view (B) and axillary view (C). Provided by the authors.

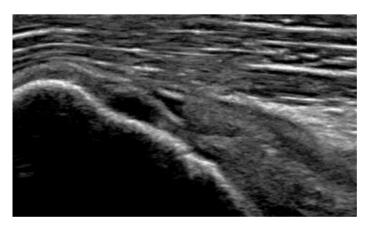


Fig. 7. Longitudinal plane ultrasound image of supraspinatus tendon. Anechoic gap and pitting due to tear. Provided by the authors.

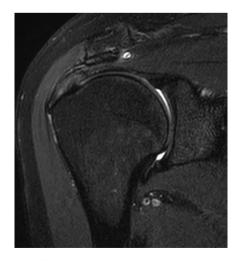


Fig. 8. Oblique coronal fat-suppressed T2-weighted MRI scan. Abnormal high signal and focal swelling of the supraspinatus tendon. Provided by the authors.



The most commonly observed radiological feature in full-thickness rotator cuff tears is high signal fluid intensity extending from the glenohumeral joint to the subacromial bursa (Fig. 9) [31]. In approximately 10% of patients, a low-signal tear is noted when the humeral head migrates superiorly, resulting in an absence of cuff tissue between the humeral head and the subacromial bursa [30].

- Subscapularis

Subscapularis tendon tears are relatively difficult to detect using MRI. These tears most commonly begin in the upper third of the tendon and tend to progress caudally (Fig. 10) [32-34].

- Infraspinatus and teres minor

Infraspinatus tears typically occur alongside supraspinatus tendon tears, with oblique coronal and sagittal fat-suppressed T2-weighted images being the most effective for detection, similar to those used for the supraspinatus tendon [35]. Isolated tears of the infraspinatus have been reported to be rare [36].

In the case of the teres minor, tears are reported in only 0.9% of cases and typically occur

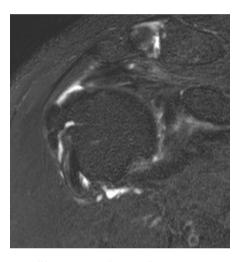


Fig. 9. Oblique coronal fat-suppressed T2-weighted MRI scan. Fluid signal intensity.

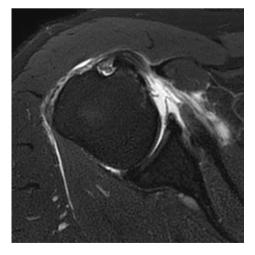


Fig. 10. Oblique sagittal and axial fat-suppressed PD-weighted MRI scan. Subscapularis full-thickness tear. Provided by the authors.



alongside tears in the supraspinatus and tears [37]. The integrity of these muscles is best assessed using oblique sagittal fat-suppressed T2-weighted images [38].

- Fatty infiltration of rotator cuff muscles

Fatty infiltration is characterized by a reduction in the elasticity of the torn rotator cuff, resulting from lipid deposition in the muscle tissue of chronic tears [39]. Therefore, fatty infiltration in the rotator cuff muscles independently influences surgical outcome [40]. The severity of this condition can be classified based on the muscle signal observed in sagittal oblique T1-weighted MRI scans (Table 1; Fig. 11) [41,42].

Table 1. Goutallier classification

Grade	Muscle description
0	Normal
I	Some fatty streaks
II	Amount of muscle is greater than fatty infiltration
III	Amount of muscle is equal to fatty infiltration
IV	Amount of fatty infiltration is greater than muscle

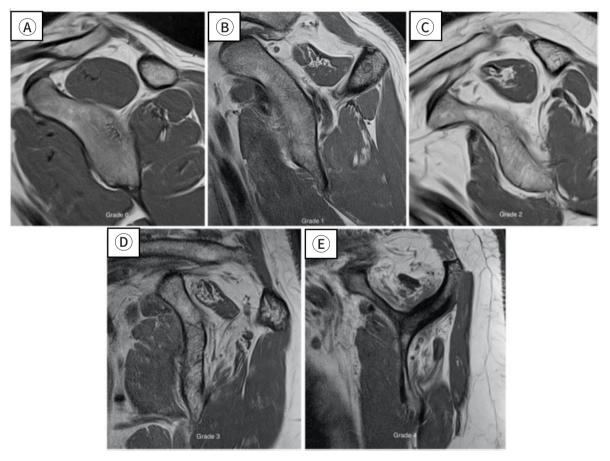


Fig. 11. Fatty infiltration. Normal (A), grade I (B), grade II (C), grade III (D), grade IV (E). Adapted from Yubran et al. [42] with CC-BY.



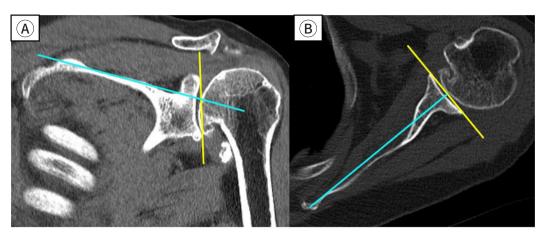


Fig. 12. CT: glenoid inclination (A), glenoid version (B). Provided by the authors.

Osteoarthritis of the glenohumeral joint

Plain radiography

Plain radiography is often the initial imaging modality used, incorporating anteroposterior (internal rotation), true anteroposterior (Grashey external rotation), outlet, and axillary views. These views are essential for assessing joint space narrowing, osteophytes, subchondral cysts, subchondral bone irregularities, glenoid bone stock, and glenoid version [10].

CT

Evaluating the precise bone stock of the glenoid—including bone loss, version, and inclination—is challenging with plain radiography due to overlapping structures. Therefore, CT is utilized for preoperative planning of arthroplasty (Fig. 12) [43].

Conclusion

To accurately diagnose and manage shoulder diseases in older adults, it is crucial to evaluate the unique radiological features of each condition. This evaluation guides the appropriate course of treatment, ranging from conservative approaches to surgical interventions. Advanced diagnostic modalities, including MRI (or MRA), known for their high sensitivity and specificity, are essential. Additionally, ultrasonography is pivotal in identifying the radiological characteristics specific to shoulder diseases in this patient group. Understanding the key findings in each case of shoulder disease is vital for effective diagnosis and management.

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Not applicable.

References -

- 1. Davis DL. Shoulder dysfunction and mobility limitation in aging. *Adv Geriatr Med Res* 2023;5(3):e230008.
 - https://doi.org/10.20900/agmr20230008
- 2. Davis DL, Sun K, Simonsick EM. Association of shoulder dysfunction with mobility limitation among older adults in the Baltimore longitudinal study of aging. *Gerontol Geriatr Med* 2023;9:23337214231179843.
 - https://doi.org/10.1177/23337214231179843
- 3. Sözlü U, Başar S, Kanatlı U. Scapular muscle endurance, shoulder pain, and functionality in patients with rotator-cuff-related shoulder pain: a matched, case-control study. *Clin Shoulder Elb* 2024;27(1):52-58.
 - https://doi.org/10.5397/cise.2023.00675
- 4. Ko SH, Na SC, Kim MS. Risk factors of tear progression in symptomatic small to medium-sized full-thickness rotator cuff tear: relationship between occupation ratio of supraspinatus and work level. *J Shoulder Elbow Surg* 2023;32(3):565-572.
 - https://doi.org/10.1016/j.jse.2022.09.012
- 5. Picasso R, Pistoia F, Zaottini F, Marcenaro G, Miguel-Pérez M, Tagliafico AS, et al. Adhesive capsulitis of the shoulder: current concepts on the diagnostic work-up and evidence-based protocol for radiological evaluation. *Diagnostics* 2023;13(22):3410.
 - https://doi.org/10.3390/diagnostics13223410
- 6. Stanborough RO, Bestic JM, Peterson JJ. Shoulder osteoarthritis. *Radiol Clin North Am* 2022;60(4):593-603.
 - https://doi.org/10.1016/j.rcl.2022.03.003
- 7. Daher M, Lopez R, Covarrubias O, Boufadel P, Fares MY, Abboud JA. Sleep disturbances in rotator cuff pathology: insights into mechanisms and clinical implications. *Clin Shoulder Elb* 2024;27(4):514-518.



- https://doi.org/10.5397/cise.2024.00010
- MacConnell AE, Davis W, Burr R, Schneider A, Dugas LR, Joyce C, et al. An objective assessment of the impact of tendon retraction on sleep efficiency in patients with fullthickness rotator cuff tears: a prospective cohort study. *Clin Shoulder Elb* 2023;26(2):169-174.
 - https://doi.org/10.5397/cise.2022.01438
- Papalexis N, Parmeggiani A, Facchini G, Miceli M, Carbone G, Cavallo M, et al. Current concepts in the diagnosis and treatment of adhesive capsulitis: role of diagnostic imaging and ultrasound-guided interventional procedures. *Radiol Med* 2022;127(12):1390-1399. https://doi.org/10.1007/s11547-022-01566-6
- Silva FD, Ramachandran S, Chhabra A. Glenohumeral osteoarthritis: what the surgeon needs from the radiologist. *Skeletal Radiol* 2023;52(11):2283-2296. https://doi.org/10.1007/s00256-022-04206-2
- Zappia M, Di Pietto F, Aliprandi A, Pozza S, De Petro P, Muda A, et al. Multi-modal imaging of adhesive capsulitis of the shoulder. *Insights Imaging* 2016;7(3):365-371. https://doi.org/10.1007/s13244-016-0491-8
- 12. Fields BKK, Skalski MR, Patel DB, White EA, Tomasian A, Gross JS, et al. Adhesive capsulitis: review of imaging findings, pathophysiology, clinical presentation, and treatment options. *Skeletal Radiol* 2019;48(8):1171-1184.
 - https://doi.org/10.1007/s00256-018-3139-6
- 13. Al Khayyat SG, Falsetti P, Conticini E, Frediani B, Galletti S, Stella SM. Adhesive capsulitis and ultrasound diagnosis, an inseparable pair: a novel review. *J Ultrasound* 2023;26(2):369-384. https://doi.org/10.1007/s40477-022-00725-9
- 14. Wu H, Tian H, Dong F, Liang W, Song D, Zeng J, et al. The role of grey-scale ultrasound in the diagnosis of adhesive capsulitis of the shoulder: a systematic review and meta-analysis. *Med Ultrason* 2020;22(3):305-312.
 - https://doi.org/10.11152/mu-2430
- 15. Tandon A, Dewan S, Bhatt S, Jain AK, Kumari R. Sonography in diagnosis of adhesive capsulitis of the shoulder: a case–control study. *J Ultrasound* 2017;20(3):227-236. https://doi.org/10.1007/s40477-017-0262-5
- Michelin P, Delarue Y, Duparc F, Dacher JN. Thickening of the inferior glenohumeral capsule: an ultrasound sign for shoulder capsular contracture. *Eur Radiol* 2013;23(10):2802-2806. https://doi.org/10.1007/s00330-013-2874-2
- 17. Tue G, Masuzzo O, Tucci F, Cavallo M, Parmeggiani A, Vita F, et al. Can secondary adhesive capsulitis complicate calcific tendinitis of the rotator cuff? An ultrasound imaging analysis. *Clin Pract* 2024;14(2):579-589.
 - https://doi.org/10.3390/clinpract14020045
- Walmsley S, Osmotherly PG, Walker CJ, Rivett DA. Power Doppler ultrasonography in the early diagnosis of primary/idiopathic adhesive capsulitis: an exploratory study. *J Manip Physiol Ther* 2013;36(7):428-435. https://doi.org/10.1016/j.jmpt.2013.05.024
- 19. Suh CH, Yun SJ, Jin W, Lee SH, Park SY, Park JS, et al. Systematic review and meta-analysis of magnetic resonance imaging features for diagnosis of adhesive capsulitis of the shoulder. *Eur Radiol* 2019;29(2):566-577.
 - https://doi.org/10.1007/s00330-018-5604-y
- 20. Mengiardi B, Pfirrmann CWA, Gerber C, Hodler J, Zanetti M. Frozen shoulder: MR



- arthrographic findings. *Radiology* 2004;233(2):486-492. https://doi.org/10.1148/radiol.2332031219
- 21. Dupont T, Idir MA, Hossu G, Sirveaux F, Gillet R, Blum A, et al. MR imaging signs of shoulder adhesive capsulitis: analysis of potential differentials and improved diagnostic criteria. *Skeletal Radiol* 2026;54(1):77-86.
 - https://doi.org/10.1007/s00256-024-04677-5
- 22. Song KD, Kwon JW, Yoon YC, Choi SH. Indirect MR arthrographic findings of adhesive capsulitis. *AJR Am J Roentgenol* 2011;197(6):W1105-W1109. https://doi.org/10.2214/AJR.10.6099
- 23. Chang EY, Chung CB. Current concepts on imaging diagnosis of rotator cuff disease. *Semin Musculoskelet Radiol* 2014;18(04):412-424. https://doi.org/10.1055/s-0034-1384830
- 24. Pierce J, Anderson M. Update on diagnostic imaging of the rotator cuff. *Clin Sports Med* 2023;42(1):25-52.
 - https://doi.org/10.1016/j.csm.2022.08.009
- 25. Gazzola S, Bleakney RR. Current imaging of the rotator cuff. *Sports Med Arthrosc Rev* 2011;19(3):300-309.
 - https://doi.org/10.1097/JSA.0b013e3182189468
- Zheng F, Wang H, Gong H, Fan H, Zhang K, Du L. Role of ultrasound in the detection of rotator-cuff syndrome: an observational study. *Med Sci Monit* 2019;25:5856-5863. https://doi.org/10.12659/MSM.915547
- 27. Rutten MJCM, Jager GJ, Blickman JG. From the RSNA refresher courses: US of the rotator cuff: pitfalls, limitations, and artifacts. *Radiographics* 2006;26(2):589-604. https://doi.org/10.1148/rg.262045719
- 28. Magee T. 3-T MRI of the shoulder: is MR arthrography necessary? *AJR Am J Roentgenol* 2009;192(1):86-92.
 - https://doi.org/10.2214/AJR.08.1097
- 29. Sein ML, Walton J, Linklater J, Harris C, Dugal T, Appleyard R, et al. Reliability of MRI assessment of supraspinatus tendinopathy. *Br J Sports Med* 2007;41(8):e9. https://doi.org/10.1136/bjsm.2006.034421
- 30. Tuite MJ. Magnetic resonance imaging of rotator cuff disease and external impingement. *Magn Reson Imaging Clin N Am* 2012;20(2):187-200. https://doi.org/10.1016/j.mric.2012.01.011
- 31. Rafii M, Firooznia H, Sherman O, Minkoff J, Weinreb J, Golimbu C, et al. Rotator cuff lesions: signal patterns at MR imaging. *Radiology* 1990;177(3):817-823. https://doi.org/10.1148/radiology.177.3.2243995
- 32. Adams CR, Schoolfield JD, Burkhart SS. Accuracy of preoperative magnetic resonance imaging in predicting a subscapularis tendon tear based on arthroscopy. *Arthroscopy* 2010;26(11):1427-1433.
 - https://doi.org/10.1016/j.arthro.2010.02.028
- 33. Kim SC, Yoo SJ, Jo JH, Lee JH, Baek E, Lee SM, et al. The impact of supraspinatus tear on subscapularis muscle atrophy and fatty infiltration. *Clin Shoulder Elb* 2024;27(4):437-446. https://doi.org/10.5397/cise.2024.00521
- 34. Yoon JP. Subscapularis tendon tear involving the first facet. *Clin Shoulder Elb* 2022;25(2):91-92.
 - https://doi.org/10.5397/cise.2022.01032



- 35. Wolff AB, Sethi P, Sutton KM, Covey AS, Magit DP, Medvecky M. Partial-thickness rotator cuff tears. *J Am Acad Orthop Surg* 2006;14(13):715-725. https://doi.org/10.5435/00124635-200612000-00003
- 36. Lee KY, Kim SH, Oh JH. Isolated ruptures of the infraspinatus: clinical characteristics and outcomes. *Clin Shoulder Elb* 2017;20(1):30-36. https://doi.org/10.5397/cise.2017.20.1.30
- 37. Melis B, DeFranco MJ, Lädermann A, Barthelemy R, Walch G. The teres minor muscle in rotator cuff tendon tears. *Skeletal Radiol* 2011;40(10):1335-1344. https://doi.org/10.1007/s00256-011-1178-3
- 38. McCrum E. MR imaging of the rotator cuff. *Magn Reson Imaging Clin N Am* 2020;28(2):165-179.
 - https://doi.org/10.1016/j.mric.2019.12.002
- 39. Mellado JM, Calmet J, Olona M, Esteve C, Camins A, Pérez del Palomar L, et al. Surgically repaired massive rotator cuff tears: MRI of tendon integrity, muscle fatty degeneration, and muscle atrophy correlated with intraoperative and clinical findings. *AJR Am J Roentgenol* 2005;184(5):1456-1463.
 - https://doi.org/10.2214/ajr.184.5.01841456
- 40. Kuzel BR, Grindel S, Papandrea R, Ziegler D. Fatty infiltration and rotator cuff atrophy. *J Am Acad Orthop Surg* 2013;21(10):613-623. https://doi.org/10.5435/JAAOS-21-10-613
- 41. Fuchs B, Weishaupt D, Zanetti M, Hodler J, Gerber C. Fatty degeneration of the muscles of the rotator cuff: assessment by computed tomography versus magnetic resonance imaging. *J Shoulder Elbow Surg* 1999;8(6):599-605.
 - https://doi.org/10.1016/S1058-2746(99)90097-6
- 42. Yubran AP, Pesquera LC, Juan ELS, Saralegui FI, Canga AC, Camara AC, et al. Rotator cuff tear patterns: MRI appearance and its surgical relevance. *Insights Imaging* 2024;15(1):61. https://doi.org/10.1186/s13244-024-01607-w
- 43. Walch G, Moraga C, Young A, Castellanos-Rosas J. Results of anatomic nonconstrained prosthesis in primary osteoarthritis with biconcave glenoid. *J Shoulder Elbow Surg* 2012;21(11):1526-1533.
 - https://doi.org/10.1016/j.jse.2011.11.030

Review



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Conservative treatment of older adult patients with shoulder diseases: a narrative review

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Keywords

Aged; Osteoarthritis; Physical examination; Rotator cuff injuries; Shoulder joint



The purpose of this review is to provide a comprehensive quide for managing older adult patients with shoulder diseases, specifically rotator cuff tears and osteoarthritis, and to explore effective nonsurgical treatment options. Chronic rotator cuff tears are typically degenerative, whereas acute tears result from trauma. A key feature of these tears is tendon degeneration accompanied by type Ill collagen predominance, predisposing tears to progression. Osteoarthritis in the glenohumeral joint arises from wear-and-tear changes that compromise cartilage integrity, leading to pain and restricted motion. Accurate clinical assessment and imaging, including plain radiographs, ultrasonography, and MRI, facilitate diagnosis and guide treatment. The physic-al examination emphasizes range of motion, rotator cuff strength, and scapular stability. Management strategies prioritize pain relief, function preservation, and improving mobility. Nonsurgical modalities, including exercise, manual therapy, and activity modification, constitute first-line treatments, especially for older adults. Pharmacological approaches involve NSAIDs, corticosteroid injections, and neuropathic pain medications. Steroid injections have short-term benefits, but repeated treatments may compromise tissue integrity. Platelet-rich plasma is a regenerative option that may improve tendon healing, but mixed findings highlight the need for further investigation. A structured physical therapy program focusing on range of motion and strengthening is essential, with alternative interventions used judiciously. Patients should be counseled regarding the potential progression of tears and the possible need for future surgical intervention if nonsurgical methods are unsuccessful. Multimodal approaches, including joint mobilization and personalized exercise regimens, hold potential for optimizing functional outcomes and supporting independence in older adults.

Introduction

Background

Shoulder pain is a prevalent issue among older adults, affecting approximately 25% to 30% of this population and leading to significant symptoms and disability [1]. This condition imposes a considerable burden on both function and quality of life, yet it is frequently overlooked and, as a result, undertreated [1]. Emphasizing treatment is crucial, particularly for older adults with persistent shoulder pain, as maintaining independence is a key concern. The loss of function in the dominant upper limb can severely impact daily activities such as grooming, cooking, and driving. Moreover,

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shoulder pain or muscle weakness around the shoulder can complicate the use of assistive devices like walkers [2,3]. Thus, it is vital to implement effective treatment strategies to minimize pain and preserve or restore function as much as possible. However, in older adults, shoulder pain and the disabilities it causes are often dismissed as inevitable aspects of aging or are seen as issues that must be endured, leading to inadequate treatment [3]. Neither older age nor the presence of comorbidities should deter the pursuit of active treatment and rehabilitation.

Objectives

This article provides a guide for approaching older adult patients with shoulder diseases, specifically focusing on rotator cuff tears (RCTs) and osteoarthritis, and explores effective nonsurgical treatment options.

Ethics statement -

As this study is a literature review, it did not require institutional review board approval or individual consent.

Rotator cuff injury

Anatomy

The rotator cuff comprises four muscle-tendon structures: the supraspinatus, infraspinatus, subscapularis, and teres minor. The supraspinatus and infraspinatus originate from their respective fossae on the posterior surface of the scapula and insert into the greater tuberosity of the proximal humerus. The supraspinatus, forming the superior aspect of the cuff, is primarily responsible for initiating abduction at the glenohumeral joint (GHJ). In contrast, the infraspinatus, along with the teres minor, facilitates external rotation of the GHJ [4,5]. The subscapularis, the largest of the cuff muscles, is tasked with internal rotation of the GHJ [4]. It originates from the anterior surface of the scapula and inserts into the lesser tuberosity of the humerus. The teres minor, arising from the middle third of the lateral border of the scapula, also inserts into the greater tuberosity, aiding in external rotation [5].

Etiology

RCTs can be categorized as acute or chronic, and as partial or full thickness. Acute RCTs typically occur in younger patients due to traumatic events such as falls or dislocations. In contrast, chronic RCTs develop in older adults and result from age-related degenerative processes. This article focuses on chronic RCTs.

The pathogenesis of RCTs in older adults is complex and multifactorial, involving degenerative processes associated with aging, impingement, and trauma. During tendon degeneration, there is a significant shift in collagen composition, notably an increase in type III collagen. This type of collagen forms thin, reticular fibers that are more susceptible to lesions, especially when compared to the sturdier type I collagen [6,7]. The degree of tendon degeneration can vary widely depending on the location of degradation and the condition of the tendon, with the supraspinatus tendon typically showing more pronounced degeneration. Tendon degeneration is a physiological process that occurs with aging and is closely linked to the individual's age [7,8]. Additionally, increasing age is associated with higher rates of retears [9].

Typically, RCTs begin as partial-thickness tears and gradually expand due to both intrinsic



and extrinsic factors, eventually resulting in a complete tear. The fibers that are initially torn are unable to contribute to load distribution, causing the remaining fibers to further propagate the tear. This process is particularly pronounced in older adults, as the tendon quality is already compromised [10]. As the force required to move the arm increases, it exacerbates the tear, thereby compromising joint biomechanics. A full-thickness tear can cause significant chronic pathological changes, including muscle atrophy, fatty infiltration, and scapular contracture, which may lead to GHJ osteoarthritis [11].

Physical examination

The patient should initially be dressed in a gown that exposes the entire back and shoulder girdle for evaluation. All physical examination maneuvers must be compared with the opposite extremity. The physician should conduct a comprehensive shoulder examination, starting with a general inspection of the patient in a resting position to check for any signs of muscle wasting. Palpation should cover the entire shoulder girdle to identify any tender areas. Rotator cuff injuries frequently manifest as tenderness at Codman's point, which is identified by rotating the proximal end of the humerus beneath the examiner's finger at the anterior corner of the acromion [12].

Both active and passive shoulder range of motion should be assessed. Forward elevation is evaluated by observing the patient from the side; it is measured as the angle between the axis of the scapula and a line extending from the shoulder to the elbow. External rotation is assessed with the elbow close to the side, rotating the forearm laterally. Internal rotation is measured by having the patient reach up their back, noting the highest spinal segments reached (Fig. 1). Both external and internal rotations can also be measured with the arm abducted to 90 degrees. Abduction is tested in the scapular plane, and it is possible to isolate glenohumeral motion from scapulothoracic motion by stabilizing the scapula. In patients suspected of having a supraspinatus tear, forward shoulder elevation may be weak. In cases of larger posterior superior tears involving both the infraspinatus and supraspinatus muscles, external rotation and forward elevation are typically weak. In the case of anterior or subscapularis tears, internal rotation may be compromised.



Fig. 1. The active range of motion is assessed by forward elevation (A), external rotation with the elbow at the side of the body (B), and the internal rotation angle is usually assessed by the height of the vertebral body (yellow line) from behind (C). Provided by the authors after consent of the examinee.



Radiological imaging

Initial evaluation of a patient with shoulder pain and dysfunction should always include a complete set of plain radiographs of the shoulder. These are essential for assessing potential causes of pain and for evaluating conditions such as osteoarthritis, superior migration of the humeral head, avascular necrosis, osteoporosis, or tumors (Fig. 2). A supraspinatus outlet view may be particularly useful for visualizing bony structures involved in scapulohumeral motions, such as bony spurs or ligamentous calcifications that could impinge on the underlying rotator cuff. An axillary view is beneficial for ruling out shoulder dislocation in cases of trauma. The rotator cuff can be examined using ultrasonography (US) or MRI. US is cost-effective and allows for real-time examination of the shoulder joint by the physician. It can determine the size and location of tears, although the results are highly subjective and depend on the operator [10]. A study found that preoperative US identified mixed hyperechoic and hypoechoic foci in the supraspinatus tendon with a sensitivity of 93%, a specificity of 94%, a positive predictive value of 82%, and a negative predictive value of 98%. MRI is considered the gold standard for imaging the rotator cuff tendons [13]. It provides a comprehensive assessment of the entire rotator cuff musculotendinous unit (Fig. 3). The presence of muscle atrophy and fatty infiltration can indicate the chronicity of tears, aiding in treatment decisions. Another study showed that MRI and US have similar diagnostic accuracy for detecting full-thickness RCTs. However, it noted that US had lower sensitivity than MRI in evaluating partial-thickness tears [14]. A diagnosis of partialthickness tears is made when there is no evidence of tendon discontinuity on T1-weighted images, and MRI shows an increased signal in the rotator cuff. A partial-thickness RCT appears as an increased signal on T2-weighted images with a focal defect that is either intra-tendinous or limited to one surface and does not extend through the entire tendon. Rotator cuff tendinitis may cause increased rotator cuff signal and reduced anatomical definition on T1-weighted and proton density images, similar to the appearance of partial-thickness RCT. However, tendinitis is differentiated from partial-thickness RCT by the presence of only moderate or decreased signal on T2-weighted images [15].

Treatment

The goal of treatment is to restore normal shoulder function and biomechanics and to



Fig. 2. The presence of osteophytes on the greater tuberosity and acromion of the humerus indicates that there is a high possibility of a rotator cuff tear. Provided by the authors.



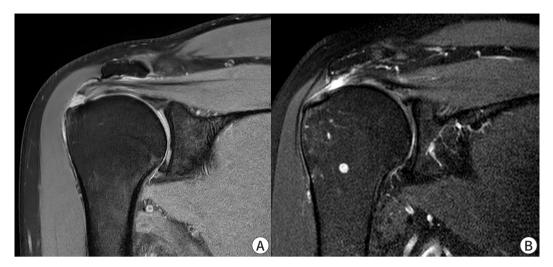


Fig. 3. Magnetic resonance images show a partial tear of the supraspinatus tendon (A), and a complete tear of the supraspinatus tendon (B). Provided by the authors.

improve functional ability. The success of nonsurgical treatment for RCTs often depends on the size of the tear and the patient's level of activity. Generally, the more active the patient and the larger the tear, the greater the likelihood that surgical intervention will be necessary [16]. In cases of acute RCTs, it is important to initially administer short-term anti-inflammatory medications, coupled with a few days of relative rest and activity modification. Additionally, light exercise during this period is essential to maintain joint range and prevent adhesions. Once the inflammation has subsided and the pain is somewhat managed, it is important to promptly start an exercise program. This program should focus on strengthening the muscles of the internal and external rotators, as well as those around the scapula, and should be implemented swiftly. Such exercise programs can positively impact clinical outcomes, even if surgery becomes necessary later [16]. Patients opting for nonsurgical treatment should be informed that while this approach may alleviate symptoms and enhance function, it does not repair the tear [6]. It is also important to convey that tears initially deemed reparable may become irreparable over time. Furthermore, the outcomes of surgery following unsuccessful non-operative treatment may be less favorable than those of primary repair [10].

Exercise and manual therapy

Exercise and manual therapy guided by a physical therapist represent the most commonly chosen initial treatment for older adult patients with RCTs [17]. A well-structured physical therapy regimen should include re-education of muscle recruitment, scapular stabilization, coordination of muscle contractions, and enhancement of proprioception [10]. Once inflammation and pain have subsided, a specialized physical therapy program should be initiated, aimed at eliminating capsular contracture and restoring full range of motion. As range of motion improves, the focus should shift to strengthening the rotator cuff and periscapular musculature. The role of the rotator cuff in dynamically stabilizing the shoulder joint is maximized through progressive resistive exercises using elastic bands or free weights. Numerous studies have reported that exercise protocols effectively provide pain relief and satisfaction for the majority of older adult patients with RCTs [18-20]. However, functional outcomes may be superior with surgical repair in cases of smaller tears that are amenable to surgery [20].



Corticosteroid injections

Corticosteroid injections are commonly utilized to treat tendon pathology due to their potent anti-inflammatory properties. Numerous studies have suggested that these injections can enhance pain scores and functional outcomes [21,22]. However, caution is advised when using these injections repeatedly, as they may compromise the internal structural integrity of the tendon. A systematic review indicated that subacromial corticosteroid injections provide only short-term pain relief and are ineffective in the comprehensive management of RCTs [23]. Another systematic review on the use of corticosteroid injections for RCTs concluded that corticosteroid injections are not efficacious [24]. Although no studies have specifically targeted the older adult population, a prospective randomized study involving patients with a mean age of 62 years found that 62.5% of those who received steroid injections were dissatisfied and ultimately opted for surgery. Consequently, the evidence supporting the use of corticosteroids in managing RCTs is limited, suggesting their role may be confined to shortterm pain management. Additionally, corticosteroid injections are associated with risks such as joint infection, tendon weakening, localized bruising, and a mild increase in blood sugar levels. Therefore, corticosteroid injections may be considered as a treatment option to alleviate pain, thereby facilitating physiotherapy.

Platelet-rich plasma injections

Platelet-rich plasma (PRP) is an autologous blood product that contains platelets in supraphysiological concentrations, which can activate various growth factors involved in tissue repair processes [25]. It possesses anti-nociceptive, anti-inflammatory, and regenerative properties [26]. Additionally, in vitro studies of tenocytes from degenerative RCTs have demonstrated that PRP increases cell proliferation and extracellular matrix synthesis [27,28]. However, clinical studies on PRP injections for RCTs have yielded mixed results. A systematic review reported that PRP injections were associated with better pain relief and functional outcomes compared to control interventions [29]. Two studies have explored the effects of PRP on healing after surgical repair in RCTs, but they have not conclusively shown clear clinical benefits [30,31]. Prospective randomized clinical trials comparing PRP to saline injections have indicated that PRP was no more effective than a placebo in improving quality of life, pain, disability, and shoulder range of motion. In contrast, another randomized prospective study found that PRP yielded superior results in terms of pain, function, and range of motion compared to dry needling [32]. A systematic review highlighted that the evidence regarding the optimal site for PRP injection in partial thickness RCTs remains unclear. PRP has shown improvements in functional outcomes for patients with partial thickness RCTs, regardless of the injection site. However, further research is necessary to determine the optimal concentration, injection frequency, and candidate selection for PRP therapy [33].

Osteoarthritis -

Anatomy and etiology

The GHJ is structurally a ball-and-socket joint and functionally considered a diarthrodial, multiaxial joint. The glenohumeral articulation involves the humeral head and the glenoid cavity of the scapula, representing the primary articulation of the shoulder girdle. Normally, the articular surfaces of the GHJ are concentric, smooth, and securely bonded to the underlying bone. However, if the glenoid concavity is compromised, stabilization of the humeral head is



lost. In an arthritic GHJ, the smooth, concentric joint surfaces deteriorate due to damage to the articular cartilage and the underlying bone. A review article noted that in cases of osteoarthritis, alenoid retroversion increased from 8° to 11° [34]. Degenerative joint disease, a common form of glenohumeral arthritis, occurs when the articular cartilage deteriorates due to heavy use, cumulative minor traumatic episodes, underlying structural defects in the joint, anomalies in cartilage composition, or a combination of these factors. Osteoarthritis, the most prevalent joint disease, is a non-inflammatory condition characterized by the weakening and deformation of joint cartilage, leading to abnormal bone formation on and around the joint surface. Osteoarthritis represents both a mechanical and biological phenomenon that arises when the normal processes of degeneration and formation of articular cartilage and subchondral bone fail. Although the causes are varied, it ultimately impacts all tissues of the movable joint, leading to joint dysfunction [35]. The majority of osteoarthritis cases in the GHJ are linked to non-specific factors, primarily advancing age, while specific risk factors are more commonly observed in younger patients [35].

Physical examination

The diagnosis of shoulder osteoarthritis is based on a combination of specific symptoms, physical examination findings, and radiographic evidence of changes to the bone. The most common initial symptom is a progressive, activity-related pain that is deep within the joint and often localized to the posterior aspect. As the condition worsens, patients frequently experience pain at night. For many, this pain is also present at rest and disrupts sleep [36]. The examination process starts by identifying which movements the patient finds most problematic. Understanding these limitations helps in determining potential treatment options. The evaluation then proceeds with a thorough assessment of shoulder mobility. This includes testing forward elevation, abduction, external rotation, external rotation in abduction, internal rotation, internal rotation in abduction, and cross-body adduction. These tests evaluate the range of motion of the humerus relative to the thorax. For a more detailed assessment of glenohumeral motion, the examiner can stabilize the scapula with one hand while using the other to assess flexion, extension, and internal and external rotation of the humerus relative to the scapula. Demonstrating the difference in motion between the affected shoulder and the contralateral, normal or less affected shoulder can be informative for both the patient and family members.

Muscle strength in the shoulder girdle muscles is assessed using manual muscle testing [37]. However, this method is subject to inter-observer variability. Hand-held dynamometers provide clinicians with a valuable tool for quantitatively assessing muscle strength and validating the effects of interventions. Previous studies have introduced reliable clinical assessment methods for scapular motion, which are categorized into visual observation and objective assessment. Changes in scapular position and motion patterns are referred to as "scapular dyskinesis" [38]. The current guideline for assessing scapular dyskinesis clinically is to employ the dynamic scapular dyskinesis test [38]. Objective assessments of scapular position and motion utilize a digital inclinometer. To evaluate scapular upward rotation, the angle of inclination measured along the scapular spine with the digital inclinometer is recorded.

Radiological imaging

Shoulder imaging is crucial for confirming diagnoses, assessing the severity of pathological changes, aiding in surgical planning, and enhancing patient comprehension of their condition. Standard plain films are vital for evaluating patients with shoulder arthritis. Employing proper radiographic techniques is essential to capture the necessary images for effective treatment



planning (Fig. 4).

The first image is an anteroposterior view captured with the X-ray beam directed through the GHJ in the scapular plane. This perspective reveals the superior-inferior positioning of the scapula, the presence of osteophytes on the scapular head and scapula, joint space narrowing, the extent of medial displacement of the humerus relative to the lateral acromion line, the condition of the humerus and scapula, the presence of loose bodies, and any collapse or deformity of the humeral head [39].

The second image is an axillary view captured with the arm functionally elevated in the scapular plane, oriented to display both the scapular notch and the scapular neck. This perspective offers a distinct visualization of the humeral anatomy, the quantity of glenoid bone, the shape of the glenoid, its version relative to the scapular plane, and the relationship between the humeral head and the glenoid.

Standardized anteroposterior and axillary views provide detailed insights into the thickness of the cartilaginous space between the humeral head and the glenoid, the relative positioning of the humeral head in relation to the glenoid, the presence of osteophytes, the degree of osteopenia, and the extent of bone deformities and erosions [39,40].

CT scans may be helpful for patients considering surgery, as they can provide a greater understanding of scapular, glenoid, and humeral anatomy and factors that may influence implant selection and placement.

Laboratory test

Laboratory tests of blood or joint fluid are not always required for evaluating an arthritic shoulder, except in two cases: when inflammatory or septic arthritis is suspected. In such instances, tests like rheumatoid factor, anti-cyclic citrullinated peptide antibody, C-reactive protein, and erythrocyte sedimentation rate may be useful [41].

Treatment

Activity modification

Most patients with shoulder osteoarthritis wish to maintain their daily, work, and recreational



Fig. 4. Anteroposterior and axillary-lateral plain X-ray images of osteoarthritis of the shoulder joint show narrowing of the joint space and formation of osteophytes. Provided by the authors.



activities. However, continued full participation in these activities may exacerbate their arthritis symptoms. Typically, jobs that require pushing heavy loads or applying shock loads, as well as certain recreational activities, can accelerate the progression of the disease and its symptoms. Making modifications in occupational and recreational activities can alleviate symptoms and extend the lifespan of the natural joint. Occupational therapy can facilitate workplace adjustments and may also recommend adaptive changes at home. Modifying sports activities can prove beneficial as well. Another crucial element of nonsurgical management involves optimizing the patient's overall health through regular aerobic exercise.

Exercise and manual therapy

Shoulder osteoarthritis is commonly linked to joint contracture and stiffness due to adhesions involving the GHJ capsule, rotator cuff muscles, and the non-articular humeroscapular motion interface. Disuse or tendon rupture can lead to weakness in the deltoid and cuff muscles. However, shoulder function can often be enhanced through a gentle range of motion and strengthening exercise program [42]. The exercise program starts with active shoulder range of motion exercises performed within a pain-free range. As pain decreases, passive shoulder range of motion exercises are introduced. Joint mobilization is a therapeutic technique used to enhance joint function and accessory motion, which can lead to pain relief and increased range of motion. Combining a structured exercise program with joint mobilization has proven effective in reducing pain and improving function in patients with various shoulder disorders [43]. Muscle strengthening begins with low-intensity resistance training using elastic bands for movements such as external and internal rotation, abduction, and forward flexion. This is complemented by modified push-ups against a wall to introduce gentle load-bearing. In more advanced phases, the program includes isometric exercises, where static pressure is applied against an immovable object to build stability, and light weightlifting to mimic functional tasks like overhead reaching. These exercises are carefully monitored to ensure they remain pain-free and are adjusted according to individual tolerance, thereby facilitating gradual improvements in strength, range of motion, and overall shoulder function.

NSAIDs

NSAIDs, such as ibuprofen, naproxen, and celecoxib, are widely used to relieve pain and reduce inflammation in arthritis. These drugs inhibit cyclooxygenase (COX) enzymes, thereby decreasing the production of prostaglandins that are responsible for mediating inflammation and pain. In osteoarthritis, NSAIDs have shown greater pain reduction compared to acetaminophen [44]. Selective COX-2 inhibitors, such as celecoxib, are associated with fewer gastrointestinal side effects than non-selective NSAIDs. In addition to oral administration, topical NSAIDs are frequently used in treatment regimens. Due to their effective pain relief and anti-inflammatory properties, NSAIDs are recommended as the first-line therapy in the conservative management of shoulder osteoarthritis [45].

Corticosteroid injections

Intra-articular corticosteroid injections offer targeted relief for moderate to severe joint inflammation. Medications like triamcinolone or methylprednisolone are injected directly into the affected joint, providing strong anti-inflammatory effects. These injections are especially effective for acute flare-ups, quickly reducing swelling and pain. However, their repeated use can lead to complications such as cartilage damage, joint infection, or systemic side effects,



including hyperglycemia. Consequently, their use is more appropriate for short-term symptom management rather than long-term treatment [46,47]. One study suggested limiting the number of injections to a maximum of three to reduce the risk of infection and other adverse effects [48].

Neuropathic pain remedies

In cases where arthritis pain includes neuropathic components, medications such as gabapentin or pregabalin can be effective. These drugs function by modulating calcium channel activity within the nervous system, which reduces the transmission of pain signals. They are particularly beneficial in scenarios where conventional pain relievers are inadequate for managing nerve-related pain. However, common side effects such as dizziness, fatigue, and weight gain necessitate careful dose adjustments to minimize adverse effects, particularly in older adult patients.

Platelet-rich plasma injections

PRP therapy involves drawing a patient's blood, concentrating the platelets, and then injecting the plasma into the affected joint to encourage healing and tissue regeneration. Platelets release growth factors that can reduce inflammation and stimulate the repair of cartilage. PRP is recognized as a regenerative treatment option and has demonstrated the potential to enhance symptoms and functionality in cases of osteoarthritis [49]. However, one study indicated that serious complications, such as infections and inflammatory reactions necessitating multiple surgical interventions, can arise following biologic injection therapy [50].

Conclusion

Shoulder pain in older adults often results from chronic degenerative RCTs or osteoarthritis, which can lead to functional impairment and a reduced quality of life. Early detection through comprehensive physical examinations and imaging is crucial for effective management. Nonsurgical approaches such as physical therapy, activity modification, pharmacotherapy, and innovative treatments like PRP can help alleviate pain, maintain mobility, and possibly postpone the need for surgery. However, each treatment option has its own advantages and drawbacks. Developing tailored, individualized treatment plans is critical for ensuring safer outcomes, especially considering the unique comorbidities present in older populations. Ultimately, timely, evidence-based care is key to preserving independence and enhancing overall well-being in the daily lives of older adults.

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References -

- Burner T, Abbott D, Huber K, Stout M, Fleming R, Wessel B, et al. Shoulder symptoms and function in geriatric patients. *J Geriatr Phys Ther* 2014;37(4):154-158. https://doi.org/10.1519/JPT.0b013e3182abe7d6
- 2. Kukkonen J, Ryösä A, Joukainen A, Lehtinen J, Kauko T, Mattila K, et al. Operative versus conservative treatment of small, nontraumatic supraspinatus tears in patients older than 55 years: over 5-year follow-up of a randomized controlled trial. *J Shoulder Elbow Surg* 2021;30(11):2455-2464.
 - https://doi.org/10.1016/j.jse.2021.03.133
- 3. Meng C, Jiang B, Liu M, Kang F, Kong L, Zhang T, et al. Repair of rotator cuff tears in patients aged 75 years and older: does it make sense? A systematic review. *Front Public Health* 2022;10:1060700.
 - https://doi.org/10.3389/fpubh.2022.1060700
- 4. Pogorzelski J, DelVecchio BM, Hussain ZB, Fritz EM, Godin JA, Millett PJ. Superior capsule reconstruction for massive rotator cuff tears key considerations for rehabilitation. *Int J Sports Phys Ther* 2017;12(3):390-401.
- 5. Radhakrishnan R, Goh J, Tan AHC. Partial-thickness rotator cuff tears: a review of current literature on evaluation and management. *Clin Shoulder Elb* 2024;27(1):79-87. https://doi.org/10.5397/cise.2022.01417
- Riley GP, Harrall RL, Constant CR, Chard MD, Cawston TE, Hazleman BL. Tendon degeneration and chronic shoulder pain: changes in the collagen composition of the human rotator cuff tendons in rotator cuff tendinitis. *Ann Rheum Dis* 1994;53(6):359-366. https://doi.org/10.1136/ard.53.6.359
- Gumina S, Kim H, Jung Y, Song HS. Rotator cuff degeneration and healing after rotator cuff repair. *Clin Shoulder Elb* 2023;26(3):323-329. https://doi.org/10.5397/cise.2023.00430
- Gumina S, Carbone S, Campagna V, Candela V, Sacchetti FM, Giannicola G. The impact of aging on rotator cuff tear size. *Musculoskelet Surg* 2013;97(Suppl 1):69-72. https://doi.org/10.1007/s12306-013-0263-2
- 9. Diebold G, Lam P, Walton J, Murrell GAC. Relationship between age and rotator cuff retear: a



- study of 1,600 consecutive rotator cuff repairs. *J Bone Joint Surg* 2017;99(14):1198-1205. https://doi.org/10.2106/JBJS.16.00770
- 10. Pill SG, Phillips J, Kissenberth MJ, Hawkins RJ. Decision making in massive rotator cuff tears. Instr Course Lect 2012;61:97-111.
- 11. Micallef J, Pandya J, Low AK. Management of rotator cuff tears in the elderly population. *Maturitas* 2019;123:9-14.
 - https://doi.org/10.1016/j.maturitas.2019.01.016
- Codman EA, Akerson IB. The pathology associated with rupture of the supraspinatus tendon. *Ann Surg* 1931;93(1):348-359. https://doi.org/10.1097/00000658-193101000-00043
- 13. Herrmann SJ, Izadpanah K, Südkamp NP, Strohm PC. Tears of the rotator cuff. Causes diagnosis treatment. *Acta Chir Orthop Traumatol Cech* 2014;81(4):256-266. https://doi.org/10.55095/achot2014/034
- 14. Lenza M, Buchbinder R, Takwoingi Y, Johnston RV, Hanchard NCA, Faloppa F. Magnetic resonance imaging, magnetic resonance arthrography and ultrasonography for assessing rotator cuff tears in people with shoulder pain for whom surgery is being considered. Cochrane Database Syst Rev 2013;2013(9):CD009020.
 - https://doi.org/10.1002/14651858.CD009020.pub2
- McConville OR, lannotti JP. Partial-thickness tears of the rotator cuff: evaluation and management. J Am Acad Orthop Surg 1999;7(1):32-43. https://doi.org/10.5435/00124635-199901000-00004
- Oh LS, Wolf BR, Hall MP, Levy BA, Marx RG. Indications for rotator cuff repair: a systematic review. *Clin Orthop Relat Res* 2007;455:52-63. https://doi.org/10.1097/BLO.0b013e31802fc175
- 17. Geary MB, Elfar JC. Rotator cuff tears in the elderly patients. *Geriatr Orthop Surg Rehabil* 2015;6(3):220-224.
 - https://doi.org/10.1177/2151458515583895
- Kuhn JE, Dunn WR, Sanders R, An Q, Baumgarten KM, Bishop JY, et al. Effectiveness of physical therapy in treating atraumatic full-thickness rotator cuff tears: a multicenter prospective cohort study. *J Shoulder Elbow Surg* 2013;22(10):1371-1379. https://doi.org/10.1016/j.jse.2013.01.026
- 19. Merolla G, Paladini P, Saporito M, Porcellini G. Conservative management of rotator cuff tears: literature review and proposal for a prognostic. Prediction score. *Muscles Ligaments Tendons J* 2011;1(1):12-19.
- 20. Moosmayer S, Lund G, Seljom U, Svege I, Hennig T, Tariq R, et al. Comparison between surgery and physiotherapy in the treatment of small and medium-sized tears of the rotator cuff: a randomised controlled study of 103 patients with one-year follow-up. *J Bone Joint Surg Br* 2010;92(1):83-91.
 - https://doi.org/10.1302/0301-620X.92B1.22609
- 21. Rajani AM, Shah UA, Mittal ARS, Gupta S, Garg R, Rajani AA, et al. Effects of glenohumeral corticosteroid injection on stiffness following arthroscopic rotator cuff repair: a prospective, multicentric, case-control study with 18-month follow-up. Clin Shoulder Elb 2023;26(1):64-70.
 - https://doi.org/10.5397/cise.2022.01256
- 22. Bokor DJ, Hawkins RJ, Huckell GH, Angelo RL, Schickendantz MS. Results of nonoperative management of full-thickness tears of the rotator cuff. *Clin Orthop Relat Res* 1993;294:103-



110.

- https://doi.org/10.1097/00003086-199309000-00013
- 23. Contreras F, Brown HC, Marx RG. Predictors of success of corticosteroid injection for the management of rotator cuff disease. *HSS J* 2013;9(1):2-5. https://doi.org/10.1007/s11420-012-9316-6
- 24. Koester MC, Dunn WR, Kuhn JE, Spindler KP. The efficacy of subacromial corticosteroid injection in the treatment of rotator cuff disease: a systematic review. *J Am Acad Orthop Surg* 2007;15(1):3-11.
 - https://doi.org/10.5435/00124635-200701000-00002
- 25. Chen X, Jones IA, Park C, Vangsness CT Jr. The efficacy of platelet-rich plasma on tendon and ligament healing: a systematic review and meta-analysis with bias assessment. Am J Sports Med 2018;46(8):2020-2032.
 - https://doi.org/10.1177/0363546517743746
- Strauss FJ, Nasirzade J, Kargarpoor Z, Stähli A, Gruber R. Effect of platelet-rich fibrin on cell proliferation, migration, differentiation, inflammation, and osteoclastogenesis: a systematic review of *in vitro* studies. *Clin Oral Investig* 2020;24(2):569-584. https://doi.org/10.1007/s00784-019-03156-9
- 27. Hoppe S, Alini M, Benneker LM, Milz S, Boileau P, Zumstein MA. Tenocytes of chronic rotator cuff tendon tears can be stimulated by platelet-released growth factors. *J Shoulder Elbow Surg* 2013;22(3):340-349.
 - https://doi.org/10.1016/j.jse.2012.01.016
- 28. Jo CH, Kim JE, Yoon KS, Shin S. Platelet-rich plasma stimulates cell proliferation and enhances matrix gene expression and synthesis in tenocytes from human rotator cuff tendons with degenerative tears. *Am J Sports Med* 2012;40(5):1035-1045. https://doi.org/10.1177/0363546512437525
- 29. Barman A, Mishra A, Maiti R, Sahoo J, Thakur KB, Sasidharan SK. Can platelet-rich plasma injections provide better pain relief and functional outcomes in persons with common shoulder diseases: a meta-analysis of randomized controlled trials. *Clin Shoulder Elb* 2022;25(1):73-89.
 - https://doi.org/10.5397/cise.2021.00353
- 30. Rodeo SA, Delos D, Williams RJ, Adler RS, Pearle A, Warren RF. The effect of platelet-rich fibrin matrix on rotator cuff tendon healing: a prospective, randomized clinical study. *Am J Sports Med* 2012;40(6):1234-1241.
 - https://doi.org/10.1177/0363546512442924
- 31. Weber SC, Kauffman JI, Parise C, Weber SJ, Katz SD. Platelet-rich fibrin matrix in the management of arthroscopic repair of the rotator cuff: a prospective, randomized, double-blinded study. *Am J Sports Med* 2013;41(2):263-270.
 - https://doi.org/10.1177/0363546512467621
- 32. Rha D, Park GY, Kim YK, Kim MT, Lee SC. Comparison of the therapeutic effects of ultrasound-guided platelet-rich plasma injection and dry needling in rotator cuff disease: a randomized controlled trial. *Clin Rehabil* 2013;27(2):113-122. https://doi.org/10.1177/0269215512448388
- 33. Dakkak M, Saleem A, Patel D, Yeager M, Oliveira L, Gilot G, et al. A systematic review of randomized control trials looking at functional improvement of rotator cuff partial thickness tears following platelet-rich-plasma injection: a comparison of glenohumeral joint vs. subacromial bursa vs. intratendinous injection locations. *JSES Int* 2024;8(3):464-471.



- https://doi.org/10.1016/j.jseint.2024.01.003
- 34. Jo YH, Kim DH, Lee BG. When should reverse total shoulder arthroplasty be considered in glenohumeral joint arthritis? *Clin Shoulder Elb* 2021;24(4):272-278. https://doi.org/10.5397/cise.2021.00633
- 35. Ibounig T, Simons T, Launonen A, Paavola M. Glenohumeral osteoarthritis: an overview of etiology and diagnostics. *Scand J Surg* 2021;110(3):441-451. https://doi.org/10.1177/1457496920935018
- 36. Millett PJ, Gobezie R, Boykin RE. Shoulder osteoarthritis: diagnosis and management. *Am Fam Physician* 2008;78(5):605-611.
- 37. Vijian K, Cheng YT, Idris Z, Izaini Ghani AR, Abdul Halim S, Abdullah JM. Manual muscle testing of the scapula and the upper limb through bedside examination. *Malays J Med Sci* 2023;30(1):198-212.
 - https://doi.org/10.21315/mjms2023.30.1.17
- 38. D'Antonio L, Fiumana G, Reina M, Lodi E, Porcellini G. Breaking the operator variability in Kibler's scapular dyskinesis assessment. *Musculoskelet Surg* 2024;108(3):347-357. https://doi.org/10.1007/s12306-024-00834-0
- 39. Märtens N, März V, Bertrand J, Lohmann CH, Berth A. Radiological changes in shoulder osteoarthritis and pain sensation correlate with patients' age. *J Orthop Surg Res* 2022;17(1):277.
 - https://doi.org/10.1186/s13018-022-03137-x
- 40. Stanborough RO, Bestic JM, Peterson JJ. Shoulder osteoarthritis. *Radiol Clin North Am* 2022;60(4):593-603.
 - https://doi.org/10.1016/j.rcl.2022.03.003
- 41. Bouillanne O, Morineau G, Dupont C, Coulombel I, Vincent JP, Nicolis I, et al. Geriatric nutritional risk index: a new index for evaluating at-risk elderly medical patients. *Am J Clin Nutr* 2005;82(4):777-783.
 - https://doi.org/10.1093/ajcn/82.4.777
- 42. Yamamoto N, Szymski D, Voss A, Ishikawa H, Muraki T, Cunha RA, et al. Non-operative management of shoulder osteoarthritis: current concepts. *J ISAKOS* 2023;8(5):289-295. https://doi.org/10.1016/j.jisako.2023.06.002
- 43. Ho CYC, Sole G, Munn J. The effectiveness of manual therapy in the management of musculoskeletal disorders of the shoulder: a systematic review. *Man Ther* 2009;14(5):463-474.
 - https://doi.org/10.1016/j.math.2009.03.008
- 44. Pincus T, Koch G, Lei H, Mangal B, Sokka T, Moskowitz R, et al. Patient preference for placebo, acetaminophen (paracetamol) or celecoxib efficacy studies (PACES): two randomised, double blind, placebo controlled, crossover clinical trials in patients with knee or hip osteoarthritis. *Ann Rheum Dis* 2004;63(8):931-939.
 - https://doi.org/10.1136/ard.2003.020313
- 45. Machado GC, Abdel-Shaheed C, Underwood M, Day RO. Non-steroidal anti-inflammatory drugs (NSAIDs) for musculoskeletal pain. *BMJ* 2021;372:n104. https://doi.org/10.1136/bmj.n104
- 46. Kim YT, Kim TY, Lee JB, Hwang JT. Glenohumeral versus subacromial steroid injections for impingement syndrome with mild stiffness: a randomized controlled trial. *Clin Shoulder Elb* 2023;26(4):390-396.
 - https://doi.org/10.5397/cise.2023.00346



- 47. Yi JW. Isolated acromioclavicular osteoarthritis and steroid injection. *Clin Shoulder Elb* 2023;26(2):107-108.
 - https://doi.org/10.5397/cise.2023.00311
- 48. Denard PJ, Wirth MA, Orfaly RM. Management of glenohumeral arthritis in the young adult. *J Bone Joint Surg* 2011;93(9):885-892. https://doi.org/10.2106/JBJS.J.00960
- 49. Elfatah AMA, Taeimah MO, Hasan MM, Ismael MSAA. Effect of platelet rich plasma therapy for shoulder osteoarthritis: double blinded randomized controlled study. *QJM Int J Med* 2023;116(Suppl 1):134-135. https://doi.org/10.1093/qjmed/hcad069.080
- 50. Eliasberg CD, Nemirov DA, Mandelbaum BR, Pearle AD, Tokish JM, Baria MR, et al. Complications following biologic therapeutic injections: a multicenter case series. *Arthroscopy* 2021;37(8):2600-2605. https://doi.org/10.1016/j.arthro.2021.03.065

Review



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Application of deep learning for diagnosis of shoulder diseases in older adults: a narrative review

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Keywords

Aged; Computer neural networks; Deep learning; Rotator cuff injuries; Shoulder pain



Shoulder diseases pose a significant health challenge for older adults, often causing pain, functional decline, and decreased independence. This narrative review explores how deep learning (DL) can address diagnostic challenges by automating tasks such as image segmentation, disease detection, and motion analysis. Recent research highlights the effectiveness of DL-based convolutional neural networks and machine learning frameworks in diagnosing various shoulder pathologies. Automated image analysis facilitates the accurate assessment of rotator cuff tear size, muscle degeneration, and fatty infiltration in MRI or CT scans, frequently matching or surpassing the accuracy of human experts. Convolutional neural network-based systems are also adept at classifying fractures and joint conditions, enabling the rapid identification of common causes of shoulder pain from plain radiographs. Furthermore, advanced techniques like pose estimation provide precise measurements of the shoulder joint's range of motion and support personalized rehabilitation plans. These automated approaches have also been successful in quantifying local osteoporosis, utilizing machine learningderived indices to classify bone density status. DL has demonstrated significant potential to improve diagnostic accuracy, efficiency, and consistency in the management of shoulder diseases in older patients. Machine learning-based assessments of imaging data and motion parameters can help clinicians optimize treatment plans and improve patient outcomes. However, to ensure their generalizability, reproducibility, and effective integration into routine clinical workflows, largescale, prospective validation studies are necessary. As data availability and computational resources increase, the ongoing development of DL-driven applications is expected to further advance and personalize musculoskeletal care, benefiting both healthcare providers and the aging population.

Introduction

Background

Shoulder diseases pose a significant health burden on the aging population, affecting millions of individuals worldwide [1–3]. Common conditions such as rotator cuff tears, impingement syndrome, osteoarthritis, and adhesive capsulitis not only cause pain but also significantly impair the daily lives of patients by restricting their mobility and independence [1,4–8]. Timely and accurate diagnosis of these conditions is crucial for optimizing treatment outcomes and enhancing patient quality of life. However, traditional diagnostic tools, such as X-rays, MRI,

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and ultrasound, face challenges including variability in interpretation and limited availability in resource-constrained environments [9]. Furthermore, these methods struggle to accurately and objectively measure joint range of motion, which further compromises their effectiveness in diagnosing musculoskeletal conditions [10].

Recent advances in artificial intelligence (AI), especially in the area of deep learning (DL), have revolutionized the diagnosis of shoulder diseases [11–14]. DL algorithms leverage artificial neural networks, modeled after the human brain, to process and analyze vast amounts of data with exceptional accuracy [15]. These algorithms can detect subtle patterns in medical images that may be overlooked by even experienced radiologists. They also analyze complex movements and postures through pose estimation techniques. By minimizing diagnostic errors, improving consistency, and facilitating detailed motion analysis, DL algorithms are widely applicable in imaging and movement assessment, transforming sectors like healthcare, rehabilitation, and biomechanics.

Objectives

This paper aims to explore recent studies on the application of DL in diagnosing shoulder diseases in older adults.

Ethics statement

As this study is a literature review, it did not require institutional review board approval or individual consent.

The analysis of rotator cuff muscles/tendons and fatty infiltrations using artificial intelligence

In 2020, Taghizadeh et al. introduced an Al model specifically designed to automatically assess rotator cuff muscle degeneration by analyzing both atrophy and fatty infiltration in CT images [14]. This model utilized a convolutional neural network (CNN) to automatically evaluate degeneration, including atrophy and fatty infiltration, in preoperative shoulder CT scans of patients with glenohumeral osteoarthritis. The CNN was tested on retrospective data from 103 CT scans and achieved Dice similarity coefficients that were comparable to those of manual radiologist segmentations. It demonstrated high accuracy in measuring atrophy (R^2 =0.87), fatty infiltration (R^2 =0.91), and overall degeneration (R^2 =0.91). These findings highlight the potential of DL to provide efficient and reliable evaluations of rotator cuff muscles preoperatively.

Similarly, Ro et al. developed a DL framework that utilizes MRI to evaluate factors such as the occupation ratio and fatty infiltration in the supraspinatus muscle of patients with rotator cuff tears [12]. This study employed a deep-learning framework to analyze the occupation ratio and fatty infiltration in the supraspinatus muscle using shoulder MRI. A full CNN facilitated rapid and precise segmentation of the supraspinatus muscle and fossa, achieving high Dice similarity coefficients (0.97 for the fossa and 0.94 for the muscle) along with excellent sensitivity and specificity. Fatty infiltration was quantified using a region-based Otsu thresholding method, which revealed significant differences across Goutallier grades (P<0.0001) [16] and demonstrated a moderate negative correlation with the occupation ratio (ρ =-0.75, P<0.0001) [17]. These findings indicate that integrating DL with automated thresholding techniques offers an objective and efficient means of quantifying key indices in shoulder MRI, thereby enhancing diagnostic accuracy and consistency.



Detection of shoulder pathologies including rotator cuff tears and fractures

Recently, DL technology has been employed to automate the segmentation and detection of rotator cuff tears using MRI.

Lee et al. developed a DL model utilizing a 3D U-Net CNN to detect, segment, and visualize rotator cuff tear lesions in three dimensions using MRI data from 303 patients [18]. The model, trained and validated on labeled MRI datasets, demonstrated robust performance. It achieved a Dice coefficient of 94.3%, a sensitivity of 97.1%, a specificity of 95.0%, a precision of 84.9%, an F1-score of 90.5%, and a Youden index of 91.8% (Fig. 1).

Hashimoto et al. assessed the diagnostic capabilities of a CNN in detecting and classifying rotator cuff tears, using 1,169 anteroposterior shoulder radiographs. These were categorized into four groups: intact, small, medium, and large-to-massive tears [19]. In binary classification tasks, the CNN achieved a sensitivity of 92%, a specificity of 69%, an accuracy of 86%, and an area under the receiver operating curve (AUC) of 0.88. The CNN outperformed orthopedic surgeons in both detection and classification accuracy, demonstrating its potential as a reliable tool for diagnosing rotator cuff tears from plain radiographs.

A recent meta-analysis demonstrated that Al could perform comparably to clinicians in

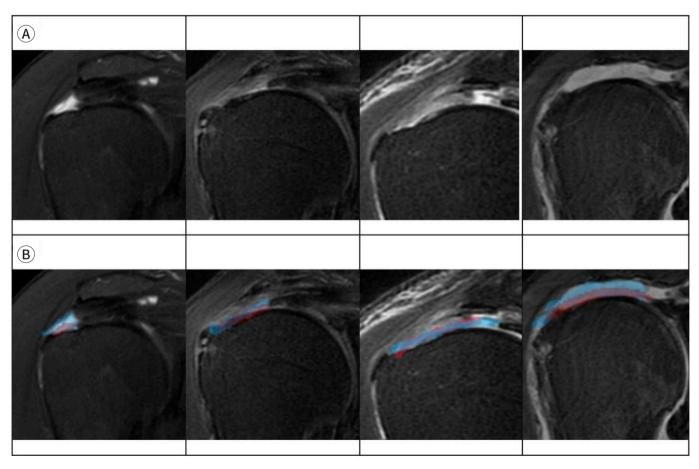


Fig. 1. Segmentation results corresponding to the rotator cuff tear site. (A) Original MRI images displaying the presence of a rotator cuff tear. (B) The red region represents the area manually labeled by shoulder specialists, while the blue region indicates the area segmented by the proposed deep learning model. Adapted from Lee et al. [18] with CC-BY.



detecting fractures, highlighting its potential for broader applications in orthopedics. Magnéli et al. developed and evaluated a CNN for classifying fractures in shoulder radiographs, focusing on proximal humeral fractures (PHF) based on the AO/OTA classification system, with secondary objectives for diaphyseal humerus, clavicle, and scapula fractures [20]. The CNN, trained on a dataset of 6,172 examinations, achieved an overall AUC of 0.89 for fracture classification. Notably, the AUC for PHF classes exceeded 0.90. The model also demonstrated excellent AUCs for diaphyseal humerus (0.97) and clavicle fractures (0.96), and a good performance for scapula fractures (0.87). Furthermore, Grauhan et al. developed a model capable of identifying a variety of common causes of shoulder pain on radiographs, extending beyond fractures to include conditions such as PHF, dislocations, periarticular calcifications, osteoarthritis, osteosynthesis, and joint prostheses [11]. This study utilized the ResNet-50 architecture to detect common causes of shoulder pain—such as fractures, dislocations, osteoarthritis, periarticular calcifications, osteosynthesis, and endoprosthesis—from plain radiographs. Trained on 2,700 radiographs and evaluated on a separate annotated dataset, the model demonstrated high accuracy. The CNN achieved excellent performance, with AUC values of 0.871 for fractures, 0.896 for joint dislocations, 0.945 for osteoarthritis, and 0.800 for periarticular calcifications. It also detected osteosynthesis and endoprosthesis with high accuracy, achieving AUC values of 0.998 and 1.0, respectively. Sensitivity and specificity varied by condition, with values of 0.75 and 0.86 for fractures, 0.95 and 0.65 for joint dislocations, 0.90 and 0.86 for osteoarthritis, and 0.60 and 0.89 for calcifications. These results underscore the potential of CNNs to aid clinicians by prioritizing worklists and improving diagnostic efficiency in high-workload settings.

Detection of local osteoporosis in the proximal humerus

Li et al. developed a diagnostic method using machine learning to assess local osteoporosis in the proximal humerus by analyzing demographic data, bone density, and X-ray ratios [21]. The study involved a cohort of 97 patients (76 females and 21 males with an average age of 73 years), categorized into groups based on bone density: normal (25 patients), osteopenia (35 patients), and osteoporosis (37 patients). Utilizing the modified Tingart index [22], a decision tree was employed to identify critical diagnostic indicators, including the humeral shaft medullary cavity ratio (M2/M4), age, and sex. An M2/M4 ratio below 1.13 was indicative of local osteoporosis, whereas a ratio of 1.13 or higher, when analyzed alongside age and sex, helped differentiate between osteoporosis, osteopenia, and normal bone density. The decision tree achieved accuracies of 76.27% in the training set and 78.95% in the validation set. Additionally, multinomial logistic regression validated significant associations of M2/M4, age, and sex with osteoporosis.

Analysis of shoulder range of motion using machine learning

Measuring shoulder joint angles accurately has been challenging due to the complexity of shoulder motion and its intricate rotational axes. Recently, pose estimation, a computer vision technique that utilizes machine learning, has garnered significant attention [23,24]. This technology predicts the positions and orientations of human joints or key points from images or videos, enabling detailed analysis of movements and postures [25]. In a recent study, the integration of pose estimation Al with machine learning has demonstrated a promising approach to estimating the range of motion of the shoulder with remarkable precision, paving the way for advancements in sports biomechanics and rehabilitation (Fig. 2).



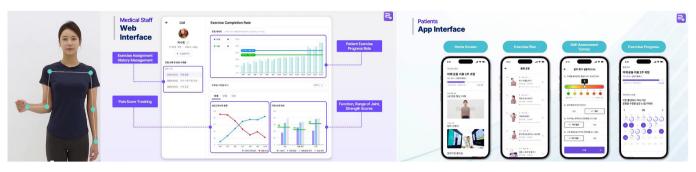


Fig. 2. A company utilizes machine learning-based pose estimation technology to measure a patient's range of motion, analyze the patient's current condition based on the results, and assign the most suitable rehabilitation exercises. This figure is used with permission from Itphy, Inc.

Takigami et al. employed pose estimation AI in conjunction with a machine learning model to estimate the internal and external rotation angles of the shoulder [26]. They processed videos of 10 healthy male volunteers (average age 37.7 years) into 10,608 images to develop parameters for training the model. Using smartphone angle measurements as the ground truth, the AI model demonstrated a correlation coefficient of 0.971 and a mean absolute error of 5.778 using linear regression. With Light GBM, it achieved a correlation coefficient of 0.999 and an mean absolute error of 0.945. This method offers a precise and efficient way to measure shoulder rotation angles, showing great potential for applications in sports biomechanics and rehabilitation.

Ramkumar et al. validated a motion-based machine learning software development kit designed to assess shoulder range of motion. They compared its accuracy with that of manual goniometer measurements across four motion arcs: abduction, forward flexion, internal rotation, and external rotation [27]. Utilizing a mobile application, 10 subjects each performed the motions five times. The software development kit recorded mean angular differences of less than 5° for all motions (P>0.05), with specific mean differences of -3.7° for abduction, -4.9° for forward flexion, -2.4° for internal rotation, and -2.6° for external rotation.

Conclusion

The use of DL in diagnosing shoulder diseases among older patients has shown considerable promise in several areas. These include analyzing rotator cuff muscle degeneration, detecting pathologies such as rotator cuff tears and fractures, evaluating local osteoporosis in the proximal humerus, and accurately measuring the shoulder's range of motion. DL models, which employ sophisticated architectures like CNNs and incorporate machine learning algorithms, consistently achieve high levels of accuracy, sensitivity, and specificity in medical imaging tasks. These models often outperform traditional diagnostic techniques and expert clinicians.

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Authors' contributions

All work was done by Sung Min Rhee.

Conflict of interest

Sung Min Rhee is the Chief Executive Officer of Itphy Inc., the company that provided Fig. 2.



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References -

- Gumina S, Kim H, Jung Y, Song HS. Rotator cuff degeneration and healing after rotator cuff repair. Clin Shoulder Elb 2023;26(3):323-329. https://doi.org/10.5397/cise.2023.00430
- Lucas J, van Doorn P, Hegedus E, Lewis J, van der Windt D. A systematic review of the global prevalence and incidence of shoulder pain. *BMC Musculoskelet Disord* 2022;23(1):1073. https://doi.org/10.1186/s12891-022-05973-8
- 3. Hodgetts CJ, Leboeuf-Yde C, Beynon A, Walker BF. Shoulder pain prevalence by age and within occupational groups: a systematic review. *Arch Physiother* 2021;11(1):24. https://doi.org/10.1186/s40945-021-00119-w
- 4. Kim YT, Kim TY, Lee JB, Hwang JT. Glenohumeral versus subacromial steroid injections for impingement syndrome with mild stiffness: a randomized controlled trial. *Clin Shoulder Elb* 2023;26(4):390-396.
 - https://doi.org/10.5397/cise.2023.00346
- 5. Mardani-Kivi M, Hashemi-Motlagh K, Darabipour Z. Arthroscopic release in adhesive capsulitis of the shoulder: a retrospective study with 2 to 6 years of follow-up. *Clin Shoulder Elb* 2021;24(3):172-177.
 - https://doi.org/10.5397/cise.2021.00311
- Hones KM, Hao KA, Buchanan TR, Trammell AP, Wright JO, Wright TW, et al. Does preoperative forward elevation weakness affect clinical outcomes in anatomic or reverse total shoulder arthroplasty patients with glenohumeral osteoarthritis and intact rotator cuff? Clin Shoulder Elb 2024;27(3):316-326.
 - https://doi.org/10.5397/cise.2024.00262
- Rhee SM, Youn SM, Kim CH, Chang GW, Kim SY, Ham HJ, et al. Rotator cuff repairs with all-suture tape anchors: no difference in outcomes between with or without all-suture tape anchors. *Knee Surg Sports Traumatol Arthrosc* 2023;31(9):4060-4067. https://doi.org/10.1007/s00167-023-07454-4
- 8. Ko YW, Park JH, Youn SM, Rhee YG, Rhee SM. Effects of comorbidities on the outcomes of manipulation under anesthesia for primary stiff shoulder. *J Shoulder Elbow Surg* 2021;30(8):E482-E492.
 - https://doi.org/10.1016/j.jse.2020.11.007



- Malavolta EA, Assunção JH, Gracitelli MEC, Yen TK, Bordalo-Rodrigues M, Ferreira Neto AA. Accuracy of magnetic resonance imaging (MRI) for subscapularis tear: a systematic review and meta-analysis of diagnostic studies. *Arch Orthop Trauma Surg* 2019;139(5):659-667. https://doi.org/10.1007/s00402-018-3095-6
- Elrahim RMA, Embaby EA, Ali MF, Kamel RM. Inter-rater and intra-rater reliability of Kinovea software for measurement of shoulder range of motion. *Bull Fac Phys Ther* 2016;21(2):80-87. https://doi.org/10.4103/1110-6611.196778
- 11. Grauhan NF, Niehues SM, Gaudin RA, Keller S, Vahldiek JL, Adams LC, et al. Deep learning for accurately recognizing common causes of shoulder pain on radiographs. *Skeletal Radiol* 2022;51(2):355-362.
 - https://doi.org/10.1007/s00256-021-03740-9
- 12. Ro K, Kim JY, Park H, Cho BH, Kim IY, Shim SB, et al. Deep-learning framework and computer assisted fatty infiltration analysis for the supraspinatus muscle in MRI. *Sci Rep* 2021;11(1):15065.
 - https://doi.org/10.1038/s41598-021-93026-w
- Shariatnia MM, Ramazanian T, Sanchez-Sotelo J, Maradit Kremers H. Deep learning model for measurement of shoulder critical angle and acromion index on shoulder radiographs. JSES Rev Rep Tech 2022;2(3):297-301.
 - https://doi.org/10.1016/j.xrrt.2022.03.002
- 14. Taghizadeh E, Truffer O, Becce F, Eminian S, Gidoin S, Terrier A, et al. Deep learning for the rapid automatic quantification and characterization of rotator cuff muscle degeneration from shoulder CT datasets. *Eur Radiol* 2021;31(1):181-190.
 - https://doi.org/10.1007/s00330-020-07070-7
- Alzubaidi L, Al-Dulaimi K, Salhi A, Alammar Z, Fadhel MA, Albahri AS, et al. Comprehensive review of deep learning in orthopaedics: applications, challenges, trustworthiness, and fusion. *Artif Intell Med* 2024;155:102935.
 - https://doi.org/10.1016/j.artmed.2024.102935
- Goutallier D, Postel JM, Bernageau J, Lavau L, Voisin MC. Fatty muscle degeneration in cuff ruptures: pre- and postoperative evaluation by CT scan. *Clin Orthop Relat Res* 1994;304:78-83.
 - https://doi.org/10.1097/00003086-199407000-00014
- 17. Jeong JY, Chung PK, Lee SM, Yoo JC. Supraspinatus muscle occupation ratio predicts rotator cuff reparability. *J Shoulder Elbow Surg* 2017;26(6):960-966. https://doi.org/10.1016/j.jse.2016.11.001
- 18. Lee SH, Lee J, Oh KS, Yoon JP, Seo A, Jeong Y, et al. Automated 3-dimensional MRI segmentation for the posterosuperior rotator cuff tear lesion using deep learning algorithm. *PLoS One* 2023;18(5):e0284111.
 - https://doi.org/10.1371/journal.pone.0284111
- Hashimoto E, Maki S, Ochiai N, Ise S, Inagaki K, Hiraoka Y, et al. Automated detection and classification of the rotator cuff tear on plain shoulder radiograph using deep learning. J Shoulder Elbow Surg 2024;33(8):1733-1739.
 - https://doi.org/10.1016/j.jse.2023.12.009
- 20. Magnéli M, Ling P, Gislén J, Fagrell J, Demir Y, Arverud ED, et al. Deep learning classification of shoulder fractures on plain radiographs of the humerus, scapula and clavicle. *PLoS One* 2023;18(8):e0289808.
 - https://doi.org/10.1371/journal.pone.0289808



- 21. Li G, Wu N, Zhang J, Song Y, Ye T, Zhang Y, et al. Proximal humeral bone density assessment and prediction analysis using machine learning techniques: An innovative approach in medical research. *Heliyon* 2024;10(15):e35451. https://doi.org/10.1016/j.heliyon.2024.e35451
- 22. Tingart MJ, Zurakowski D, Warner JJP, Apreleva M, von Stechow D. The cortical thickness of the proximal humeral diaphysis predicts bone mineral density of the proximal humerus. *J Bone Joint Surg Br* 2003;85(4):611-617. https://doi.org/10.1302/0301-620X.85B4.12843
- 23. van den Hoorn W, Lavaill M, Cutbush K, Gupta A, Kerr G. Comparison of shoulder range of motion quantified with mobile phone video-based skeletal tracking and 3D motion capture: preliminary study. Sensors 2024;24(2):534. https://doi.org/10.3390/s24020534
- Pereira B, Cunha B, Viana P, Lopes M, Melo ASC, Sousa ASP. A machine learning app for monitoring physical therapy at home. *Sensors* 2024;24(1):158. https://doi.org/10.3390/s24010158
- 25. Sun K, Xiao B, Liu D, Wang J. Deep high-tesolution representation learning for human pose estimation. Proceedings of the 2019 IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR); 2019 Jun 15-20; Long Beach, CA. Piscataway (NJ): IEEE; 2019. p.5693-5703.
- 26. Takigami S, Inui A, Mifune Y, Nishimoto H, Yamaura K, Kato T, et al. Estimation of shoulder joint rotation angle using tablet device and pose estimation artificial intelligence model. Sensors 2024;24(9):2912. https://doi.org/10.3390/s24092912
- 27. Ramkumar PN, Haeberle HS, Navarro SM, Sultan AA, Mont MA, Ricchetti ET, et al. Mobile technology and telemedicine for shoulder range of motion: validation of a motion-based machine-learning software development kit. *J Shoulder Elbow Surg* 2018;27(7):1198-1204. https://doi.org/10.1016/j.jse.2018.01.013

Review



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Occupational disease monitoring by the Korea **Occupational Disease Surveillance Center:** a narrative review

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Data accuracy; Health policy; Occupational diseases; Republic of Korea: Workforce



This review examines the challenges associated with occupational disease surveillance in Korea, particularly emphasizing the limitations of current data sources such as the Industrial Accident Compensation Insurance (IACI) statistics and special health examinations. The IACI system undercounts cases due to its emphasis on severe diseases and restrictions on approvals. Special health examinations, although they cover a broad workforce, are constrained by their annual scheduling, which leads to missed acute illnesses and subclinical conditions. The paper also explores the history of occupational disease surveillance in Korea, highlighting the fragmented and disease-specific approach of earlier systems. The authors introduce the newly established Korea Occupational Disease Surveillance Center (KODSC), a comprehensive nationwide system designed to gather, analyze, and

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interpret data on occupational diseases through a network of regional centers. By incorporating hospital-based surveillance and focusing on acute poisonings and other sentinel events, the KODSC aims to overcome the limitations of previous systems and promote collaboration with various agencies. Although it is still in the early stages of implementation, the KODSC demonstrates potential for improving data accuracy and contributing valuable insights for public health policy.

Introduction

Background

Korea began its industrialization in the 1960s, leading to the construction of numerous factories throughout the 1970s and 1980s. As a result, coal mining expanded significantly to meet the energy demands of the manufacturing industry and to provide a source of home heating. The manufacturing processes involved the use of various chemicals. This shift towards a manufacturing-based economy has been associated with several occupational diseases, including carbon disulfide and heavy metal poisoning [1]. In recent years, Korea has achieved global competitiveness in several sectors, including mobile phones, semiconductors, automobiles, chemicals, and steel manufacturing. Additionally, Korean cultural content such as music, gaming, and webtoons has become a vital industry, playing a pivotal role in the national economy. Despite these advancements, the manufacturing sector remains the largest in terms of gross domestic product (GDP), followed by sales and retail [2].

Despite Korea's impressive economic growth, occupational injuries continue to pose a significant problem. By 2022, the rate of fatal occupational injuries per 100,000 workers is projected to be 4.33. This figure is substantially higher than Japan's rate of 1.54 and Germany's 0.84, placing Korea among the higher ranks of International Labour Organisation (ILO) member countries [3]. The ILO reports that approximately 2.3 million women and men globally die each year from work-related accidents or diseases, which equates to over 6,000 deaths daily. Furthermore, around 340 million occupational accidents and 160 million cases of work-related illnesses are recorded annually worldwide [4].

Recent Global Burden of Disease research has concentrated on the impact of occupational factors; however, this impact is relatively minor in high-income countries. Determining the burden of occupational diseases presents significant challenges, particularly due to the incubation period of chronic diseases, high turnover rates in flexible labor markets, and the necessity for reliable information to confirm exposure [5]. Identifying cases linked to occupational factors is crucial for compiling these data, which are vital for public health. Routine surveillance systems, such as the Health and Occupation Research (THOR) network, play a key role in providing important data sources [6].

Objectives

This review examines the importance of establishing a routine surveillance scheme as a foundational framework for comprehending the burden of occupational diseases. It also describes the occupational disease surveillance system that was recently implemented in Korea.

Ethics statement -

As this study is a literature review, it did not require institutional review board approval or individual consent.



Occupational disease and surveillance

The term "surveillance" originates from a French word meaning "to watch over" [7]. It is defined as the continuous, systematic collection, analysis, and interpretation of health-related data that are crucial for the planning, implementation, and evaluation of public health practices. This process is tightly linked with the prompt dissemination of these data to individuals responsible for prevention and control measures [8]. The goal of surveillance is to supply information that public health personnel, government leaders, and the community can use to inform public health policies and programs [9,10].

It is important to utilize multiple data sources to accurately gauge the prevalence of occupational diseases. In Korea, the Industrial Accident Compensation Insurance (IACI) statistics serve as one such source for tracking the number of occupational diseases. However, this system only allows claims for severe diseases, and approximately two-thirds of these claims are approved. Consequently, the IACI statistics may not fully represent the actual incidence of occupational diseases. Additionally, the disparity between the ratios of fatal to non-fatal cases in occupational injuries and illnesses indicates that some data might be missing [11].

In 2022, statistics approved by the IACI indicated that 23,134 individuals were recognized as having occupational or work-related diseases. Although this figure might initially appear substantial, a deeper analysis highlights several concerning issues. More than half of these cases were attributed to musculoskeletal disorders, deaths from cardio- or cerebrovascular diseases due to overwork, and mental illnesses. Noise-induced hearing loss was responsible for 5,376 cases, while pneumoconiosis accounted for 1,679 cases [12]. Given the presence of 600,000 manufacturing workplaces and 3.4 million workers in Korea, the reported 553 cases related to exposure to hazardous chemicals seem implausibly low. This significant discrepancy points to a potential shortfall in the current system's ability to capture a comprehensive range of occupational diseases.

Another source of occupational disease surveillance is special health examinations. These are occupational health screening tests designed for the early detection of selected occupational diseases in workers. It is mandatory for employees exposed to 181 risk factors, including hazardous chemicals, gases, physical risk factors, and night work, to undergo these examinations. To date, almost 2.2 million workers have been examined under this system. However, due to the nature of medical examinations, which are typically conducted at oneyear intervals based on exposure to specific physical and chemical hazards, they are useful in identifying chronic diseases in workers who have been employed for more than one year. Nonetheless, they have limitations in identifying subclinical conditions or diseases that may manifest acutely in the absence of a clinical examination [13]. Periodic health examinations cannot detect acute illnesses or subclinical conditions and require workers to have been employed at a workplace for more than a year. Consequently, short-term or day laborers who frequently change workplaces are not included in the statistics. This system also overlooks small-scale workplaces and foreign laborers. The most commonly observed conditions (95%) are pneumoconiosis and noise-induced hearing loss, with examinations typically conducted annually. This frequency makes it challenging to detect diseases that arise acutely. Indeed, an analysis of the rate of special health examinations in workplaces with five or more employees revealed that less than 5% of manufacturing workplaces had fewer than five employees, 20% of workplaces had between 5 and 49 employees, and 85% had 50 or more employees [14]. As a result, similar poisonings and deaths, such as those caused by methanol [15], mercury [16],



fire extinguishing agent HCFC-123 [17], and dichloromethane [18], have continued to occur until recently.

There are inherent gaps in Korea's occupational disease surveillance system when it relies solely on compensation data from the IACI and special health examinations. The current statistics on occupational diseases are inadequate for understanding the full extent of this issue in South Korea. To adequately represent and include vulnerable groups, it is crucial to establish surveillance systems based on reporting and registration.

History of occupational disease surveillance

Awareness of occupational health issues has led to the development of various disease surveillance systems, which are centered around specific diseases, regions, and exposures. While these systems have achieved some of their intended outcomes during their operational periods, the need for a more integrated approach has become increasingly apparent. Among the most notable disease-focused surveillance systems are those targeting asthma and lung cancer. A comprehensive overview of the different surveillance systems implemented in Korea is detailed in Table 1. The Occupational Asthma Surveillance System, the longest-running system of its kind in Korea, has been instrumental in estimating the incidence of occupational asthma and identifying its major risk factors [19]. Similarly, the lung cancer surveillance system has been

Table 1. History of the occupational disease surveillance system in Korea

Category	Details	Period	
Occupational disease surveilland	ce		
Disease-oriented	Asthma	1998-2002, 2004-2011	
	Musculoskeletal disorders	2000-2004	
	Skin disorders	1998	
	Mesothelioma and leukemia	2001	
	Mesothelioma	2002-2013	
	Lung cancer	2006-2010	
	Lymphohematopoietic disorders	2007-2010	
	Injury	2008-2011	
	Cerebro- and cardiovascular diseases	2010-2011	
Region-oriented	Incheon	2001-2010	
	Busan, Ulsan, and Gyungnam	2001-2003, 2005-2010	
	Gumi	2002-2003	
	Changwon	2004	
	Jungbu-Nambu Regional Lung Cancer and Leukemia	2011-2016	
Exposure monitoring	Construction workers	2002	
	Needle stick injury	2009-2013	
	DMF (dimethylformamide) biological exposure indices monitoring	2010	
Mixed type	Petroleum industry	1999-2000	
	Workplace-oriented occupational disease surveillance	2011-2012	
	Acute poisoning disorders	2016-2020	



crucial in providing data on lung cancer cases, highlighting the potential for prevention through reduced exposure to hazards in the workplace [20].

Despite some achievements, funding for these surveillance systems was provided in a fragmented manner, primarily through research grants, which posed challenges in establishing a system capable of continuous operation. Furthermore, as researchers developed diseasespecific, hazard-specific, and regional surveillance systems, inconsistencies arose in their definitions, scopes, and priorities. Consequently, there is a growing need for a continuous, fulltime, nationwide surveillance system. With advancements in big data science and technology, there is an increasing interest in developing a surveillance system that leverages regularly produced data, adhering to legal regulations concerning occupational health. Efforts are underway to create a carcinogen surveillance system utilizing national data, as well as a system that integrates various national datasets [21-23].

However, the aforementioned limitations inherent in the national data suggest that data-driven surveillance is not suitable for addressing urgent issues. Identifying sentinel health events is crucial for the prevention and treatment of occupational diseases [24]. This process also marks the initial step in recognizing emerging occupational diseases or health hazards, such as acute poisoning from newly developed industrial chemicals or unforeseen exposures. The acute poisoning event discussed earlier exemplifies this issue. Consequently, discussions are underway to establish a surveillance system specifically tailored to acute poisoning. This system aims to prevent and identify incidents caused by newly introduced industrial chemicals, beyond the previously mentioned cases of methanol poisoning, dichloromethane poisoning, or HCFC-123.

The Occupational Acute Poisoning Disease Regional Surveillance Pilot Project, which ran from 2016 to 2020, achieved significant outcomes, including the identification of a case of toxic encephalopathy caused by 1,2-dichloropropane. This pilot project utilized a mixed surveillance system that focused on region-specific diseases. The results underscored the importance of implementing a hospital-based surveillance system that involves direct interaction with patients to effectively detect acute poisoning and occupational diseases. In response to these findings, the government has decided to manage the surveillance system as a government-led initiative, transitioning away from the previous research-oriented approach. However, due to the challenges government agencies face in direct management, the system now operates through partnerships with the Department of Occupational and Environmental Medicine (OEM) and other clinical departments in major general hospitals, where patients receive care.

New scheme for occupational disease surveillance -

The Korea Occupational Disease Surveillance Center (KODSC) is a surveillance system designed to collect, analyze, and interpret cases of occupational disease. It was established in 2022, and by 2024, 10 regional centers were operational, in accordance with the regional Ministry of Employment and Labor (MOEL) offices.

The missions of KODSC are as follows:

- Collect suspected cases of occupational disease reported by clinicians
- Carry out data production and management
- Perform workplace inspections and walk-through surveys to detect occupational risk
- Provide medical consultations for occupational disease or injury cases of MOEL regional offices



Fig. 1 shows the overall organizational chart. A substantial component of this surveillance system is dedicated to gathering reports of occupational diseases, including acute poisoning, from key emergency medical facilities in the region. Although certain aspects of the current system may not be monitored, it is expected that individuals will seek medical care at a hospital when they feel unwell. The KODSC surveillance network system has been established across ten regional centers. These centers are typically university hospitals, which are the primary hospitals in their respective regions. They feature collaborations between the Department of OEM and the Regional Emergency Medical Center, serving both severe trauma patients and those with various other diseases.

The Department of OEM at the university hospital, designated as the center, will work in collaboration with the MOEL regional office to establish a coordination system. This system will involve various hospitals within the region and will integrate with the emergency medical system and other clinical departments of the hospital. The aim is to facilitate the reporting of various suspected cases of occupational diseases identified in the region. Each center compiles these reports and submits them to the MOEL, allowing for a national overview of the data. Data concerning monitored cases of occupational diseases are communicated to the MOEL and the Korea Occupational Safety and Health Agency. Some of these reported cases may undergo further testing for confirmation. If necessary, preventive measures may be developed in collaboration with the MOEL and the Korea Occupational Health and Safety Agency.

Fig. 2 illustrates the roles and responsibilities of the center, which is divided into three teams: the Investigation and Analysis Team (IAT), the Prevention and Support Team (PST), and the Corporate Relations Team (CRT). Each center includes occupational and environmental clinics that diagnose and treat patients with occupational diseases. The IAT manages the KODSC, which initially collects patient information when a suspected occupational disease is reported. This team also determines whether a risk investigation is necessary. If so, the IAT coordinates an on-site investigation at the workplace where the disease was reported. The primary role of

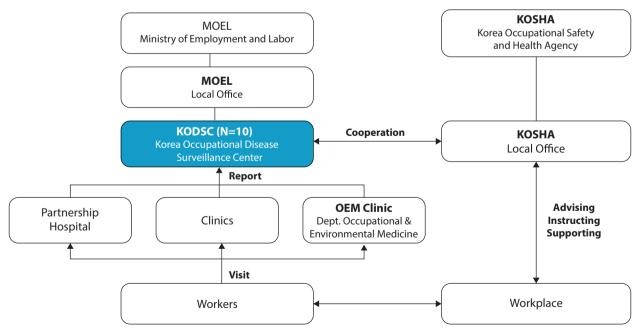


Fig. 1. The organizations of Korea Occupational Disease Surveillance.



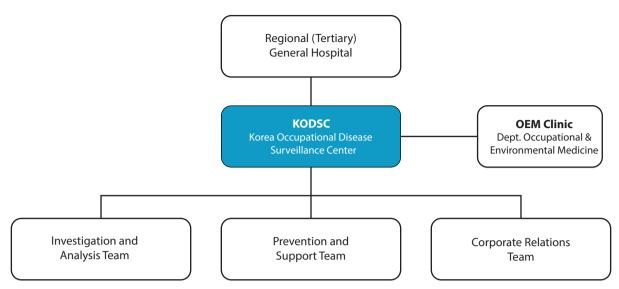


Fig. 2. The organization of each Korea Occupational Disease Surveillance Center.

the IAT is to assess the work-relatedness of the disease in patients with suspected occupational diseases and to manage data on these cases. Doctors and health professionals in emergency rooms or clinics may encounter patients suspected of having occupational diseases. In such instances, they can report these cases to the KODSC without a confirmatory test. They simply complete a prespecified form and submit it via a homepage, SMS, social network service, or health information system. Most reported cases are stored in the database after evaluation and clarification by the OEM doctors and health professionals at the KODSC.

In cases requiring urgent intervention, the KODSC collaborates with MOEL and KOSHA to support occupational disease investigations. This includes conducting workplace inspections and walk-through surveys to identify occupational hazards. PST supports the IAT in executing on-site workplace investigations. Working closely with KOSHA, the team visits sites where severe occupational diseases have been reported or are likely to occur, offering consultation and recommendations for improvements. For instance, after an on-site investigation, the team may conduct sample analyses of suspect chemicals, such as cleaning agents, either independently or in cooperation with KOSHA. Following the investigation, in conjunction with KOSHA, the team provides details on the workplace environmental improvement support scheme. Additionally, if necessary, they offer information on workers' compensation procedures to patients with occupational diseases.

The CRT is responsible for maintaining and managing a network designed to collect reports of suspected occupational diseases. The team strives to ensure the network remains fully operational to handle incoming cases. It collaborates with the emergency department coordinator to confirm the medical histories of patients visiting the emergency department. Additionally, the CRT routinely visits partner hospitals and other relevant institutions within the region to gather data on suspected occupational disease cases, which are then forwarded to the IAT. This process forms the foundation of the national occupational disease database. However, significant cases and outbreaks necessitate immediate action. Establishing a network through connections with local medical staff is crucial. Moreover, maintaining a strong relationship with the MOEL and KOSHA is essential. To achieve these goals, we consistently engage in various activities, including publishing newsletters and organizing workshops.



Korea Occupational Disease Surveillance Center statistics

The case definitions for reporting included occupational diseases caused by physical, chemical, and biological factors, with the exception of cases involving evident trauma. There was a particular emphasis on reporting suspected cases of acute poisoning in relation to the Serious Accident Punishment Act (SAPA). Work-related musculoskeletal disorders, which represent the majority of workers' compensation claims, are not required to be reported. Additionally, cerebrovascular or cardiovascular disorders that have already been diagnosed and are known are also excluded from reporting. As a general rule, all occupational diseases must be reported, regardless of the patient's nationality or whether they are enrolled in a worker's compensation insurance scheme.

Table 2 displays the number of suspected cases reported since the establishment of the KODSC in 2023. That year, a total of 4,341 suspected cases were reported nationwide, with 57 cases receiving assistance for investigations under the SAPA. About 30% of these cases were reported through outpatient services or admissions at hospitals operating their own KODSC. Meanwhile, approximately 39% of the cases were reported by partner hospitals participating in the network.

In relation to the total number of reports, organic chemicals emerged as the most common risk factor associated with these health issues, comprising 20.5% of the cases. This was followed by mineral dust, which accounted for 12.9%. Subsequent risk factors included biological elements such as gases, metals, acids, and alkalis. Welding fumes were suspected as the causative agent in 3.5% of the incidents. In 5.3% of the cases, identifying a probable risk factor was not feasible due to privacy or consent limitations during the reporting process, which hindered further investigation of the workplace (Table 3).

The most commonly reported condition was "Injuries involving multiple body regions, poisoning, other traumas," which includes acute poisoning, the primary focus of the surveillance system, accounting for 28.6% of all reports. Respiratory diseases were present in 23.8% of the cases, and cancer was reported in 301 cases (Table 4). Considering that workers' compensation recognizes only about 500 chemical exposure-related illnesses annually, the surveillance system captures a broader spectrum of milder illnesses, complicating direct comparisons. Nevertheless, it proves effective in uncovering the broader scope of issues beneath the surface.

Some reported cases were sentinel cases of high public health importance that urgently required government intervention. For example, in Seoul, a case of toxic hepatitis linked to trichloromethane in a cleaning product was reported. Following confirmation of this case, an ad hoc medical examination of all workers using the product identified six additional cases of toxic hepatitis. In Gwangju, a case of blood cancer potentially caused by benzene exposure prompted a thorough assessment of workplace conditions and biological monitoring of the workers. Lastly,

Table 2. Reported cases in 2023

Suspicious case reports				Investigation		Total	
KODSC OPD or Adm	KODSC ER	Partner hospital	Others	Total	Risk investigation	Investigation support	
1,306	509	1,700	826	4,341	24	33	4,389
(30.1%)	(11.7%)	(39.2%)	(19.0%)	(100.0%)			

KODSC, Korea Occupational Disease Surveillance Center.



Table 3. Suspected risk factors for reported cases in 2023

Risk factors	Number (%)
Organic chemicals	888 (20.5)
Mineral dusts	560 (12.9)
Biological factors	349 (8.0)
Gases	316 (7.3)
Metals	284 (6.5)
Acids or alkalis	256 (5.9)
Asbestos	214 (4.9)
Ultraviolet	214 (4.9)
High temperature	178 (4.1)
Welding fume	154 (3.5)
Нурохіа	92 (2.1)
Wood dust	58 (1.3)
Metalworking fluids	40 (0.9)
Man-made fibers (glass fibers)	13 (0.3)
lonizing radiation	6 (0.1)
Abnormal barometric pressure	3 (0.1)
Others	484 (11.1)
Unknown	232 (5.3)
Total	4,341 (100)

Table 4. Disease classifications of reported cases in 2023

Dise	ease classification	Number (%)
Α	Infection	46 (1.1)
В	Virus or parasite	76 (1.8)
С	Malignant neoplasm	301 (6.9)
D	Benign neoplasm, hematologic or immune	34 (0.8)
Е	Endocrine, nutritional and metabolic	6 (0.1)
F	Mental and behavioral	4 (0.1)
G	Nervous system	32 (0.7)
Н	Eye and adnexa, ear and mastoid process	374 (8.6)
	Circulatory system	76 (1.8)
J	Respiratory system	1,034 (23.8)
Κ	Digestive system	26 (0.6)
L	Skin and subcutaneous tissue	259 (6)
М	Musculoskeletal system and connective tissue	21 (0.5)
Ν	Genitourinary system	26 (0.6)
R	Symptoms, signs and abnormal clinical and laboratory findings	247 (5.7)
S	Injuries	69 (1.6)
Т	Injuries involving multiple body regions, poisoning, other traumas	1,241 (28.6)
U	Codes for special purposes	1 (0)
V	Transport accidents	1 (0)
W	Other external causes of accidental injury	9 (0.2)
Χ	High temperature	272 (6.3)
Υ	Event of undetermined intent	1 (0)
Ζ	Factors influencing health status and contact with health services	110 (2.5)
Unkı	nown	75 (1.7)
Tota	l	4,341 (100)



in Daegu, a reported case of acute arsine poisoning, along with several other serious illnesses in the workplace, initiated an investigation into provisional medical examinations and compliance with relevant laws and regulations.

Conclusion -

More workers are being approved for compensation for work-related illnesses because the workforce is aging and various occupational factors exacerbate workers' health problems. Workers engaged in multiple or short-term, precarious jobs are particularly vulnerable to acute poisoning, especially if they lack familiarity with their work environments or the chemicals they handle. There is a growing academic and policy focus on socio-psychological risk factors, such as work hours and stress [25]. However, due to shifts in the labor market, health issues are increasingly being examined in sectors with a high concentration of vulnerable workers, such as construction [26] and gig labor [27]. The labor market's increasing polarization and flexibility have resulted in a diverse group of workers who fall outside the protection of the current occupational health system and workers' compensation insurance. Consequently, implementing full-time surveillance systems in hospitals has become a crucial policy tool [28].

The KODSC is a regional hospital-based surveillance system designed to detect occupational diseases, including acute poisoning. Established in April 2022, it builds on the experiences of various surveillance systems in Korea. Despite its recent inception, the KODSC has successfully identified previously unrecognized occupational diseases of varying severity. It specifically addresses cases of acute poisoning that necessitate immediate intervention in the workplace and contributes to the establishment of national prevention policies through prompt action.

The foundational structure for strengthening the promotion and delivery of occupational health services involves collecting, analyzing, and disseminating data on workers' health at the national level [29]. In this context, the KODSC plays a crucial role as it is a publicly funded, hospital-based system that allows the government to continuously monitor various occupational diseases. Utilizing the KODSC, data on occupational diseases can be generated to aid in the planning and implementation of policies. This enables us to address critical questions like, 'What is the most important and urgent problem?' Addressing this question is the initial step in resolving public health issues.

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Conflict of interest

No potential conflict of interest relevant to this article was reported.

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Data availability

The data are available upon request.

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Supplementary materials

Not applicable.

References

- 1. Kang SK, Kim EA. Occupational diseases in Korea. *J Korean Med Sci* 2010;25(Suppl):S4-S12. https://doi.org/10.3346/jkms.2010.25.S.S4
- 2. Korean Women's Development Institute. Gender statistics [Internet]. Seoul (KR): Korean Women's Development Institute; c2024 [cited 2024 Nov 10]. Available from: https://gsis.kwdi.re.kr/statHtml/statHtml.do?orgld=338&tblld=DT_2EB0209N&conn_path=12
- 3. Japan Industrial Safety & Health Association. Fatal occupational injuries per 100'000 workers in ILOSTAT (2012 2022) [Internet]. Tokyo (JP): Japan Industrial Safety & Health Association; c2024 [cited 2024 Nov 10]. Available from: https://www.jisha.or.jp/english/statistics/202310_38.html



- 4. Peter Lundberg, United Nations, Montenegro. World health and safety day: a healthy working environment as fundamental work right [Internet]. Montenegro (ME): United Nations; c2023 [cited 2024 Nov 10]. Available from: https://montenegro.un.org/en/257596-world-health-and-safety-day-healthy-working-environment-fundamental-work-right
- 5. Rushton L. The global burden of occupational disease. *Curr Environ Health Rep* 2017;4(3):340-348.
 - https://doi.org/10.1007/s40572-017-0151-2
- 6. Coggon D. Estimating population burdens of occupational disease. *Scand J Work Environ Health* 2022;48(2):83-85.
 - https://doi.org/10.5271/sjweh.4007
- 7. Lele DV. Occupational health surveillance. *Indian J Occup Environ Med* 2018;22(3):117-120. https://doi.org/10.4103/ijoem.IJOEM_251_18
- Soucie JM. Public health surveillance and data collection: general principles and impact on hemophilia care. *Hematology* 2012;17(sup1):s144-s146. https://doi.org/10.1179/102453312X13336169156537
- 9. Thacker SB, Birkhead GS. Surveillance. In: Gregg M, editor. Field epidemiology. Oxford: Oxford University Press; 2008. p.38-64.
- 10. Smith PF, Hadler JL, Stanbury M, Rolfs RT, Hopkins RS. "Blueprint version 2.0": updating public health surveillance for the 21st century. *J Public Health Manag Pract* 2013;19(3):231-239.
 - https://doi.org/10.1097/PHH.0b013e318262906e
- 11. Choi SB, Lee S, Lee W. Status and prediction of disapproval of the Korean workers' compensation insurance for diseases and injuries. *J Occup Health* 2023;65(1):e12392. https://doi.org/10.1002/1348-9585.12392
- 12. Ministry of Employment and Labor. Analysis of industrial accidents in 2022 [Internet]. Sejong (KR): Ministry of Employment and Labor; c2023 [cited 2024 Nov 10]. Available from: https://www.moel.go.kr/policy/policy/data/view.do?bbs_seq=20231201612
- 13. Kang SK, Jee YK, Ahn YS, Kim HO, Ha MN, Kwon HJ, et al. The present status and perspective of nationwide occupational diseases surveillance system. *Korean J Occup Environ Med* 2001;13(2):116-126.
 - https://doi.org/10.35371/kjoem.2001.13.2.116
- 14. Ryu HW, Kim EA. A coverage estimation of workplace environment measurement and specialty medical exam [Internet]. Ulsan (KR): KOSHA; c2017 [cited 2024 Nov 10]. Available from: https://www.kosha.or.kr/oshri/publication/researchReportSearch.do?mode=view&articleNo=408187&attachNo=
- Ryu J, Lim KH, Ryu DR, Lee HW, Yun JY, Kim SW, et al. Two cases of methyl alcohol intoxication by sub-chronic inhalation and dermal exposure during aluminum CNC cutting in a small-sized subcontracted factory. *Ann Occup Environ Med* 2016;28(4):65. https://doi.org/10.1186/s40557-016-0153-9
- 16. Do SY, Lee CG, Kim JY, Moon YH, Kim MS, Bae IH, et al. Cases of acute mercury poisoning by mercury vapor exposure during the demolition of a fluorescent lamp factory. *Ann Occup Environ Med* 2017;29(2):19.
 - https://doi.org/10.1186/s40557-017-0184-x
- 17. Shin MY, Park JS, Park HD, Lee J. HCFC-123-induced toxic hepatitis and death at a Korean fire extinguisher manufacturing facility: a case series. *Ann Occup Environ Med* 2018;30(1):20. https://doi.org/10.1186/s40557-018-0231-2



- Hwang JH, Kim JI. A case report of toxic hepatitis caused by chloroform in automotive parts manufacturer coating process. *Ann Occup Environ Med* 2022;34:e22. https://doi.org/10.35371/aoem.2022.34.e22
- Kwon SC, Song J, Kim Y, Calvert GM. Work-related asthma in Korea findings from the Korea work-related asthma surveillance (KOWAS) program, 2004-2009. *Allergy Asthma Immunol Res* 2015;7(1):51-59. https://doi.org/10.4168/aair.2015.7.1.51
- 20. Leem JH, Kim HC, Ryu JS, Won JU, Moon JD, Kim YC, et al. Occupational lung cancer surveillance in South Korea, 2006-2009. *Saf Health Work* 2010;1(2):134-139. https://doi.org/10.5491/SHAW.2010.1.2.134
- 21. Koh DH, Park JH, Lee SG, Kim HC, Choi S, Jung H, et al. Development of Korean CARcinogen EXposure: an initiative of the occupational carcinogen surveillance system in Korea. *Ann Work Expo Health* 2021;65(5):528-538. https://doi.org/10.1093/annweh/wxaa135
- 22. Min YS, Lee S, Kim M, Ahn YS. Rheumatoid arthritis in low-level toluene-exposed workers based on nationwide medical surveillance data in Korea. *Am J Ind Med* 2021;64(4):245-250. https://doi.org/10.1002/ajim.23226
- 23. Min YS, Ahn YS. Central nervous system diseases of organic solvents exposed workers based on nationwide medical surveillance-data in Korea. *Am J Ind Med* 2016;59(5):392-398. https://doi.org/10.1002/ajim.22568
- 24. Rutstein DD, Mullan RJ, Frazier TM, Halperin WE, Melius JM, Sestito JP. Sentinel health events (occupational): a basis for physician recognition and public health surveillance. *Am J Public Health* 1983;73(9):1054-1062. https://doi.org/10.2105/AJPH.73.9.1054
- 25. Kang HT, Kim CJ, Lee DW, Park SG, Lee J, Youn K, et al. Statement by the Korean Society of Occupational and Environmental Medicine on the proposed reform of working hours in South Korea. *Ann Occup Environ Med* 2023;35:e17. https://doi.org/10.35371/aoem.2023.35.e17
- 26. Lee S, Kim YJ, Kim Y, Kang D, Kim SC, Kim SY. Incidence rates of injury, musculoskeletal, skin, pulmonary and chronic diseases among construction workers by classification of occupations in South Korea: a 1,027 subject-based cohort of the Korean Construction Worker's Cohort (KCWC). *Ann Occup Environ Med* 2023;35:e26. https://doi.org/10.35371/aoem.2023.35.e26
- 27. Kim MS, Oh J, Sim J, Yun BY, Yoon JH. Association between exposure to violence, job stress and depressive symptoms among gig economy workers in Korea. *Ann Occup Environ Med* 2023;35:e43.
 - https://doi.org/10.35371/aoem.2023.35.e43
- 28. Yang L, Branscum A, Kincl L. Understanding occupational safety and health surveillance: expert consensus on components, attributes and example measures for an evaluation framework. *BMC Public Health* 2022;22(1):498. https://doi.org/10.1186/s12889-022-12895-6
- 29. Kang D. Problems and suggested improvement plans for occupational health service in Korea. *Ann Occup Environ Med* 2023;35:e10. https://doi.org/10.35371/aoem.2023.35.e10



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Environmental disease monitoring by regional Environmental Health Centers in Korea: a narrative review

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Environmental health: Health policy: Local government: Republic of Korea: Socioeconomic factors

This study explores the development, roles, and key initiatives of the Regional Environmental Health Centers in Korea, detailing their evolution through four distinct phases and their impact on environmental health policy and local governance. It chronicles the establishment and transformation of these centers from their inception in May 2007, through four developmental stages. Originally named Environmental Disease Research Centers, they were subsequently renamed Environmental Health Centers following legislative changes. The analysis includes the expansion in the number of centers, the transfer of responsibilities to local governments, and the launch of significant projects such as the Korean Children's Environmental Health Study (Ko-CHENS). During the initial phase (May 2007-February 2009), the 10 centers concentrated on research-driven activities, shifting from a media-centered to a receptor-centered approach. In the second phase, prompted by the enactment of the Environmental Health Act, six additional centers were established, broadening their scope to address national environmental health issues. The third phase introduced Ko-CHENS, a 20-year national cohort project designed to influence environmental health policy by integrating research findings into policy frameworks. The fourth phase marked a decentralization of authority, empowering local governments and redefining the centers' roles to focus on regional environmental health challenges. The Regional Environmental Health Centers have significantly evolved and now play a crucial role in addressing local environmental health issues and supporting local government policies. Their capacity to adapt and respond to region-specific challenges is essential for the effective implementation of environmental health policies, reflecting geographical, socioeconomic, and demographic differences.

Introduction

Background

Industrialization has played a significant role in increasing environmental pollution and the prevalence of diseases associated with hazardous chemicals, profoundly impacting public health, quality of life, and socioeconomic systems. In 1985, South Korea faced a major public health crisis known as the "Onsan Disease" in Onsan-myeon, Ulsan. This incident was triggered by pollutants discharged into the air and water from a nearby metal industrial complex, leading to neuralgia, skin diseases, and systemic pain among 700 local residents, including children. During the 1990s, health issues surfaced among residents living near the Yeosu Yeocheon industrial complex, attributed to unpleasant odors, particulate matter, and toxic gases released by oil refining and fertilizer manufacturing facilities [1].

The 1991 Nakdong River phenol contamination incident, resulting from two illegal discharges in March and April, polluted the middle and downstream sections of the Nakdong River. This event heightened national awareness of environmental issues and prompted substantial changes in environmental policies [2].

Abandoned metal mines, such as the one in Goseong County, Gyeongnam, have been linked to suspected cases of itai-itai disease among nearby residents [3]. Additionally, residents living near cement factories have experienced health impacts, including chronic obstructive pulmonary disease and pneumoconiosis, due to exposure to dust. These incidents exemplify the public health damages caused by environmental pollution during the industrialization process [4]. Furthermore, the production, processing, and use of various chemical substances have led to significant environmental issues. There is increasing evidence that these environmental



exposures negatively impact biologically vulnerable populations, such as infants and children. Specifically, these exposures can affect respiratory and pulmonary functions [5,6], growth and development [7], neurocognitive development [8–11], and renal function [12].

Per- and polyfluoroalkyl substances were detected in 99% of participants in the National Environmental Health Survey [13]. Higher concentrations of harmful substances in adults were associated with the use of personal hygiene products, including cosmetics and hair care items, as well as food storage containers [14,15]. Additionally, children's use of slime or clay was linked to exposure to bisphenol A [16].

Public awareness of environmental issues is increasing, leading to a greater interest in the relationship between the environment and human health. This shift has encouraged the adoption of lifestyles that emphasize sustainability and well-being. In response, the Ministry of Environment, pursuant to Article 26 of the Environmental Health Act [17], has operated Environmental Health Centers since 2007. These centers aim to proactively manage health risks linked to environmental hazards.

Objectives

This study explores the evolution of Environmental Health Centers over time and assesses the roles and significance of the current Regional Environmental Health Centers by evaluating their status and functions.

Evolution of Environmental Health Centers in Korea

Phase 1: Environmental Disease Research Centers (May 2007-February 2009)

Phase 1 marked the establishment of Environmental Disease Research Centers following the formulation of the 10-Year Comprehensive Environmental Health Plan in 2006 and the drafting of the Environmental Health Act [18]. This stage represented a shift from the traditional media-centered approach, which focused on air, water, waste, and soil, to a receptor-centered approach that emphasized the impacts of environmental pollution on humans and ecosystems. Ten centers were designated in total: eight focused on environmental diseases, one on hazardous factors, and one on asbestos [19].

In 2007, three specialized research centers were established: the Asthma Research Center at Korea University Anam Hospital, the Atopic Dermatitis Research Center at Samsung Medical Center, and the Pediatric Developmental Disorders Research Center at Dankook University Medical Center. These centers focused on identifying vulnerable populations, investigating environmental factors influencing asthma, and exploring the links between environmental exposure and pediatric developmental disorders.

In 2008, six additional centers were established to focus on congenital disorders, allergic diseases, pediatric cancers, and asbestos-related diseases. Notable initiatives included monitoring and public health interventions in areas impacted by environmental pollution, such as the oil spill in Taean [20]. By 2009, the Asbestos Pulmonary Disease Research Center at Soonchunhyang University Cheonan Hospital had been designated to study asbestos-related diseases.

This phase was pivotal in changing the paradigm surrounding environmental issues and enhancing public awareness of environmental diseases. However, its emphasis on research faced difficulties in effectively communicating findings to the public and translating them into actionable policies [21].



Phase 2: Environmental Health Centers (March 2009–2015)

The second phase commenced with the enactment of the Environmental Health Act in 2009, which led to the renaming of the centers as Environmental Health Centers. This phase signaled a nationwide expansion to 16 centers, including nine disease-focused centers, five centers concentrating on hazardous factors, and two centers specifically addressing asbestos-related issues.

The six new centers are each dedicated to a specific area of research: Ulsan University Hospital focuses on atopic diseases, Yonsei University Wonju Campus investigates natural radon exposure, Gangwon National University Hospital explores respiratory diseases, Dong-A University studies heavy metal exposure, Soonchunhyang University Gumi Hospital examines harmful gas exposure, and Asan Medical Center researches hazardous chemicals.

During this phase, the Environmental Health Centers played a critical role in addressing emerging environmental health issues and generating diverse research outcomes.

Phase 3: Environmental Health Centers with National Cohort Projects (2015–2019)

Phase 3 introduced the Korean Children's Environmental Health Study (Ko-CHENS) [22], a 20year national cohort project aimed at examining the effects of environmental hazards on growth, development, allergies, and emotional health from fetal to adolescent stages. Between 2015 and 2020, approximately 70,000 pregnant women enrolled in the study, with follow-up assessments planned until their children reach the age of 16.

Environmental Health Centers engaged in various cohort-related activities, including conducting environmental surveys, collecting biological samples, assessing growth and neurocognitive development, and monitoring indoor air quality. Throughout this phase, the centers strategically shifted their focus, contributing to the development of comprehensive environmental health policies through evidence-based research.

Phase 4: Regional Environmental Health Centers (2020–Present)

The Fourth Comprehensive Environmental Health Plan (2020) highlighted the importance of a "community-centered environmental health foundation" [23]. This shift transferred responsibilities from the central government to local governments, thereby strengthening the legal framework for regional environmental health planning, health impact assessments, and governance.

Regional Environmental Health Centers are now focused on developing local environmental health systems, addressing issues specific to each region, managing regional governance, and delivering tailored environmental health services. By integrating local characteristics into their policies, these centers strive to improve community well-being and promote sustainable development.

In addition to the Regional Environmental Health Centers, four Policy Environmental Health Centers have been established to support the development and implementation of environmental health policies. These centers specialize in different areas of expertise and are divided into four distinct categories. The Environmental Big Data Center, managed by the Korea Environment Institute, is dedicated to developing an integrated environmental health information system. It focuses on monitoring environmental factors and using advanced data analysis techniques to predict health impacts. The Environmental Toxicology Center, situated at Soonchunhyang University Gumi Hospital, aims to create a comprehensive database of chemical information related to bioactive ingredients found in consumer products. This center also plays a



crucial role in enhancing public education and outreach concerning toxic substances.

The Environmental Health Research Information Center, managed by Seokyeong University, consolidates environmental health research into a centralized database. It performs literature reviews and generates reports on both domestic and international environmental health issues and research trends, offering valuable insights for policymakers and researchers. The Health Big Data Center, located at Wonju Severance Christian Hospital, leverages data from the National Health Insurance Service to produce detailed statistics on environmental diseases. The work of this center enhances our understanding of the connections between environmental factors and public health, aiding in evidence-based decision-making. Together, these centers provide essential infrastructure and expertise that bolster environmental health policies and research in Korea.

To cultivate environmental health professionals, the Department of Preventive Medicine at Catholic University, University of Seoul, Inha University Hospital, and the Korean Society of Environmental Health are actively training experts in preventive medicine, toxicology, occupational and environmental medicine, and environmental health sciences.

Status and role of regional Environmental Health Centers

Current status

As of December 2024, 14 Regional Environmental Health Centers are operational across South Korea, located in Gangwon, Chungnam, Seoul, Incheon, Daejeon, Ulsan, Busan, Chungbuk, Jeju, Jeonbuk, Gyeongam, Gyeonggi, Gyeongbuk, and Jeonnam (Table 1) [24]. These centers are hosted by leading institutions, including Kangwon National University Hospital in Gangwon, Ajou University in Gyeonggi, Gyeongsang National University in Gyeongnam, Dongguk University in Gyeongbuk, and Seoul National University College of Medicine in Seoul, among others (Fig. 1).

Personnel structure

The Ministry of Environment mandates that organizations eligible to operate Regional Environmental Health Centers must possess the capability to conduct research and surveys, as well as provide policy support related to environmental health information [25]. Eligible organizations include national or public research institutions, universities, and public or private hospitals located within the specified region.

Each center is comprised of a director, a secretariat head, and administrative staff. The director is generally an expert in disciplines pertinent to the center's goals, while the secretariat head is usually a specialist with a background in environmental health, either academic or professional. Currently, the directors are predominantly physicians and professors with expertise in preventive medicine, occupational and environmental medicine, and respiratory medicine. Secretariat heads, on the other hand, often hold doctoral degrees in fields such as preventive medicine, public health, or environmental engineering, reflecting the center's focus. As of 2024, the 14 Regional Environmental Health Centers employ approximately 200 personnel, including both full-time and part-time staff. The staffing at each center varies, ranging from as many as 30 to as few as 5 members, based on the center's size and operational scope.

Funding

The financial support for Regional Environmental Health Centers is equally divided between the Ministry of Environment and local governments, with each contributing 50%. Starting in 2024, each center will operate with an annual budget of approximately 600 million KRW, which



Table 1. Current status of regional Environmental Health Centers (as of December 2024)

No.	Designated area	Host institution	Operating period	Project focus
1	Gangwon	Kangwon National University Hospital	`20.01.01–`24.12.31	Establishing an environmental health foundation for the Gangwon region
2	Chungnam	Soonchunhyang University Cheonan Hospital	`21.01.04-`24.12.31	Establishing an environmental health foundation for the Chungnam region
3	Seoul	Seoul National University College of Medicine	`22.03.02–`26.12.31	Establishing an environmental health foundation for the Seoul region
4	Incheon	Gachon University	`22.03.02=`26.12.31	Establishing an environmental health foundation for the Incheon region
5	Daejeon	Daejeon University	`22.03.02-`26.12.31	Establishing an environmental health foundation for the Daejeon region
6	Ulsan	Ulsan University Hospital	`22.03.02-`26.12.31	Establishing an environmental health foundation for the Ulsan region
7	Busan	Dong-A University	`22.03.02-`26.12.31	Establishing an environmental health foundation for the Busan region
8	Chungbuk	Chungbuk National University Hospital	`22.03.02-`26.12.31	Establishing an environmental health foundation for the Chungbuk region
9	Jeju	Jeju National University	`22.03.02-`26.12.31	Establishing an environmental health foundation for the Jeju region
10	Jeonbuk	Jeonbuk National University	`23.04.01=`27.12.31	Establishing an environmental health foundation for the Jeonbuk region
11	Gyeongnam	Gyeongsang National University	`23.04.01=`27.12.31	Establishing an environmental health foundation for the Gyeongnam region
12	Gyeonggi	Ajou University	`24.03.20=`28.12.31	Establishing an environmental health foundation for the Gyeonggi region
13	Gyeongbuk	Dongguk University (WISE Campus)	`24.03.20=`28.12.31	Establishing an environmental health foundation for the Gyeongbuk region
14	Jeonnam	Chonnam National University Hospital, Hwasun	`24.03.20=`28.12.31	Establishing an environmental health foundation for the Jeonnam region

is split evenly between the Ministry of Environment and local governments, each providing 300 million KRW.

Major activities

The primary activities of the Regional Environmental Health Centers are outlined in Table 2.

Establishing a preliminary monitoring system

Centers are responsible for investigating and monitoring environmental diseases and hazardous factors. Their activities include assessing and monitoring exposure in vulnerable areas, as well as using biological samples (e.g., blood and urine) to evaluate region-specific exposures.

Building a regional environmental health foundation

While the authority and responsibility for environmental health have been transferred to local governments, many still lack the necessary human and systemic resources for effective implementation. The centers are vital in supporting local governments to carry out environmental health policies. They assist in developing regional environmental health plans, establishing collaborative governance structures, conducting regional health impact assessments, and



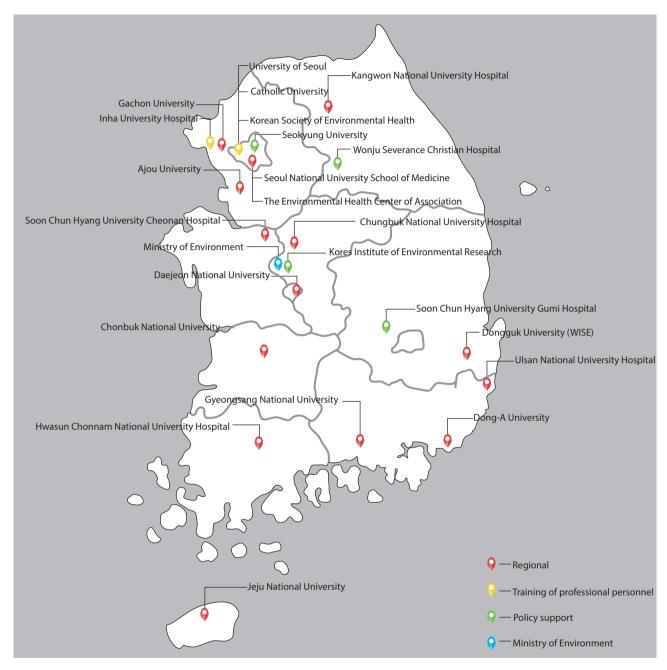


Fig. 1. Current landscape of Environmental Health Centers in Korea.

building big data systems for environmental health. This support provides the scientific evidence needed for local policymaking.

Facilitating risk communication

Centers increase public awareness of environmental health by providing information to local residents, offering tailored education programs for sensitive populations, conducting environmental health camps, and disseminating information online. These efforts help to raise public consciousness about environmental health.



Table 2. Activities of regional Environmental Health Centers

Category	Detailed activities			
Establishing preliminary monitoring systems	 Investigation and monitoring of environmental diseases and hazardous factors Exposure and health monitoring in environmentally vulnerable areas Chemical exposure assessment using biological samples (e.g., blood or urine) by region 			
Strengthening regional environmental health systems	 Supporting the development of regional environmental health policies Establishing collaborative governance for environmental health Supporting health impact assessments and petition handling Building regional environmental health big data Conducting expert forums and related initiatives to strengthen the regional environmental health foundation 			
Developing regional risk communication systems	 Establishing and operating environmental health information delivery systems Hosting environmental health camps for residents on local environmental health issues Conducting environmental health communication activities (e.g., Environmental Health Open Concerts, newsletters) 			
Collaboration in key research projects of the Ministry of Environment	 Conducting health impact studies in environmentally vulnerable areas Participating in the Ko-CHENS Supporting investigations and assessments related to humidifier disinfectants Conducting preventive initiatives for vulnerable groups with environmental diseases Health support projects in health impact assessment areas 			
Other activities	 Supporting the Environmental Health Integrated Information System Conducting research, investigations, or providing consultations, as stipulated in the Environmental Health Act or as requested by the Minister of Environment or local governments 			

Supporting research and investigations

Centers support health impact assessments in environmentally vulnerable areas and support projects like the Children's Environmental Health Birth Cohort Study.

Other activities

Centers are responsible for managing the Environmental Health Integrated Information System, which was established by the Ministry of Environment. They also conduct research, investigations, and consultations as required by the Environmental Health Act or as requested by the Minister of Environment and local governments.

Key achievements [26]

Establishment of a preliminary monitoring system for environmental hazards

- Health impact surveys supported vulnerable populations, with 2,776 individuals completing questionnaires and 2,893 undergoing clinical examinations.
- For environmental hazard monitoring, 34 internet of things-based air quality monitoring stations were established, and a database of 10,788 entries was developed.

Strengthening regional environmental health systems

- Identifying regional environmental health issues and supporting the development of environmental health plans.
- Article 6-2 of the Environmental Health Act mandates that mayors and governors formulate regional environmental health plans considering local characteristics. Centers in Seoul, Jeju, and Gangwon have supported the formulation and implementation of these plans for respective local governments.



Strengthening governance for environmental health systems

- Projects were initiated to strengthen governance by facilitating local environmental health petitions and supporting risk communication during health impact assessments, as specified in Article 17 of the Environmental Health Act. For example, the Ulsan Center carried out health impact assessments and improved communication for residents living near an asphalt concrete plant. Additionally, governance structures were reinforced by disseminating information about regional environmental health conditions and policy trends, and by exploring solutions to local challenges.

Advancing risk communication in environmental health

- Efforts include establishing cooperative frameworks with relevant institutions to efficiently address environmental health issues.
 - The "Mobile Environmental School" initiative was launched in collaboration with environmental disease prevention centers to provide elementary students with education and activities focused on the climate crisis and disease prevention. In 2023, this program reached 1,159 students across 55 classes in 24 schools, including those in underserved island regions, thereby ensuring equitable access to environmental health education.
- An environmental health concert was held to address citizens' concerns about environmental health through a series of online and offline lectures, complemented by real-time Q&A sessions. In 2023, the event comprised five sessions, which were attended by 1,474 participants, thereby increasing public awareness.

Hosting international symposia on environmental health

- Centers collaborated with domestic and international experts to host symposia, fostering knowledge-sharing and networking. For example, in 2024, the Seoul Center co-hosted two symposia with WHO ACE, focusing on "Environmental Health Indicators for Climate Change." These events shared global and local case studies and identified actionable points for Seoul.

Health Sharing Camps and support programs

- Health Sharing Camps were organized to serve individuals with environmental diseases and vulnerable populations, offering educational and ecological experiences. In 2023, a total of 27 camps were conducted, engaging 1,097 participants in collaboration with the National Park Service.
- The Vulnerable Population Support Program offered medical and prescription cost assistance to 118 individuals with environmental diseases.

Participation in the National Children's Environmental Health Birth Cohort Study

- Since 2015, various centers have been involved in a long-term cohort project aimed at investigating the health impacts of environmental factors from pregnancy through adolescence. As of 2023, follow-up studies have been conducted for 2,223 children.

Conclusion

The role of Environmental Health Centers has evolved significantly over time. Initially established as Environmental Disease Research Centers with a focus on research-oriented activities, their responsibilities have now expanded to include education, public outreach, and



risk communication with citizens. This transition reflects a shift from a centrally driven model to one where local governments are supported in developing and implementing environmental health policies, as well as in identifying and addressing region-specific issues.

Currently, 14 Environmental Health Centers are operational, and the Ministry of Environment intends to increase this number. Addressing environmental health challenges necessitates tailored solutions that consider the geographical, environmental, socioeconomic, and demographic characteristics specific to each region. In this context, the Regional Environmental Health Centers function as specialized institutions that assist in developing and implementing localized environmental health policies.

Moreover, these centers play an important role in promoting governance by facilitating discussions among local governments, experts, and residents to address regional environmental issues. They serve as communication hubs, responding to the growing public need for information on environmental health and offering services focused on citizen well-being. As primary contacts for local environmental health matters, these centers aim to boost public involvement and provide concrete benefits to communities, in line with the increasing awareness and expectations of citizens about the relationship between the environment and health.

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References ·

- 1. Han SJ. Environmental degradation and relocation issues around Ulsan and Yeocheon industrial complexes. Seoul: Korean Sociological Association; 2000. p.294-302.
- 2. Choi MO. A case study of environmental policy formation: a focus on the phenol spills in Nakdong river of 1991 and 2008. *GRI Rev* 2013;15(1):91-112.
- 3. Kwon HJ. Lessons of Goseong abandoned metal mine accident. *J Environ Health Sci* 2011;37(5):335-341.
 - https://doi.org/10.5668/JEHS.2011.37.5.335
- 4. Leem JH. Cement dust and environmental diseases. *J Korean Med Assoc* 2012;55(3):230-233.
 - https://doi.org/10.5124/jkma.2012.55.3.230
- Burbank AJ, Sood AK, Kesic MJ, Peden DB, Hernandez ML. Environmental determinants of allergy and asthma in early life. *J Allergy Clin Immunol* 2017;140(1):1-12. https://doi.org/10.1016/j.jaci.2017.05.010
- Vernet C, Pin I, Giorgis-Allemand L, Philippat C, Benmerad M, Quentin J, et al. *In utero* exposure to select phenols and phthalates and respiratory health in five-year-old boys: a prospective study. *Environ Health Perspect* 2017;125(9):097006. https://doi.org/10.1289/EHP1015
- Choe Y, Kim KN, Lee YJ, Kim JI, Kim BN, Lim YH, et al. Prenatal and childhood exposure to endocrine-disrupting chemicals and early thelarche in 8-year-old girls: a prospective study using Bayesian kernel regression. *Environ Res* 2024;263(Part 1):120056. https://doi.org/10.1016/j.envres.2024.120056
- 8. Kim JI, Kim BN, Lee YA, Shin CH, Hong YC, Døssing LD, et al. Association between early-childhood exposure to perfluoroalkyl substances and ADHD symptoms: a prospective cohort



- study. *Sci Total Environ* 2023;879:163081. https://doi.org/10.1016/j.scitotenv.2023.163081
- Kim M, Park C, Sakong J, Ye S, Son S, Baek K. Association of heavy metal complex exposure and neurobehavioral function of children. *Ann Occup Environ Med* 2023;35:e23. https://doi.org/10.35371/aoem.2023.35.e23
- Boucher O, Jacobson SW, Plusquellec P, Dewailly É, Ayotte P, Forget-Dubois N, et al. Prenatal methylmercury, postnatal lead exposure, and evidence of attention deficit/hyperactivity disorder among Inuit children in Arctic Quebec. *Environ Health Perspect* 2012;120(10):1456-1461.
 - https://doi.org/10.1289/ehp.1204976
- 11. Yu CJ, Du JC, Chiou HC, Chung MY, Yang W, Chen YS, et al. Increased risk of attention-deficit/hyperactivity disorder associated with exposure to organophosphate pesticide in Taiwanese children. *Andrology* 2016;4(4):695-705. https://doi.org/10.1111/andr.12183
- Yun J, Jang EC, Kwon SC, Min YS, Lee YJ. The association of perfluoroalkyl substances (PFAS) exposure and kidney function in Korean adolescents using data from Korean National Environmental Health Survey (KoNEHS) cycle 4 (2018–2020): a cross-sectional study. *Ann Occup Environ Med* 2023;35:e5. https://doi.org/10.35371/aoem.2023.35.e5
- 13. Hong S, Kim OJ, Jung SK, Jeon HL, Kim S, Kil J. The exposure status of environmental chemicals in South Korea: the Korean National Environmental Health Survey 2018–2020. *Toxics* 2024;12(11):829.
 - https://doi.org/10.3390/toxics12110829
- 14. Kim S, Cho S, Yoon S, Kim D, Park HW, Kang J, et al. Relationship between the use of hair products and urine benzophenone-3: the Korean National Environmental Health Survey (KoNEHS) cycle 4. *Ann Occup Environ Med* 2024;36:e20. https://doi.org/10.35371/aoem.2024.36.e20
- 15. Huh SW, Cho S, Yoon S, Kim D, Park HW, Kang J, et al. Relationship between crustacean consumption and serum perfluoroalkyl substances (PFAS): the Korean National Environmental Health Survey (KoNEHS) cycle 4. *Ann Occup Environ Med* 2024;36:e12. https://doi.org/10.35371/aoem.2024.36.e12
- Shin S, Ryoo JH. Environment-wide association study to identify exposure pathways of bisphenol A in Korean children and adolescents: Korean National Environmental Health Survey (KoNEHS) 2018-2020. *Environ Res* 2023;238(Part 2):117187. https://doi.org/10.1016/j.envres.2023.117187
- 17. Korea Ministry of Government Legislation. Environmental Health Act [Internet]. Sejong (KR): Korea Ministry of Government Legislation; c2024 [cited 2024 Dec 11]. Available from: https://www.law.go.kr/법령/환경보건법
- 18. Ministry of Environment. The 10-year comprehensive environmental health plan (2006–2015). Sejong: Ministry of Environment; 2006.
- 19. Ministry of Environment. Research on advancing Environmental Health Centers. Sejong: Ministry of Environment; 2017.
- 20. Park MS, Choi KH, Lee SH, Hur JI, Noh SR, Jeong WC, et al. Health effect research on Hebei Spirit Oil Spill (HEROS) in Korea: a cohort profile. *BMJ Open* 2019;9(8):e026740. https://doi.org/10.1136/bmjopen-2018-026740
- 21. National Institute of Environmental Research. Research on establishing national



- environmental health governance systems. Incheon: National Institute of Environmental Research; 2010.
- 22. Jeong KS, Kim S, Kim WJ, Kim HC, Bae J, Hong YC, et al. Cohort profile: beyond birth cohort study The Korean Children's Environmental Health Study (Ko-CHENS). *Environ Res* 2019;172:358-366.
 - https://doi.org/10.1016/j.envres.2018.12.009
- 23. Ministry of Environment. The 2nd comprehensive environmental health plan (2021–2030). Sejong: Ministry of Environment; 2020.
- 24. Environmental Health Integrated Information System. Current status of regional Environmental Health Centers [Internet]. Seoul (KR): Korea Environmental Industry and Technology Institute; c2024 [cited 2024 Dec 20]. Available from: https://www.ehtis.or.kr/cmn/sym/mnu/mpm/62004000/htmlMenuView.do
- 25. Ministry of Environment. Guidelines for operating Environmental Health Centers. Sejong: Ministry of Environment; 2023.
- 26. Ministry of Environment. 2023 Environmental Health Center performance report. Sejong: Ministry of Environment; 2024.

Review



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Challenges from 14 years of experience at Workers' Health Centers in basic occupational health services for micro and small enterprises in Korea: a narrative review

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Keywords

Case managers; Occupational diseases; Occupational health services; Republic of Korea; Workplace



Health and safety issues in micro and small enterprises (MSEs) are recognized as a global challenge. This study aimed to examine Workers' Health Centers (WHCs) as a representative public organization providing occupational health services to MSEs in Korea. WHCs were established in 2011 after a trial period aimed at addressing occupational diseases in MSEs with limited resources. As of 2024, there are 24 WHCs, 22 branch offices, and 23 trauma counseling centers for workers. These health centers are managed by the Korea Occupational Safety and Health Agency, with their actual operation delegated to private organizations. Each WHC employs an average of 13 staff members and is organized into four specialized teams: cardiovascular disease prevention, workplace environment improvement, musculoskeletal disease prevention, and occupational stress management. These centers also offer common basic programs along with region-specific specialized initiatives. In 2023, the total cumulative number of users reached 203,877, with employees from MSEs comprising approximately 88.5% of the total. WHCs can thus be seen as playing a pivotal role as case managers of health requirements in the workplace by fostering strong relationships with MSEs and linking them to other relevant programs through a problem-solving-oriented approach. Given the limited resources of these enterprises, proactive policies and the equitable application of safety and health regulations are essential. A balanced strategy that combines regulatory enforcement with practical assistance is critical to ensure the success of WHCs in improving health and safety conditions in MSEs.

Introduction

Background

Health and safety issues in micro and small enterprises (MSEs), which account for 70 percent of total employment worldwide [1], are recognized as a significant global challenge [2-4]. According to Organization for Economic Co-operation and Development (OECD) criteria, microenterprises are businesses with fewer than 10 employees, while small enterprises have between 10 and 49 employees. Thus, MSEs are workplaces with fewer than 50 employees. To sustain themselves,

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MSEs typically adopt a low-road strategy, relying on low wages and price competitiveness. They occupy a less powerful position in the global value chain compared to medium and large businesses and often bear the risks and costs transferred from their larger counterparts. With increasing pressures on working conditions, such as unstable contracts, low wages, and unpaid overtime [5], the workforce becomes increasingly vulnerable to occupational safety and health (OSH) risks. Additionally, as organizational interdependence becomes more complex and employment relationships fracture, the gap between employment contracts, employment regulations, and management controls widens. Therefore, MSEs lack the resources necessary for OSH prevention and appropriate management, leaving their employees exposed to significant risks to their well-being, along with poor working conditions and low-quality work.

In OECD countries, the rates of fatal occupational injuries in 2020 ranged from less than one to over five per 100,000 workers [6]. In the same year, Korea reported a rate of 4.65 fatal occupational injuries per 100,000 workers. Although this rate is decreasing, it remains significantly high. Similar to MSEs in other countries [7], those in Korea experience a higher incidence of occupational injuries and diseases compared to medium and large enterprises [8]. A 2022 report on industrial accidents revealed that the overall company accident rate was 0.65, while workplaces with fewer than five employees had a rate of 1.12 [9]. In contrast, enterprises with 50 or more employees all reported rates below the average. In MSEs, musculoskeletal disorders (MSDs), such as back pain, constitute almost 55% of occupational diseases, making them the most prevalent [9-11]. These are followed by hearing loss, pneumoconiosis, and cardiovascular disease (CVD). Additionally, new types of occupational diseases are emerging, including MSD, CVD, and psychological issues. which differ from the traditional chemical or metal poisoning still present in Korea, as shown by the industrial accident compensation insurance data [9]. However, it is important to note that the industrial accident compensation insurance data does not cover all individuals affected by industrial accidents, especially those with occupational diseases. Coverage is limited to those who have applied for and been granted compensation.

Efforts to prevent occupational diseases in MSEs in Korea have led to the development of three main support programs focused on occupational health: the Clean Workplace Project, financial support for work environment assessments or special medical examinations, and private contractor programs for health and Workers' Health Centers (WHCs) [12,13]. These initiatives collectively target nearly 2 million MSEs, accounting for 98% of the total, and approximately 11 million workers [14]. The Clean Workplace Project offers up to \$23,000 in financial assistance to manufacturing companies with fewer than 50 employees to enhance their OSH facilities. Additionally, financial support is provided for work environment assessments and special medical examinations specifically for MSEs. Private contractor programs for health and WHCs deliver direct occupational health services. The private contractor program for health, which operates solely in the workplace, focuses on managing chronic diseases and workplace hygiene through the services of a nurse or occupational hygienist [8]. In contrast, WHCs are situated in industrial complexes and staffed by a range of specialists including experts in occupational and environmental medicine, nurses, exercise specialists, occupational hygienists, and psychological counselors [15]. These centers offer services both onsite and at the workplace.

Objectives

Although the Korean WHC has been operational for over a decade, there is a notable scarcity of literature that systematically organizes the current status and discussions surrounding these institutions. In light of this gap, this study explores the WHC as a key public organization



providing occupational health services to MSEs in Korea.

Ethics statement

It is a literature database-based review; therefore, neither approval by the institutional review board nor obtainment of informed consent was required.

Methods

To explore the status and discussions regarding WHCs in Korea, we first used domestic and international search tools to locate WHC-focused papers and reports authored by Korean researchers. For Korean-language papers, we searched using the keywords 근로자건강센 터 ("workers' health center") and 직업트라우마센터 ("trauma counseling center for workers") in Google Scholar, the DataBase Periodical Information Academic (DBPIA), the Research Information Sharing Service (RISS), the Korean Studies Information Service System (KISS), and the National Assembly Library. To identify English-language papers, we used the search terms "workers' health center and Korea" and "trauma counseling center for workers and Korea" in Google Scholar and PubMed. We also reviewed references cited in the initially identified documents, as well as official WHC operations reports published by the Korea Occupational Safety and Health Agency (KOSHA). The content of the selected papers and reports was analyzed and categorized into data on the background, development, and performance of WHCs. Papers and reports unrelated to WHCs were excluded from the analysis.

Results -

Background of Workers' Health Centers

The Participatory Government, which was established in February 2003, formed the Presidential Advisory Committee on Aging and Future Society in March 2004. This committee was tasked with developing a national strategy to address the challenges of a low birth rate and an aging population [16]. In September 2004, the committee released the Healthcare System Reform Plans for Ensuring Public Health in an Aging and Future Society [17]. Included in this report was a proposal to create an industrial health management system through collaboration with the Ministry of Health and Welfare and the Ministry of Labor. To support this initiative, these ministries launched a joint project aimed at establishing an industrial health center, which would offer industrial health services funded by the National Health Promotion Fund [18].

In September 2006, the establishment review committee selected the Banwol-Sihwa area, a national industrial complex with a high concentration of MSEs, as the site for the new industrial health center. The Banwol-Sihwa Regional Center for Occupational Health opened in March 2007 [19]. From 2007 to 2009, the center was operated by KOSHA and its staff. In 2010, while KOSHA continued to oversee the center's management and provide administrative support, service provision was handled by medical staff, nurses, and industrial hygienists employed by a privately entrusted organization. By 2011, funding for the Banwol-Sihwa Regional Center for Occupational Health was not included in the National Health Promotion Fund's budget, leading to its closure after four years of operation [18].

The Ministry of Employment and Labor facilitated the establishment of a WHC to provide primary care to MSEs, funded by the Industrial Accident Compensation Insurance and



Prevention Fund. The entire process, from business planning to operation, was delegated to private operating agencies. The inaugural WHC, the Gyeonggi Western WHC, was set up in the Banwol-Sihwa Industrial Complex area, leveraging the existing infrastructure of the Banwol-Sihwa Regional Center for Occupational Health [20]. Subsequently, the Incheon WHC and Gwangju WHC were introduced in 2011 through a public offering [18,21].

Development of Workers' Health Centers

Purpose, legal basis, and funding sources of Workers' Health Centers

The purpose of the WHCs has evolved slightly in line with the operational directives of KOSHA. Initially, when WHCs were introduced in 2012, their primary function was to enhance the prevention of occupational diseases and to support the health maintenance and promotion of workers by offering basic public occupational health services. These services included counseling on preventing occupational diseases, specifically targeting workers in MSEs, which are known for their relatively weak health management systems [22]. By 2016, KOSHA had redefined the purpose of WHCs, positioning them to fulfill the responsibilities of a health officer in MSEs that are not mandated to appoint one [21]. A health officer is tasked with supporting the business owner or the person responsible for safety and health management, especially concerning technical issues, as stipulated by the Occupational Safety and Health Act. This shift marked a transition from a broad and progressive goal of providing basic occupational health services to a more focused objective aligned with the specific duties of a health officer within the Korean occupational health framework. Following the 2018 report on WHC operations, the centers' foundational purpose was no longer explicitly described [23,24]. The focus shifted from defining their "purpose" to specifying their "role," which now includes acting as health officers for MSEs and serving as health quardians for vulnerable enterprises.

The legal basis for the WHCs was established in 2013 when the Occupational Safety and Health Act was revised to include a provision allowing the Minister of Employment and Labor to establish and operate "facilities for maintaining and promoting workers' health" [25]. This revision was further detailed in Notification No. 2013-6 from the Ministry of Employment and Labor, which defined WHCs and outlined the services they offer [26]. In 2019, amendments to the Occupational Safety and Health Act broadened the range of facility users from "workers" to "persons providing labor" [27]. Subsequently, in 2020, specific quidelines for the establishment and operation of WHCs were integrated into Notification No. 2020-19 issued by the Ministry of Employment and Labor [28].

WHCs are funded through the Industrial Accident Compensation Insurance and Prevention Fund, with budgets that vary based on the size of each center. In 2023, the operating budget for each center ranged from 564 to 968 million won (approximately \$400,000-\$670,000, using 2024 exchange rates) [24]. When examining the growth of WHCs in terms of personnel and budget, the number of employees increased by 1.9 times, from 172 in 2016 to 332 in 2023. However, the budget for WHCs only grew by 1.7 times, from KRW 10.33 billion to KRW 17.774 billion over the same period [21,24].

Nationwide distribution and facilities

As of 2024, there are 24 WHCs, 22 branch offices, and 23 trauma counseling centers for workers (Table 1, Fig. 1). The expansion of WHCs began in the early 2010s, with three centers established in 2011, two in 2012, and five annually from 2013 to 2015. Since then, the growth rate has decreased, with one WHC established in 2016, two in 2020, and one in 2024. Starting in



 Table 1. Workers' health centers, branch offices, and trauma counseling centers for workers by region and operating agencies in Korea

Region	Workers' Health Center (WHC)	Branch office (BO)	Trauma counseling center for workers	Operating agency
Seoul	Seoul WHC	Seoul Jung-gu BO	0	Ewha University-Industry Collaboration Foundation
	Seoul Western WHC	Seoul Seongdong BO	0	Seoul National University Research and Development Business Foundation
Busan	Busan WHC	Yangsan BO	0	Busan University Research and Business Development Foundation
Daegu	Daegu WHC	Seodaegu BO	0	Korean Association of Occupational Health Nurses,
		Daegu Dalseong BO		Incorporated Association
Incheon	Incheon WHC	Incheon Bupyeong BO	0	Yonsei University University-Industry Foundation
Gwangju	Gwangju WHC	Gwangju Gwangsan BO	0	Korean Association of Occupational Health Nurses, Incorporated Association
Daejeon	Daejeon WHC	-	0	Korean Association of Occupational Health Nurses, Incorporated Association
Ulsan	Ulsan WHC	Ulsan Buk-gu BO	0	Dong-a University Industry-Academy Cooperation Foundation
Gyeonggi-do	Gyeonggi Western WHC	Gunpo BO	0	Korea University Research and Business Foundation
	Gyeonggi Eastern WHC	Seongnam BO	0	The Catholic University of Korea, Industry-Academic Cooperation Foundation.
	Bucheon WHC	Gimpo Yangchon BO	0	The Catholic University of Korea, Industry-Academic Cooperation Foundation
		Gimpo Gochon BO		
	Gyeonggi Southern WHC	Pyeongtaek BO	0	Korea Workers' Compensation & Welfare Service Ansar Hospital
	Gyeonggi Northern WHC	Namyangju BO	0	Gachon University Industry-Academic Cooperation Foundation
Gangwon special self- governing province	Gangwon WHC	Chuncheon BO	0	Yonsei University Wonju Severance Christian Hospital
Chungcheongbuk-do	Chungbuk WHC	=	0	Korea Industrial Health Association
Chungcheongnam-do	Chungnam WHC	Asan BO	0	Dankook University Industry-Academia Cooperation Foundation
	Chungnam Western WHC	-	-	Mirae Hygiene Environment Institute Co., Ltd.
Jeonbuk special self- governing province	Jeonbuk WHC	Wanju BO	0	Korean Association of Occupational Health Nurses, Incorporated Association
Jeollanam-do	Jeonnam Eastern WHC	-	0	Won-jin Foundation for occupational diseases Green Hospital
	Jeonnam Western WHC	-	-	Mokpo National University Industry-Academic Cooperation Foundation
Gyeongsangbuk-do	Gyeongbuk Northern WHC	Gumi BO	0	Gumi Ganddong Hospital
	Gyeongsan WHC	Yeongcheon BO	0	Korean Association of Occupational Health Nurses, Incorporated Association
Gyeongsangnam-do	Gyeongnam WHC	Changwon BO	0	Teo Occupational and Environmental Medicine Center
	=	Geoje BO	0	Daewoo Medical Foundation
Jeju special self- governing province	Jeju WHC	Jeju Yeon-dong BO	0	Cheju Halla General Hospital



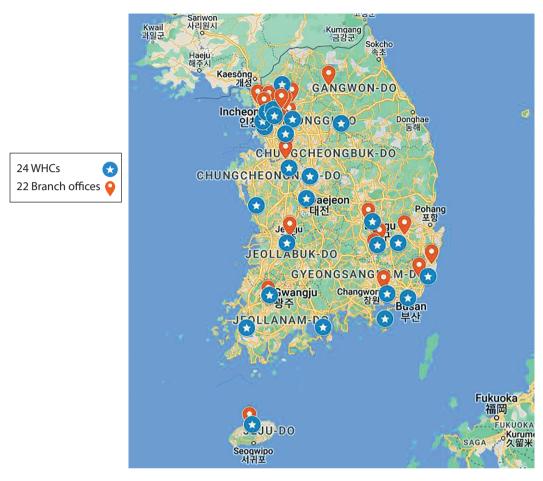


Fig. 1. Distribution of Workers' Health Centers (WHCs) in Korea.

2016, five new branch offices were established to serve workers in industrial complexes located beyond the reach of existing WHCs [21]. The years 2017 and 2023 saw the addition of 16 and one branch office, respectively. To address trauma among workers who have experienced significant industrial accidents, a pilot trauma counseling center for workers was launched in 2018 and 2019. This initiative led to the official establishment of eight institutions in 2020 [29]. The network expanded with five additional centers in 2021, one in 2023, and nine in 2024, totaling 23 operational trauma counseling centers for workers.

WHC facilities cover an area of 400 to 500 square meters, while branch offices range from 80 to 100 square meters [24]. Each center includes a front desk, separate counseling rooms for MSD and CVD prevention, an education room, an exercise room, a psychological counseling room, and a doctor's counseling room. Since WHCs are not medical facilities, they are not equipped to perform diagnostic procedures such as blood draws or X-ray examinations. However, they do have basic testing devices for consultations, exercise equipment, and protective gear for use in the workplace. Since 2018, the WHCs have been maintaining user consultation records through a web-based computer system. This system functions as an integrated platform for both WHCs and branch offices, with data centrally managed by KOSHA [30].

Management and operational staff

The managing agency, KOSHA, oversees the operational status of WHCs and manages



the Central Operation Committee. The actual operation of WHCs is delegated to private organizations, with annual contract renewals between KOSHA and these consignment agencies. ensuring a quaranteed operation period of three years [31]. KOSHA contracts with private agencies that fulfill specific qualification requirements. These agencies are categorized into four types: university-industry collaboration foundations, health-related associations, general hospitals, and hospitals of the Korea Workers' Compensation and Welfare Service [31].

As of December 2023, the total number of employees at WHCs and their branch offices was 302. This count does not include the staff at trauma counseling centers for workers or the Geoje WHC, which operates under a unique staffing structure. This brings the average staffing level to approximately 13 employees per center [24]. Each center is structured into four specialized teams: the CVD Prevention Team, which includes nurses: the Workplace Environment Improvement Team, made up of industrial hygienists; the MSD Prevention Team, staffed by physical therapists or exercise specialists; and the Occupational Stress Management Team. which comprises counseling psychologists. Additionally, each center employs physicians who provide comprehensive counseling. Centers that have a branch office are staffed with one nurse and one additional specialist. In contrast, each trauma counseling center for workers is staffed by two psychology counselors.

Among the operational personnel of WHCs, irregular workers constitute nearly 70%. Their contracts are renewed annually, leading to significant job insecurity [31,32]. In 2021, the turnover rate at WHCs was 15.8%, approximately three times higher than the overall industry average of 4.8% [31]. A 2021 survey revealed that WHC employees are dissatisfied with job security and wage fairness, yet they express considerable satisfaction with their work and job achievements. The most challenging aspects of their work include unilateral work directives from KOSHA, additional tasks stemming from government policies, rude customer behavior, and unfair treatment by contracting agencies, listed in order of difficulty [31].

Key programs and activities

The programs of a WHC are categorized into basic and regional specialization initiatives. Basic programs, implemented by all centers nationwide, encompass post-examination health counseling following general and special health examinations, work environment consulting, health counseling for CVD or MSD prevention, job stress management, education on occupational disease prevention, and monitoring of occupational disease occurrence. Regional specialization initiatives, on the other hand, are tailored to the specific needs of the region in which each center operates. For instance, the Seoul WHC offers an occupational disease prevention program tailored for workers in the printing industry, a health management program for mobile workers such as designated drivers and delivery personnel, and a health management program for care workers [24]. All programs are available both at the center and in the workplace, and can be provided either individually or in groups.

WHCs prioritize networking with a variety of community stakeholders. They share information and experiences, and coordinate activities with regional employment and labor offices of the Ministry of Employment and Labor, regional offices of KOSHA, labor unions, regional organizations, occupational health institutes, and university hospitals, among others. Public relations play a crucial role in promoting and recognizing WHCs. They publicize their activities through websites, social networking sites, leaflets, articles, videos, and TV or radio broadcasts.



Performance of Workers' Health Centers

Key performance indicators

All WHCs are evaluated annually based on performance indicators that encompass quantitative, qualitative, operational, user satisfaction, and bonus categories, as of 2023 [24]. The quantitative evaluation relies on metrics such as improvements in health levels, stabilization rates of occupational trauma, and post-examination health counseling for essential and special employment workers. The qualitative assessment evaluates the appropriateness of regional specialization programs, conducted by a panel of approximately five internal and external experts from KOSHA. The operational evaluation includes on-site inspections by KOSHA officials, who review compliance with operational plans, staffing and operations, the appropriateness of program implementation and budget execution, and personal data protection. The satisfaction survey is conducted by an external company hired by KOSHA, which performs a sample survey of users. Bonus points are awarded for the identification of potential occupational diseases or for winning awards at the Workers' Health Center Excellence Case Competition [24].

Performance of Workers' Health Centers

The number of WHC users has increased alongside the rise in the number of WHCs established (Fig. 2) [24,33,34]. In 2023, the average cumulative number of users per center reached 8,864, equating to about 35 users per day at each center. Employees of MSEs represent approximately 88.5% of the total usage of these centers. As of 2019, 42.9% of all users visited the centers for counseling, while 57.1% received this service at their workplace [35]. User satisfaction with WHCs is exceptionally high. Annually, from the end of October to the end of November, a contracted company conducts a telephone-based structured interview survey. For this survey, 80 users per WHC and 35 users per branch office are randomly selected to participate. The survey assesses various aspects such as convenience, equipment utilization, staff attitudes, service expertise, appropriateness of consultation time, and intention to reuse

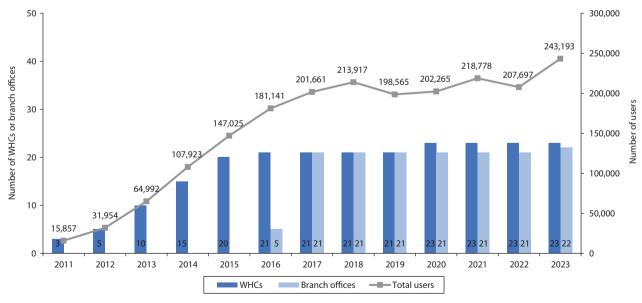


Fig. 2. The number of Workers' Health Centers (WHCs), branch offices, and users by year.



the services. In 2023, the overall satisfaction score for WHCs and branch offices was an impressive 95.4 out of 100 [24].

The WHCs have played a key role in addressing social concerns related to occupational diseases. In 2016, they carried out a health survey targeting retired workers who had been exposed to methyl alcohol [21]. This initiative was in response to several cases of methyl alcohol poisoning among subcontracted MSEs producing smartphone components [36]. Furthermore, when instances of occupational diseases such as toxic liver disease, lead, or arsenic poisoning were reported, health impact assessments were performed for retired workers from the implicated factories [30]. In cases where radon-contaminated consumer goods were detected, assessments were extended to both current and retired workers from the affected workplaces [23]. Additionally, these centers provided support for health counseling and the processing of claims for industrial accident compensation insurance.

Discussion

Over the past 14 years, Korea's WHCs have developed slowly but steadily. These centers focus on providing services to MSEs, where occupational health is often at risk. Several factors contribute to the poor occupational health and safety observed in MSEs. These include a "general and multifaceted lack of resources" [2,37,38]. First, there is a lack of understanding of legal obligations, especially those related to OSH. Additionally, there is limited interest in OSH, minimal time devoted to it, and a general indifference toward learning about improvement measures. Second, MSEs restrict workers' access to the autonomous representation of their interests through work councils and trade unions. Third, MSEs have less access to external health and safety services compared to larger enterprises. Fourth, both workers and employers in MSEs typically have limited experience. Lastly, inspections and controls are infrequent. These conditions may be worsened by other vulnerabilities such as job insecurity, the economic vulnerability of the enterprise, the ongoing threat of unemployment, limited profitability, and the prevalence of illegal work and workers associated with MSEs. All these issues are also relevant in the Korean context [15].

To ensure that the WHCs in Korea effectively fulfill their role in promoting safety and health in MSEs, several challenges must be addressed. Firstly, increasing WHC acceptance among MSEs requires an understanding of their unique characteristics and the development of diversified programs tailored to these attributes. MSE owners, often entrepreneurs and craftsmen, have a strong sense of self-identity [2]. They see themselves as responsible individuals who care for their workers and seek recognition for their commitment. Consequently, identifying workplace risks might be perceived as an indirect criticism, implying negligence or a failure to fulfill their responsibilities. This perception can lead to resistance against external health management. Recognizing these characteristics provides an opportunity to build trust with MSE owners. Engaging in open, meaningful conversations can help address their concerns and foster greater acceptance of workplace safety and health management programs [38]. A strategy that emphasizes trust and dialogue—an action-driven, problem-solving-oriented, low-cost approach combined with aligning health and safety with other management goals, has proven to be the most successful intervention method [38]. WHCs have been providing occupational health services to communities for over 10 years, laying a foundation for establishing credibility with MSEs and creating a structure that facilitates collaboration across various professional fields. WHCs can play a crucial role in case management, building strong relationships with these enterprises, and linking them to other relevant programs, such as the Clean Workplace Project or financial support



programs for work environment assessments and special medical examinations. It is also essential to diversify initiatives, not only by increasing the number of WHC users but also by expanding into programs that prioritize addressing problems specific to MSEs.

Legal regulations should be strengthened to enhance compliance among MSEs. In Korea, these companies are partially exempt from certain regulations. To manage occupational diseases effectively, employers must establish an occupational health management system within their enterprises. The legal requirements for this vary based on the company's size and the industry in which it operates. For enterprises with more than 50 employees, health officers are appointed to provide or oversee health management services. Workplaces with fewer than 300 employees have the option to outsource their workplace health management services to external organizations. While MSEs are required to assess their work environments and conduct health checkups, they are not obligated to acquire workplace health management services. This is in stark contrast to Finland, where it is mandatory for all employers to provide comprehensive occupational health services, including preventive services, to their employees [32]. Administrative oversight often overlooks MSEs, making it challenging to effectively monitor compliance with systems such as work environment assessments and workers' health checks. This lack of supervision reduces the motivation of MSEs to implement health management measures. WHC staff often encounter refusals when attempting to arrange visits to workplaces, which they report as a significant obstacle in fulfilling their responsibilities [32]. Active government efforts to strengthen regulations and improve OSH infrastructure [39] are essential to encourage MSEs to utilize occupational health services.

Additionally, measures should be taken to increase accessibility for MSEs and their workers. In Korea, as in other countries, a significant portion of the workforce is employed by small and medium-sized enterprises; nearly 2 million companies, or 98% of all businesses, have fewer than 50 employees. Among these, approximately 62% of employees work in MSEs, accounting for about 11 million workers [14]. The country is served by 24 WHCs, each managing around 120,000 workplaces and 500,000 workers. Additionally, there is a growing number of workers in nontraditional employment relationships, such as gig workers. WHCs need to expand their services to better support these vulnerable groups. The primary role of WHCs aligns with providing basic occupational health services, delivered by community professionals [40]. These services are a fundamental right for all workers, and OSH should be upheld without discrimination based on region, employment type, workplace size, or other socioeconomic factors. However, the current number of WHCs, established to address the needs of small enterprises and disadvantaged workers, is woefully inadequate. A strategic plan for expanding WHCs should be developed with a long-term perspective in mind [32,41,42]. Furthermore, with the rising number of migrant workers, it is crucial to develop strategies to overcome language and cultural barriers to enhance the accessibility of basic occupational health services.

Finally, an essential task is to develop a long-term strategy for the advancement of WHCs, supported by the creation of an organization dedicated to this purpose. While outsourced projects have been implemented to enhance WHCs, these efforts have primarily focused on short-term improvements, leaving the directions for mid- to long-term development unaddressed [31,32,41,42]. To ensure the effective delivery of basic occupational health services, intermediate or secondary-level support structures are necessary, in addition to national-level efforts [39]. KOSHA's WHC department struggles to fulfill its role as a control tower due to limited personnel and resources [31,32]. This underscores the urgent need for a WHC support organization equipped with the expertise and capacity to serve as a central



coordinating body. This organization should be responsible for formulating long-term plans for WHCs, including their expansion and the prioritization of service subjects. It should also tackle the communication structure and governance to enhance coordination within WHCs and between WHCs, KOSHA, the Ministry of Employment and Labor, and other relevant agencies. The organization should focus on standardizing practices, developing new approaches that incorporate emerging technologies, and providing comprehensive training for WHC staff, emphasizing the center's vision, goals, and basic occupational health services. Enhancing the capacity of WHC staff to deliver both occupational safety and health services, tailored to the specific needs and circumstances of MSEs, would be beneficial. Additionally, the organization should monitor program effectiveness, disseminate best practices from various centers, and manage data generated by WHCs to inform future improvements. Establishing a robust plan to ensure job security for WHC employees is also a critical priority.

WHCs were established in Korea to prevent occupational diseases in MSEs that have minimal resources. These centers are the only public health centers dedicated to providing basic occupational health services to vulnerable workers in the country without seeking profit. To fulfill the mission of a WHC, the development of programs should consider the unique characteristics of MSEs. OSH regulations should be uniformly applied to these companies, and proactive policies should be targeted at these entities due to their resource limitations. WHCs may be essential as case managers, fostering strong relationships with MSEs and linking them to other relevant programs. By emphasizing workplace-centered connections, WHCs contribute to improving work environments, either independently or with support from KOSHA or private institutions. A problem-solving-oriented approach is crucial; a balanced strategy that integrates regulation with practical support is key to ensuring success.

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References

- Kok JD, Berrios M. Small matters: global evidence on the contribution to employment by the self-employed, micro-enterprises and SMEs. Geneva: International Labour Organization (ILO); 2019.
- 2. Walters D, Wadsworth E, Hasle P, Refslund B, Ramioul M. Safety and health in micro and small enterprises in the EU: final report from the 3-year SESAME project. Luxembourg: Publications Office of the European Union; 2018.
- 3. Walters D. Health and safety in small enterprises: European strategies for managing improvement. Brussels: Presses Interuniversitaires Européennes; 2001.
- 4. Serrano MR, Xhafa E. Industrial relations in micro and small enterprises: patterns, trends and prospects. Geneva: International Labour Organization (ILO); 2024.
- 5. Kim I, Min J. Working hours and the regulations in Korea. *Ann Occup Environ Med* 2023;35:e18. https://doi.org/10.35371/aoem.2023.35.e18
- 6. Our World in Data. Data page: fatal occupational injury rates [Internet]. Oxford (UK): Our World in Data; c2024 [cited 2024 Nov 10]. Available from: https://ourworldindata.org/grapher/fatal-occupational-injuries-among-employees
- 7. European Agency for Safety and Health at Work. Contexts and arrangements for occupational safety and health in micro and small enterprises in the EU: SESAME projects. Luxembourg: Publications Office of the European Union; 2016.
- 8. Park H, Ha E, Kim J, Jung H, Paek D. Occupational health services for small-scale enterprises in Korea. *Ind Health* 2002;40(1):1-6. https://doi.org/10.2486/indhealth.40.1
- 9. Ministry of Employment and Labor. 2022 Industrial accident status. Sejong: Ministry of Employment and Labor; 2023.
- 10. Yang M, Myong JP, Lee J, Park MY, Kang MY. Association between irregular working hours and work-related musculoskeletal pain: results from the 6th Korean Working Conditions Survey. *Ann Occup Environ Med* 2023;35:e21.
 - https://doi.org/10.35371/aoem.2023.35.e21
- 11. Park J, Park J, Han B, Kim Y. Vulnerability of employees in businesses with fewer than five workers (micro-enterprises) to occupational safety and health problems. *Am J Ind Med* 2017;60(12):1056-1065.
 - https://doi.org/10.1002/ajim.22783
- 12. Yi Y. Development of health management for small business workers. *Korean J Occup Health Nurs* 2021;30(1):28-35.
 - https://doi.org/10.5807/kjohn.2021.30.1.28
- Kang D. Problems and suggested improvement plans for occupational health service in Korea. Ann Occup Environ Med 2023;35:e10. https://doi.org/10.35371/aoem.2023.35.e10
- 14. Ministry of Employment and Labor. Number of establishments and workers by



- region, industry, gender, and size [Internet]. Sejong (KR): Ministry of Employment and Labor; c2022 [cited 2024 Nov 10]. Available from: https://kosis.kr/statHtml/statHtml. do?orgId=118&tblId=DT_118N_SAUPN50&conn_path=12
- 15. Park J, Kim Y. The history of occupational health in South Korea. *Arch Environ Occup Health* 2019;74(1-2):50-57.
 - https://doi.org/10.1080/19338244.2018.1541859
- 16. Presidential Advisory Council on Policy Planning. Response to low birthrate and aging society. Seoul: Presidential Advisory Council on Policy Planning; 2008.
- 17. National Archives of Korea. Major policy records guidebook: welfare section (National Archives of Korea). Daejeon: National Archives of Korea; 2015.
- Kim JS, Kim DS, Gil HJ, Park YS, Sin HH, Park JT. The significance and prospects of the Workers' Health Center. J Korean Med Assoc 2014;57(2):159-166. https://doi.org/10.5124/jkma.2014.57.2.159
- 19. Lee SU, Kim DS, Gang SG. Regional Occupational Health Promotion Center in Korea for the purpose of promoting health of small-scale industry workers-assessment of the first year's results. *Ind Health* 2008;(8):54-55.
- Nam KC, Park JS, Koh JW, Kim JS, Park JT, Kim HJ, et al. An assessment of the needs and the affecting factors for small scale enterprise Worker's Health Centers. Korean J Occup Environ Med 2011;23(4):407-419.
 - https://doi.org/10.35371/kjoem.2011.23.4.407
- 21. Korea Occupational Safety and Health Agency. 2016 Workers' Health Center establishment and operation comprehensive results. Ulsan: Korea Occupational Safety and Health Agency; 2017.
- 22. Korea Occupational Safety and Health Agency. 2012 Workers' Health Center work performance guide. Ulsan: Korea Occupational Safety and Health Agency; 2012.
- 23. Korea Occupational Safety and Health Agency. 2018 Comprehensive results of Workers' Health Center and branch operations. Ulsan: Korea Occupational Safety and Health Agency; 2019
- 24. Korea Occupational Safety and Health Agency. 2023 Comprehensive results of Workers' Health Center and branch perations. Ulsan: Korea Occupational Safety and Health Agency; 2024.
- 25. Korea Legislation Research Institute. Occupational Safety And Health Act. Sejong: Korea Legislation Research Institute; 2013.
- 26. Ministry of Employment and Labor. Notification No. 2013-6 of the Ministry of Employment and Labor. Sejong: Ministry of Employment and Labor; 2013.
- 27. Korea Legislation Research Institute. Occupational Safety And Health Act. Sejong: Korea Legislation Research Institute; 2019.
- 28. Ministry of Employment and Labor. Notification No. 2020-19 of the Ministry of Employment and Labor. Sejong: Ministry of Employment and Labor; 2020.
- 29. Korea Occupational Safety and Health Agency. 2022 Comprehensive results of Workers' Health Center operations. Ulsan: Korea Occupational Safety and Health Agency; 2023.
- 30. Korea Occupational Safety and Health Agency. 2017 Workers' Health Center establishment and operation comprehensive results. Ulsan: Korea Occupational Safety and Health Agency; 2018.
- 31. Chung HJ, Kim SH, Rheu HC, Park JH, Lee JH, Yoo BH, et al. A study on developing improvement plans for the commissioned operation of Workers' Health Centers. Ulsan: Korea



- Occupational Safety and Health Agency; 2022.
- 32. Han BS, Kim SK, Choi EH, Kim HR, Jung TS, Lee JS, et al. A study on developing mid- to long-term development plans for Workers' Health Centers. Ulsan: Korea Occupational Safety and Health Agency; 2018.
- 33. Korea Occupational Safety and Health Agency. 2020 Comprehensive results of Workers' Health Center and branch operations. Ulsan: Korea Occupational Safety and Health Agency; 2021.
- 34. Korea Occupational Safety and Health Agency. 2021 Comprehensive results of Workers' Health Center and branch operations. Ulsan: Korea Occupational Safety and Health Agency; 2022
- 35. Korea Occupational Safety and Health Agency. 2019 Comprehensive results of Workers' Health Center and branch operations. Ulsan: Korea Occupational Safety and Health Agency; 2020.
- 36. Ryu J, Lim KH, Ryu DR, Lee HW, Yun JY, Kim SW, et al. Two cases of methyl alcohol intoxication by sub-chronic inhalation and dermal exposure during aluminum CNC cutting in a small-sized subcontracted factory. *Ann Occup Environ Med* 2016;28:65. https://doi.org/10.1186/s40557-016-0153-9
- 37. Choi SM, Kim CW, Park HO, Park YT. Association between unpredictable work schedule and work-family conflict in Korea. *Ann Occup Environ Med* 2023;35:e46. https://doi.org/10.35371/aoem.2023.35.e46
- 38. Laird I, Olsen K, Harris LA, Legg S, Perry MJ. Utilising the characteristics of small enterprises to assist in managing hazardous substances in the workplace. *Int J Workplace Health Manag* 2011;4(2):140-163.
 - https://doi.org/10.1108/17538351111143312
- 39. Rantanen J. Basic occupational health services. 3rd ed. Geneva: International Labour Organization (ILO); 2007.
- 40. Rantanen J. Basic occupational health services: their structure, content and objectives. *Scand J Work Environ Health Suppl* 2005;(1):5-15.
- 41. Joo YS, Noh SC, Lim J, Lim HJ, Jung YK, Bang YW, et al. A study on establishing operational models and developing performance indicators for the expanded installation of Workers' Health Centers. Ulsan: Korea Occupational Safety and Health Agency; 2013.
- 42. Yang SH, Kang DM, Kang MY, Kim W, Kim JI, Rheu HC, et al. A study on improvement plans for the roles and functions of Workers' Health Centers. Ulsan: Korea Occupational Safety and Health Agency; 2016.

Review



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Trauma counseling centers for psychological support to manage trauma from workplace injuries in Korea: a narrative review

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Keywords

Crisis intervention; Counseling; Posttraumatic stress disorders; Psychosocial intervention; Workplace



This review describes a psychological support service designed to address post-traumatic stress disorder in workers impacted by workplace injuries, assisting in their recovery and facilitating their return to work. It explores the rationale and context behind establishing trauma counseling centers for these individuals, along with the status, roles, future directions, and recommendations for these centers. The review details the operational framework and functions of the workplace injury trauma management program, the scope of the impacts of such injury, the groups targeted for crisis intervention, and the psychological interventions tailored to each stage of recovery. Initiated as a pilot project in 2018, trauma counseling centers for workers have gradually become more common, with 23 centers in operation across Korea as of 2024.

Introduction

Background

Insights from workplace disasters and policy interventions

The tragic fire at the primary battery facility in Hwaseong in 2024, which resulted in numerous fatalities, serves as a grim reminder of past workplace accidents. These include the crane collapse in 2017, the fatal accident involving a conveyor at a power plant in Taean in 2018, and the fire at a logistics center in Icheon in 2020. These incidents have left deep scars and reignited public discourse on the importance of workplace safety. Despite a decreasing trend in the rate of fatal injuries in South Korea since 2014, the country's rates remain quite high compared to other industrialized nations [1]. For instance, in 2023, South Korea's fatal injury rate was 0.39 per 10,000 employees, which is 2.3 times higher than the average rate of 1.66 per 100,000 employees reported by EU member countries in 2022 [2].

Under Korea's Occupational Safety and Health Act, a workplace injury is defined as "any death, injury, or disease of a person who provides labor caused by structures, equipment, raw materials, gas, vapor, powder, dust, etc. related to [their] duties, or by [their] work or other duties." A "serious accident" is a severe incident that involves one or more fatalities or affects many victims [3].

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Since the implementation of the Serious Accidents Punishment Act in 2022, which applies to companies with 50 or more employees, increased attention has been paid to workplace safety systems and accident prevention [4,5].

Workplace accidents result in not only the loss of life and physical and emotional suffering for workers but also economic and social costs, including property damage and loss of productivity. For instance, the 2017 crane collapse at Samsung Heavy Industries caused six deaths and severely injured 25 workers, with over 1,000 people witnessing the tragedy either directly or indirectly. Similarly, the suicide of a stablehand in July 2017 highlighted the mental health risks that workers face, marking a pivotal moment for heightened awareness of mental health in the workplace [6].

Psychological impact of serious workplace accidents

The psychological trauma experienced by workers exposed to serious workplace accidents varies depending on the severity and proximity of their exposure. Individuals who directly witness such events are more likely to face severe psychological effects than those who do not witness them firsthand [7]. The psychological consequences of experiencing catastrophic workplace accidents can be categorized as follows:

1) Psychological disorders stemming from trauma

Traumatic experiences, such as workplace disasters, can trigger a range of mental health issues, including dissociative symptoms like depersonalization and derealization [8,9]. If these issues are not addressed, they may lead to post-traumatic stress disorder (PTSD), depression, panic disorders, substance abuse, and anxiety disorders [10-12]. Survivors may experience insomnia, intrusive memories, nightmares, impaired concentration, and hypersensitivity to noise. They may also grapple with feelings of quilt, hopelessness, and emotional detachment from others [13].

2) Intrusive responses and emotional dysregulation

Trauma survivors often report re-experiencing distressing events, feeling as if they are being repeatedly exposed to the same incident. Intrusive symptoms, a hallmark of PTSD, are frequently associated with excessive alcohol consumption used as a coping mechanism. Research indicates that individuals with severe early symptoms of PTSD are at increased risk of problematic drinking and persistent PTSD [14–17].

Workers who have been exposed to workplace accidents frequently report a lower quality of life, along with higher rates of suicidal thoughts and depressive symptoms, compared to those who have not experienced such incidents [18,19]. Factors contributing to this reduced quality of life include poor sleep, decreased motivation, depression, and anxiety, with anxiety identified as particularly key [20].

The Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition, published by the American Psychiatric Association, recognizes that experiencing or witnessing traumatic events can result in involuntary, intrusive memories and prolonged psychological distress [21]. Similarly, the National Institute for Occupational Safety and Health has identified a range of symptoms associated with traumatic incident stress. These include chest pain, difficulty breathing, memory problems, nightmares, anxiety, guilt, fear, and uncontrollable anger, and are frequently observed following exposure to catastrophic workplace events [22].

3) Cognitive and social impacts

Trauma resulting from workplace accidents can also impact cognitive functions and social adaptability. Studies investigating the neurological effects of trauma have shown that individuals with smaller hippocampal volumes or larger cavum septum pellucidum 1 month after trauma



exposure tend to exhibit more severe symptoms at both 1 and 14 months post-trauma. These findings highlight the importance of long-term monitoring, psychological stabilization, and early intervention within the first year following exposure [23,24].

The severity of disabilities following trauma, alongside mental health challenges and reduced adaptability, significantly impacts the ability of workers to return to their jobs and maintain productivity [25,26].

Returning to work: balancing recovery and livelihood

Returning to work is often a primary concern for individuals affected by industrial accidents. However, the prospect of encountering recurring traumatic triggers in the workplace presents considerable challenges. Despite the profound psychological impact of workplace injuries, recovery is achievable.

Social support plays a critical role in protecting mental health. Research has demonstrated that social support reduces the likelihood of developing PTSD, mitigates the effects of substance abuse, and helps preserve mental well-being, even during crises such as the coronavirus disease 2019 pandemic [27].

Establishing a robust psychological support system can assist workers in navigating their trauma and developing resilience, empowering them to move forward with their lives despite the challenges.

Policy and prevention: addressing trauma at the workplace

Recognizing the urgent need to address trauma resulting from workplace injuries, Korea has enacted policies aimed at preventing and mitigating PTSD among workers who have been exposed to serious workplace accidents. In 2018, the Korea Occupational Safety and Health Agency (KOSHA) initiated a pilot program for an Occupational Trauma Center, designed to protect the mental health of workers and facilitate their recovery.

Objectives

This article provides an overview of the establishment, current operations, and future directions of the Occupational Trauma Center regarding its expanding role in supporting affected workers and promoting mental health recovery at the community level.

Ethics statement

As this study is a literature review, it did not require institutional review board approval or individual consent

Purpose and status of Occupational Trauma Centers

According to data from the Ministry of Employment and Labor, the number of workers covered by industrial accident compensation insurance has steadily increased annually, rising from 15.44 million in 2013 to 19.07 million in 2018 before reaching 20.63 million in 2023 (Fig. 1). In the context of work-related injuries, the approval rate for PTSD claims has increased from two cases in 2011 to 83 in 2021, representing a 40-fold surge (Table 1). This trend reflects a growing societal recognition of post-traumatic stress as an occupational disease.

Job trauma refers to the psychological and physical responses—including fear, anxiety,



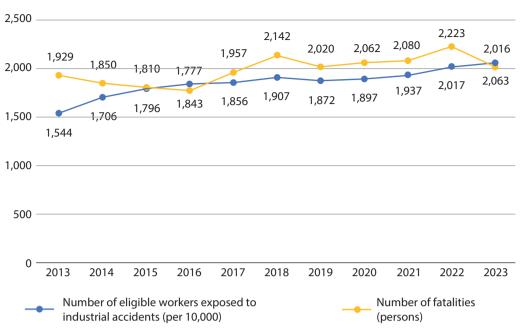


Fig. 1. Number and rate of fatalities due to industrial accidents. Data from Ministry of Employment and Labor [1].

Table 1. Mental health disorders associated with occupational injuries (2011–2022)

Category 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 Applications 102 127 137 137 165 183 213 268 331 581 720 678 Approvals 26 47 53 47 63 85 126 201 231 396 515 445 Approval rate (%) 25.5 37 38.7 34.3 38.2 46.4 59.2 75 69.8 68.2 71.5 65.6 Depression 14 15 14 17 17 14 52 72 66 113 113 80 Adjustment disorder 2 11 5 11 13 21 32 53 78 162 248 227 Acute stress disorder 4 7 14 3 9 5 8 15 15 23													
Approvals 26 47 53 47 63 85 126 201 231 396 515 445 Approval rate (%) 25.5 37 38.7 34.3 38.2 46.4 59.2 75 69.8 68.2 71.5 65.6 Depression 14 15 14 17 17 14 52 72 66 113 113 80 Adjustment disorder 2 11 5 11 13 21 32 53 78 162 248 227 Acute stress disorder 4 7 14 3 9 5 8 15 15 23 10 26 Post-traumatic stress disorder 2 7 9 9 14 25 21 36 39 55 83 63 Anxiety disorder 2 1 2 3 2 4 1 5 13 19 21	Category	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Approval rate (%) 25.5 37 38.7 34.3 38.2 46.4 59.2 75 69.8 68.2 71.5 65.6 Depression 14 15 14 17 17 14 52 72 66 113 113 80 Adjustment disorder 2 11 5 11 13 21 32 53 78 162 248 227 Acute stress disorder 4 7 14 3 9 5 8 15 15 23 10 26 Post-traumatic stress disorder 2 7 9 9 14 25 21 36 39 55 83 63 Anxiety disorder 2 1 2 3 2 4 1 5 13 19 21 23	Applications	102	127	137	137	165	183	213	268	331	581	720	678
Depression 14 15 14 17 17 14 52 72 66 113 113 80 Adjustment disorder 2 11 5 11 13 21 32 53 78 162 248 227 Acute stress disorder 4 7 14 3 9 5 8 15 15 23 10 26 Post-traumatic stress disorder 2 7 9 9 14 25 21 36 39 55 83 63 Anxiety disorder 2 1 2 3 2 4 1 5 13 19 21 23	Approvals	26	47	53	47	63	85	126	201	231	396	515	445
Adjustment disorder 2 11 5 11 13 21 32 53 78 162 248 227 Acute stress disorder 4 7 14 3 9 5 8 15 15 23 10 26 Post-traumatic stress disorder 2 7 9 9 14 25 21 36 39 55 83 63 Anxiety disorder 2 1 2 3 2 4 1 5 13 19 21 23	Approval rate (%)	25.5	37	38.7	34.3	38.2	46.4	59.2	75	69.8	68.2	71.5	65.6
Acute stress disorder 4 7 14 3 9 5 8 15 15 23 10 26 Post-traumatic stress disorder 2 7 9 9 14 25 21 36 39 55 83 63 Anxiety disorder 2 1 2 3 2 4 1 5 13 19 21 23	Depression	14	15	14	17	17	14	52	72	66	113	113	80
Post-traumatic stress disorder 2 7 9 9 14 25 21 36 39 55 83 63 Anxiety disorder 2 1 2 3 2 4 1 5 13 19 21 23	Adjustment disorder	2	11	5	11	13	21	32	53	78	162	248	227
disorder Anxiety disorder 2 1 2 3 2 4 1 5 13 19 21 23	Acute stress disorder	4	7	14	3	9	5	8	15	15	23	10	26
		2	7	9	9	14	25	21	36	39	55	83	63
Others 2 6 9 4 8 16 12 20 20 24 40 26	Anxiety disorder	2	1	2	3	2	4	1	5	13	19	21	23
	Others	2	6	9	4	8	16	12	20	20	24	40	26

Data from Korea Workers' Compensation & Welfare Service [28].

and anger—that emerge after direct or indirect exposure to a significant industrial accident or comparable event in the workplace [29]. In 2014, the Worker Health Center in East Gyeonggi initiated programs aimed at stabilizing acute stress and preventing post-traumatic stress among manufacturing workers affected by workplace accidents, whether directly or indirectly. These initiatives highlighted the importance of psychological interventions in the aftermath of such incidents, prompting the Center to seek appropriate countermeasures.

In 2017, a crane accident in the heavy industry sector resulted in numerous casualties and public outcry. At the time, no specialized system had been implemented to address trauma among workers impacted by such an event. This large-scale disaster underscored the critical need for occupational trauma management to alleviate post-traumatic stress and support workers' return to their jobs following industrial accidents. In response, a pilot Occupational



Trauma Center was established in Daegu in 2018, with a focus on addressing industrial accidents throughout the nation for a 2-year period [30]. By 2020, the initiative had expanded to include eight centers across the country. As of 2024, Korea has a total of 23 such centers operating under the jurisdiction of KOSHA, which also oversees on-site accident investigations to ensure effective coordination with affiliated organizations.

Occupational Trauma Centers are located within Worker Health Centers across the country. Each trauma center is staffed with two counseling psychologists and equipped with private consultation rooms to promote psychological safety. Table 2 details the annual operational status of these centers [31].

Occupational Trauma Management Program and operational framework

The Occupational Trauma Management Program is a psychological support initiative designed to alleviate the emotional impact on workers who have experienced serious workplace accidents, work-related injuries, or incidents such as a colleague's intentional self-harm, workplace violence (including bullying), and verbal or physical abuse from customers. This program is designed to support workers in their return to their jobs. In the case of serious workplace accidents, where the extent of damage and worker exposure may be extensive, timely coordination of postincident psychological support is crucial. Following an accident, a rapid assessment is conducted to evaluate each affected individual's level of exposure, the extent of the impact, relationships with injured parties, available support systems and resources, and the company's response to the accident. This ensures that high-risk groups can be prioritized for psychological support.

When a serious workplace accident occurs, referrals can be made through the following channels:

First, in the event of a serious workplace accident, the local branch (or sub-branch) of the Ministry of Employment and Labor responsible for investigating the scene may inform the affected workplace and recommend the implementation of the Occupational Trauma Management Program. The incident can be referred to the Occupational Trauma Center if the workplace has 50 or more employees; if two or more fatalities have occurred, resulting in widespread exposure; or if the accident has generated substantial public concern. Additionally, if investigators interviewing witnesses of a significant industrial accident determine that occupational trauma management is necessary, they have the authority to notify the local KOSHA office (Fig. 2).

Table 2. Operational status of Occupational Trauma Centers in Korea by year

Year	Number of centers opened	Centers
2018-2019	1	Pilot center with national jurisdiction (Daegu Occupational Trauma Center)
2020	8	Eastern Gyeonggi, Western Gyeonggi, Gyeongnam, Gwangju, Bucheon, Daegu, Daejeon, Incheon
2021	5	Northern Gyeonggi, Ulsan, Jeonju, Jeju, Chungnam
2023	1	Geoje
2024	9	Gangwon, Southern Gyeonggi, Northern Gyeongbuk, Gyeongsan, Busan, Seoul, Western Seoul, Chungbuk, Eastern Jeonnam

Data from Korea Occupational Safety and Health Agency [31].





Fig. 2. Operational framework of the occupational trauma management program. Data from Korea Occupational Safety and Health Agency [28].

Second, when investigating a serious workplace accident, the Central Accident Investigation Team of KOSHA may recommend and promote the implementation of the Occupational Trauma Management Program.

Third, the Occupational Trauma Management Program may be activated following a serious workplace accident or incident if either the workplace or individual workers recognize the need for occupational trauma management and request psychological support.

Furthermore, in the event of large-scale accidents—such as the 2020 fire at the Logistics Center in Icheon or the 2024 fire at a primary battery plant in Hwaseong—that result in a significant number of casualties and widespread exposure among workers, response efforts may extend beyond jurisdictional boundaries through coordinated requests among government ministries [32].

Additionally, it is crucial to regularly monitor KOSHA's reports on fatal accidents, regardless of whether a request for occupational trauma management has been made. Access to up-todate information about accidents and the number of victims within the relevant jurisdiction can facilitate rapid intervention.

Psychological responses by post-accident phase

Psychological states—including physical, emotional, cognitive, and behavioral aspects evolve following an accident. Within 48 hours after the event, individuals typically enter a period of shock, while within 7 days of the incident, they begin to distance themselves from the immediate psychological impact. Recovery rates vary from person to person. The period from 1 week to 1 month after the accident is generally regarded as the recovery phase. This is followed by a period of adaptation, which facilitates reintegration into daily life (Fig. 3). The following overview summarizes each phase in the Occupational Trauma Management Program's psychological response following an accident.

Emergency response phase (within 7 days of the incident)

During this stage, intrusive symptoms are highly active. Survivors may experience guilt, a sense of loss, anger, grief, irritability, dissociation, flashbacks, nightmares, and insomnia, with these symptoms collectively peaking in severity for up to a week. Symptoms observed between 3 days and 1 month after exposure meet the criteria for acute stress reaction, with PTSD being diagnosed after 1 month. The primary goal is to stabilize the individual psychologically; however, debriefing about the event can trigger re-experiencing, so caution is advised [33,34].





Fig. 3. Changes in psychological responses by phase after exposure to or witnessing of an accident. Data from Korea Occupational Safety and Health Agency [29].

If an individual exhibits extreme psychological and physical reactions in the early stages, it is crucial to establish a safe environment where they can access counseling services to achieve psychological stabilization. Survivors should not be compelled to share personal thoughts or emotions about the incident [35]. If symptoms are not severe, clinicians should encourage the maintenance or swift resumption of daily activities and recommend medication if necessary. Additionally, they should endeavor to prevent isolation and to pay close attention to any difficulties the worker reports.

As an example, the Eastern Gyeonggi Occupational Trauma Center has an emergency response team—consisting of an occupational and environmental medicine specialist, a counseling professional, and a musculoskeletal disorder prevention specialist—in place for rapid crisis intervention. Depending on the needs of the workplace and workers, nursing or occupational hygiene professionals may also be added to the team (Table 3).

The primary targets for emergency intervention are detailed in Table 4. In cases of physical injury, psychological intervention can occur after appropriate medical treatment has been administered. Individuals who initially discover or respond to accidents, such as safety managers and health managers, may also be at high risk for PTSD and are therefore prioritized for support [36].

Early response phase (8 days to 1 month after the incident)

During the early response phase, symptoms of post-traumatic stress may intensify, including insomnia, major depression, alcohol dependence, and anxiety. The primary objective of management is to prevent the development of PTSD, sleep disorders, major depression, anxiety disorders, alcohol dependence, and suicidal behavior. At this stage, clinicians typically administer screening assessments, such as tests for post-traumatic stress reactions, physical responses, emotional issues like depression or anxiety, and suicidal ideation. Formal counseling is often initiated at this point. Any ongoing acute stress reactions must also be monitored. Individuals with mild symptoms are encouraged to practice self-care and resume their daily activities. However, if recovery is not observed after 1 month, or if severe insomnia, panic disorder, or an exacerbation of pre-existing mental health conditions occur within this first month, the use of psychiatric medication may be considered.

Mid-term response phase (1 to 3 months after the incident)

Starting at the 1-month mark, the objective is to reduce symptoms of PTSD and prevent lasting effects. During this period, an individual may be formally diagnosed with PTSD. While many people begin to show improvement or recovery, those who do not should receive ongoing



Table 3. Crisis intervention programs offered by the Eastern Gyeonggi Occupational Trauma Center

Focus area	Support personnel	Activities
Psychological education	Counseling specialist	 Education on physical, cognitive, emotional, and behavioral trauma responses Information on recovery processes Referral to trauma counseling services
Physical stabilization training	Musculoskeletal disorder Prevention specialist	Muscle relaxation through physical exercisesPromotion of body awareness and preventing dissociation
Medical and psychological assessment	Occupational and environmental medicine Specialist	- Medical diagnosis of pre-existing and physical conditions - Assessment of psychological state
	Counseling specialist	- Initial psychological evaluation for stress and emotional responses
Psychological stabilization	Counseling specialist	 Counseling to prevent hyperarousal and dissociation Expansion of emotional safety and promotion of psychological comfort Individual or group counseling
Administrative support	Office manager	- External cooperation and scheduling - Support during mobile counseling
Work environment improvement	Occupational environment specialist	- Consultation to ensure safety in the accident area

Data from Eastern Gyeonggi Occupational Trauma Center.

Table 4. Victims and priority groups for crisis intervention

Victim type	Description
Primary victims	Survivors experiencing physical injuries or psychological trauma
Secondary victims	Witnesses or responders to fatalities or injuries, accident response managers, team members of victims, roommates, or others feeling responsible for the incident
Program eligibility	Includes directly affected individuals, first responders, safety managers, health officers, colleagues with close personal ties to victims, and coworkers or roommates

Data from Korea Occupational Safety and Health Agency [37].

follow-up. Most individuals are capable of resuming their daily activities, with the option of receiving further counseling if necessary.

Long-term response phase (3+ months after the incident)

The long-term response is the stage of follow-up designed to alleviate any residual effects of post-traumatic stress. At this point, most individuals can fully resume normal activities, and the restoration of regular routines is encouraged. However, in workplaces where multiple accidents have occurred, gradual recovery may require flexible adjustments to the number of counseling sessions.

From a managerial perspective, once an accident occurs, operations at the workplace should be temporarily halted to prevent secondary incidents. Exposed workers must be monitored for potential sleep, dietary, health, or psychological issues, and transparent information should be provided to prevent misunderstandings or mistrust regarding the incident. Workers who require it should be granted time off or leave to support their psychological well-being. Those affected should be separated from the accident site and public areas, and if the demands of their job are high, they should be temporarily reassigned to lighter duties to avoid overwork. If any individual experiences chest pain, difficulty breathing, severe pain, extreme anxiety, or insomnia, management should ensure they have access to appropriate medical care [37].



Crisis intervention methods and case examples

Before any crisis intervention takes place, it is essential to establish the objectives and process of psychological intervention and adapt them to the specific workplace environment. A private counseling area that fosters a sense of safety should be designated, and efforts should be made to offer psychological services to all exposed workers, ensuring clear advance communication to avoid misunderstandings. Research has shown that employing multiple intervention methods is more effective than relying on a single approach [38].

The Occupational Trauma Management Program involves a variety of crisis intervention strategies. These include group-based psychological education aimed at immediate stabilization, individual and group counseling, and follow-up services.

Psychological education

This training provides trauma education based on Psychological First Aid (PFA), with core principles including the neurophysiological foundations of physical, emotional, cognitive, and behavioral responses, as well as the processes of arousal control, normalization, and validation. The safety of survivors should be promoted and emphasized [39]. PFA is widely endorsed by experts as a key early intervention for individuals affected by disasters and is considered the standard for mental health and psychosocial support in catastrophic or extreme conditions [40]. One advantage of psychological education is its capacity to address many individuals simultaneously. Its objectives are to promote personal awareness of acute reactions (such as anxiety or fear), increase psychological stability, and prepare individuals for potential future psychological shifts. When feasible, this education is offered during the emergency and early response phases, although the timing can be adjusted as necessary (Table 5). Additionally, psychological education can help support physical safety when integrated with activities like group stretching or muscle relaxation exercises.

Individual counseling

Sessions are conducted on a one-on-one basis and typically last between 40 and 60 minutes. The details can be adjusted depending on the individual's level of exposure and the degree of trauma. If medical treatment or medication is required, psychiatric referrals can be made. Initial sessions are generally focused on stabilization; once individuals can self-regulate, they proceed to processing memories and mourning, and ultimately to reintegration and resuming their daily

Table 5. Processes and activities associated with psychological support for witnesses to workplace fatalities at a manufacturing company

Processes	Activity
Collaboration request	 The local branch of the Ministry of Employment and Labor or KOSHA sent a request to the Occupational Trauma Center for collaboration on the case. The Occupational Trauma Center coordinated with the health and safety manager of the company to select workers who required psychological support.
Rapid intervention	 The Occupational Trauma Center formed an emergency response team. The emergency response team administered a psychological and physical stabilization program. Psychological evaluations for trauma, depression, and anxiety were conducted along with individual counseling.
Worker recovery support	Two to nine sessions of individual psychological counseling were provided.Follow-up evaluations were completed at 1 month, 6 months, and 3 years after the accident.

KOSHA, Korea Occupational Safety and Health Agency. Data from Eastern Gyeonggi Trauma Counseling Center.



activities [41]. The degree of early stabilization may be indicative of prognosis.

Group counseling

Approximately 10 workers experiencing similar levels of shock may participate in a group. If an individual's symptoms are severe, one-on-one counseling is preferable. Group members can verbalize or use other media to express their grief and shock, collectively engage in mourning processes, and contribute to psychological healing. At the initiation of group counseling, rules should be established to prevent secondary trauma, such as avoiding blame or accusations.

Follow-up

Follow-up services begin when individuals have largely returned to normal functioning and are approaching discharge from the program. These services aim to prevent relapses and verify successful adaptation.

The following brief example from a crisis intervention for witnesses of a fatal accident at a workplace in the eastern Gyeonggi region illustrates how psychological support can facilitate post-accident intervention.

When the Occupational Trauma Management Program intervention was applied, individual recovery times varied. Nonetheless, psychological assessments conducted at 1 month, 6 months, and 3 years after the accident revealed reductions in post-traumatic stress, depression, and anxiety to more stable levels compared to initial measurements. These outcomes are illustrated in Fig. 4.

Role of the Occupational Trauma Center

Occupational Trauma Centers were established to prevent post-traumatic stress among workers exposed to sudden workplace accidents and to support their return to normal life and

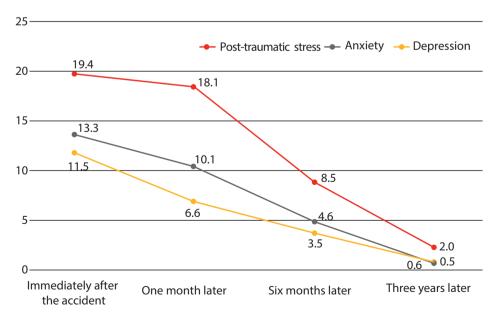


Fig. 4. Changes in post-traumatic stress and emotional state among workers receiving psychological support. Data from Kim et al. [24].



work. The Occupational Trauma Management Program plays a key role in safeguarding the mental health of workers impacted by workplace injuries. As of 2024, a total of 23 Occupational Trauma Centers have been established within Worker Health Centers across Korea, aligning with the jurisdictions of local branches of the Ministry of Employment and Labor.

The key prerequisites for Occupational Trauma Centers to foster psychological safety and ensure prompt stabilization for workers are as follows:

- 1) Timely intervention after workplace accidents: Early interventions, including PFA and community-based trauma care, are vital for improving outcomes for survivors [42]. When investigating industrial accidents, local offices of the Ministry of Employment and Labor should actively recommend the implementation of the Occupational Trauma Management Program.
- 2) Regional accessibility: Korea now has 23 Occupational Trauma Centers operating within Worker Health Centers, making psychological interventions for industrial accidents in nearby jurisdictions more accessible than ever. The availability of on-site services helps to alleviate the time and financial burdens faced by businesses.
- 3) Follow-up for exposed workers: Monitoring is necessary to prevent secondary trauma, track worker recovery, and evaluate the ongoing efficacy of treatment.

Conclusion

In the context of workplace injury, it is imperative to raise awareness about the need for collaboration among relevant agencies, workplaces, and individuals to safeguard the mental health of victims and to ensure that the hidden suffering associated with high rates of workrelated fatalities is addressed. Employers must recognize that preventing post-traumatic stress is key to helping workers resume their duties and minimizing lost labor time.

Going forward, Occupational Trauma Centers must emphasize public accessibility, professional expertise, and diverse empirical research to validate the effectiveness of the program, as follows.

Public accessibility

Nationwide legislation is required to protect workers' mental health following workplace accidents. Such legislation would increase awareness of mental health in the workplace, facilitate prompt access to psychological services for affected individuals, and promote the consistent implementation of Occupational Trauma Management Programs. Although improving accident investigation systems to prevent recurrence is crucial, now is also the time for active referral to and promotion of Occupational Trauma Centers to avoid secondary psychological harm resulting from accidents.

Professional expertise

A training system for occupational trauma experts must be established. Specialized counseling personnel—trained to address industrial disasters, as these differ from other forms of disaster or personal trauma)—are needed. It is essential to develop a structured educational system that considers variations by timeframe, recovery phase, and risk level, and that supports the acquisition of empirically verified techniques. Such a system is crucial for the continuous improvement of professional standards in the field of industrial accident trauma counseling.

Empirical research

To evaluate the Occupational Trauma Management Program, a variety of empirical studies are



necessary. More experts are encouraged to generate evidence-based findings regarding the effectiveness of psychological interventions after industrial accidents.

Large-scale workplace accidents continue to occur, and climate change has led to an increase in significant catastrophes. Consequently, there is a growing need for collaborative responses across multiple agencies. Extending beyond public institutions, more robust networks of occupational health managers must be fostered within workplaces. Such networks would ensure that community-based systems can operate effectively to safeguard the mental health of workers affected by workplace accidents.

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References

- Ministry of Employment and Labor. 2023 Analysis of workplace injury status [Internet]. Sejong (KR): Ministry of Employment and Labor; c2023 [cited 2024 Nov 10]. Available from: https://www.moel.go.kr/common/downloadFile.do?file_seq=20241203273&bbs_seq=20241201548&bbs_id=29&file_ext=pdf
- 2. Eurostat. Accidents at work statistics [Internet]. Luxembourg (LU): Eurostat; c2024 [cited 2024 Nov 10]. Available from: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Accidents_at_work_statistics



- Korea Law Information Center. Occupational safety and health act [Internet]. Sejong (KR): Ministry of Government Legislation; c2022 [cited 2023 Jan 14]. Available from: https://www.law.go.kr/
- 4. Ministry of Government Legislation. National Law Information Center [Internet]. Sejong (KR): Ministry of Government Legislation; c2024 [cited 2024 Nov 10]. Available from: http://www.moleg.go.kr
- Kim M, Park S. The effect of corporate characteristics on occupational injuries: comparison of SMEs and large enterprises. *Ind Res* 2023;47(2):139-169. https://doi.org/10.22915/rifi.2023.47.2.005
- 6. Ministry of Employment and Labor. Pilot operation of the occupational trauma counseling center in Daequ. Sejong: Ministry of Employment and Labor; 2018.
- 7. Lim JM, Jang MS, Kim KW. A study on psychological trauma, safety climate, safety accidents, and safety behavior among workers with industrial experience. *Korean J Health Psychol* 2020;25(6):1077-1095.
- 8. Black DW, Grant JE. DSM-5 quidebook. 1st ed. Seoul: Hakjisa; 2018.
- Boyer SM, Caplan JE, Edwards LK. Trauma-related dissociation and the dissociative disorders: neglected symptoms with severe public health consequences. *Dela J Public Health* 2022;31(2):78-84. https://doi.org/10.32481/djph.2022.05.010
- Jang JM, Choi NH, Kang HS, Park SH. Levels of event impact, anxiety, and depression among workers with industrial accidents. J Korean Acad Community Health Nurs 2009;20(2):234-242
- Woo JM, Kang TY, Lee JE. Increasing risk of mental health problems among subway drivers experiencing accidents on the track. *Korean J Occup Environ Med* 2005;17(1): 36-43. https://doi.org/10.35371/kjoem.2005.17.1.36
- 12. Wiseman TA, Curtis K, Lam M, Foster K. Incidence of depression, anxiety and stress following traumatic injury: a longitudinal study. *Scand J Trauma Resusc Emerg Med* 2015;23:29. https://doi.org/10.1186/s13049-015-0109-z
- 13. Lee DY, Na J, Sim M. Psychological reactions and physical trauma by types of disasters: view from man-made disaster. *J Korean Neuropsychiatr Assoc* 2015;54(3):261-268. https://doi.org/10.4306/jknpa.2015.54.3.261
- 14. Kim CS, Kim JW, Lee SY, Cho SE, Cho YM, Koo JW, et al. A case study on posttraumatic stress responses among workers who witnessed industrial accidents in a manufacturing workplace. Proceedings of the Korean Society of Occupational and Environmental Medicine Conference; 2014 Nov 6-8; Gyeongju. Seoul (KR): The Korean Society of Occupational & Environmental Medicine; 2014. p.321-322.
- 15. Kim I, Lee D. The effects of intrusive and intentional rumination on psychological distress and problem drinking in adults: mediating effects of PTSD symptoms and emotion regulation difficulties. *J Rehabil Psychol* 2024;30(4):117-142. https://doi.org/10.35734/karp.2024.30.4.006
- 16. Yoon MS, Lee HJ. Moderating role of social support on the relationship between posttraumatic stress disorder (PTSD) and drinking behavior among employees. *Mental Health Soc Work* 2014;42(4):115-142.
- 17. Kim JB, Lim JH. Effects of trauma level, initial symptom severity and problematic alcohol on PTSD symptoms in victims of disaster: focusing on exposure to natural disasters causing death and injury. *Ment Health Soc Work* 2023;51(2):29-52.



- https://doi.org/10.24301/MHSW.2023.06.51.2.29
- 18. Kim SI, Yeon GY, Ha EH, Woo HW, Kim YC. Quality of life, suicide ideation, and depressive symptoms in industrial injury patients. *J Korean Neuropsychiatr Assoc* 2001;40(3):416-424.
- Sluys K, Häggmark T, Iselius L. Outcome and quality of life 5 years after major trauma. J Trauma Acute Care Surg 2005;59(1):223-232. https://doi.org/10.1097/01.TA.0000173832.01547.CB
- 20. Heo SJ. Effects of pain, sleep quality, rehabilitation motivation, depression, and anxiety on quality of life in occupational accident patients [M.S. thesis]. Gongju: Kongju National University; 2021.
- 21. American Psychiatric Association. Diagnostic and statistical manual of mental disorders. 5th ed. Arlington: American Psychiatric Association; 2013.
- 22. National Institute for Occupational Safety and Health (NIOSH). National Institute for Occupational Safety and Health [Internet]. Washington (DC): NIOSH; c2024 [cited 2024 Nov 10]. Available from: https://www.cdc.gov/niosh/index.html
- 23. Ben-Zion Z, Artzi M, Niry D, Keynan NJ, Zeevi Y, Admon R, et al. Neuroanatomical risk factors for posttraumatic stress disorder in recent trauma survivors. *Biol Psychiatry Cogn Neurosci Neuroimaging* 2020;5(3):311-319. https://doi.org/10.1016/j.bpsc.2019.11.003
- 24. Kim CS, Kong JO, Jeong HJ, Koo JW. A case of trauma management for co-workers after a workplace fatality. Proceedings of the Korean Society of Occupational and Environmental Medicine Conference; 2022 Nov 11; Jeju. Seoul (KR): The Korean Society of Occupational & Environmental Medicine; 2022.
- 25. Baek SU, Lee WT, Kim MS, Lim MH, Yoon JH, Won JU. Self-esteem trajectories after occupational injuries and diseases and their relation to changes in subjective health: result from the panel study of workers' compensation insurance (PSWCI). *J Korean Med Sci* 2023;38(37):e284.
 - https://doi.org/10.3346/jkms.2023.38.e284
- 26. Hong CM. Work performance among workers without disabilities after industrial accidents: a longitudinal study. *Open Pub Health J* 2024;17:e18749445296395. https://doi.org/10.2174/0118749445296395240502042735
- 27. Shin J, Park K, Lee Y, Choi S, Jang Y, You M. The protective effect of perceived social support on psychological health during the COVID-19 pandemic: the case of Gyeonggi province in South Korea. *Korean Soc Health Educ Promot* 2023;40(2):1-14. https://doi.org/10.14367/kjhep.2023.40.2.1
- 28. Ministry of the Interior and Safety. Korea workers' compensation & welfare service work-related injury disease mental disorders [Internet]. Sejong (KR): Ministry of the Interior and Safety; c2022 [cited 2024 Nov 10]. Available from: https://www.data.go.kr/data/15113358/fileData.do#tab-layer-file
- 29. Korea Occupational Safety and Health Agency. Occupational trauma management program operating manual. Ulsan: Korea Occupational Safety and Health Agency; 2020.
- 30. Lee MS, Kim EY. Current status and challenges of industrial accident trauma support in Korea: a case study of the occupational trauma center in region D. Korean *J Counsel Psychotherapy* 2023;35(4):1517-1541. https://doi.org/10.23844/kjcp.2023.11.35.4.1517
- 31. Korea Occupational Safety & Health Agency. Notice [Internet]. Ulsan (KR): Korea Occupational Safety & Health Agency; c2025 [cited 2024 Nov 10]. Available from: https://



- kosha.or.kr/kosha/report/notice.do?
- 32. Ministry of Health and Welfare. Press release: provided psychological support to victims, families, and injured in the Hwaseong factory fire [Internet]. Sejong (KR): Ministry of Health and Welfare; c2024 [cited 2024 Nov 10]. Available from: https://www.mohw.go.kr/board.es? mid=a10503010100&bid=0027&act=view&list_no=1482084&tag=&nPage=1
- 33. Mayou RA, Ehlers A, Hobbs M. Psychological debriefing for road traffic accident victims: three-year follow-up of a randomised controlled trial. *Br J Psychiatry* 2000;176(6):589-593. https://doi.org/10.1192/bjp.176.6.589
- 34. van Emmerik AAP, Kamphuis JH, Hulsbosch AM, Emmelkamp PMG. Single session debriefing after psychological trauma: a meta-analysis. *Lancet* 2002;360(9335):766-771. https://doi.org/10.1016/S0140-6736(02)09897-5
- 35. McNally RJ, Bryant RA, Ehlers A. Does early psychological intervention promote recovery from posttraumatic stress? *Psychol Sci Pub Interest* 2003;4(2):45-79. https://doi.org/10.1111/1529-1006.01421
- 36. Lee SH, Kim SJ, Sim MY, Yoo SY, Won SD, Lee BC. Mental health of disaster workers. *J Korean Neuropsychiatr Assoc* 2015;54(2):135-141.
- 37. Korea Occupational Safety and Health Agency. Occupational trauma management program operating manual. Ulsan: Korea Occupational Safety and Health Agency; 2021.
- 38. Roberts NP, Kitchiner NJ, Kenardy J, Robertson L, Lewis C, Bisson JI. Multiple session early psychological interventions for the prevention of post-traumatic stress disorder. *Cochrane Database Syst Rev* 2019;8(3):CD006869. https://doi.org/10.1002/14651858.CD006869.pub2
- 39. Caramela S. PTSD and safety: how to feel safe after trauma [Internet]. San Antonio (TX): HealthyPlace; c2023 [cited 2024 Dec 15]. Available from: https://www.healthyplace.com/blogs/traumaptsdblog/2023/11/ptsd-and-safety-how-to-feel-safe-after-trauma
- 40. Shultz JM, Forbes D. Psychological first aid: rapid proliferation and the search for evidence. Disaster Health 2013;2(1):3-12. https://doi.org/10.4161/dish.26006
- 41. Lee E. Trauma counseling model: focusing on understanding the stage-by-stage healing mechanism and techniques. *J Couns Stud* 2015;16(3):581-602. https://doi.org/10.15703/kic.16.3.201506.581
- 42. Magruder KM, McLaughlin KA, Elmore Borbon DL. Trauma is a public health issue. *Eur J Psychotraumatol* 2017;8(1):1375338. https://doi.org/10.1080/20008198.2017.1375338

Review



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Management strategies for advanced hepatocellular carcinoma with portal vein tumor thrombosis

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Hepatocellular carcinoma with portal vein tumor thrombosis presents a significant therapeutic challenge due to its poor prognosis and limited treatment options. This review thoroughly examines diagnostic methods, including imaging techniques and classification systems such as the Japanese Vp and Cheng's classifications, to aid in clinical decision-making. Treatment strategies encompass liver resection and liver transplantation, particularly living donor liver transplantation after successful downstaging, which have shown potential benefits in selected cases. Locoregional therapies, including hepatic arterial infusion chemotherapy, transarterial chemoembolization, transarterial radioembolization, and external beam radiation therapy, remain vital components of treatment. Recent advancements in systemic therapies, such as sorafenib, lenvatinib, and immune checkpoint inhibitors (e.g., atezolizumab plus bevacizumab) have demonstrated improvements in overall survival and progression-free survival. These developments underscore the importance of a multidisciplinary and personalized approach to improve outcomes for patients with hepatocellular carcinoma and portal vein tumor thrombosis.

Introduction

Background

In recent years, treatment strategies for hepatocellular carcinoma (HCC) have significantly advanced, incorporating locoregional therapies, surgical resection, liver transplantation (LT), and systemic therapies, including immunotherapy [1-3]. Despite these advancements, portal vein tumor thrombosis (PVTT) continues to pose a major challenge in the treatment of HCC. It represents a critical prognostic factor associated with advanced disease, limited therapeutic options, and poor clinical outcomes [4-6].

The American Association for the Study of Liver Diseases (AASLD), the European Association for the Study of the Liver (EASL), and groups in the Asia-Pacific region have published regionspecific guidelines for treating HCC with PVTT. These guidelines account for differences in clinical practices, resource availability, and patient characteristics [7-11]. Despite these efforts, a consensus on the best treatment approach has yet to be reached, making the management of HCC with PVTT a significant clinical challenge.

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Objectives

This review comprehensively summarizes and analyzes treatment strategies for HCC with PVTT. By integrating the latest research evidence and clinical insights, this article provides guidance on identifying the most optimal treatment strategies for HCC with PVTT in real-world clinical settings.

Ethics statement

As this study is a literature review, it did not require institutional review board approval or individual consent.

Diagnosis and classification of portal vein tumor thrombosis

PVTT is the most prevalent type of macrovascular invasion (MVI) in HCC, with its occurrence at diagnosis ranging from 10% to over 40% [5,12,13]. It can be identified via imaging techniques, particularly on three-phase contrast-enhanced CT scans, where it presents as solid lesions within the portal vein across all phases. These lesions are marked by contrast enhancement during the arterial phase and subsequent washout in the portal venous phase [14]. In contrast, portal vein thrombosis (PVT), often resulting from complications related to cirrhosis or splenectomy, does not show arterial phase enhancement and can be managed with anticoagulant therapy. Thus, accurately differentiating PVTT from PVT is crucial [15]. Another diagnostic tool, ¹⁸F-fluorodeoxyglucose (FDG) positron emission tomography/CT, has proven highly effective in distinguishing between malignant and benign thrombi. Malignant thrombi show moderate to high FDG uptake, unlike their benign counterparts [16,17]. The non-invasive diagnostic criteria for differentiating PVTT from PVT, referred to as A-VENA, rely on the presence of three or more indicators: alpha-fetoprotein levels exceeding 1,000 ng/dL, venous expansion, thrombus enhancement, neovascularity, and proximity to HCC [18].

Two widely used systems for assessing the extent of PVTT are the Japanese Vp classification [19] and Cheng's classification, as illustrated in Fig. 1 [20]. The VP classification divides the extent of tumor thrombus in the portal vein into four levels: Vp1, which involves the segmental branches of the portal vein; Vp2, affecting the second-order branches; Vp3, involving the first-order branches; and Vp4, which affects the main trunk of the portal vein and/or the contralateral branch. Cheng's classification also delineates four grades: type I, where the tumor thrombus is located in the segmental or sectoral branches of the portal vein or higher; type II, involving the right or left portal vein; type III, affecting the main portal vein; and type IV, involving the superior mesenteric vein.

Treatment options for hepatocellular carcinoma with portal vein tumor thrombosis

The current evidence-based treatment algorithms for HCC patients with PVTT are presented in Fig. 2.

Liver resection

Liver resection is a curative treatment for patients with HCC and, according to the Barcelona Clinic Liver Cancer (BCLC) staging system, is considered feasible only in early-stage HCC (BCLC stage 0 or A). The presence of PVTT, regardless of tumor size or extent, is classified



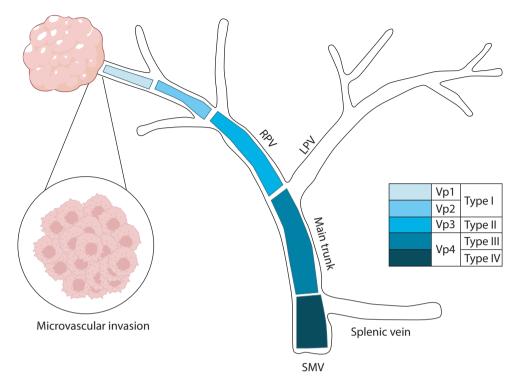


Fig. 1. Classification of portal vein tumor thrombosis in hepatocellular carcinoma. RPV, right portal vein; LPV, left portal vein; SMV, superior mesenteric vein.

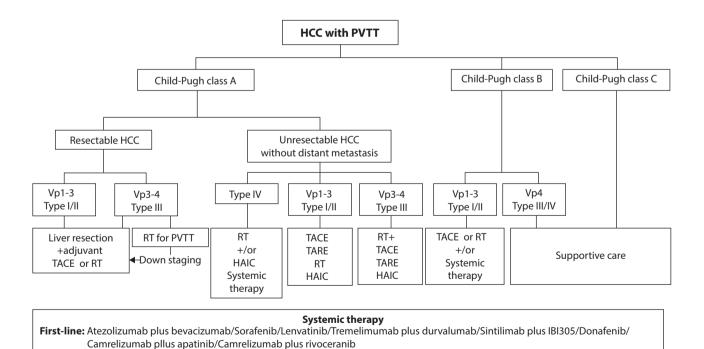


Fig. 2. Current treatment algorithm for hepatocellular carcinoma patients with portal vein tumor thrombosis. HCC, hepatocellular carcinoma; PVTT, portal vein tumor thrombosis; TACE, transarterial chemoembolization; RT, radiation therapy; HAIC, hepatic artery infusion chemotherapy; TARE, transarterial radioembolization.

Second-line: Regorafenib/Cabozantinib/Ramucirumab/Pembrolizumab/Nivolumab plus ipilimumab/Camrelizumab/Tislelizumab



as BCLC stage C, making liver resection contraindicated [21]. However, in the Asia-Pacific region, liver resection is performed for selected patients outside the BCLC staging system, with several studies demonstrating moderately favorable outcomes. Retrospective analyses have shown that liver resection significantly improves overall survival (OS) in patients with HCC and PVTT, particularly in those with Child-Pugh class A liver function, except in cases involving Vp4 PVTT [22]. A systematic review of 29 studies found that the median OS was longer in patients undergoing liver resection compared to those receiving systemic therapy. The location and extent of PVTT were critical factors influencing survival outcomes, with patients exhibiting distal portal vein branch invasion achieving a 5-year survival rate of 45%, while those with main trunk invasion had survival rates of less than 15% [23]. Clinical guidelines in Korea recommend liver resection for HCC patients with PVTT if the main portal trunk is not involved and liver function is well-preserved [8]. Similarly, Japanese guidelines permit liver resection in cases of portal vein invasion up to the first branch (Vp1-[3]) [9]. In China, liver resection is advised for patients with Child-Pugh class A liver function, PVTT types I or II, and an ECOG performance status of 0-1. Patients with type III PVTT are also considered eligible for liver resection either directly or after tumor downstaging through radiotherapy [7].

Liver transplantation

PVTT has traditionally been viewed as an absolute contraindication due to its strong association with high recurrence rates and poor prognosis [24,25]. Additionally, the use of deceased donor LT in managing HCC with PVTT is limited by the scarcity of available donor organs. However, advancements in surgical techniques have led to an increased adoption of living donor LT for patients with HCC and PVTT. With improvements in locoregional therapies for HCC with PVTT, LT following successful downstaging has emerged as a key area of interest. Retrospective analyses indicate that patients with segmental PVTT who underwent living donor LT experienced significantly better OS and disease-free survival (DFS) rates than those with lobar PVTT [26]. Similarly, studies involving patients with major vascular invasion who underwent downstaging using 3D conformal radiation therapy (RT) and transarterial chemoembolization (TACE) prior to LT showed significantly higher 3-year DFS and OS rates for those meeting the Milan criteria than those who did not [26].

Hepatic artery infusion chemotherapy

Hepatic arterial infusion chemotherapy (HAIC) is a commonly used treatment for advanced HCC. This method involves delivering chemotherapeutic agents such as platinum/oxaliplatin and 5-fluorouracil directly into intrahepatic tumor lesions via a catheter or pump. HAIC is recommended for HCC patients who have major portal vascular invasion and Child-Pugh A liver function but are not eligible for hepatectomy, radiofrequency ablation, TACE, or systemic therapy [9]. A meta-analysis of six studies demonstrated that HAIC outperformed sorafenib in HCC patients with PVTT, particularly in those with types III-IV PVTT. HAIC showed better OS, progression-free survival (PFS), and disease control rate, although it was associated with higher rates of myelosuppression [27]. Additionally, a phase III randomized controlled trial (SILIUS study) from Japan reported that combining HAIC with sorafenib improved OS compared to sorafenib alone in patients with Vp4 PVTT. However, no significant difference in median OS was observed for patients with Vp1-3 PVTT [28]. Furthermore, a study comparing TACE-HAIC combined with targeted therapy and immunotherapy to TACE alone in HCC patients with PVTT showed superior outcomes for the combination group, with significantly better OS [29].



Transarterial chemoembolization

TACE is a widely utilized technique for managing unresectable HCC with PVTT [30]. It is particularly considered for patients with good liver function and sufficient collateral circulation around the obstructed portal vein [31,32]. In patients with type III/IV PVTT, its application remains controversial due to the associated risks of liver infarction and hepatic failure, although TACE has shown potential to extend OS [33]. A meta-analysis of 13 trials involving 1,933 patients was conducted to assess the safety and efficacy of TACE in managing HCC with PVTT. The study found that patients with PVTT in the main portal vein trunk had significantly worse survival rates compared to those with segmental PVTT (P<0.001) [34]. The limited effectiveness of TACE as a standalone therapy highlights the importance of combining it with other treatment modalities to improve OS in patients with HCC and PVTT [35]. A study comparing the effectiveness of TACE combined with RT against sorafenib therapy demonstrated that the combination therapy achieved a median OS of 12.8 months, significantly higher than the 10.0 months observed with sorafenib alone (P=0.04) [36]. An analysis of 25 studies, including 2,577 patients, revealed that combining TACE with RT significantly improved the 1-year survival rate compared to TACE alone [37]. This finding suggests that the TACE and RT combination could serve as a primary treatment approach for HCC patients with MVI [38]. The median OS was significantly longer in the TACE and sorafenib combination group compared to the sorafenib monotherapy group (8.9 vs. 5.9 months, P=0.009), with improved OS observed in patients with MVI (hazard ratio [HR] 0.64; 95% CI 0.44-0.92; P=0.02) [39]. The clinical outcomes of combining TACE with immune checkpoint inhibitors are still limited, and further research is needed to establish their efficacy and potential benefits.

Transarterial radioembolization

Transarterial radioembolization (TARE) with yttrium-90 microspheres is recognized as an effective treatment option for HCC patients with PVTT, offering a unique approach that combines microembolization with targeted radiotherapy [40]. Two phase III studies found no significant difference in OS between TARE and sorafenib [41,42]. However, a meta-analysis of 17 trials revealed higher 6-month and 1-year OS rates in the TARE group (76% and 47%, respectively) compared to the sorafenib group (54% and 24%) [43]. A case report suggested that concurrent TARE and combination therapy with atezolizumab plus bevacizumab could be an effective and safe treatment regimen for patients with infiltrative HCC and PVTT [44]. Nonetheless, retrospective studies and clinical trials are warranted to validate these findings. Existing evidence suggests that TARE is an effective treatment for HCC patients with PVTT, with response rates ranging from 50% to 75% and a median survival time of approximately 10 months [40]. Although internal radiotherapy is a more invasive treatment, it delivers a sustained high dose of radiation to PVTT while sparing nearby normal liver tissue, making it particularly beneficial for patients with malignant portal vein stenosis or occlusion [45].

External beam radiation therapy

For patients with unresectable HCC and all types of PVTT, RT is recommended, targeting both the primary tumor and PVTT lesions. Advances in technologies such as three-dimensional conformal RT, intensity-modulated RT, and stereotactic body RT (SBRT) have enabled higher radiation doses to be delivered to the targeted areas while protecting adjacent normal tissues [46,47]. Target localization for RT often utilizes CT and magnetic resonance imaging fusion based on lipiodol deposition following TACE [48]. The optimal irradiation area remains a topic



of debate and should be personalized. In cases where the hepatic lesion is small and PVTT is nearby, both the tumor and PVTT can be targeted simultaneously. For larger tumors or distant PVTT, irradiation may be focused exclusively on the PVTT [49]. Studies have shown that RT, either as a standalone treatment or combined with other modalities, improves survival and quality of life in these patients. When comparing sorafenib and RT in HCC patients with Vp3-4 PVTT, RT showed a significantly better median OS after propensity score matching (10.9 vs. 4.8 months; P=0.025) [50]. Similarly, in a Korean multicenter retrospective cohort study using propensity score matching, RT demonstrated an improved response rate in HCC patients with PVTT [51]. The efficacy of SBRT combined with sorafenib compared to SBRT alone was retrospectively assessed in patients with HCC and PVTT [52]. The findings demonstrated that the combination therapy resulted in longer median PFS (6 vs. 3 months) and median OS (12.5 vs. 7 months) than SBRT alone, although these differences were not statistically significant.

Systemic therapy

Atezolizumab with bevacizumab

The combination of atezolizumab and bevacizumab has been established as a first-line systemic therapy for unresectable HCC, as demonstrated by its superiority over sorafenib in the IMbrave150 trial [53]. This regimen has demonstrated a strong antitumor effect in advanced HCC with Vp4 PVTT and is associated with minimal impact on hepatic function in the early stages of treatment [54], along with a favorable initial response [55]. Updated efficacy and safety data from the IMbrave150 trial show that patients with MVI experienced improved median OS and PFS when treated with atezolizumab plus bevacizumab compared to those treated with sorafenib (Tables 1, 2) [56]. Additionally, therapeutic outcomes of atezolizumab plus bevacizumab and lenvatinib have been found comparable for managing HCC with PVTT [57]. A multicenter cohort study conducted in South Korea demonstrated that atezolizumab plus bevacizumab achieved superior 1-year survival and PFS rates compared to TACE plus RT in HCC patients with PVTT and no metastasis. These findings suggest that atezolizumab plus bevacizumab should be considered a primary treatment option for this patient group [58].

Other immune checkpoint inhibitors

Subgroup analyses from multiple clinical trials of immune checkpoint inhibitors have assessed clinical outcomes in patients with HCC and MVI (Tables 1, 2). The HIMALAYA trial evaluated the clinical outcomes of combining tremelimumab with durvalumab versus using sorafenib alone. It showed a trend toward improved OS in patients with HCC and MVI, although the results did not reach statistical significance [59]. The CARES-310 trial compared camrelizumab plus rivoceranib with sorafenib and demonstrated statistically significant improvements in both OS and PFS for patients with HCC and MVI [60]. In the context of second-line treatment, the KEYNOTE-240 trial, which compared pembrolizumab to placebo, was the sole study to specifically analyze clinical outcomes in patients with HCC and MVI. Despite not achieving statistical significance, pembrolizumab exhibited a trend toward better OS and PFS compared to placebo [61]. Notably, unlike the IMbrave150 trial, these clinical trials excluded patients with Vp4 or type III/IV PVTT.

Sorafenib

Sorafenib, an orally administered multi-kinase inhibitor, was the first targeted therapy approved for HCC patients with PVTT, based on the results of two phase III randomized, double-



Table 1. Overall survival in clinical trials of first-line or second-line systemic therapy for unresectable HCC with PVTT

Author/trial (year)	Phase	Treatment	Number of patients MVI/AII	Median OS in all patients	HR (95% CI) in all patients	Median OS with MVI	HR (95% CI) with MVI	
First-line								
Cheng et al. [56] IMbrave150 updated	III	Atezolizumab plus bevacizumab	129/336	19.2 months (17.0–23.7)	0.66 (0.52-0.85)	14.2 months (11.0–19.4)	0.68 (0.47–0.98)	
(2022)		Sorafenib	71/165	13.4 (11.4–16.9)	Reference	9.7 months (6.1–13.1)	Reference	
Abou-Alfa et al. [59] HIMALAYA (2022)	III	Tremelimumab plus durvalumab	103/393	16.4 months (14.2–19.6)	0.78 (0.65–0.93)	-	0.78 (0.57–1.07)	Exclude Vp4/Type III/IV
		Durvalumab	94/389	16.6 months (14.1–19.1)	0.86 (0.73-1.03)	-	0.85 (0.62–1.17)	
		Sorafenib	100/389	13.8 months (12.3–16.1)	Reference	-	Reference	
Qin et al. [60] CARES-310 (2023)	III	Camrelizumab plus rivoceranib	40/272	22.1 months (19.1–27.2)	0.62 (0.49–0.80)	-	0.56 (0.32–0.99)	Exclude Vp4/Type III/IV
		Sorafenib	52/271	15.2 months (13.0–18.5)	Reference	-	Reference	
Second-line								
Finn et al. [61] KEYNOTE 240 (2020)	III	Pembrolizumab	36/278	13.9 months (11.6–16.0)	0.78 (0.61–0.998)	-	0.57 (0.29–1.13)	Exclude Vp4/Type III/IV
		Placebo	16/135	10.6 months (8.3–13.5)	Reference	-	Reference	

HCC, hepatocellular carcinoma; PVTT, portal vein tumor thrombosis; MVI, macrovascular invasion; OS, overall survival; HR, hazard ratio.

Table 2. Progression-free survival in clinical trials of first-line or second-line systemic therapy for unresectable HCC with PVTT

Author/trial (year)	Phase	Treatment	Number of patients MVI/AII	Median PFS in all patients	HR (95% CI) in all patients	Median PFS with MVI	HR (95% CI) with MVI	
First-line								
Cheng et al. [56] IMbrave150 updated	III	Atezolizumab plus bevacizumab	129/336	6.9 months (5.7–8.6)	0.65 (0.53–0.81)	6.7 months (5.4–8.3)	0.59 (0.43–0.83)	
(2022)		Sorafenib	71/165	4.3 months (4.0–5.6)	Reference	4.2 months (2.8–5.3)	Reference	
Abou-Alfa et al. [59] HIMALAYA (2022)	III	Tremelimumab plus durvalumab	103/393	3.8 months (3.7–5.3)	0.90 (0.77–1.05)	-	-	Exclude Vp4/Type III/IV
		Durvalumab	94/389	3.7 months (3.2–3.8)	1.02 (0.88–1.19)	-	-	
		Sorafenib	100/389	4.1 months (3.8–5.5)	Reference	-	-	
Qin et al. [60] CARES-310 (2023)	III	Camrelizumab plus rivoceranib	40/272	5.6 months (5.5–6.3)	0.52 (0.41–0.65)	-	0.55 (0.44–0.70)	Exclude Vp4/Type III/IV
		Sorafenib	52/271	3.7 months (2.8–3.7)	Reference	-	Reference	
Second-line								
Finn et al. [61] KEYNOTE 240 (2020)	III	Pembrolizumab	36/278	3.0 months (2.8–4.1)	0.72 (0.57–0.90)	-	0.80 (0.42–1.51)	Exclude Vp4/Type III/IV
		placebo	16/135	2.8 months (1.6–3.0)	Reference	-	Reference	

HCC, hepatocellular carcinoma; PVTT, portal vein tumor thrombosis; MVI, macrovascular invasion; PFS, progression-free survival; HR, hazard ratio.



blind, placebo-controlled trials [62,63]. The SHARP trial reported a median survival time of 10.7 months [63], whereas an Asia-Pacific study reported a median survival time of 6.5 months [10]. However, real-world outcomes may be less favorable due to potential selection bias in clinical trials [10,64]. The phase III STAH study suggested that combining sorafenib with TACE might improve OS in HCC patients with PVTT compared to sorafenib alone, although the difference was not statistically significant [65]. Additionally, a randomized controlled trial involving 99 patients with HCC, cirrhosis, and PVTT found that combining sorafenib with radiofrequency ablation significantly improved OS rates compared to sorafenib monotherapy [66].

Lenvatinib

Lenvatinib, a multi-kinase inhibitor with antiangiogenic properties, has been shown to be effective in treating advanced HCC, as evidenced by a randomized phase III noninferiority trial [67]. In comparison to sorafenib, lenvatinib not only demonstrated similar median survival times but also achieved a higher objective response rate and longer PFS [67]. Additionally, a case report highlighted that after 11 months of treatment with lenvatinib for advanced HCC with PVTT, the PVTT became undetectable, and the vascularization of the primary tumor had resolved [68].

Conclusion

The management of HCC with PVTT requires a multidisciplinary approach that incorporates locoregional therapies, systemic treatments, and surgical interventions, all tailored to the specific clinical context of each patient. Recent advancements, such as immune checkpoint inhibitors and combination strategies like TACE with RT, have shown considerable promise in enhancing clinical outcomes. These developments highlight the critical need for personalized treatment strategies to navigate the complexities and improve the prognosis for this high-risk population.

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References

- 1. Teufel A, Kudo M, Qian Y, Daza J, Rodriquez I, Reissfelder C, et al. Current trends and advancements in the management of hepatocellular carcinoma. Dig Dis 2024;42(4):349-360.
 - https://doi.org/10.1159/000538815
- 2. Sankar K, Gong J, Osipov A, Miles SA, Kosari K, Nissen NN, et al. Recent advances in the management of hepatocellular carcinoma. Clin Mol Hepatol 2024;30(1):1-15. https://doi.org/10.3350/cmh.2023.0125
- 3. Yang X, Yang C, Zhang S, Geng H, Zhu AX, Bernards R, et al. Precision treatment in advanced hepatocellular carcinoma. Cancer Cell 2024;42(2):180-197. https://doi.org/10.1016/j.ccell.2024.01.007
- 4. Chan SL, Mo FKF, Johnson PJ, Liem GS, Chan TC, Poon MC, et al. Prospective validation of the Chinese University Prognostic Index and comparison with other staging systems for hepatocellular carcinoma in an Asian population. J Gastroenterol Hepatol 2011;26(2):340-347.
 - https://doi.org/10.1111/j.1440-1746.2010.06329.x
- 5. Llovet JM, Bustamante J, Castells A, Vilana R, Del Carmen Ayuso M, Sala M, et al. Natural history of untreated nonsurgical hepatocellular carcinoma: rationale for the design and evaluation of therapeutic trials. Hepatology 1999;29(1):62-67. https://doi.org/10.1002/hep.510290145
- 6. Connolly GC, Chen R, Hyrien O, Mantry P, Bozorgzadehd A, Abt P, et al. Incidence, risk factors and consequences of portal vein and systemic thromboses in hepatocellular carcinoma. Thromb Res 2008;122(3):299-306. https://doi.org/10.1016/j.thromres.2007.10.009
- 7. Sun J, Guo R, Bi X, Wu M, Tang Z, Lau WY, et al. Guidelines for diagnosis and treatment of hepatocellular carcinoma with portal vein tumor thrombus in China (2021 edition). Liver Cancer 2022;11(4):315-328.
 - https://doi.org/10.1159/000523997
- 8. Korean Liver Cancer Association, National Cancer Center (NCC) Korea. 2022 KLCA-NCC Korea practice guidelines for the management of hepatocellular carcinoma. Korean J Radiol 2022;23(12):1126-1240.
 - https://doi.org/10.3348/kjr.2022.0822
- 9. Kudo M, Kawamura Y, Hasegawa K, Tateishi R, Kariyama K, Shiina S, et al. Management of hepatocellular carcinoma in Japan: JSH consensus statements and recommendations 2021 update. Liver Cancer 2021;10(3):181-223. https://doi.org/10.1159/000514174
- 10. Galle PR, Forner A, Llovet JM, Mazzaferro V, Piscaglia F, Raoul JL, et al. EASL clinical practice guidelines: management of hepatocellular carcinoma. J Hepatol 2018;69(1):182-236. https://doi.org/10.1016/j.jhep.2018.03.019



- Finn RS, Zhu AX, Farah W, Almasri J, Zaiem F, Prokop LJ, et al. Therapies for advanced stage hepatocellular carcinoma with macrovascular invasion or metastatic disease: a systematic review and meta-analysis. *Hepatology* 2018;67(1):422-435. https://doi.org/10.1002/hep.29486
- 12. Quirk M, Kim YH, Saab S, Lee EW. Management of hepatocellular carcinoma with portal vein thrombosis. *World J Gastroenterol* 2015;21(12):3462-3471. https://doi.org/10.3748/wig.v21.i12.3462
- 13. Minagawa M, Makuuchi M. Treatment of hepatocellular carcinoma accompanied by portal vein tumor thrombus. *World J Gastroenterol* 2006;12(47):7561-7567. https://doi.org/10.3748/wjg.v12.i47.7561
- Hennedige T, Venkatesh SK. Advances in computed tomography and magnetic resonance imaging of hepatocellular carcinoma. World J Gastroenterol 2016;22(1):205-220. https://doi.org/10.3748/wjg.v22.i1.205
- 15. Ponziani FR, Zocco MA, Campanale C, Rinninella E, Tortora A, Maurizio LD, et al. Portal vein thrombosis: insight into physiopathology, diagnosis, and treatment. *World J Gastroenterol* 2010;16(2):143-155.
 - https://doi.org/10.3748/wjg.v16.i2.143
- Agarwal KK, Shah D, Shah N, Mayank M. Differentiation of malignant thrombus from bland thrombus of the portal vein in patient with hepatocellular carcinoma on 18F-FDG PET CT. Clin Nucl Med 2017;42(11):e472-e474.
 - https://doi.org/10.1097/RLU.000000000001840
- 17. Wu B, Zhang Y, Tan H, Shi H. Value of 18F-FDG PET/CT in the diagnosis of portal vein tumor thrombus in patients with hepatocellular carcinoma. *Abdom Radiol* 2019;44(7):2430-2435. https://doi.org/10.1007/s00261-019-01997-2
- Sherman CB, Behr S, Dodge JL, Roberts JP, Yao FY, Mehta N, et al. Distinguishing tumor from bland portal vein thrombus in liver transplant candidates with hepatocellular carcinoma: the A-VENA criteria. *Liver Transpl* 2019;25(2):207-216. https://doi.org/10.1002/lt.25345
- Ikai I, Yamamoto Y, Yamamoto N, Terajima H, Hatano E, Shimahara Y, et al. Results of hepatic resection for hepatocellular carcinoma invading major portal and/or hepatic veins. *Surg Oncol Clin N Am* 2003;12(1):65-75. https://doi.org/10.1016/s1055-3207(02)00082-0
- 20. Shuqun C, Mengchao W, Han C, Feng S, Jiahe Y, Guanghui D, et al. Tumor thrombus types influence the prognosis of hepatocellular carcinoma with the tumor thrombi in the portal vein. *Hepato-gastroenterology* 2007;54(74):499-502.
- 21. Reig M, Forner A, Rimola J, Ferrer-Fàbrega J, Burrel M, Garcia-Criado Á, et al. BCLC strategy for prognosis prediction and treatment recommendation: the 2022 update. *J Hepatol* 2022;76(3):681-693.
 - https://doi.org/10.1016/j.jhep.2021.11.018
- 22. Kokudo T, Hasegawa K, Matsuyama Y, Takayama T, Izumi N, Kadoya M, et al. Survival benefit of liver resection for hepatocellular carcinoma associated with portal vein invasion. *J Hepatol* 2016;65(5):938-943.
 - https://doi.org/10.1016/j.jhep.2016.05.044
- 23. Glantzounis GK, Paliouras A, Stylianidi MC, Milionis H, Tzimas P, Roukos D, et al. The role of liver resection in the management of intermediate and advanced stage hepatocellular carcinoma. A systematic review. *Eur J Surg Oncol* 2018;44(2):195-208.



- https://doi.org/10.1016/j.ejso.2017.11.022
- 24. Mazzaferro V, Llovet JM, Miceli R, Bhoori S, Schiavo M, Mariani L, et al. Predicting survival after liver transplantation in patients with hepatocellular carcinoma beyond the Milan criteria: a retrospective, exploratory analysis. *Lancet Oncol* 2009;10(1):35-43. https://doi.org/10.1016/S1470-2045(08)70284-5
- 25. Xu X, Lu D, Ling Q, Wei X, Wu J, Zhou L, et al. Liver transplantation for hepatocellular carcinoma beyond the Milan criteria. *Gut* 2016;65(6):1035-1041. https://doi.org/10.1136/gutjnl-2014-308513
- 26. Choi HJ, Kim DG, Na GH, Hong TH, Bae SH, You YK, et al. The clinical outcomes of patients with portal vein tumor thrombi after living donor liver transplantation. *Liver Transpl* 2017;23(8):1023-1031.
 - https://doi.org/10.1002/lt.24782
- 27. Liu M, Shi J, Mou T, Wang Y, Wu Z, Shen A. Systematic review of hepatic arterial infusion chemotherapy versus sorafenib in patients with hepatocellular carcinoma with portal vein tumor thrombosis. *J Gastroenterol Hepatol* 2020;35(8):1277-1287. https://doi.org/10.1111/jgh.15010
- 28. Kudo M, Ueshima K, Yokosuka O, Ogasawara S, Obi S, Izumi N, et al. Sorafenib plus low-dose cisplatin and fluorouracil hepatic arterial infusion chemotherapy versus sorafenib alone in patients with advanced hepatocellular carcinoma (SILIUS): a randomised, open label, phase 3 trial. *Lancet Gastroenterol Hepatol* 2018;3(6):424-432. https://doi.org/10.1016/S2468-1253(18)30078-5
- 29. Yuan Y, He W, Yang Z, Qiu J, Huang Z, Shi Y, et al. TACE-HAIC combined with targeted therapy and immunotherapy versus TACE alone for hepatocellular carcinoma with portal vein tumour thrombus: a propensity score matching study. *Int J Surg* 2023;109(5):1222-1230. https://doi.org/10.1097/JS9.00000000000000056
- 30. Xue TC, Xie XY, Zhang L, Yin X, Zhang BH, Ren ZG. Transarterial chemoembolization for hepatocellular carcinoma with portal vein tumor thrombus: a meta-analysis. *BMC Gastroenterol* 2013;13:60.
 - https://doi.org/10.1186/1471-230X-13-60
- 31. Chung GE, Lee JH, Kim HY, Hwang SY, Kim JS, Chung JW, et al. Transarterial chemoembolization can be safely performed in patients with hepatocellular carcinoma invading the main portal vein and may improve the overall survival. *Radiology* 2011;258(2):627-634.
 - https://doi.org/10.1148/radiol.10101058
- 32. Kim HC, Chung JW, Lee W, Jae HJ, Park JH. Recognizing extrahepatic collateral vessels that supply hepatocellular carcinoma to avoid complications of transcatheter arterial chemoembolization. *Radiographics* 2005;25(suppl_1):S25-S39. https://doi.org/10.1148/rg.25si055508
- 33. Chan SL, Chong CCN, Chan AWH, Poon DMC, Chok KSH. Management of hepatocellular carcinoma with portal vein tumor thrombosis: review and update at 2016. *World J Gastroenterol* 2016;22(32):7289-7300. https://doi.org/10.3748/wjg.v22.i32.7289
- 34. Silva JP, Berger NG, Tsai S, Christians KK, Clarke CN, Mogal H, et al. Transarterial chemoembolization in hepatocellular carcinoma with portal vein tumor thrombosis: a systematic review and meta-analysis. *HPB* 2017;19(8):659-666. https://doi.org/10.1016/j.hpb.2017.04.016



- 35. Luo F, Li M, Ding J, Zheng S. The progress in the treatment of hepatocellular carcinoma with portal vein tumor thrombus. *Front Oncol* 2021;11:635731. https://doi.org/10.3389/fonc.2021.635731
- 36. Yoon SM, Ryoo BY, Lee SJ, Kim JH, Shin JH, An JH, et al. Efficacy and safety of transarterial chemoembolization plus external beam radiotherapy vs sorafenib in hepatocellular carcinoma with macroscopic vascular invasion: a randomized clinical trial. *JAMA Oncol* 2018;4(5):661-669.
 - https://doi.org/10.1001/jamaoncol.2017.5847
- 37. Huo YR, Eslick GD. Transcatheter arterial chemoembolization plus radiotherapy compared with chemoembolization alone for hepatocellular carcinoma: a systematic review and meta-analysis. *JAMA Oncol* 2015;1(6):756-765.
 - https://doi.org/10.1001/jamaoncol.2015.2189
- 38. Jin S, Choi WM, Shim JH, Lee D, Kim KM, Lim YS, et al. Subclassification of advanced-stage hepatocellular carcinoma with macrovascular invasion: combined transarterial chemoembolization and radiotherapy as an alternative first-line treatment. *J Liver Cancer* 2023;23(1):177-188.
 - https://doi.org/10.17998/jlc.2023.03.04
- 39. Choi GH, Shim JH, Kim MJ, Ryu MH, Ryoo BY, Kang YK, et al. Sorafenib alone versus sorafenib combined with transarterial chemoembolization for advanced-stage hepatocellular carcinoma: results of propensity score analyses. *Radiology* 2013;269(2):603-611. https://doi.org/10.1148/radiol.13130150
- 40. Liu PH, Huo TI, Miksad RA. Hepatocellular carcinoma with portal vein tumor involvement: best management strategies. *Semin Liver Dis* 2018;38(03):242-251. https://doi.org/10.1055/s-0038-1666805
- 41. Chow PKH, Gandhi M, Tan SB, Khin MW, Khasbazar A, Ong J, et al. SIRveNIB: selective internal radiation therapy versus sorafenib in Asia-Pacific patients with hepatocellular carcinoma. *J Clin Oncol* 2018;36(19):1913-1921. https://doi.org/10.1200/JCO.2017.76.0892
- 42. Vilgrain V, Pereira H, Assenat E, Guiu B, Ilonca AD, Pageaux GP, et al. Efficacy and safety of selective internal radiotherapy with yttrium-90 resin microspheres compared with sorafenib in locally advanced and inoperable hepatocellular carcinoma (SARAH): an open-label randomised controlled phase 3 trial. *Lancet Oncol* 2017;18(12):1624-1636. https://doi.org/10.1016/S1470-2045(17)30683-6
- 43. Kim PH, Choi SH, Kim JH, Park SH. Comparison of radioembolization and sorafenib for the treatment of hepatocellular carcinoma with portal vein tumor thrombosis: a systematic review and meta-analysis of safety and efficacy. *Korean J Radiol* 2019;20(3):385-398. https://doi.org/10.3348/kjr.2018.0496
- 44. Park MK, Yu SJ. Concurrent transarterial radioembolization and combination atezolizumab/bevacizumab treatment of infiltrative hepatocellular carcinoma with portal vein tumor thrombosis: a case report. *J Liver Cancer* 2022;22(1):69-74. https://doi.org/10.17998/jlc.2022.03.09
- 45. Tan Z, Lu J, Zhu G, Chen L, Wang Y, Zhang Q, et al. Portal vein irradiation stent plus chemoembolization versus external radiotherapy plus chemoembolization in hepatocellular carcinoma with portal vein tumour thrombus: a retrospective study. *Cardiovasc Intervent Radiol* 2021;44(9):1414-1422.
 - https://doi.org/10.1007/s00270-021-02889-z



- 46. Hsieh CH, Liu CY, Shueng PW, Chong NS, Chen CJ, Chen MJ, et al. Comparison of coplanar and noncoplanar intensity-modulated radiation therapy and helical tomotherapy for hepatocellular carcinoma. *Radiat Oncol* 2010;5:40. https://doi.org/10.1186/1748-717X-5-40
- 47. Kang J, Nie Q, Du R, Zhang L, Zhang J, Li Q, et al. Stereotactic body radiotherapy combined with transarterial chemoembolization for hepatocellular carcinoma with portal vein tumor thrombosis. *Mol Clin Oncol* 2014;2(1):43-50. https://doi.org/10.3892/mco.2013.196
- 48. Wang MH, Ji Y, Zeng ZC, Tang ZY, Fan J, Zhou J, et al. Impact factors for microinvasion in patients with hepatocellular carcinoma: possible application to the definition of clinical tumor volume. *Int J Radiat Oncol Biol Phys* 2010;76(2):467-476. https://doi.org/10.1016/j.ijrobp.2009.01.057
- 49. Yu Jl, Park HC. Radiotherapy as valid modality for hepatocellular carcinoma with portal vein tumor thrombosis. *World J Gastroenterol* 2016;22(30):6851-6863. https://doi.org/10.3748/wjg.v22.i30.6851
- 50. Nakazawa T, Hidaka H, Shibuya A, Okuwaki Y, Tanaka Y, Takada J, et al. Overall survival in response to sorafenib versus radiotherapy in unresectable hepatocellular carcinoma with major portal vein tumor thrombosis: propensity score analysis. *BMC Gastroenterol* 2014;14:84.
 - https://doi.org/10.1186/1471-230X-14-84
- 51. Im JH, Yoon SM, Park HC, Kim JH, Yu JI, Kim TH, et al. Radiotherapeutic strategies for hepatocellular carcinoma with portal vein tumour thrombosis in a hepatitis B endemic area. *Liver Int* 2017;37(1):90-100.
 - https://doi.org/10.1111/liv.13191
- 52. Que J, Wu HC, Lin CH, Huang CI, Li LC, Ho CH, et al. Comparison of stereotactic body radiation therapy with and without sorafenib as treatment for hepatocellular carcinoma with portal vein tumor thrombosis. *Medicine* 2020;99(13):e19660. https://doi.org/10.1097/MD.00000000000019660
- 53. Finn RS, Qin S, Ikeda M, Galle PR, Ducreux M, Kim TT, et al. Atezolizumab plus bevacizumab in unresectable hepatocellular carcinoma. *N Engl J Me*d 2020;382(20):1894-1905. https://doi.org/10.1056/NEJMoa1915745
- 54. Komatsu S, Fujishima Y, Kido M, Kuramitsu K, Goto T, Yanagimoto H, et al. Significant response to atezolizumab plus bevacizumab treatment in unresectable hepatocellular carcinoma with major portal vein tumor thrombus: a case report. *BMC Gastroenterol* 2021;21(1):470.
 - https://doi.org/10.1186/s12876-021-02053-4
- 55. Hiraoka A, Kumada T, Tada T, Hirooka M, Kariyama K, Tani J, et al. Atezolizumab plus bevacizumab treatment for unresectable hepatocellular carcinoma: early clinical experience. *Cancer Rep* 2022;5(2):e1464.
 - https://doi.org/10.1002/cnr2.1464
- 56. Cheng AL, Qin S, Ikeda M, Galle PR, Ducreux M, Kim TY, et al. Updated efficacy and safety data from IMbrave150: atezolizumab plus bevacizumab vs. sorafenib for unresectable hepatocellular carcinoma. *J Hepatol* 2022;76(4):862-873. https://doi.org/10.1016/j.jhep.2021.11.030
- 57. Park J, Lee YB, Ko Y, Park Y, Shin H, Hur MH, et al. Comparison of atezolizumab plus bevacizumab and lenvatinib for hepatocellular carcinoma with portal vein tumor thrombosis.



- J Liver Cancer 2024;24(1):81-91. https://doi.org/10.17998/jlc.2023.12.25
- 58. Lee SK, Kwon JH, Lee SW, Lee HL, Kim HY, Kim CW, et al. A real-world comparative analysis of atezolizumab plus bevacizumab and transarterial chemoembolization plus radiotherapy in hepatocellular carcinoma patients with portal vein tumor thrombosis. *Cancers* 2023;15(17):4423.
 - https://doi.org/10.3390/cancers15174423
- 59. Abou-Alfa GK, Lau G, Kudo M, Chan SL, Kelley RK, Furuse J, et al. Tremelimumab plus durvalumab in unresectable hepatocellular carcinoma. *NEJM Evid* 2022;1(8):EVIDoa2100070. https://doi.org/10.1056/EVIDoa2100070
- 60. Qin S, Chan SL, Gu S, Bai Y, Ren Z, Lin X, et al. Camrelizumab plus rivoceranib versus sorafenib as first-line therapy for unresectable hepatocellular carcinoma (CARES-310): a randomised, open-label, international phase 3 study. *Lancet* 2023;402(10408):1133-1146. https://doi.org/10.1016/S0140-6736(23)00961-3
- 61. Finn RS, Ryoo BY, Merle P, Kudo M, Bouattour M, Lim HY, et al. Pembrolizumab as second-line therapy in patients with advanced hepatocellular carcinoma in KEYNOTE-240: a randomized, double-blind, phase III trial. *J Clin Oncol* 2020;38(3):193-202. https://doi.org/10.1200/JCO.19.01307
- 62. Llovet JM, Ricci S, Mazzaferro V, Hilgard P, Gane E, Blanc JF, et al. Sorafenib in advanced hepatocellular carcinoma. *N Engl J Med* 2008;359(4):378-390. https://doi.org/10.1056/NEJMoa0708857
- 63. Cheng AL, Kang YK, Chen Z, Tsao CJ, Qin S, Kim JS, et al. Efficacy and safety of sorafenib in patients in the Asia-Pacific region with advanced hepatocellular carcinoma: a phase III randomised, double-blind, placebo-controlled trial. *Lancet Oncol* 2009;10(1):25-34. https://doi.org/10.1016/S1470-2045(08)70285-7
- 64. Jeong SW, Jang JY, Shim KY, Lee SH, Kim SG, Cha SW, et al. Practical effect of sorafenib monotherapy on advanced hepatocellular carcinoma and portal vein tumor thrombosis. *Gut Liver* 2013;7(6):696-703.
 - https://doi.org/10.5009/gnl.2013.7.6.696
- 65. Park JW, Kim YJ, Kim DY, Bae SH, Paik SW, Lee YJ, et al. Sorafenib with or without concurrent transarterial chemoembolization in patients with advanced hepatocellular carcinoma: the phase III STAH trial. *J Hepatol* 2019;70(4):684-691. https://doi.org/10.1016/j.jhep.2018.11.029
 - https://doi.org/10.1016/j.jhep.2018.11.029
- 66. Giorgio A, Merola MG, Montesarchio L, Merola F, Santoro B, Coppola C, et al. Sorafenib combined with radio-frequency ablation compared with sorafenib alone in treatment of hepatocellular carcinoma invading portal vein: a western randomized controlled trial. Anticancer Res 2016;36(11):6179-6183.
 - https://doi.org/10.21873/anticanres.11211
- 67. Kudo M, Finn RS, Qin S, Han KH, Ikeda K, Piscaglia F, et al. Lenvatinib versus sorafenib in first-line treatment of patients with unresectable hepatocellular carcinoma: a randomised phase 3 non-inferiority trial. *Lancet* 2018;391(10126):1163-1173. https://doi.org/10.1016/S0140-6736(18)30207-1
- 68. Takeda H, Nishijima N, Nasu A, Komekado H, Kita R, Kimura T, et al. Long-term antitumor effect of lenvatinib on unresectable hepatocellular carcinoma with portal vein invasion. *Hepatol Res* 2019;49(5):594-599. https://doi.org/10.1111/hepr.13294

Review



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Nutritional management for breast cancer patients

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Breast cancer is a complex disease influenced by environmental, genetic, dietary, and hormonal factors. This underscores the importance of postoperative nutritional management in supporting recovery, minimizing complications, and enhancing long-term outcomes. This review synthesizes clinical guidelines, expert recommendations, and observational studies to provide a comprehensive overview of dietary interventions for breast cancer patients following surgery. Post-surgical nutritional care is centered around three primary objectives: supporting wound healing through high-quality protein intake, maintaining optimal nutritional status to prevent malnutrition, and promoting healthy lifestyle habits to reduce the risk of recurrence. To achieve these objectives, postoperative dietary strategies focus on several key components: ensuring adequate hydration for metabolic processes and tissue repair, consuming a balanced diet rich in fresh vegetables and fruits to mitigate oxidative stress, incorporating whole grains to support overall healing, and maintaining sufficient intake of high-quality protein from sources such as fish, meat, and dairy products to aid tissue repair and immune system recovery. Patients are also advised to avoid alcohol, limit saturated fats, and reduce intake of salty, sugary, and smoked foods to minimize inflammation. As research progresses, the implementation of personalized dietary plans remains essential for optimizing recovery outcomes in breast cancer patients.

Introduction

Breast cancer represents a significant health burden, with its incidence consistently rising over the past several decades. In 2021, South Korea reported 28,861 new cases of breast cancer, which represented 10.4% of all cancer diagnoses and 21.5% of cancers in women, making it the second most prevalent cancer among women. Although the rate of increase has slightly declined since 2007, the incidence of breast cancer continues to rise. This trend is influenced by improvements in diagnostic techniques and changes in risk factors, including lifestyle alterations and an aging population. Breast cancer also exhibits a high survival rate, with a 5-year relative survival rate of 93.8%, due to advances in early detection and treatment methods. Nonetheless, breast cancer remains a significant cause of cancer-related mortality among women, accounting for 8.6% of female cancer deaths in 2023 [1].

Breast cancer represents a significant global health challenge, not only in South Korea but worldwide. According to the World Health Organization, approximately 2.3 million women were diagnosed with breast cancer globally in 2022, resulting in 670,000 deaths. In the same

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year, breast cancer was the most common cancer among women in 157 out of 185 countries, underscoring its widespread impact on women's health [2]. Furthermore, from 1990 to 2019, the number of global breast cancer cases more than doubled, increasing from 876,990 to 2,002,350, with an average annual percentage increase of 0.33%. Although the number of deaths has also risen during this period, advancements in medical care have led to a 0.56% annual decrease in mortality rates worldwide [3]. The high prevalence of breast cancer and its significant impact on public health underscore the urgent need for comprehensive management strategies that include prevention, treatment, and recovery support.

Surgery is the cornerstone of breast cancer treatment and serves as the primary curative intervention. It provides essential local disease control and critical pathological staging information necessary for treatment planning [4]. Although advancements in surgical techniques and therapeutic options have significantly improved outcomes over the years, major surgical complications can still occur. These complications, which include surgical issues such as bleeding, wound disruption, infection, or foreign body retention, as well as medical complications like myocardial infarction, pulmonary embolism, pneumonia, or acute respiratory distress syndrome, have been linked to worse cancer-specific and overall survival [5]. Additionally, cancer survivors face the risk of accelerated functional decline, which adversely affects physical functioning, recovery, and overall quality of life [6]. Therefore, truly successful treatment must extend beyond the operating room to include a comprehensive recovery process and longterm survivorship support. Within this framework, perioperative strategies, including proper nutritional management, are crucial for supporting immediate recovery. To achieve optimal long-term outcomes, a coordinated multidisciplinary approach is essential. This approach promotes healthy practices, reduces the risks of recurrence and secondary malignancies, and minimizes complications from comorbidities [7]. Nutritional support is a key component of this multidisciplinary approach.

Preoperative nutritional support has been demonstrated to reduce hospital stays, complication rates, and cancer recurrence [8]. Protective factors consist of regular consumption of vegetables, fruits, fiber, and carotenoids, as well as consistent physical activity. Conversely, factors that increase risk include obesity, alcohol consumption, high meat intake, and diets high in saturated fats [9]. Addressing these dietary habits is crucial for prevention.

During the postoperative period, proper nutrition plays a crucial role in healing, enhances treatment tolerance, and improves rehabilitation outcomes, establishing it as a fundamental aspect of comprehensive breast cancer management [10]. Given the significant implications, this review concentrates on evidence-based nutritional management strategies for patients who have undergone breast cancer surgery.

Ethics statement

As this study is a literature review, it did not require institutional review board approval or individual consent.

Breast cancer and nutritional factors

Recovery management

Surgical stress induces the upregulation of glucagon, cortisol, and proinflammatory cytokines, which extensively catabolize hepatic and muscle glycogen to meet the energy requirements of



wound healing. This process also involves increased gluconeogenesis in the liver, using lactate, amino acids, and glycerol as the primary substrates. The elevated levels of catabolic hormones hinder insulin secretion and the clearance of blood glucose, leading to insulin resistance and hyperglycemia. If not properly managed, these conditions can impair immune function and heighten the risk of infection. These complex metabolic alterations, which include changes in protein synthesis, energy utilization, and nutrient processing, culminate in a hypermetaboliccatabolic state. To address these challenges, patients need specialized nutritional interventions during recovery that focus on a balanced diet and lifestyle modifications [11].

Post-surgical nutritional care is centered around three main objectives. First, ensuring balanced meals with high-quality protein intake is essential for supporting surgical wound healing and physical recovery [12,13]. Second, maintaining optimal nutritional status and preventing malnutrition are key to facilitating a faster and smoother return to daily activities, as well as enhancing health-related quality of life [14]. Third, adopting proper lifestyle habits is crucial in preventing cancer recurrence [7].

To facilitate rapid recovery following breast cancer surgery, a comprehensive nutritional strategy has been developed (Fig. 1). This strategy aligns with the Korean Dietary Guidelines [15] and underscores the significance of balanced meals. It advocates for the daily intake of fresh vegetables and fruits, alongside suitable amounts of grains, fish, meat, and dairy products. Adequate hydration, achieved through sufficient water consumption, is also emphasized. Additionally, regular physical activity is crucial for maintaining a healthy body weight and promoting overall recovery.

In the following sections, we will discuss each component of this nutritional strategy in detail. This includes the rationale behind the recommended food groups, hydration guidelines, and the role of physical activity in postoperative recovery.

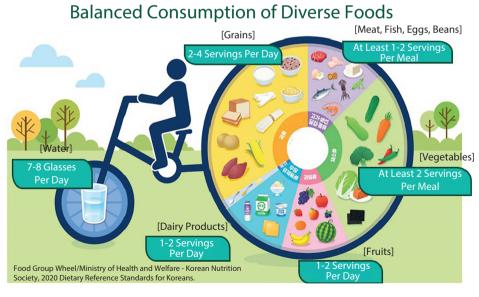


Fig. 1. Food group wheel. The figure illustrates the recommended daily intake of diverse foods, emphasizing balanced consumption to support recovery and overall health. It provides guidance on the types of foods to be consumed and their appropriate portions for each day. Adapted from Ministry of Health and Welfare and The Korean Nutrition Society [15] with CC-BY.



Nutritional factors

Water and hydration

Water is fundamental to human physiology and plays a crucial role in maintaining health. It is the primary component of blood and body tissues, acting as an important carrier for nutrients and waste products. Additionally, water regulates body temperature and supports various metabolic processes [16].

For breast cancer patients, maintaining adequate hydration is crucial during both treatment and recovery phases. Treatments such as chemotherapy, radiation, and surgery can significantly increase the body's water requirements and the risk of fluid loss. Dehydration, a frequent side effect of cancer therapies, can occur due to persistent vomiting, diarrhea, bleeding, prolonged fever, or excessive sweating. These conditions can severely impair the body's ability to heal [17].

Proper hydration is essential for these patients, as it promotes wound healing, alleviates treatment-related side effects, maintains electrolyte balance, and increases overall physiological resilience during recovery [1]. Medical guidelines typically advise adults to drink at least 7 to 8 cups of water per day, although specific needs may vary based on treatment intensity, physical activity, and general health [15]. Besides water, other beneficial beverages include herbal teas, nonfat soymilk, and diluted fruit juice, which not only aid in hydration but also provide additional nutrients. Conversely, the consumption of alcohol, coffee, decaffeinated coffee, black tea, decaffeinated tea, and caffeinated sodas is discouraged. These beverages may lead to fluid loss, hinder nutrient absorption, or worsen treatment-related side effects [18].

Protein intake

Protein plays a crucial role in the post-surgical recovery of breast cancer patients. It aids in various processes including wound healing, muscle preservation, blood cell production, immune system strengthening, and overall recuperation [12]. However, surgical stress significantly increases protein catabolism. The hypercortisolemia associated with surgery inhibits protein synthesis and accelerates protein breakdown, leading to a net loss of amino acids from skeletal muscle [13]. This shift results in the loss of skeletal muscle, which directly diminishes strength and functionality, thereby impeding the recovery process. To mitigate these catabolic effects and enhance recovery, it is essential to maintain adequate protein intake.

Lean meats are an excellent source of high-quality protein, providing a balanced profile of amino acids that fulfill human physiological needs. To minimize health risks, it is recommended that meat consumption be limited to 500 grams per week [19], which amounts to small portions roughly the size of a ping-pong ball [20]. Patients should opt for lean cuts such as skinless poultry or those with minimal fat, rather than fattier options like ribs, pork belly, or chicken skin. Conversely, the consumption of red meats such as beef, lamb, and pork, along with processed meats like ham and sausages, has been associated with an increased risk or exacerbation of cancer outcomes. These meats may contain carcinogenic compounds such as heterocyclic amines and polycyclic aromatic hydrocarbons, which form during cooking at high temperatures. Red meat also includes hormone residues and pro-inflammatory molecules such as N-glycolylneuraminic acid, which may contribute to chronic inflammation and tumor growth. Additionally, processed meats often contain nitrites and nitrates that can transform into carcinogenic nitrosamines [21]. Therefore, red meat consumption should be restricted to one serving per meal and no more than two servings per week, and processed meats should be avoided due to their potential health risks [22].



Cooking techniques significantly influence the nutritional value and potential carcinogenic properties of protein sources. It is advisable to use indirect cooking methods such as grilling, steaming, baking, or preparing light stir-fries. These methods help preserve the nutritional integrity of foods while minimizing health risks by reducing the formation of harmful compounds like heterocyclic amines and benzopyrene, which are produced when protein is subjected to high direct heat or charring [23]. To limit the intake of excessive saturated fats, patients should avoid deep-frying or pan-frying with excessive oil. Healthier cooking options, such as steaming or braising, are preferable [24]. It is also beneficial to incorporate unsaturated fats from sources like blue-backed fish, sesame oil, perilla oil, and olive oil, which offer nutritional advantages [25]. Furthermore, patients should avoid reusing cooking oils [26] and consuming smoked foods [27], as these practices can lead to the formation of carcinogenic compounds.

Instead of high-fat meats, patients are encouraged to opt for healthier protein options such as a single fish fillet or dishes made with soy-based ingredients [20]. Soy products, rich in isoflavones, function as phytoestrogens and offer hormonal balance as well as antioxidant and anticancer properties. It is advisable to consume these in whole food forms, including tofu, edamame, and traditional soy products, while avoiding concentrated soy supplements that may contain harmful compounds [28]. For portion control, about two tablespoons of black beans or one-fifth of a tofu block per serving is recommended to achieve health benefits [20].

Vegetable and fruit consumption

Consuming a wide variety of colorful fruits and vegetables is crucial for breast cancer patients because each color represents different phytochemicals, each with unique health-protective properties. These phytochemicals are bioactive compounds that plants naturally produce as a defense mechanism. Beyond their protective role in plants, these compounds provide numerous health benefits for humans, including anti-inflammatory, antioxidant, and anticancer effects, and they help prevent chronic conditions such as heart disease and metabolic disorders [29].

Table 1 highlights key anti-breast cancer phytochemicals, their dietary sources, and their

Table 1. Major anti-breast cancer phytochemicals, their sources, and the related benefits

Anticancer phytochemicals	Sources	Benefits	References
Flavones	Red and yellow fruits and vegetables (watermelons, bell peppers)	- Reduced risk of coronary heart diseases, cancers, chronic inflammation, osteoporosis and other age-related diseases Lowering estrogen levels that can help inhibit breast tumor growth and reduces the risk of recurrence.	[31]
Isoflavones	Sour cherries, tomatoes, broccoli, and carrots	 Inhibition of cancer cell growth, suppression of metastasis, and induction of apoptosis. Inhibits the proliferation of breast cancer cells by inducing cell cycle arrest. 	[32]
Prenylated flavonoids	Morus alba, Artocarpus heterophyllus, Glycine max, and Ficus carica	 Anti-cancer, anti-inflammatory, neuroprotective, anti-diabetic, anti-obesity, cardioprotective effects, and anti-osteoclastogenic activities. Induced apoptosis suppresses cytotoxicity against human breast cancer cells. 	[33]
Lignans	Potatoes, broccoli, berries	 Resolves immunodeficiency, cancer, inflammation, hypertension, hyperlipidemia. Reduced risks of postmenopausal breast cancer. 	[34]
Sitosterol	Fat-rich vegetables (avocados)	- Reduces immunomodulatory, antimicrobial, anticancer, anti – inflammatory, and lipid-lowering effect Inhibits breast cancer cell growth and induces apoptosis	[35]



health benefits. Flavones, present in red and yellow fruits and vegetables, are linked to lower risks of coronary heart disease, various cancers, and chronic inflammation. They also help reduce estrogen levels, potentially inhibiting the growth of breast tumors. Isoflavones, found in foods such as sour cherry, tomato, broccoli, and carrot, play a role in cancer prevention by suppressing metastasis and inducing apoptosis in breast cancer cells. Prenylated flavonoids, found in Morus alba, Artocarpus heterophyllus, Glycine max, and Ficus carica, have been shown to induce apoptosis and reduce cytotoxicity in breast cancer cells. Lignans, present in potatoes, broccoli, and berries, are associated with a reduced risk of postmenopausal breast cancer and other chronic conditions. Lastly, sitosterol, commonly found in fat-rich vegetables like avocado, has demonstrated significant anticancer and anti-inflammatory effects by inhibiting the growth of breast cancer cells and inducing apoptosis.

The Mediterranean Diet (MeDi), which emphasizes the daily consumption of fruits and vegetables, has been shown to provide an optimal intake of polyphenols (phenolic acids, flavonoids, stilbenes, lignans) and fiber. These components, abundantly found in these foods, are linked to improved outcomes in breast cancer survivors [30].

To achieve these benefits, patients should be encouraged to consume 5-9 servings of fruits (approximately 150 g per serving) and vegetables (approximately 75 g per serving) daily [36]. This can be accomplished by including at least two plates of diverse vegetables per meal, prepared in various styles such as namul, salads, or stir-fries, and by consuming 1-2 portions of fruit daily. These fruit portions should be divided into 1-2 servings, each roughly the size of an apple, to manage sugar intake [19].

Physical activity and weight management

Maintaining an appropriate body weight is crucial in strategies for breast cancer recovery and prevention. Being overweight or obese after a breast cancer diagnosis is associated with an increased risk of cancer recurrence, mortality, and second primary contralateral breast cancer [37].

Higher weekly energy expenditure through exercise has been shown to significantly improve physical functioning in survivors. Additionally, cancer patients have reported positive effects of physical activity on mental well-being. It helps alleviate common treatment-related side effects, such as fatigue, and supports overall health, resilience, quality of life, and physical functioning [38].

Patients are encouraged to engage in physical activity at least five times per week, with each session lasting 30 minutes or more, while also balancing their dietary intake. Combining physical activity with a balanced diet amplifies the benefits of each, enhancing overall health and supporting weight management. Providing structured programs and tailored guidance can further enhance patients' motivation and engagement, leading to more effective outcomes [39].

Dairy products

Dairy products are rich in essential nutrients such as calcium, vitamin D, butyrate, lactoferrin, and conjugated linoleic acid, all of which have shown anticarcinogenic properties [40]. These nutrients are vital in reducing the risk of breast cancer as they support cellular health and inhibit carcinogenic pathways. For breast cancer patients, particularly postmenopausal women, maintaining adequate calcium intake is crucial to prevent osteoporosis [41]. It is advisable to consume at least one serving of milk or dairy products daily, either with a meal or as a snack, to ensure adequate calcium levels [19]. Additionally, incorporating a variety of calcium sources,



such as dried anchovies and seaweed, can provide dietary flexibility and balance [42].

Due to the high saturated fat content in dairy products, it is advisable to choose low-fat or non-fat options [9]. For individuals who experience difficulty digesting milk, alternatives like lactose-free milk, soy milk, yogurt, or yogurt drinks serve as excellent substitutes. Yogurt, in particular, provides superior nutritional benefits compared to milk, including probiotics, protein. calcium, and essential vitamins such as B6 and B12. Additionally, the probiotic Lactobacillus acidophilus found in yogurt has shown potential in enhancing the immune response to breast cancer, underscoring its importance in a balanced post-surgical diet [43].

Alcohol consumption

Alcohol is metabolized into acetaldehyde, a carcinogenic compound, in the body. This process increases the secretion of estrogen and androgen, which in turn promotes the development of breast cancer, irrespective of the type of alcohol consumed or the age of the individual. Ethanol intensifies this risk by encouraging tumor growth and the formation of metastases. It also enhances the effects of estrogens on breast tissue through various pathways [44]. Additionally, alcohol impairs the immune system and depletes essential nutrients, including folate, which is vital for DNA synthesis and repair to maintain genomic stability. As a folate antagonist, alcohol diminishes the bioavailability of folate, thereby undermining cellular health and elevating cancer risk [45].

Evidence shows that alcohol consumption, regardless of the type of alcoholic beverage or menopausal status, is consistently linked to a higher risk of breast cancer. A dose-response meta-analysis revealed that for every 10 grams of ethanol consumed daily, the risk of breast cancer rises by about 5% in premenopausal women and 9% in postmenopausal women [46].

Moreover, studies have reported that high alcohol intake, defined as more than 20 grams per day, is associated with increased breast cancer mortality, and a dose-response relationship has been observed [47]. Among breast cancer survivors, consuming more than one drink daily has been found to increase the risk of late recurrence (i.e., occurring more than 5 years after diagnosis) by 28% [48]. Therefore, abstinence from alcohol, regardless of the type, is recommended.

Caffeine

Coffee consumption has not been strongly correlated with cancer recurrence in breast cancer patients [49]. However, because caffeine may hinder calcium absorption and impact the prevention of osteoporosis, it is advisable to limit coffee intake to one or two cups per day. Including a small amount of milk in coffee may help mitigate the effects of caffeine on calcium absorption [50].

Conclusion -

While no single food can definitively prevent breast cancer or its recurrence, maintaining a balanced diet, consuming high-quality protein, adopting proper lifestyle habits, and engaging in regular physical activity can significantly promote overall health and may offer valuable support in managing cancer.

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References ·

- 1. National Cancer Information Center. Cancer information [Internet]. Goyang (KR): National Cancer Information Center; c2024 [cited 2024 Aug 23]. Available from: https://www.cancer. qo.kr/
- 2. World Health Organization (WHO). Breast cancer fact sheet [Internet]. Geneva (CH): WHO; c2024 [cited 2024 Aug 23]. Available from: https://www.who.int/news-room/fact-sheets/ detail/breast-cancer
- 3. Xu Y, Gong M, Wang Y, Yang Y, Liu S, Zeng Q. Global trends and forecasts of breast cancer incidence and deaths. Sci Data 2023;10(1):334. https://doi.org/10.1038/s41597-023-02253-5
- 4. Wang J, Wu SG. Breast cancer: an overview of current therapeutic strategies, challenge, and perspectives. Breast Cancer Target Ther 2023;15:721-730. https://doi.org/10.2147/BCTT.S432526
- 5. de Boniface J, Szulkin R, Johansson ALV. Medical and surgical postoperative complications after breast conservation versus mastectomy in older women with breast cancer: Swedish population-based register study of 34 139 women. Br J Surg 2023;110(3):344-352. https://doi.org/10.1093/bjs/znac411



- 6. Demark-Wahnefried W, Morey MC, Sloane R, Snyder DC, Cohen HJ. Promoting healthy lifestyles in older cancer survivors to improve health and preserve function. J Am Geriatr Soc 2009;57(s2):s262-s264.
 - https://doi.org/10.1111/j.1532-5415.2009.02507.x
- 7. Lustberg MB, Kuderer NM, Desai A, Bergerot C, Lyman GH. Mitigating long-term and delayed adverse events associated with cancer treatment: implications for survivorship. Nat Rev Clin Oncol 2023;20(8):527-542.
 - https://doi.org/10.1038/s41571-023-00776-9
- 8. Martínez-Ortega AJ, Piñar-Gutiérrez A, Serrano-Aguayo P, González-Navarro I, Remón-Ruíz PJ, Pereira-Cunill JL, et al. Perioperative nutritional support: a review of current literature. Nutrients 2022;14(8):1601.
 - https://doi.org/10.3390/nu14081601
- 9. Karimi Z, Jessri M, Houshiar-Rad A, Mirzaei HR, Rashidkhani B. Dietary patterns and breast cancer risk among women. Pub Health Nutr 2014;17(5):1098-1106. https://doi.org/10.1017/S1368980013001018
- 10. Otero K, Ferri C, Araya C. Nutritional rehabilitation of breast and gynecologic cancer patients. In: Cristian A, editor. Breast cancer and gynecologic cancer rehabilitation. St. Louis: Elsevier; 2021. p.51-61.
- 11. Ho CY, Ibrahim Z, Abu Zaid Z, Mat Daud ZA, Mohd Yusop NB, Mohd Abas MN, et al. Postoperative dietary intake achievement: a secondary analysis of a randomized controlled trial. Nutrients 2022;14(1):222.
 - https://doi.org/10.3390/nu14010222
- 12. Quintero KJ, Resende AS, Leite GSF, Lancha Junior AH. An overview of nutritional strategies for recovery process in sports-related muscle injuries. *Nutrire* 2018;43(1):27. https://doi.org/10.1186/s41110-018-0084-z
- 13. Gillis C, Carli F. Promoting perioperative metabolic and nutritional care. Anesthesiology 2015;123(6):1455-1472.
 - https://doi.org/10.1097/ALN.0000000000000795
- 14. Youn SB, Ahn SH, Cho DH, Myoung H. Impact of postoperative dietary types on nutrition and treatment prognosis in hospitalized patients undergoing oral and maxillofacial surgery: a comparative study. Korean J Community Nutr 2024;29(2):129-143. https://doi.org/10.5720/kjcn.2024.29.2.129
- 15. Ministry of Health and Welfare, The Korean Nutrition Society. Dietary reference intakes for Koreans 2020. Sejong: Ministry of Health and Welfare; 2020.
- 16. Case LP, Daristotle L, Hayek MG, Raasch MF. Energy and water. In: Case LP, Daristotle L, Hayek MG, Raasch MF, editors. Canine and feline nutrition. 3rd ed. St. Louis: Mosby; 2011.
- 17. Hwa YL, Kull MR. The why and how of maintaining hydration during cancer therapy. Curr Opin Support Palliat Care 2020;14(4):324-332. https://doi.org/10.1097/SPC.000000000000526
- 18. University of California, San Francisco (UCSF) Health. Breast cancer self-care and recovery: hydration [Internet]. San Francisco (CA): UCSF; c2025 [cited 2025 Jan 2]. Available from: https://www.ucsfhealth.org/education/breast-cancer-self-care-and-recovery-hydration
- 19. Asan Medical Center. Healthy meal therapy for cancer patients [Internet]. Seoul (KR): Asan Medical Center; c2025 [cited 2025 Jan 2]. Available from: https://www.amc.seoul.kr/asan/ healthinfo/mealtherapy/mealTherapyDetail.do?mtld=86



- 20. Ministry of Health and Welfare. Dietary reference intakes for Koreans 2020. Sejong: Ministry of Health and Welfare; 2020.
- Farvid MS, Stern MC, Norat T, Sasazuki S, Vineis P, Weijenberg MP, et al. Consumption of red and processed meat and breast cancer incidence: a systematic review and meta-analysis of prospective studies. *Int J Cancer* 2018;143(11):2787-2799. https://doi.org/10.1002/ijc.31848
- 22. World Cancer Research Fund International, American Institute for Cancer Research. Limit consumption of red and processed meat [Internet]. London (UK): World Cancer Research Fund; c2023 [cited 2025 Jan 2]. Available from: https://www.wcrf.org/research-policy/evidence-for-our-recommendations/limit-red-processed-meat/
- 23. Nadeem HR, Akhtar S, Ismail T, Sestili P, Lorenzo JM, Ranjha MMAN, et al. Heterocyclic aromatic amines in meat: formation, isolation, risk assessment, and inhibitory effect of plant extracts. *Foods* 2021;10(7):1466. https://doi.org/10.3390/foods10071466
- 24. Zainordin NH, Abd Talib R, Shahril MR, Sulaiman S, Karim NA. Dietary changes and its impact on quality of life among Malay breast and gynaecological cancer survivors in Malaysia. Asian Pac J Cancer Prev 2020;21(12):3689-3696. https://doi.org/10.31557/APJCP.2020.21.12.3689
- 25. Virani S, Afreen S, Perthiani A, Sangster E, Lanka N, Acharya P, et al. The impact of dietary unsaturated fat or the Mediterranean diet on women diagnosed with breast cancer: a systematic review. *Cureus* 2024;16(7):e65362. https://doi.org/10.7759/cureus.65362
- 26. Ganesan K, Sukalingam K, Xu B. Impact of consumption of repeatedly heated cooking oils on the incidence of various cancers: a critical review. *Crit Rev Food Sci Nutr* 2019;59(3):488-505.
 - https://doi.org/10.1080/10408398.2017.1379470
- 27. Sugimura T, Wakabayashi K, Nakagama H, Nagao M. Heterocyclic amines: mutagens/carcinogens produced during cooking of meat and fish. *Cancer Sci* 2005;95(4):290-299. https://doi.org/10.1111/j.1349-7006.2004.tb03205.x
- 28. Reinwald S, Akabas SR, Weaver CM. Whole versus the piecemeal approach to evaluating Soy. *J Nutr* 2010;140(12):2335S-2343S. https://doi.org/10.3945/jn.110.124925
- 29. Zhang L, Tian Y, Zhang L, Zhang H, Yang J, Wang Y, et al. A comprehensive review on the plant sources, pharmacological activities and pharmacokinetic characteristics of syringaresinol. *Pharmacol Res* 2025;212:107572. https://doi.org/10.1016/j.phrs.2024.107572
- 30. Hardt L, Mahamat-Saleh Y, Aune D, Schlesinger S. Plant-based diets and cancer prognosis: a review of recent research. *Curr Nutr Rep* 2022;11(4):695-716. https://doi.org/10.1007/s13668-022-00440-1
- 31. Barakat R, Park CJ, Perez PA, Chiu K, Ko C. Female antiestrogens. In: Skinner MK, editor. Encyclopedia of reproduction. 2nd ed. Oxford: Academic Press; 2018. p.740-747.
- 32. Bustamante-Rangel M, Delgado-Zamarreño MM, Pérez-Martín L, Rodríguez-Gonzalo E, Domínguez-Álvarez J. Analysis of isoflavones in foods. *Compr Rev Food Sci Food Saf* 2018;17(2):391-411. https://doi.org/10.1111/1541-4337.12325
- 33. Lv HW, Wang QL, Luo M, Zhu MD, Liang HM, Li WJ, et al. Phytochemistry and pharmacology



- of natural prenylated flavonoids. *Arch Pharm Res* 2023;46(4):207-272. https://doi.org/10.1007/s12272-023-01443-4
- 34. Durazzo A, Lucarini M, Camilli E, Marconi S, Gabrielli P, Lisciani S, et al. Dietary lignans: definition, description and research trends in databases development. *Molecules* 2018;23(12):3251.
 - https://doi.org/10.3390/molecules23123251
- 35. Babu S, Jayaraman S. An update on β -sitosterol: a potential herbal nutraceutical for diabetic management. *Biomed Pharmacother* 2020;131:110702. https://doi.org/10.1016/j.biopha.2020.110702
- 36. Limon-Miro AT, Lopez-Teros V, Astiazaran-Garcia H. Dietary guidelines for breast cancer patients: a critical review. *Adv Nutr* 2017;8(4):613-623. https://doi.org/10.3945/an.116.014423
- 37. Chan DSM, Vieira R, Abar L, Aune D, Balducci K, Cariolou M, et al. Postdiagnosis body fatness, weight change and breast cancer prognosis: Global Cancer Update Program (CUP global) systematic literature review and meta-analysis. *Int J Cancer* 2023;152(4):572-599. https://doi.org/10.1002/ijc.34322
- 38. Misiąg W, Piszczyk A, Szymańska-Chabowska A, Chabowski M. Physical activity and cancer care: a review. *Cancers* 2022;14(17):4154. https://doi.org/10.3390/cancers14174154
- 39. Browall M, Mijwel S, Rundqvist H, Wengström Y. Physical activity during and after adjuvant treatment for breast cancer: an integrative review of women's experiences. *Integr Cancer Ther* 2018;17(1):16-30.
 - https://doi.org/10.1177/1534735416683807
- 40. Do TM, Nguyen QHN, Le NHD, Nguyen HD, Phung AHT, Tran TS, et al. Association between dietary factors and breast cancer risk: a matched case-control study in Vietnam. *BMC Cancer* 2024;24(1):1224.
 - https://doi.org/10.1186/s12885-024-12918-y
- 41. Hodges JK, Cao S, Cladis DP, Weaver CM. Lactose intolerance and bone health: the challenge of ensuring adequate calcium intake. *Nutrients* 2019;11(4):718. https://doi.org/10.3390/nu11040718
- 42. Safitri FR, Sari EM, Nurfajriah S. Analysis of calcium levels in wet and dried anchovies at traditional markets in Bekasi city. *Chempublish J* 2023;7(2):88-98. https://doi.org/10.22437/chp.v7i2.28526
- 43. Thu MS, Ondee T, Nopsopon T, Farzana IAK, Fothergill JL, Hirankarn N, et al. Effect of probiotics in breast cancer: a systematic review and meta-analysis. *Biology* 2023;12(2):280. https://doi.org/10.3390/biology12020280
- 44. De Cicco P, Catani MV, Gasperi V, Sibilano M, Quaglietta M, Savini I. Nutrition and breast cancer: a literature review on prevention, treatment and recurrence. *Nutrients* 2019;11(7):1514.
 - https://doi.org/10.3390/nu11071514
- 45. Meadows GG, Zhang H. Effects of alcohol on tumor growth, metastasis, immune response, and host survival. *Alcohol Res* 2015;37(2):311-322.
- 46. World Cancer Research Fund, American Institute for Cancer Research. Diet, nutrition, physical activity and cancer: a global perspective: A summary of the third expert report [Internet]. London (UK): World Cancer Research Fund; c2018 [cited 2025 Jan 2]. Available from: https://www.wcrf.org/wp-content/uploads/2024/11/Summary-of-Third-Expert-



- Report-2018.pdf
- 47. Gou YJ, Xie DX, Yang KH, Liu YL, Zhang JH, Li B, et al. Alcohol consumption and breast cancer survival: a metaanalysis of cohort studies. *Asian Pac J Cancer Prev* 2013;14(8):4785-4790.
 - https://doi.org/10.7314/APJCP.2013.14.8.4785
- 48. Nechuta S, Chen WY, Cai H, Poole EM, Kwan ML, Flatt SW, et al. A pooled analysis of post-diagnosis lifestyle factors in association with late estrogen-receptor–positive breast cancer prognosis. *Int J Cancer* 2015;138(9):2088-2097. https://doi.org/10.1002/ijc.29940
- 49. Jiang W, Wu Y, Jiang X. Coffee and caffeine intake and breast cancer risk: an updated dose-response meta-analysis of 37 published studies. *Gynecol Oncol* 2013;129(3):620-629. https://doi.org/10.1016/j.ygyno.2013.03.014
- 50. Heaney RP. Effects of caffeine on bone and the calcium economy. *Food Chem Toxicol* 2002;40(9):1263-1270.
 - https://doi.org/10.1016/S0278-6915(02)00094-7

Review



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Sex differences in the prevalence of common comorbidities in autism: a narrative review

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utism spectrum disorder; Sex differences; Comorbidity; Prevalence



Autism spectrum disorder involves challenges in social communication and restricted, repetitive behaviors. Historically, males have received autism diagnoses at comparatively high rates, prompting an underrepresentation of females in research and an incomplete understanding of sex-specific symptom presentations and comorbidities. This review examines sex differences in the prevalence of common comorbidities of autism to inform tailored clinical practices. These conditions include attention deficit hyperactivity disorder, anxiety disorders, conduct disorder, depression, epilepsy, intellectual disability, and tic disorders. Attention deficit hyperactivity disorder is prevalent in both sexes; however, females may more frequently exhibit the inattentive subtype. Anxiety disorders display inconsistent sex differences, while conduct disorder more frequently impacts males. Depression becomes more common with age; some studies indicate more pronounced symptoms in adolescent girls, while others suggest greater severity in males. Epilepsy is more prevalent in females, especially those with intellectual disabilities. Despite displaying a male predominance, intellectual disability may exacerbate the severity of autism to a greater degree in females. No clear sex differences have been found regarding tic disorders. Overall, contributors to sex-based differences include biases stemming from male-centric diagnostic tools, compensatory behaviors like camouflaging in females, genetic and neurobiological differences, and the developmental trajectories of comorbidities. Recognizing these factors is crucial for developing sensitive diagnostics and sex-specific interventions. Inconsistencies in the literature highlight the need for longitudinal studies with large, diverse samples to investigate autism comorbidities across the lifespan. Understanding sex differences could facilitate earlier identification, improved care, and personalized interventions, thus enhancing quality of life for individuals with autism.

Introduction

Background

Autism is a neurodevelopmental condition that affects an individual's ability to communicate and interact socially, often accompanied by restricted and repetitive behaviors (RRBs). Its presentation varies widely across individuals, leading to the popular saying, "If you've met

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one person with autism, you've met one person with autism," which emphasizes the distinct strengths and challenges of each individual. Numerous genetic and neurobiological studies have sought to understand the etiology behind the observed sex differences in autism, but the multifactorial nature of the condition has posed challenges. Historically, males with autism have been over-represented compared to females. This disparity is largely reflected in epidemiological research, with an analysis of data from 43 studies indicating a mean male:female prevalence ratio of 4.2:1 [1].

The imbalanced ratio of males to females diagnosed with autism has resulted in an incomplete understanding of core symptom presentations across sexes. Previous studies comparing the social communication skills of males and females with autism have yielded mixed results; some studies have identified distinct challenges faced by each sex [2,3], while others have found no statistically significant differences [4-6]. Similar inconsistencies have been reported concerning RRBs, with certain studies suggesting greater severity in males [4,6] and other research not corroborating these results [3,5].

A variety of factors could explain the observed or unobserved sex differences in autism, ranging from the limitations of measurement tools to participant characteristics such as the developmental stage of the individual, their overall severity of autism, or the presence of comorbid conditions. Comorbidities, which may include neurological, cognitive, psychiatric, and physical conditions, increase the complexity of the person's needs and underscore the critical importance of seeking medical advice and interventions [7,8]. Moreover, comorbid conditions may influence the manifestation of symptoms [9]. For instance, a study by Gu et al. [10] revealed that boys were more likely than girls to be diagnosed between the ages of 3 and 11, whereas girls were more likely to receive a diagnosis either before age 3 or after age 11. However, after adjusting for comorbid neurodevelopmental and psychiatric conditions, these age-related patterns were no longer significant. The interaction between the core symptoms of autism and these additional challenges emphasizes the necessity for a more comprehensive understanding of sex differences. This understanding is crucial for the development of tailored intervention strategies and could explain how a subset of the autistic population could be overlooked.

Objectives

This review aims to explore the differences in the prevalence of comorbid conditions between males and females with autism, establishing a necessary foundation to understand the baseline disparities. These insights could guide further investigation into sex-specific clinical presentations and targeted interventions. By examining sex-based discrepancies, we intend to highlight areas in need of additional research and suggest considerations for clinical practice, thus fostering a more inclusive understanding of autism.

Ethics statement

This study is based solely on the review of published literature and did not involve data collection, thus no informed consent was required

Sex differences in psychiatric and neurologic comorbidities

Attention deficit hyperactivity disorder

Attention deficit hyperactivity disorder (ADHD) is characterized by challenges in maintaining



attention, along with hyperactivity and impulsivity. It represents one of the most common childhood neurodevelopmental disorders, with a weighted prevalence of 10.47% in the United States from 2021 to 2022 [11]. Clinical observations have indicated that a substantial number of children with autism also exhibit symptoms of ADHD, with reported comorbidity rates ranging widely from 30% to 80% [12-14]. Additionally, the behavioral overlaps between these two conditions suggest they may share a pathophysiological basis [15]. While ADHD has traditionally been recognized to display a male predominance, with a male-to-female prevalence ratio of 2.28 to 1 [16], a study by Margari et al. [17] found no significant sex differences in the prevalence of ADHD as a comorbid condition in adolescents with autism. Notably, female sex was more frequently associated with the predominantly inattentive presentation of ADHD, whereas male participants tended to display the combined presentation.

Anxiety disorders

Anxiety disorders represent prevalent and chronic mental conditions, with large-scale research suggesting that it may affect around 33.7% of the population at some point in their lives [18]. Up to 40% of individuals with autism may experience at least one comorbid anxiety disorder, most commonly specific phobia [19]. Although anxiety disorders are generally more prevalent among females, research on individuals with autism has yielded mixed results. Some studies have found comparable levels of anxiety between sexes [17,20], while others have reported higher anxiety scores [21] or more internalizing problems in females with autism [22].

Conduct disorder

Conduct disorder is a complex behavioral disorder characterized by aggressive and destructive behavior patterns. The lifetime prevalence of conduct disorder in the general population is approximately 9.5% [23], and it increases to around 13% among individuals with autism [24]. Regarding sex differences, males typically exhibit higher rates of physical aggression [25]. Within the autism community, studies indicate higher rates in males, with a greater manifestation of externalizing problems [24,26]. Notably, however, this research has generally involved small sample sizes, underscoring the need for further large-scale research to fully understand the extent of conduct disorder comorbidity in autism.

Depression

The prevalence of depression among individuals with autism, particularly those without intellectual disability, appears to increase with age. DeFilippis [27] noted that adolescents with autism encounter substantial challenges as they navigate their identity and interpersonal relationships. Oswald et al. [28] found that early adolescent girls with autism show more severe depressive symptoms than either their male counterparts or girls without autism. In a statistical analysis by Stacy et al. [29], the rates of mild and moderate/severe depression in girls with autism were estimated at 7.2% and 3.6%, respectively, while boys with autism experience these conditions at rates of 4.5% and 7.8%. These findings not only emphasize the occurrence of depression among individuals with autism but also highlight sex differences in its prevalence, suggesting that males tend to experience more severe forms of depression.

Epilepsy

Epilepsy, a neurological condition characterized by recurrent seizures, affects approximately 1.2% of the general population [30]. A comprehensive meta-analysis conducted by Liu et al.



[31] revealed a disparity in the prevalence of epilepsy between children (7%) and adults (19%) with autism. In a pooled analysis of 14 studies, females with autism were found to have a higher prevalence of epilepsy at 34.5%, compared to 18.5% in males [32]. Furthermore, Amiet et al. [32] observed that the incidence of epilepsy is positively correlated with the severity of intellectual disability, suggesting that an increase in cognitive impairment is associated with a heightened risk of epilepsy.

Intellectual disability

Intellectual disability is a lifelong condition characterized by below-average cognitive functioning. A systematic review conducted in 2016 examined the prevalence and incidence of intellectual disabilities, yielding prevalence estimates ranging from 0.05% to 1.55% [33]. Among six studies that compared sex differences, five reported higher rates of intellectual disability in males [33]. Intellectual disability is also a common comorbid condition in children with autism, with an estimated prevalence of 21.7% [9]. Among individuals with autism, the male-to-female ratio of comorbid intellectual disability was 1.9:1 [34]. In a meta-analysis, Saure et al. [35] found that intellectual disability tends to exacerbate the severity of autism symptoms more in females than in males. These findings indicate that phenotypic differences in autism may be influenced by the level of cognitive functioning.

Tic disorders

Tic disorders are characterized by sudden, rapid motor movements or vocal outbursts and are estimated to affect between 5 and 6 per 1,000 school-aged children [36]. Among individuals with autism, tic disorders are a common comorbidity, affecting approximately 18% to 22% [37,38]. Generally, females with tic disorders are diagnosed less frequently than males and typically report a later age of symptom onset [39]. Kim et al. [38] found no significant sex differences between a group of individuals with autism alone and one with both autism and tic disorders, based on parental reports. However, further research is warranted. Studies that utilize clinician assessments to evaluate the type and severity of tics by sex could provide a deeper understanding of their manifestation in individuals with autism.

Potential factors contributing to sex differences in prevalence

The exploration of sex-based differences in the prevalence of comorbid conditions among individuals with autism is complex. It involves diagnostic and reporting biases, sex-specific symptom presentations, biological factors, and distinct patterns of comorbidity. In the present exploration of current research, we aim to provide a thorough understanding of these contributing factors.

Measurement bias

Concerns have arisen regarding the measurement tools used in autism diagnosis, which are often developed with a male-centric bias due to the disproportionate representation of the sexes. This bias toward the male autism phenotype may result in the misclassification of female patients. In an investigation of potential sex biases in widely used diagnostic instruments, Belcher et al. [40] conducted a confirmatory factor analysis on the Autism Spectrum Quotient using data from a large UK adult cohort. Their findings revealed that all but two items showed sex biases, notably indicating that women were more likely than men to endorse items related



to social skills and communication. Similarly, Kalb et al. [41] examined the Autism Diagnostic Observation Schedule-2 via differential item functioning analysis and identified five items with significant differential item functioning. This suggests that these items function differently for males and females, potentially impacting diagnostic accuracy [42]. Furthermore, there is a clear deficiency in accurate and reliable tools for assessing the wide range of psychiatric comorbid conditions in individuals with autism. Although efforts have been made to validate modified screening tools for psychopathology in children and adolescents with autism, research specifically addressing sex differences remains scarce.

Compensatory behaviors

The term "camouflaging" refers to the use of compensatory behaviors or coping strategies by individuals with autism to mask their autistic traits and conform to social norms. These methods often involve mimicking the behaviors and interests of others or deliberately making eye contact. Camouflaging is commonly reported among females and is considered a key reason why this demographic is often overlooked. Such masking strategies contribute to a higher likelihood of misdiagnosis in females with autism compared to their male counterparts [43]. In their research, Cage and Troxell-Whitman [44] underscore the critical need for clinicians to recognize the impact of camouflaging. Acknowledging these behaviors is essential for improving the wellbeing of individuals with autism, especially when addressing comorbid mental health conditions.

Different trajectories of comorbid conditions

Considering an individual's age and developmental stage is crucial when examining psychiatric conditions. It is well-established that certain internalizing and externalizing disorders manifest at different times, often influenced by sex-specific developmental trajectories. For example, in the general population, boys are more likely to experience externalizing problems, such as aggression, hyperactivity, and conduct problems, and these patterns tend to remain stable across adolescence [45]. Conversely, males have a lower risk of internalizing problems, such as mood and anxiety issues [46], with the onset of such conditions typically occurring at a later age compared to females. Therefore, the inherent characteristics of these comorbid conditions may meaningfully impact the observed sex differences in individuals with autism.

Implications

In the context of autism, understanding sex-based differences in prevalence is critical, as it can lead to the creation of more sensitive screening and diagnostic tools, as well as the development of therapeutic plans tailored to individual needs.

Sensitive measurement tools

Early and accurate identification of autism is crucial for improving outcomes in young children. However, research has shown that girls are consistently diagnosed later than boys, highlighting the need for diagnostic tools that are sensitive to sex differences. Additionally, females with autism often have a higher incidence of comorbid conditions compared to males [14], including internalizing behaviors that result in anxiety, depression, and social withdrawal [47]. The overlap between these psychiatric comorbidities and the core features of autism can complicate the diagnostic process, potentially leading to delayed diagnoses in female patients.



Sex-specific intervention planning

Creating a sex-specific intervention strategy for autism requires a nuanced understanding of the ways in which the condition presents in females versus males. Females with autism often demonstrate better communication and social interaction skills and exhibit fewer RRBs than their male counterparts. The use of compensatory mechanisms, such as masking, may further complicate the development of effective intervention strategies, as these behaviors can conceal the true extent of the challenges these individuals face. For females with autism, creating a sex-specific intervention strategy could involve focusing on the management of psychiatric comorbidities through a combination of various therapies and self-advocacy education. By customizing interventions to address both shared characteristics and sex-specific differences in autism, we can improve support for individuals, helping them to realize their full potential.

Conclusion -

This review examines the prevalence of various comorbid conditions among males and females with autism. The current body of research on comorbidities is mixed, with some studies finding no significant differences between sexes and others reporting certain conditions as more common in one sex. These inconsistencies may stem from differences in measurement tools, masking behaviors that complicate diagnosis, and the age of study participants. The recognition of distinct patterns of comorbidity could indicate the presence of subgroups within the autism spectrum. Consequently, longitudinal studies with larger sample sizes are required to explore comorbid conditions from a life-course perspective, considering the developmental trajectories of both sexes. Given our preliminary findings on the differences in the prevalence of common comorbid conditions among individuals with autism, it is imperative that future research expand upon this work by examining potential sex differences in their manifestation. A deeper understanding of these patterns could support earlier autism diagnosis and improve access to care, enabling the creation of more personalized intervention plans that improve quality of life for those on the autism spectrum.

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Conflict of interest

No potential conflict of interest relevant to this article was reported.



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Supplementary materials

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References -

- 1. Fombonne E. Epidemiology of pervasive developmental disorders. *Pediatr Res* 2009;65(6):591-598.
 - https://doi.org/10.1203/PDR.0b013e31819e7203
- Evans SC, Boan AD, Bradley C, Carpenter LA. Sex/gender differences in screening for autism spectrum disorder: implications for evidence-based assessment. *J Clin Child Adolesc Psychol* 2019;48(6):840-854.
 - https://doi.org/10.1080/15374416.2018.1437734
- 3. Song DY, Kim SY, Bong G, Kim YA, Kim JH, Kim JM, et al. Exploring sex differences in the manifestation of autistic traits in young children. *Res Autism Spectr Disord* 2021;88:101848. https://doi.org/10.1016/j.rasd.2021.101848
- 4. Mandy W, Chilvers R, Chowdhury U, Salter G, Seigal A, Skuse D. Sex differences in autism spectrum disorder: evidence from a large sample of children and adolescents. *J Autism Dev Disord* 2012;42(7):1304-1313.
 - https://doi.org/10.1007/s10803-011-1356-0
- Sutherland R, Hodge A, Bruck S, Costley D, Klieve H. Parent-reported differences between school-aged girls and boys on the autism spectrum. *Autism* 2017;21(6):785-794. https://doi.org/10.1177/1362361316668653
- 6. Wilson CE, Murphy CM, McAlonan G, Robertson DM, Spain D, Hayward H, et al. Does sex influence the diagnostic evaluation of autism spectrum disorder in adults? *Autism* 2016;20(7):808-819.
 - https://doi.org/10.1177/1362361315611381
- de Bruin El, Ferdinand RF, Meester S, de Nijs PFA, Verheij F. High rates of psychiatric comorbidity in PDD-NOS. *J Autism Dev Disord* 2007;37(5):877-886. https://doi.org/10.1007/s10803-006-0215-x
- 8. Joshi G, Petty C, Wozniak J, Henin A, Fried R, Galdo M, et al. The heavy burden of psychiatric comorbidity in youth with autism spectrum disorders: a large comparative study of a psychiatrically referred population. *J Autism Dev Disord* 2010;40(11):1361-1370. https://doi.org/10.1007/s10803-010-0996-9
- 9. Khachadourian V, Mahjani B, Sandin S, Kolevzon A, Buxbaum JD, Reichenberg A, et al. Comorbidities in autism spectrum disorder and their etiologies. *Transl Psychiatry*



- 2023;13(1):71.
- https://doi.org/10.1038/s41398-023-02374-w
- 10. Gu Z, Dawson G, Engelhard M. Sex differences in the age of childhood autism diagnosis and the impact of co-occurring conditions. Autism Res 2023;16(12):2391-2402. https://doi.org/10.1002/aur.3043
- 11. Li Y, Yan X, Li Q, Li Q, Xu G, Lu J, et al. Prevalence and trends in diagnosed ADHD among US children and adolescents, 2017-2022. JAMA Netw Open 2023;6(10):e2336872. https://doi.org/10.1001/jamanetworkopen.2023.36872
- 12. van der Meer JMJ, Oerlemans AM, van Steijn DJ, Lappenschaar MGA, de Sonneville LMJ, Buitelaar JK, et al. Are autism spectrum disorder and attention-deficit/hyperactivity disorder different manifestations of one overarching disorder? Cognitive and symptom evidence from a clinical and population-based sample. J Am Acad Child Adolesc Psychiatry 2012;51(11):1160-1172.E3.
 - https://doi.org/10.1016/j.jaac.2012.08.024
- 13. Gnanavel S, Sharma P, Kaushal P, Hussain S. Attention deficit hyperactivity disorder and comorbidity: a review of literature. World J Clin Cases 2019;6(17):2420-2426. https://doi.org/10.12998/wjcc.v7.i17.2420
- 14. Vadukapuram R, Elshokiry AB, Trivedi C, Abouelnasr A, Bataineh A, Usmani S, et al. Sex differences in psychiatric comorbidities in adolescents with autism spectrum disorder: a national inpatient sample analysis. Prim Care Companion CNS Disord 2022;24(5):21m03189. https://doi.org/10.4088/PCC.21m03189
- 15. Hours C, Recasens C, Baleyte JM. ASD and ADHD comorbidity: what are we talking about? Front Psychiatry 2022;13:837424.
 - https://doi.org/10.3389/fpsyt.2022.837424
- 16. Ramtekkar UP, Reiersen AM, Todorov AA, Todd RD. Sex and age differences in attentiondeficit/hyperactivity disorder symptoms and diagnoses: implications for DSM-V and ICD-11. J Am Acad Child Adolesc Psychiatry 2010;49(3):217-228.e1-e3. https://doi.org/10.1016/j.jaac.2009.11.011
- 17. Margari L, Palumbi R, Peschechera A, Craiq F, de Giambattista C, Ventura P, et al. Sexgender comparisons in comorbidities of children and adolescents with high-functioning autism spectrum disorder. Front Psychiatry 2019;10:159.
 - https://doi.org/10.3389/fpsyt.2019.00159
- 18. Bandelow B, Michaelis S. Epidemiology of anxiety disorders in the 21st century. Dialogues Clin Neurosci 2015;17(3):327-335.
 - https://doi.org/10.31887/DCNS.2015.17.3/bbandelow
- 19. van Steensel FJA, B Bens SM, Perrin S. Anxiety disorders in children and adolescents with autistic spectrum disorders: a meta-analysis. Clin Child Fam Psychol Rev 2011;14(3):302-317.
 - https://doi.org/10.1007/s10567-011-0097-0
- 20. Sukhodolsky DG, Scahill L, Gadow KD, Arnold LE, Aman MG, McDougle CJ, et al. Parentrated anxiety symptoms in children with pervasive developmental disorders: frequency and association with core autism symptoms and cognitive functioning. J Abnorm Child Psychol 2008;36(1):117-128.
 - https://doi.org/10.1007/s10802-007-9165-9
- 21. Solomon M, Miller M, Taylor SL, Hinshaw SP, Carter CS. Autism symptoms and internalizing psychopathology in girls and boys with autism spectrum disorders. J Autism Dev Disord



- 2012;42(1):48-59.
- https://doi.org/10.1007/s10803-011-1215-z
- 22. Prosperi M, Turi M, Guerrera S, Napoli E, Tancredi R, Igliozzi R, et al. Sex differences in autism spectrum disorder: an investigation on core symptoms and psychiatric comorbidity in preschoolers. Front Intear Neurosci 2021:14:594082.
 - https://doi.org/10.3389/fnint.2020.594082
- 23. Nock MK, Kazdin AE, Hiripi E, Kessler RC. Prevalence, subtypes, and correlates of DSM-IV conduct disorder in the National Comorbidity Survey Replication. Psychol Med 2006;36(5):699-710.
 - https://doi.org/10.1017/S0033291706007082
- 24. Ivanovi/ I. Psychiatric comorbidities in children with ASD: autism centre experience. Front Psychiatry 2021;12:673169.
 - https://doi.org/10.3389/fpsyt.2021.673169
- 25. Moffitt TE, Caspi A, Rutter M, Silva PA. Sex differences in antisocial behaviour: conduct disorder, delinquency, and violence in the Dunedin Longitudinal Study. Cambridge: Cambridge University Press; 2001.
- 26. Napolitano A, Schiavi S, La Rosa P, Rossi-Espagnet MC, Petrillo S, Bottino F, et al. Sex differences in autism spectrum disorder: diagnostic, neurobiological, and behavioral features. Front Psychiatry 2022;13:889636.
 - https://doi.org/10.3389/fpsyt.2022.889636
- 27. DeFilippis M. Depression in children and adolescents with autism spectrum disorder. Children 2018;5(9):112.
 - https://doi.org/10.3390/children5090112
- 28. Oswald TM, Winter-Messiers MA, Gibson B, Schmidt AM, Herr CM, Solomon M. Sex differences in internalizing problems during adolescence in autism spectrum disorder. J Autism Dev Disord 2016;46(2):624-636.
 - https://doi.org/10.1007/s10803-015-2608-1
- 29. Stacy ME, Zablotsky B, Yarger HA, Zimmerman A, Makia B, Lee LC. Sex differences in cooccurring conditions of children with autism spectrum disorders. Autism 2014;18(8):965-974.
 - https://doi.org/10.1177/1362361313505719
- 30. Zack MM, Kobau R. National and state estimates of the numbers of adults and children with active epilepsy: United States, 2015. MMWR Morb Mortal Wkly Rep 2017;66(31):821-825. https://doi.org/10.15585/mmwr.mm6631a1
- 31. Liu X, Sun X, Sun C, Zou M, Chen Y, Huang J, et al. Prevalence of epilepsy in autism spectrum disorders: a systematic review and meta-analysis. Autism 2022;26(1):33-50. https://doi.org/10.1177/13623613211045029
- 32. Amiet C, Gourfinkel-An I, Bouzamondo A, Tordjman S, Baulac M, Lechat P, et al. Epilepsy in autism is associated with intellectual disability and gender: evidence from a meta-analysis. Biol Psychiatry 2008;64(7):577-582.
 - https://doi.org/10.1016/j.biopsych.2008.04.030
- 33. McKenzie K, Milton M, Smith G, Ouellette-Kuntz H. Systematic review of the prevalence and incidence of intellectual disabilities: current trends and issues. Curr Dev Disord Rep 2016;3(2):104-115.
 - https://doi.org/10.1007/s40474-016-0085-7
- 34. Fombonne E. Epidemiological surveys of autism and other pervasive developmental



- disorders: an update. *J Autism Dev Disord* 2003;33(4):365-382. https://doi.org/10.1023/a:1025054610557
- 35. Saure E, Castras M, Mikkola K, Salmi J. Intellectual disabilities moderate sex/gender differences in autism spectrum disorder: a systematic review and meta-analysis. *J Intellect Disabil Res* 2023;67(1):1-34.
 - https://doi.org/10.1111/jir.12989
- 36. Scahill L, Specht M, Page C. The prevalence of tic disorders and clinical characteristics in children. *J Obsessive Compuls Relat Disord* 2014;3(4):394-400.
 - https://doi.org/10.1016/j.jocrd.2014.06.002
- 37. Canitano R, Vivanti G. Tics and Tourette syndrome in autism spectrum disorders. *Autism* 2007;11(1):19-28.
 - https://doi.org/10.1177/1362361307070992
- 38. Kim YR, Song DY, Bong G, Han JH, Kim JH, Yoo HJ. Clinical characteristics of comorbid tic disorders in autism spectrum disorder: exploratory analysis. *Child Adolesc Psychiatry Ment Health* 2023;17(1):71.
 - https://doi.org/10.1186/s13034-023-00625-8
- 39. Baizabal-Carvallo JF, Jankovic J. Sex differences in patients with Tourette syndrome. *CNS Spectr* 2022;28(2):205-211.
 - https://doi.org/10.1017/S1092852922000074
- 40. Belcher HL, Uglik-Marucha N, Vitoratou S, Ford RM, Morein-Zamir S. Gender bias in autism screening: measurement invariance of different model frameworks of the autism spectrum quotient. *BJPsych Open* 2023;9(5):e173.
 - https://doi.org/10.1192/bjo.2023.562
- 41. Kalb LG, Singh V, Hong JS, Holingue C, Ludwig NN, Pfeiffer D, et al. Analysis of race and sex bias in the autism diagnostic observation schedule (ADOS-2). *JAMA Netw Open* 2022;5(4):e229498.
 - https://doi.org/10.1001/jamanetworkopen.2022.9498
- 42. Brickhill R, Atherton G, Piovesan A, Cross L. Autism, thy name is man: exploring implicit and explicit gender bias in autism perceptions. *PLoS One* 2023;18(8):e0284013.
 - https://doi.org/10.1371/journal.pone.0284013
- 43. Lai MC, Lombardo MV, Ruigrok ANV, Chakrabarti B, Auyeung B, Szatmari P, et al. Quantifying and exploring camouflaging in men and women with autism. *Autism* 2017;21(6):690-702. https://doi.org/10.1177/1362361316671012
- 44. Cage E, Troxell-Whitman Z. Understanding the reasons, contexts and costs of camouflaging for autistic adults. *J Autism Dev Disord* 2019;49(5):1899-1911. https://doi.org/10.1007/s10803-018-03878-x
- 45. Fernandez Castelao C, Kröner-Herwig B. Developmental trajectories and predictors of externalizing behavior: a comparison of girls and boys. *J Youth Adolesc* 2014;43(5):775-789. https://doi.org/10.1007/s10964-013-0011-9
- 46. Kovess-Masfety V, Woodward MJ, Keyes K, Bitfoi A, Carta MG, Koç C, et al. Gender, the gender gap, and their interaction; analysis of relationships with children's mental health problems. Soc Psychiatry Psychiatr Epidemiol 2021;56(6):1049-1057. https://doi.org/10.1007/s00127-020-01950-5
- 47. Bauminger N, Solomon M, Rogers SJ. Externalizing and internalizing behaviors in ASD. *Autism Res* 2010;3(3):101-112. https://doi.org/10.1002/aur.131

Review



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Prevalence and factors influencing postpartum depression and its culture-specific cutoffs for women in Asia: a scoping review

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Asia; Cultural characteristics; Mothers; Postpartum depression



The prevalence of postpartum depression (PPD) in Asia is reported to range from 13.53% to 22.31%. However, there remains a gap in the identification of PPD, particularly regarding cultural cutoff points. Therefore, the purpose of this scoping review was to determine the prevalence and associated factors of PPD in Eastern, South-eastern, Western, and Southern Asian countries and analyze the cutoff points of the Edinburgh Postnatal Depression Scale (EPDS) used across these countries. Following Arksey and O'Malley's five-step scoping review framework, the population was defined as mothers, the concept as the EPDS, and the context as the Asian region. A literature search was conducted using PubMed, Embase, CINAHL, PsycINFO, and Web of Science. The data analysis focused on demographic characteristics, EPDS cutoffs and features, PPD prevalence, and its associated factors. Nineteen studies were selected. Most countries used translated versions of the EPDS with demonstrated reliability and validity. The cutoff scores varied, with most using scores of 10 or higher. The prevalence of PPD ranged from 5.1% to 78.7%. Key associated factors for PPD included cultural factors such as relationships with in-laws and preferences for the newborn's sex. To improve the accuracy of PPD screening in Asia, the EPDS should be used consistently, and appropriate cutoff criteria must be established. In addition, prevention strategies and programs that reflect the cultural characteristics and social context of Asia need to be developed for the early detection and prevention of PPD.

Introduction

The postpartum period is a critical transitional phase for women, characterized by significant

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physical and psychological changes. During this period, the prevalence of depression is reported to be more than twice as high as at other times in a woman's life [1]. Postpartum depression (PPD) is considered a precursor to major depressive disorder and is defined by symptoms such as sadness, excessive crying, anxiety, agitation, low mood, loss of interest, and sleep disturbance [2]. PPD can progress to long-term depressive illness, particularly when accompanied by thoughts of self-harm [3]. PPD typically begins 6 weeks after childbirth and ranges in severity from mild to severe [4,5]. The prevalence of PPD has been estimated at 17.2%, with reported rates in Asia ranging from 13.53% to 22.32% [6]. Despite its prevalence, PPD remains among the most underdiagnosed and undertreated forms of depression, and there is limited awareness regarding the importance of prevention and intervention.

Several instruments have been used to identify PPD promptly, including the Edinburgh Postnatal Depression Scale (EPDS), the PPD Screening Scale, and Beck's Depression Inventory. The EPDS is considered the most reliable of these instruments in terms of its sensitivity. specificity, and clinical validity for measuring PPD in the postpartum period [7]. Moreover, the EPDS includes a specific item on suicidal ideation, which is critical for evaluating the severity of depression and facilitating timely referrals to mental health services [8].

PPD is associated with various demographic and psychosocial factors, including low economic status, low education, single motherhood, major stressful events, lack of social and family support, history of depression, and unplanned pregnancy [9,10]. In Asian cultures, traditional support from in-laws or female relatives can provide physical and psychological comfort; however, it can also lead to interpersonal conflict and emotional distress [4.5.11]. Furthermore. a longstanding cultural preference for male offspring, particularly for the first child, is found in regions such as Eastern Asia, South-eastern Asia, Western Asia (including Arab countries and Türkiye), and Southern Asia (including India), which may contribute to the development of PPD

Studies have systematically reviewed the prevalence and associated factors of PPD. However, these studies were limited in scope, either focusing on single countries within Asia [12,13] or providing broad reviews of the global literature [6] that lacked an Asia-specific context. In 2024, a systematic review was conducted in Asian cultural contexts [5], but it did not address the characteristics of the EPDS in these contexts, such as culture-specific cutoff points, nor did it explore cultural factors influencing PPD.

To fill this research gap, this study aimed to compare and analyze the prevalence of PPD across Asian countries, examine the EPDS cutoffs used in each country, and identify the cultural, psychosocial, and demographic factors associated with PPD.

Methods -

Ethical statement

As a scoping review of the existing literature, this study did not require approval from the institutional review board or informed consent.

Study design

This study employed a scoping review design following the five-step framework proposed by Arksey and O'Malley [14]. The process included (a) identification of research questions, (b) literature search, (c) selection of relevant literature, (d) data analysis, and (e) summarizing and reporting the findings [14]. The study adhered to the Preferred Reporting Items for Systematic



Reviews and Meta-Analysis Extension for Scoping Review (PRISMA ScR) reporting guidelines for topical scoping reviews [15].

Step 1: identification of the research question

The primary research question was: "What are the recent research trends in Asian countries regarding maternal PPD?" The specific research questions were: (a) What is the prevalence of PPD among Asian mothers, (b) How do the EPDS cutoffs differ across Asian countries, and (c) What are the cultural, psychosocial, and demographic factors influencing PPD?

Step 2: literature search

A literature search was conducted between October 7 and October 14, 2024, in five electronic databases: PubMed, Embase, CINAHL (EBSCO), PsycINFO, and Web of Science, using a combination of three main search terms: "postpartum depression," "EPDS," and "Asia." Asian countries were defined based on the United Nations Geoscheme [16], including countries from Eastern Asia, South-eastern Asia, Southern Asia, and Western Asia.

Search strategies were developed by two researchers (authors L, M) using Boolean operators to combine Medical Subject Headings (MeSH) with keywords and synonyms. The final search strategies were reviewed by a professional librarian at the authors' institution. The search strategies for each database are detailed in Supplement 1. The search was restricted to titles and abstracts using the final search strategy in each database. Additionally, a supplementary search for relevant literature not identified by the database search was conducted using Google Scholar for 7 days following October 14, 2024.

Step 3: selection and exclusion criteria

Studies were included if they 1) were peer-reviewed journal articles addressing the prevalence and factors associated with PPD in Asian mothers, 2) included the usage of EPDS, 3) were written in English, and 4) were published from January 1, 2020 to September 30, 2024. The exclusion criteria were as follows: 1) gray literature such as dissertations, case reports, posters, or abstracts; (b) review articles or qualitative studies; (c) articles for which the full text was not available; (d) studies that did not include outcomes at 6-8 weeks postpartum; and (e) studies that did not address cultural, psychosocial, or demographic factors associated with PPD (e.g., only included biological markers, etc.).

The screening process was conducted independently by two researchers (authors L, M). In the first phase, titles and abstracts of all retrieved studies were reviewed based on the inclusion and exclusion criteria. In the second phase, the full texts of the selected studies were reviewed using the same criteria for the final selection. Any disagreements at any stage were resolved through discussion. If no consensus was reached, a third researcher (author K) was consulted.

The initial search yielded 2,480 studies. After excluding duplicates, 850 studies remained for screening. Based on titles and abstracts, 629 studies were excluded, leaving 221 studies for full-text review. After applying the inclusion and exclusion criteria to the full texts, 202 studies were excluded, and 19 studies [4,8-10,17-31] were finally selected for analysis (Fig. 1). The bibliographic management software EndNote 20 was used to store retrieved studies and remove duplicates.

Step 4: data analysis

A draft analysis framework was developed to record the data from the selected literature, and



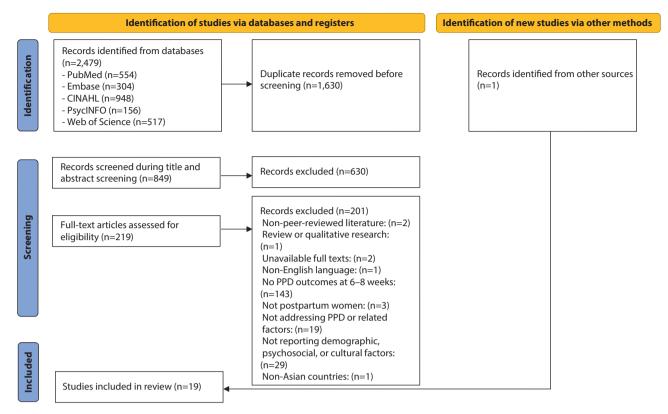


Fig. 1. PRISMA 2020 flow diagram. PPD, postpartum depression.

the final analysis framework was finalized through research meetings. The framework consisted of five main categories: publication characteristics, study characteristics, EPDS characteristics, participant characteristics, and study outcomes. All data were extracted, and frequency analysis and descriptive statistics were performed using Microsoft Excel 2020.

Results

General characteristics of the selected studies

Table 1 summarizes the general characteristics of the selected studies. The analysis of 19 studies revealed that publications originated from 10 countries. China accounted for the largest share with 7 studies (36.8%) [19-25], followed by India with 3 studies (15.79%) [26-28], and Saudi Arabia with 2 studies (10.53%) [8,31]. One study (5.26%) each was conducted in Bhutan [17], Cambodia [18], South Korea [29], Laos [10], Myanmar [4], the Philippines [30], and Türkiye

The distribution of studies over the past 5 years showed an increasing trend, despite a dip during the COVID-19 pandemic. Specifically, 6 studies (31.58%) were published in 2020 [9,10,21,24,27,30], 3 studies (15.79%) in 2021 [22,23,29], and 1 study (5.26%) each in 2022 and 2023 [19,31]. The year 2024 saw a significant rise, with 8 studies (42.11%) [4,8,17,18,20,25,26,28].

Regarding study design, the majority were cross-sectional (n=17, 89.47%) [4,8,10,17-28,30,31], one was a prospective cohort study (5.26%) [29], and one was a prospective longitudinal study (5.26%) [9]. The number of participants ranged from 65 to 4,813. One study [29] included both mothers and their spouses. Two studies [18,30] recruited participants from primary health care



Table 1. General characteristics of the selected studies (n=19)

UN Geoscheme	Country	References	Study design	Recruitment site
Eastern Asia	China	Chen and Shi [19]	Cross-sectional study	Hospital
		He et al. [20]	Cross-sectional study	Hospital
		Liu et al. [21]	Cross-sectional study	Hospital
		Liu et al. [22]	Cross-sectional study	Hospital
		Peng et al. [23]	Cross-sectional study	Hospital
		Xiong and Deng [24]	Cross-sectional study	Hospital
		Yi and Ahn [25]	Cross-sectional study	Hospital
	South Korea	Yoo et al. [29]	Prospective cohort study	Hospital
South-Eastern Asia	Cambodia	Guechhorng et al. [18]	Cross-sectional study	Primary healthcare institutions
	Laos	Inthaphatha et al. [10]	Cross-sectional study	Hospital
	Myanmar	Wyunn et al. [4]	Cross-sectional study	Hospitals
	Philippines	Labrague et al. [30]	Cross-sectional study	Primary healthcare institutions
Western Asia	Saudi Arabia	Alhusaini et al. [31]	Cross-sectional study	Hospital
		Alshowkan and Shdaifat [8]	Cross-sectional study	Hospital
	Türkiye	Çankaya [9]	Prospective longitudinal cohort study	Hospital
Southern Asia	Bhutan	Zangmo et al. [17]	Cross-sectional study	Hospital
	India	Begum et al. [26]	Cross-sectional study	Hospital
		Murry [27]	Cross-sectional study	Hospital
		Priya et al. [28]	Cross-sectional study	Hospital

centers, while 17 studies [4,8–10,17,19–29,31] recruited participants from hospitals.

General characteristics of the participants

The general characteristics of the participants are summarized in Table 2. Twelve studies reported the mean age of participants, which was calculated to be 28.06±4.44 years. The age range of participants varied across the studies; some included mothers aged 16 years and older [10], while others included those aged 17 years and older [17,31]. Additionally, two studies [19,24] focused on older mothers, aged 35 years or older.

Regarding obstetric characteristics, 3 studies [9,22,25] focused on primiparity, and 6 studies [4,9,10,18,22,29] included only mothers of singleton births. Nine studies [8,19,20,24-26,28-30] included mothers with no psychiatric history, and 7 [10,18,20-22,25,28] recruited only participants with no health problems or complications related to pregnancy and birth. One study [26] excluded mothers with a history of abortion or induced termination of pregnancy, and another [27] excluded cases where the infant had health conditions.

Edinburgh Postnatal Depression Scale characteristics by country

Edinburgh Postnatal Depression Scale version

A total of 16 studies (84.21%) described the EPDS version used, with 13 (68.42%) using translated versions validated for reliability and validity in their respective countries. Six of those used the Chinese version [20-25], followed by Hindi [27,28], Arabic [8,31], Korean [29], Burmese



negative delivery experience, and poor - Lower familial support - Lower level of education (<high school education), and history of pregnancy pregnancy, and lower economic status pregnancy, and perceived stress after disorder Poor health condition of the newborn - Poor relationship with friends/in-laws Dissatisfaction with economic status, unplanned pregnancy, and spouse's employment in manual labor/faming/ Younger matemal age and history of Lower level of education, unplanned History of pregnancy complications, Lower social support, symptoms of Factors associated with PPD Lower familial support, lower social support from colleagues or friends, Perceived changes in body image, - Poor relationship with spouse and perceived increased stress during caregiver of mother and newborn, and dissatisfaction with childbirth postpartum post-traumatic stress mother-in-law as the primary health status of the newborn - Co-habitation with in-laws Co-habitation with in-laws pregnancy complications Higher daily life stress
 Housewife, primiparity mother-in-law complications factory work delivery 279 (23.2%) 267 (23.5%) prevalence 47 (14.97%) 133 (30.2%) 51 (21.34%) 559 (11.6%) 73 (14.5%) % u <u>6</u> Cutoff/mean suspected PPD: 14.17±3.44 - Mean score of Mean score: 9.54±4.46 Mean score: Mean score: 8.18±5.80 - ≥13 Translated and pilot- -≥10 tested (n=11) _ \ \ >10 >10 ტ /I Franslated and pilot-tested (n=30) No information on Chinese version Chinese version Chinese version **EPDS version** Chinese version **EPDS version Fime frame** postpartum 6-8 weeks 4-8 weeks 6-7 weeks 6-8 weeks 6 weeks 6 weeks 6 weeks healthy term births, and no postpartum complications postpartum complications Mean age of PPD mothers: 29 (27-32) Mean age of PPD mothers: pregnancy, and no thyroid pregnancy complications, 28.25±3.785 (vs 29.57±4.123 in non-PPD) and medical conditions Mothers ≥18 years, with Age range: 17-48 years a history of psychiatric a history of psychiatric **Excluded mothers with** a history of psychiatric Mothers with singleton a history of psychiatric Mothers with singleton Included mothers with Included mothers with psychiatric disorders, - Mean age: 30.16±3.91 Included mothers with Characteristics - Mean age: 28.6 years pregnancy, and no Mothers ≥35 years **Excluded history of** psychiatric history psychiatric history No information on No information on disorders disorders disorders Sample 4,813 440 239 1,204 1,136 Size 503 314 Cambodia Country Bhutan China China China China China Chen and Shi [19] Zangmo et al. [17] References Guechhorna He et al. [20] Liu et al. [21] Liu et al. [22] Peng et al. [23] et al. [18]

Table 2. Detailed characteristics of the selected studies (n=19)



Table 2. Continued References Co	Inued		Sample		EPDS			Findings
		Size	Characteristics	Time frame (postpartum)	EPDS version	Cutoff/mean	PPD prevalence n (%)	Factors associated with PPD
Xiong and Deng [24]	China	1,124	- Mothers ≥35 years - Excluded mothers with a history of psychiatric disorders	6 weeks	Chinese version	≥13	202 (18%)	- Demale newbom, gap between familial expectations for fetal sex and actual sex of the newbom, poor relationship with mother-in-law
Y and Ahn [25]	Ohina	150	- Mean age: 26,25±3.90 - Excluded mothers with a history of psychiatric disorders - Mothers with Primiparity, and no pregnancy complications	6 weeks	Chinese version	- ≥10 - Mean score: 13.94±5.70	118 (78.7%)	- Gap between familial expectations for fetal sex and actual sex of the newborn, poor relationship with spouse, mother-in-law, and one's parents - Higher parenting stress, the gap between perceived and actual family support - Younger matemal age, lower economic status, and poor health condition of the newborn
Begum et al. [26]	India	92	- Wean age: 21.58±2.31 - Excluded mothers with a history of psychiatric disorders - Mothers with no abortions/ medical terminations	6-8 weeks	No information on EPDS version	∑ ₁ 3	22 (33.8%)	- Living in an extended family structure, pressure from the family to become pregnant, pressure for a female child, and poor relationship with spouse, inlaws, and one's parents - Younger maternal age, lower level of education, lower economic status, history of pregnancy complications, multiple fetuses, and unplanned pregnancy
Murry [27]	India	284	- Mean age: 28.6±4.61 - No information on psychiatric history - Mothers excluding those with infants diagnosed with acute illnesses	6-8 weeks	Hindi version	- ≥12 - Mean score: 7.67±5.9	72 (25.3%)	- Lower familial support, and poor relationship with mother-in-law - Dissatisfaction with marriage - History of pregnancy complications
Priya et al. [28]	India	426	- No information on maternal mean age - Excluded mothers with a history of psychiatric disorders or neurological disorders	6 weeks	English, Hindi	>10	74 (17.4%)	- Living in a nuclear family, and female newborn - Unplanned pregnancy, and multiparity
Yoo et al. [29]	South Korea	183 and 130 of their spouses	- Mean age: 32.9±3.41 - Excluded mothers with a history of psychiatric disorders - Mothers with a singleton pregnancy and their spouses	At six points (at 20, 28, and 36 weeks of pregnancy and at 2, 6, and 12 weeks postpartum)	Korean version	V 10	45 (24.6%)	- Lower social support, dissatisfaction with marriage, higher parenting stress, higher daily life stress, and lower level of self-esteem



Table 2. Continued	inued							
References	Country		Sample		EPDS			Findings
		Size	Characteristics	Time frame (postpartum)	EPDS version	Cutoff/mean	PPD prevalence n (%)	Factors associated with PPD
Inthaphatha et al. [10]	Laos	428	- Mean age: 281 (16–44) - Included mothers with a history of psychiatric disorders - Mothers with a singleton pregnancy, and no thyroid disorders	6-8 weeks	Translated and pilot-tested (n=20)	- ≥10 - Mean score: 7,1±4,6	136 (31.8%)	- Poor relationship with spouse, one's parents, and mother-in-law - Dissatisfaction with childbirth experiences - Higher education levels of participants and spouses, unplanned pregnancy, multiparity, housewife, and spousal unemployment
Wyunn et al. [4]	Myanmar	552	- Mean age: 27.9±4.8 (18–43) - No information on psychiatric history - Mothers with a singleton pregnancy	6-8 weeks	Myanmar version	- ≥10 - Mean score: 6.4±5.2	176 (31.9%)	- Living in a nuclear family and lower familial support - Dissatisfaction with economic status - Unplanned pregnancy
Labrague et al. [30]	Philippines	165	- Mean age: 23.98±5.74 - Excluded mothers with a history of psychiatric disorders	6 weeks	No information on EPDS version	>10	27 (16.4%)	- Having a professional occupation, multiparity
Alhusaini et al. [31]	Saudi Arabia	354	- Mean age: 31.58±5.8 (17-5.3) - Included mothers with a history of psychiatric disorders	Twice, immediately after birth and 6 weeks	Arabic version	≥13	18 (5.1%)	- Lower social support
Alshowkan and Shdaifat [8]	Saudi Arabia	270	- Married mothers aged 18-49 years - Excluded mothers with a history of psychiatric disorders	6 weeks	Arabic version	- ≥10 - Mean score: 2.54±4.5	15 (5.6%)	 Living in an extended family structure Lower level of education, spousal unemployment, lower economic status, multiple fetuses, history of pregnancy complications
Çankaya [9]	Türkiye	245	- Mean age: 273±5.2 - Mean age of PPD mothers: 28.2±5.2 (vs 27.2±5.2 non- PPD) - No information on psychiatric history - Mothers with Primiparity and a singleton pregnancy	6-8 weeks	Turkish version	<u>N</u>	44 (18%)	- Increased marital conflict - Increased perceived stress during pregnancy

EPDS, Edinburgh Postnatal Depression Scale; PPD, postpartum depression.



[4], and Turkish [9] versions. Three studies (17.79%) used translations done by the researchers, pilot-tested but without reported psychometric analyses: these were from Bhutan [17], Cambodia [18], and Laos [10].

Edinburgh Postnatal Depression Scale cutoff points

The EPDS is typically validated for reliability and validity within each country, with a standard cutoff of 13 or higher frequently adapted to fit the local cultural context [32]. However, among these 19 studies, there was variability in cutoff points, even within the same country.

A cutoff point of 10 or higher was most commonly used, appearing in 10 out of the 19 studies (42.11%). These studies spanned various regions: India [28] in Southern Asia; Cambodia [18], Laos [10], Myanmar [4], and the Philippines [30] in Southeastern Asia; Saudi Arabia [8] in Western Asia; and South Korea [29] along with China [20,23,25] in Eastern Asia. Two studies from Cambodia [18] and Laos [10] cited research on EPDS cutoff points in primary healthcare settings in non-English-speaking countries [33]. Meanwhile, studies from China [23], South Korea [29], Myanmar [10], and Saudi Arabia [8] referenced validation studies of the EPDS translated into their respective languages [34-37]. Additionally, 2 studies from China [22,24] utilized cutoffs based on research assessing the clinical significance of EPDS cutoffs in Englishspeaking mothers [38].

A cutoff point of 9 or higher was reported in one study (5.26%) conducted in China [19], referencing a prior validation study of the Chinese version of the EPDS [39]. One study (5.26%) from Bhutan [17] used a cutoff of 11 or higher, which based its criteria on a systematic review of EPDS cutoffs in the global literature [40]. Another study (5.26%) from India [27] used a cutoff point of 12 or higher but did not provide details on a specific rationale or evidence for this criterion.

In contrast, a cutoff point of 13 or higher was reported in six studies from China [21,22,24], India [26], Saudi Arabia [31], and Türkiye [9]. The rationale for this cutoff included a validation study of the Turkish EPDS version [41] and a previously validated Arabic version that was assessed for reliability and validity [42]. Conversely, two Chinese studies [21,22] cited a systematic review of EPDS cutoff points in global literature [43] and the original developer's publication on the EPDS [44]. Two other studies [24,26] did not provide a rationale for their chosen cutoff points. However, the original developer of the EPDS [44] recommended that cutoff points for translated versions of the EPDS might not be universally applicable across different cultures and emphasized the importance of establishing semantic, technical, diagnostic, and conceptual equivalence when adapting the EPDS for various cultural contexts.

Edinburgh Postnatal Depression Scale mean scores

Nine studies (47.37%) reported mean EPDS scores and SD, although one [17] provided only the mean for participants suspected of having PPD. The remaining 8 studies [4,8,10,18,21,22,25,27] showed a mean EPDS score of 7.75±5.09.

The mean and SD of EPDS scores from studies conducted in South-Eastern Asia, specifically in Cambodia [18], Laos [10], and Myanmar [4], were calculated to be 6.72±4.71. A study from India [27] in Southern Asia reported slightly higher values (7.67±5.9), while a study from Saudi Arabia [8] in Western Asia reported lower values (2.54±4.5). The unusually low EPDS mean score in the Saudi study [8] may be attributed to the demographic characteristics of the participants, over 90% of whom had a university education or higher and resided in nuclear family settings.



Prevalence and associated factors of postpartum depression

Prevalence

The prevalence of PPD ranged from 5.1% [8] to 78.7% [25]. In Eastern Asia, South Korea [29] reported 24.6%, while Chinese studies ranged from 11.6% [23] to 78.7% [25]. In South-eastern Asia, reported prevalence was 30.2% in Cambodia [18], 31.8% in Laos [10], 31.9% in Myanmar [4], and 16.4% in the Philippines [30]. In Southern Asia, Bhutan [17] reported 14.9%, while rates in India ranged from 17.4% [28] to 33.8% [26]. In Western Asia, Türkiye [9] reported 18%, whereas Saudi Arabia reported the lowest rates (5.1% [31] and 5.6% [8]). Thus, the lowest prevalence was found in Saudi Arabia, while the highest was found in China.

Cultural factors

Various cultural factors contributing to PPD were identified in 18 studies (Table 3), with a particular focus on family relationships. The most frequently mentioned factor was poor relationships with in-laws (n=7), followed by negative relationships with the spouse (n=4) and the mother's own parents (n=3). Additionally, living with in-laws (n=2) and having the motherin-law as the primary caregiver for the mother and newborn (n=1) were also reported as contributing factors.

The influence of newborn sex also emerged as a significant cultural factor, particularly when the newborn was female (n=2) or when there was a discrepancy between family expectations and the actual sex of the newborn (n=2). Additionally, one study identified family pressure to conceive as a factor linked to PPD.

Psychosocial factors

Thirteen studies identified psychosocial factors associated with PPD [4,9,10,17–19,21–23,25,27,29,31]. The most commonly reported factors were low family support and low social support from colleagues or friends, each mentioned in four studies. Other factors included high levels of daily life stress, parenting stress, dissatisfaction with marriage, childbirth experiences, and economic status, each cited in two studies.

Demographic factors

The most commonly reported demographic factors included pregnancy complications and unplanned pregnancies, each cited in six studies. These were followed by low economic status, reported in five studies; low level of education, in four studies; and young maternal age, multiparity, and poor neonatal health, each noted in three studies. Less frequently mentioned factors were spousal unemployment, the mother's occupation as a housewife, primiparity, and multiple fetuses, each reported in two studies.

Discussion

This study found that the prevalence of PPD was lowest in Saudi Arabia at 5.1% [8] and highest in China at 78.7% [25]. These findings are somewhat consistent with previous reports, which have shown PPD prevalence in Asian countries to range from 4.9% to 93% [5]. Earlier studies have indicated variability in PPD prevalence across Asia, with the lowest rates reported in South Korea [5,6] and the highest in Japan [5] or Afghanistan [6]. However, considering that Korean nurses exhibited significantly higher rates of PPD (45.9%) compared to their US counterparts (3.4%) [45], it is crucial to carefully examine variations in sampling methods, participant



Table 3. Classification of factors associated with PPD

Factors	Categories	n	References
Cultural	Poor relationship with in-laws	7	10,17,18,24-27
	Poor relationship with spouse	4	10,18,25,26
	Poor relationship with parents	3	10,25,26
	Co-habitation with in-laws	2	20,23
	Female newborn	2	24,28
	Gap between familial expectations for fetal sex and actual sex of the newborn	2	24,25
	Living in an extended family structure	2	8,26
	Living in a nuclear family	2	4,28
	Mother-in-law as the primary caregiver of mother and newborn	1	21
	Pressure from the family to become pregnant	1	26
	Pressure for a female child	1	26
Psychosocial	Lower familial support	4	4,19,21,27
	Lower social support	4	21,22,29,31
	Higher daily life stress	2	23,29
	Higher parenting stress	2	25,29
	Dissatisfaction with marriage	2	27,29
	Dissatisfaction with childbirth experiences	2	10,21
	Dissatisfaction with economic status	2	4,18
	Perceived increased stress during pregnancy	2	9,17
	Perceived stress after delivery	1	17
	Symptoms of postpartum post-traumatic stress disorder	1	22
	Perceived changes in body image	1	17
	Gap between perceived and actual family support	1	25
	Lower level of self-esteem	1	29
	Increased marital conflict	1	9
Demographic	History of pregnancy complications	6	8,17,19,20,26,27
	Unplanned pregnancy	6	4,10,18,21,26,28
	Lower economic status	5	8,21,25,26
	Lower level of education	4	8,19,21,26
	Younger maternal age	3	20,25,26
	Multiparity	3	10,28,30
	Poor health condition of the newborn	3	17,22,25
	Spousal unemployment	2	8,10
	Housewife	2	10,23
	Primiparity	2	23,24
	Multiple fetuses	2	8,26
	Higher education levels of participants and spouses	1	10
	Negative delivery experience	1	17
	Spouse's employment in manual labor/farming/factory work	1	18
	Having a professional occupation	1	30

PPD, postpartum depression.



characteristics, and the use of culturally sensitive cutoffs.

Among the cultural factors associated with PPD, a negative relationship with in-laws has been identified as a contributing factor, consistent with findings from a previous study in Japan [46]. This may be linked to Confucian influences that emphasize recognition and affirmation by the extended family in Asia. Similarly, the extended family—a traditional family structure in Asian countries—has been reported to increase the risk of PPD [46]. However, while some studies have identified the extended family as a factor [8,26], others have pointed to the nuclear family structure as associated with PPD [4,28]. Interestingly, living with a mother-in-law was found to be a significant factor for PPD, aligning with results from a previous study in China [47]. Our findings regarding cultural factors related to the newborn's sex also mirror those of the earlier study conducted in China [47], suggesting that Confucian preferences for boys in Asian countries may contribute to familial conflict and, consequently, increase the risk of PPD.

In terms of the psychosocial factors associated with PPD, a lack of family and social support was identified as a key factor. Family support during the postpartum period is crucial for maternal well-being, as close relationships and daily interactions with the spouse and other family members offer both emotional and practical support [4]. This observation aligns with the findings of systematic reviews from Western Asia, which analyzed the relationship between social support and PPD [1,48]. These insights suggest that healthcare providers should consider the family environment and educate spouses and family members about PPD. Regarding demographic characteristics, unplanned pregnancies, low education levels, low income, and younger maternal age have been significantly associated with PPD. These associations are consistent with studies conducted in Western Asia [1,11].

This study has limitations. Strict inclusion criteria may have excluded some articles that contained relevant insights into PPD. In addition, most included studies were cross-sectional, limiting conclusions about causality. Some recent research suggests that environmental factors (e.g., endocrine disruptors, and air pollution) could also influence PPD [49,50]. Future research should consider these factors to gain a more comprehensive understanding of PPD. Despite these limitations, this review highlights the need for consistent use of the EPDS and the establishment of standardized cutoff points to enhance the accuracy of PPD screening in Asian countries. It also emphasizes the importance of strengthening family and community support systems to improve maternal psychological well-being and prevent PPD. Developing prevention strategies and programs that reflect Asia's diverse cultural and social contexts will be key to the early detection and prevention of PPD.

In conclusion, the prevalence of PPD in Asian countries widely varied, ranging from 5.1% to 78.7%. Although most studies used translated EPDS versions that had been previously validated for reliability and validity, there was variability in the EPDS cutoff points, even within individual countries such as India, Saudi Arabia, and China. This variability underscores the need for a standardized approach to using the EPDS, including adopting internationally recognized standardized translations and establishing consistent cutoff criteria that take into account the cultural characteristics of Asian countries.

This study identified that cultural factors, including relationships with in-laws and issues related to the sex of the newborn, are significant in the context of PPD among Asian mothers. To definitively establish the connection between cultural influences and PPD, further prospective cohort or population-based studies are required.



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Supplement 1. The search strategies for each database

References

1. Harandi TF, Taghinasab MM, Nayeri TD. The correlation of social support with mental health:



- a meta-analysis. *Electron Physician* 2017;9(9):5212-5222. https://doi.org/10.19082/5212
- 2. O'Hara MW, McCabe JE. Postpartum depression: current status and future directions. *Annu Rev Clin Psychol* 2013;9:379-407.
 - https://doi.org/10.1146/annurev-clinpsy-050212-185612
- 3. Iliadis SI, Skalkidou A, Ranstrand H, Georgakis MK, Axfors C, Papadopoulos FC. Self-harm thoughts postpartum as a marker for long-term morbidity. *Front Public Health* 2018;6:34. https://doi.org/10.3389/fpubh.2018.00034
- 4. Wyunn KM, Than Wai ZZ, Ei Swe KE, Inthaphatha S, Nishino K, Yamamoto E. Factors associated with postpartum depression among Myanmar women in Yangon: a cross-sectional study. *Heliyon* 2024;10(13):e33425.
 - https://doi.org/10.1016/j.heliyon.2024.e33425
- Yaqoob H, Ju XD, Bibi M, Anwar S, Naz S. A systematic review of risk factors of postpartum depression. Evidence from Asian culture. *Acta Psychol* 2024;249:104436. https://doi.org/10.1016/j.actpsy.2024.104436
- 6. Wang Z, Liu J, Shuai H, Cai Z, Fu X, Liu Y, et al. Mapping global prevalence of depression among postpartum women. *Transl Psychiatry* 2021;11(1):543. https://doi.org/10.1038/s41398-021-01663-6
- Hewitt CE, Gilbody SM, Brealey S, Paulden M, Palmer S, Mann R, et al. Methods to identify postnatal depression in primary care: an integrated evidence synthesis and value of information analysis. *Health Technol Assess* 2009;13(36):1-145. https://doi.org/10.3310/hta13360
- 8. Alshowkan A, Shdaifat E. Factors influencing postpartum depression in Saudi women: a cross-sectional descriptive study. *Womens Health Nurs* 2024;30(2):164-173. https://doi.org/10.4069/whn.2024.06.18
- Çankaya S. The effect of psychosocial risk factors on postpartum depression in antenatal period: a prospective study. *Arch Psychiatr Nurs* 2020;34(3):176-183. https://doi.org/10.1016/j.apnu.2020.04.007
- 10. Inthaphatha S, Yamamoto E, Louangpradith V, Takahashi Y, Phengsavanh A, Kariya T, et al. Factors associated with postpartum depression among women in Vientiane Capital, Lao People's Democratic Republic: a cross-sectional study. *PLoS One* 2020;15(12):e0243463. https://doi.org/10.1371/journal.pone.0243463
- 11. Alshikh Ahmad H, Alkhatib A, Luo J. Prevalence and risk factors of postpartum depression in the Middle East: a systematic review and meta–analysis. *BMC Pregnancy Childbirth* 2021;21:1-12.
 - https://doi.org/10.1186/s12884-021-04016-9
- 12. Keser Özcan N, Boyacıoğlu NE, Dinç H. Postpartum depression prevalence and risk factors in Turkey: a systematic review and meta-analysis. *Arch Psychiatr Nurs* 2017;31(4):420-428. https://doi.org/10.1016/j.apnu.2017.04.006
- 13. Upadhyay RP, Chowdhury R, Salehi A, Sarkar K, Singh SK, Sinha B, et al. Postpartum depression in India: a systematic review and meta-analysis. *Bull World Health Organ* 2017;95(10):706-717C.
 - https://doi.org/10.2471/BLT.17.192237
- 14. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. *Int J Soc Res Methodol* 2005;8(1):19-32.
 - https://doi.org/10.1080/1364557032000119616



- Tricco AC, Lillie E, Zarin W, O'Brien KK, Levac D, Peters MDJ, et al. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Ann Intern Med* 2018;169(7):467-473.
 - https://doi.org/10.7326/M18-0850
- 16. Wikipedia. United Nations geoscheme for Asia [Internet]. San Francisco (CA): Wikipedia; c2024 [cited 2024 Sep 24]. Available from: https://en.wikipedia.org/wiki/United_Nations_geoscheme_for_Asia
- Zangmo S, Boonchieng W, Suvanayos C, Gyeltshen K, Siewchaisakul P. Prevalence and factors associated with postpartum depression among Bhutanese mothers: a crosssectional study. Womens Health Nurs 2024;30(3):238-249. https://doi.org/10.4069/whn.2024.09.02
- Guechhorng I, Inthaphatha S, Nishino K, Takahashi Y, Hamajima N, Yamamoto E. Determinants of postpartum depression among women in Kampong Chhnang Province, Cambodia. *Arch Psychiatr Nurs* 2024;50:60-66. https://doi.org/10.1016/j.apnu.2024.03.007
- Chen L, Shi Y. Analysis of influencing factors and the construction of predictive models for postpartum depression in older pregnant women. World J Psychiatry 2023;13(12):1079-1086.
 - https://doi.org/10.5498/wjp.v13.i12.1079
- 20. He J, Li Y, Chen L, Zhang Y. Non-biological factors associated with postpartum depression among women in Shenzhen: a case-control study. *Front Public Health* 2024;12:1417861. https://doi.org/10.3389/fpubh.2024.1417861
- 21. Liu Y, Guo N, Li T, Zhuang W, Jiang H. Prevalence and associated factors of postpartum anxiety and depression symptoms among women in Shanghai, China. *J Affect Disord* 2020;274:848-856.
 - https://doi.org/10.1016/j.jad.2020.05.028
- 22. Liu Y, Zhang L, Guo N, Jiang H. Postpartum depression and postpartum post-traumatic stress disorder: prevalence and associated factors. *BMC Psychiatry* 2021;21(1):487. https://doi.org/10.1186/s12888-021-03432-7
- 23. Peng S, Lai X, Du Y, Meng L, Gan Y, Zhang X. Prevalence and risk factors of postpartum depression in China: a hospital-based cross-sectional study. *J Affect Disord* 2021;282:1096-1100.
 - https://doi.org/10.1016/j.jad.2021.01.012
- 24. Xiong R, Deng A. Incidence and risk factors associated with postpartum depression among women of advanced maternal age from Guangzhou, China. *Perspect Psychiatr Care* 2019;56(2):316-320.
 - https://doi.org/10.1111/ppc.12430
- 25. Yi F, Ahn S. Effects of postpartum fatigue, parenting stress, and family support on postpartum depression in Chinese first-time mothers: a cross-sectional study. *Womens Health Nurs* 2024;30(3):226-237.
 - https://doi.org/10.4069/whn.2024.09.02.1
- 26. Begum S, Anitha S, Sushantha. A cross-sectional study on magnitude of post-partum depression and factors associated with it among postnatal mothers visiting a tertiary care setting in Mangalore, Karnataka. *Indian J Public Health Res Dev* 2024;15(3):371-377. https://doi.org/10.37506/58n00148
- 27. Murry LL, Devi YS, Joshi P, Dabas S, Kumari V, Singh KJ. Postpartum depression and its risk



- factors among Indian women. *Nurs J India* 2020;111(4):186-190. https://doi.org/10.48029/nji.2020.cxi408
- 28. Priya T, Kaushal S, Dogra P, Dogra V. Prevalence and risk factors of postpartum depression in sub-Himalayan region. *Med J Armed Forces India* 2024;80(2):161-165. https://doi.org/10.1016/j.mjafi.2021.12.003
- 29. Yoo H, Ahn S, Park S, Kim J, Oh J, Koh M. Factors influencing prenatal and postpartum depression in Korea: a prospective cohort study. *Korean J Women Health Nurs* 2021;27(4):326-336.
 - https://doi.org/10.4069/kjwhn.2021.11.17
- 30. Labrague LJ, McEnroe-Petitte D, Tsaras K, Yboa BC, Rosales RA, Tizon MM, et al. Predictors of postpartum depression and the utilization of postpartum depression services in rural areas in the Philippines. *Perspect Psychiatr Care* 2019;56(2):308-315. https://doi.org/10.1111/ppc.12428
- 31. Alhusaini NA, Zarban NA, Shoukry ST, Alahmadi M, Gharawi NK, Arbaeyan R, et al. Prevalence of postpartum depression among mothers giving birth at King Abdulaziz University Hospital, Jeddah, Kingdom of Saudi Arabia from 2020 until 2022. *Cureus* 2022;14(11):e31365. https://doi.org/10.7759/cureus.31365
- 32. Cox JL, Holden JM, Sagovsky R. Detection of postnatal depression: development of the 10-item Edinburgh postnatal depression scale. *Br J Psychiatry* 1987;150(6):782-786. https://doi.org/10.1192/bjp.150.6.782
- 33. Bennett HA, Einarson A, Taddio A, Koren G, Einarson TR. Prevalence of depression during pregnancy: systematic review. *Obstet Gynecol* 2004;103(4):698-709. https://doi.org/10.1097/01.AOG.0000116689.75396.5f
- 34. Lee DTS, Yip SK, Chiu HFK, Leung TYS, Chan KPM, Chau IOL, et al. Detecting postnatal depression in Chinese women: validation of the Chinese version of the Edinburgh Postnatal Depression Scale. *Br J Psychiatry* 1998;172(5):433-437. https://doi.org/10.1192/bjp.172.5.433
- 35. Kim YK, Hur JW, Kim KH, Oh KS, Shin YC. Clinical application of Korean version of Edinburgh Postnatal Depression Scale. *J Korean Neuropsychiatr Assoc* 2008;47(1):36-44.
- 36. Ing H, Fellmeth G, White J, Stein A, Simpson JA, McGready R. Validation of the Edinburgh Postnatal Depression Scale (EPDS) on the Thai–Myanmar border. *Trop Doct* 2017;47(4):339-347.
 - https://doi.org/10.1177/0049475517717635
- 37. Hanach N, Radwan H, Fakhry R, Dennis WB, Faris ME, Obaid RS, et al. Prevalence and risk factors of postpartum depression among women living in the United Arab Emirates. *Soc Psychiatry Psychiatr Epidemiol* 2023;58(3):395-407. https://doi.org/10.1007/s00127-022-02372-1
- 38. Matthey S. Calculating clinically significant change in postnatal depression studies using the Edinburgh Postnatal Depression Scale. *J Affect Disord* 2004;78(3):269-272. https://doi.org/10.1016/S0165-0327(02)00313-0
- 39. Yu J, Zhang Z, Deng Y, Zhang L, He C, Wu Y, et al. Risk factors for the development of postpartum depression in individuals who screened positive for antenatal depression. *BMC Psychiatry* 2023;23(1):557.
 - https://doi.org/10.1186/s12888-023-05030-1
- 40. Levis B, Negeri Z, Sun Y, Benedetti A, Thombs BD. Accuracy of the Edinburgh Postnatal Depression Scale (EPDS) for screening to detect major depression among pregnant and



- postpartum women: systematic review and meta-analysis of individual participant data. *Br Med J* 2020;371:m4022.
- https://doi.org/10.1136/bmj.m4022
- 41. Engindeniz AN, Küey L, Kültür S. Turkish version of the Edinburgh Postpartum Depression Scale: reliability and validity study. In: Psychiatric Organization of Türkiye, editor. Proceedings of the Spring Symposiums I; 1996. Ankara (TR): Psychiatric Organization of Türkiye; 1996. p.51-52.
- 42. Montazeri A, Torkan B, Omidvari S. The Edinburgh Postnatal Depression Scale (EPDS): translation and validation study of the Iranian version. *BMC Psychiatry* 2007;7:11. https://doi.org/10.1186/1471-244X-7-11
- 43. Gibson J, McKenzie-McHarg K, Shakespeare J, Price J, Gray R. A systematic review of studies validating the Edinburgh Postnatal Depression Scale in antepartum and postpartum women. *Acta Psychiatr Scand* 2009;119(5):350-364. https://doi.org/10.1111/j.1600-0447.2009.01363.x
- 44. Cox J. Thirty years with the Edinburgh Postnatal Depression Scale: voices from the past and recommendations for the future. *Br J Psychiatry* 2019;214(3):127-129. https://doi.org/10.1192/bjp.2018.245
- 45. Kim O, Kim B, Kim SY, Cho E, Lee HY, Cha C, et al. Comparison of factors associated with postpartum depression from two cohorts of nurses: the Korea Nurses' Health Study and the Nurses' Health Study 3. *Occup Environ Med* 2023;80(4):209-217. https://doi.org/10.1136/oemed-2022-108609
- 46. Honjo K, Kimura T, Baba S, Ikehara S, Kitano N, Sato T, et al. Association between family members and risk of postpartum depression in Japan: does "who they live with" matter? -The Japan environment and Children's study. Soc Sci Med 2018;217:65-72. https://doi.org/10.1016/j.socscimed.2018.09.043
- Peng S, Lai X, Qiu J, Du Y, Yang J, Bai Y, et al. Living with parents-in-law increased the risk of postpartum depression in Chinese women. *Front Psychiatry* 2021;12:736306. https://doi.org/10.3389/fpsyt.2021.736306
- 48. Atif M, Halaki M, Raynes-Greenow C, Chow CM. Perinatal depression in Pakistan: a systematic review and meta-analysis. *Birth* 2021;48(2):149-163. https://doi.org/10.1111/birt.12535
- 49. Kim JH, Shin HS, Lee WH. Impact of endocrine-disrupting chemicals in breast milk on postpartum depression in Korean mothers. *Int J Environ Res Public Health* 18;9:4444. https://doi.org/10.3390/ijerph18094444
- 50. Lamichhane DK, Jung DY, Shin YJ, Lee KS, Lee SY, Ahn K, et al. Association of ambient air pollution with depressive and anxiety symptoms in pregnant women: a prospective cohort study. *Int J Hyg Environ Health* 2021;237:113823. https://doi.org/10.1016/j.ijheh.2021.113823

Review



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Challenges and strategies for cultivating young teachers in pathophysiology departments at Chinese medical colleges: a narrative review

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This narrative review examines the challenges, strategies, and future directions in the development of voung teachers within the pathophysiology departments of Chinese medical colleges. A thorough review of 49 studies published between 2013 and 2024 was carried out using PubMed, Web of Science, and various Chinese databases. The primary challenges identified include teaching innovation (cited in 84.2% of the studies), research pressure (91.2%), disciplinary characteristics (87.7%), and career development (80.7%). Medical schools have responded by enhancing training systems (94.7%), innovating teaching methods (93.0%), and bolstering research support (96.5%). Looking ahead, trends are shifting toward the application of new technologies, interdisciplinary integration, and international collaboration. The focus on cultivating young teachers is increasingly geared towards personalization and diversification, which are essential for advancing education in pathophysiology. High-quality young teachers are pivotal in raising teaching standards, fostering research innovation, and facilitating interdisciplinary exchanges. Based on these insights, we recommend several practical measures to enhance the quality of pathophysiology education in China. These include establishing comprehensive training programs that integrate teaching innovation and research skills; developing structured mentorship systems with clear pathways for career advancement; creating platforms that support technology-enhanced teaching and international collaboration; and implementing systematic evaluation mechanisms to assess teaching effectiveness. These targeted interventions will require a coordinated effort from department heads, educational institutions, and policymakers to ensure a sustained improvement in the quality of pathophysiology education.

Introduction

Background

Pathophysiology, which serves as a "bridge" between basic medical sciences and clinical

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medicine [1], occupies a crucial position in medical education [2]. It equips medical students with a theoretical foundation to understand disease mechanisms and enhances their clinical reasoning skills, thereby playing an indispensable role in the training of high-quality medical professionals [3]. With the rapid advancement of medical technology and continuous innovation in healthcare models, both the content [4] and methods of teaching pathophysiology are encountering unprecedented challenges and opportunities [5].

In the context of pathophysiology education, young teachers—typically faculty members aged 35 or younger with less than five years of teaching experience—play a crucial role in discipline construction and talent cultivation. Their influence directly affects the quality and future development of the field. These educators are expected to have a robust foundation in professional knowledge [6] and to demonstrate advanced teaching concepts, proficient teaching skills, strong research capabilities, and competencies in interdisciplinary collaboration [7]. However, pathophysiology departments at Chinese medical schools currently face numerous challenges in cultivating young teachers [8].

These challenges include the following:

- 1) The accelerating pace of expansion in medical knowledge, which requires continuous learning of new knowledge and technologies;
- 2) Innovations in teaching methods, such as flipped classrooms [9] and problem-based learning, which place higher demands on teaching abilities [10];
- 3) The pressure to balance research with teaching tasks, securing funding, and producing high-quality research outputs [11]: and
- 4) The trend for interdisciplinary integration, which requires cross-disciplinary perspectives [12] and collaboration skills [13].

Objectives

This nationwide narrative review systematically analyzes the primary challenges faced in cultivating young teachers within the pathophysiology departments of Chinese medical schools. It aims to propose targeted strategies and suggestions to optimize the young teacher cultivation system and provide a theoretical basis and practical guidance for enhancing the guality of pathophysiology education in China. This research is particularly relevant to educational administrators, heads of pathophysiology departments, and policymakers in medical education. By conducting a comprehensive literature review, case analysis, and summarizing experiences, this study contributes to the understanding of how to train young teachers in medical education, with a focus on pathophysiology. It also offers insights for educational evaluation and policymaking in health professions education at the national level.

Methods -

Ethics statement

This is a literature-based study; therefore, neither approval by the institutional review board nor the obtainment of informed consent was required.

Study design

This is a nationwide narrative review based on a comprehensive search and analysis of published literature on the cultivation of young teachers in the pathophysiology departments of Chinese medical schools. It provides a broad perspective on the current state of young teacher



development across medical institutions throughout mainland China. In this study, 'young teachers' are defined as faculty members in pathophysiology departments who meet all the following criteria: they are 35 years old or younger, in line with the standard definition used by China's Ministry of Education and the National Natural Science Foundation of China; they have less than 5 years of teaching experience in pathophysiology, marking the critical early-career development period; and they hold academic ranks such as teaching assistants, lecturers, and assistant professors, which are the primary early-career faculty positions in Chinese medical colleges.

Information sources

We conducted a systematic search of both Chinese and English language databases, including PubMed, Web of Science, China National Knowledge Infrastructure (CNKI), and Wanfang Data. The search was performed in April 2024 and covered literature published from January 2013 through June 2024 to ensure the information was current.

Search strategy

The following search strategy was used for English databases: ("young teacher*" OR "early career faculty" OR "junior faculty") AND (pathophysiology OR "patho-physiology") AND (China OR Chinese) AND ("medical education" OR "medical school*" OR "medical universit*").

For Chinese databases, the equivalent Chinese terms were used: (青年教师 OR 年轻教师 OR 初级教师) AND (病理生理学 OR 病生) AND (医学教育 OR 医科大学 OR 医学院).

Study selection and data collection

A flow diagram of the study selection process is shown in Fig. 1. In our initial search, we

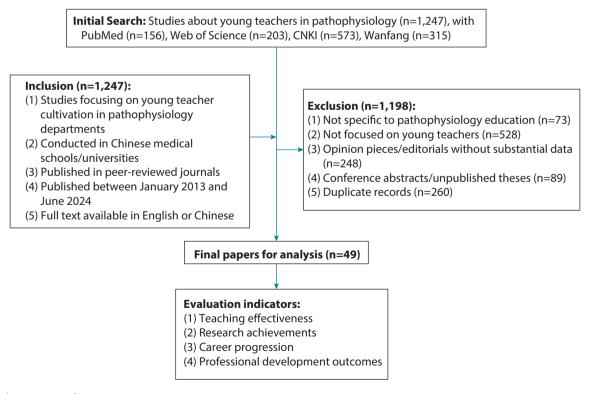


Fig. 1. The flow diagram of the study selection process.



retrieved 1,247 articles from four databases: 156 from PubMed, 203 from Web of Science, 573 from CNKI, and 315 from Wanfang. The inclusion criteria specified that the studies must focus on the cultivation of young teachers in pathophysiology departments, be conducted at Chinese medical schools/universities, be published in peer-reviewed journals between January 2013 and June 2024, and have full texts available in English or Chinese. Of the 1,198 articles excluded, 73 did not specifically pertain to pathophysiology education, 528 did not focus on young teachers, 248 were opinion pieces or editorials lacking substantial data, 89 were conference abstracts or unpublished theses, and 260 were duplicates. Ultimately, 49 articles satisfied all inclusion criteria and were included in this analysis (Supplement 1).

Evaluation indicators

Evaluation criteria for support strategies included the following components: Teaching effectiveness was indicated by student evaluation scores, teaching awards, the implementation of innovative teaching methods, and peer review results. Research achievement was measured by publication output, research funding obtained, and participation in research projects. Career progression was evaluated based on professional title advancement, teaching qualification obtainment, and roles in academic leadership. Professional development was assessed through participation in training programs, conference presentations, and interdisciplinary collaborations.

Results

Key challenges in cultivating young teachers in pathophysiology

The analysis of the literature identified multiple significant challenges in nurturing young teachers within the pathophysiology departments of Chinese medical schools (Fig. 2, Dataset 1). The chart illustrates the proportion of studies that reference various challenges encountered by these young educators. Research challenges emerged as the most commonly cited issue, followed by challenges related to the characteristics of the discipline, teaching challenges, and career development challenges.

Research challenges

Fig. 3 (Dataset 1) presents the specific aspects of research challenges encountered by

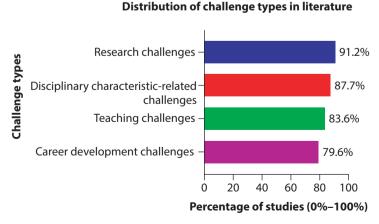


Fig. 2. Distribution of types of challenges in the literature.



Specific aspects of research challenges and their distribution

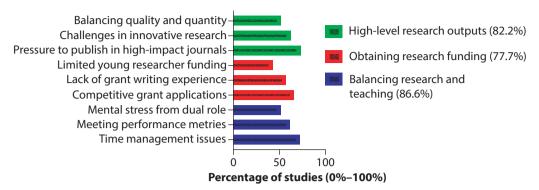


Fig. 3. Specific aspects of research challenges and their distribution.

junior faculty in the pathophysiology departments of Chinese medical schools, along with their frequency of mention in the literature. This figure effectively highlights the relative significance of various aspects within each primary category of research challenges, facilitating straightforward comparisons both within and between categories. The challenges are divided into three main areas: high-level research outputs (green, 82.2%), securing research funding (red, 77.7%), and balancing research with teaching (blue, 86.6%). Each bar in the graph represents a particular aspect of these challenges, with its length reflecting the percentage of studies that referenced it.

Disciplinary characteristic-related challenges

Table 1 provides a detailed analysis of the challenges faced by young teachers in pathophysiology departments, as identified in 87.7% of the 49 studies reviewed. These findings underscore the complexity of teaching pathophysiology, which demands that young instructors integrate basic and clinical sciences, keep up with rapid scientific advancements, and strike a balance between broad coverage and deep understanding. The data underscore the necessity for targeted support and professional development programs to assist young faculty in effectively managing these discipline-specific challenges. This information is essential for medical education policymakers and administrators in developing curricula and faculty development initiatives tailored to the unique requirements of pathophysiology education.

Teaching challenges

Fig. 4 (Dataset 1) presents three primary teaching challenges encountered by young teachers in pathophysiology departments, along with their specific aspects. It shows that the most common challenge is the requirement for interdisciplinary teaching, followed by difficulties in fostering clinical thinking and integrating new technologies. Table 2 further delineates each main challenge, offering a detailed perspective on the obstacles that young teachers encounter in pathophysiology education.

Career development challenges

Table 3 presents a comprehensive analysis of the career development challenges faced by young teachers in the pathophysiology departments of Chinese medical schools. The data suggest that although promotional opportunities and work-life balance are significant concerns, the most pressing issue is the difficulty in pursuing continuous professional development amid



Table 1. Breakdown of disciplinary characteristic-related challenges faced by young teachers in pathophysiology departments

Disciplinary characteristic-related challenges	Specific aspects	Number of studies	Percentage
Intersection of pathophysiology with basic	Integrating basic science concepts with clinical applications	38	77.55
medical sciences and clinical medicine (78.9% of studies)	Keeping up with rapid advancements in both basic and clinical sciences	32	65.31
	Translating complex pathophysiological mechanisms into clinically relevant teaching	27	55.10
Adapting to rapid developments at the disciplinary forefront (73.7% of studies)	Continuously updating course content to reflect latest research findings	36	73.46
	Incorporating emerging technologies and methodologies into teaching	30	61.22
	Pressure to stay current with an ever-expanding body of knowledge	26	53.06
Balancing depth and breadth in pathophysiology	Covering a wide range of topics while maintaining sufficient depth	34	69.38
education (70.2% of studies)	Allocating appropriate time to each sub-discipline within pathophysiology	28	57.14
	Contextualizing pathophysiology within the broader medical curriculum	24	48.97

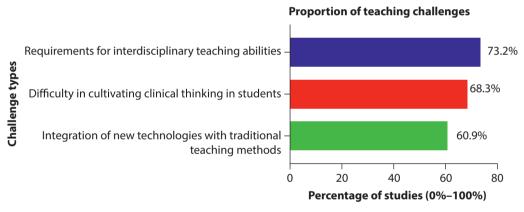


Fig. 4. Proportion of teaching challenges.

Table 2. Breakdown of teaching challenges faced by young teachers in pathophysiology departments

Teaching challenges	Specific aspects	Number of studies	of Percentage
Integration of new technologies with traditional	Difficulties in effectively using online teaching platforms	22	44.89
teaching methods (61.4% of studies)	Challenges in incorporating simulation technologies	17	34.69
	Issues with balancing technology use and traditional face-to-face instruction	15	30.61
Requirements for interdisciplinary teaching abilities (73.7% of studies)	Need for broad knowledge base spanning basic sciences and clinical medicine	30	61.22
	Challenges in collaborating with teachers from other disciplines	24	48.97
	Difficulties in designing interdisciplinary courses	19	38.77
Difficulty in cultivating clinical thinking in	Challenges in bridging theoretical knowledge with clinical scenarios	26	53.06
students (66.7% of studies)	Issues with designing effective case-based learning activities	21	42.85
	Lack of clinical experience among young teachers as a barrier	17	34.69



Table 3. Breakdown of career development challenges faced by young teachers in pathophysiology departments

Career development challenges	Specific aspects	Number of studies	Percentage
Competition in promotion channels	Limited number of senior positions available	30	61.22
(71.9% of studies)	High standards for promotion in academic medicine	26	53.06
	Potential for burnout due to intense competition	21	42.85
Work-life balance pressure (68.4% of studies)	Difficulties in managing personal and professional responsibilities	27	55.11
	Impact of work stress on personal relationships and health	24	48.97
	Lack of institutional support for maintaining work-life balance	19 38.77	38.77
Time constraints for continuing education and	Difficulties in finding time for additional training or education	32	65.31
self-improvement (75.4% of studies)	Rapid pace of medical advancements requiring constant learning	21	42.85
	Lack of structured time for self-improvement activities	24	48.98

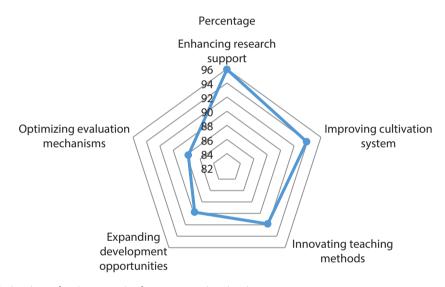


Fig. 5. Radar chart of major strategies for young teacher development.

demanding academic responsibilities. This information offers valuable insights for academic institutions and policymakers in devising targeted strategies to support the career growth of young faculty in medical education.

Relative importance of major strategies for young teacher development

A radar chart (Fig. 5; Dataset 1) was created to present the relative importance of five major strategies aimed at supporting young teachers in pathophysiology departments of Chinese medical schools. Each strategy is represented by a spoke on the radar chart, with its importance indicated by the distance from the center. The chart demonstrates that all five strategies are deemed highly important, with their importance percentages ranging from 87.8% to 95.9%. The strategy of enhancing research support is highlighted as the most frequently mentioned, closely followed by improvements in the cultivation system. Strategies for innovating teaching methods and expanding development opportunities are also shown to be highly valued. Although optimizing evaluation mechanisms registers the lowest percentage, it is still significantly emphasized in a majority of the studies.



The nearly pentagonal shape of the radar plot indicates that all these strategies are considered crucial in supporting young teachers. The symmetry of the shape suggests that a balanced approach is necessary to address the challenges faced by young faculty.

Discussion-

Key results

The key finding of this study is that young pathophysiology teachers at Chinese medical colleges encounter a range of challenges in their professional development. The most common challenges identified were research pressure (91.2%) and disciplinary characteristics (87.7%), followed by teaching innovation requirements (83.6%) and career development issues (79.6%). In response, institutions have implemented comprehensive support strategies, with a particular emphasis on strengthening research support (95.9%), improving the cultivation system (93.8%) and innovating teaching methods (91.8%). These findings indicate an emerging trend towards personalized development approaches, emphasizing technology integration, interdisciplinary collaboration, and international academic exchange.

Interpretation/comparison with previous studies

Teaching innovation challenges

Our finding that 84.2% of studies mentioned teaching challenges aligns with previous research. [14-18]. Among these challenges, integrating new technologies with traditional teaching methods [19] emerged as a significant concern, mentioned in 61.4% of studies, which confirms the findings of Wei et al. [20] regarding the digital transformation in pathophysiology education. Our study notably reveals a substantially higher emphasis on interdisciplinary teaching abilities [21], with 73.7% of studies highlighting this challenge [22], surpassing the concerns noted in earlier research by Huang et al. [23]. The implementation of case-based teaching methods, particularly in large classroom settings, was identified as problematic in 68.9% of studies [24], while 57.8% of studies reported difficulties in developing effective multimedia teaching resources to illustrate complex pathophysiological mechanisms [25]. These findings collectively suggest an evolving landscape of teaching challenges that require comprehensive pedagogical training addressing both technological and methodological aspects.

Research pressure and academic development

The prevalence of research challenges, identified in 91.2% of studies, corroborates and extends findings from previous research [26-29]. Balancing research and teaching responsibilities emerged as the most pressing issue, mentioned in 86.0% of studies, supporting the conclusions of Wang et al. [30] about workload management. Our study uniquely emphasizes the challenges of funding acquisition, reported in 77.2% of studies, an aspect less emphasized in earlier research [31]. Publication requirements were cited as a significant pressure in 82.5% of studies, while proficiency in research methodology (71.9%) and opportunities for international collaboration (63.2%) were also frequently cited concerns. Laboratory management skills, although mentioned less frequently (58.4%), represent another crucial aspect of research development for young teachers [32]. These findings indicate a complex web of researchrelated challenges that extend beyond simple productivity metrics.



Career development and professional growth

Our findings on career development challenges, which were present in 80.7% of the studies, significantly expanded upon the previous work by Gong et al. [33]. Work-life balance [34] emerged as a significant concern in 68.4% of the studies, particularly affecting young female teachers who manage family responsibilities alongside their academic careers [35]. Time constraints for continuing education [36], mentioned in 75.4% of the studies, highlighted the persistent challenge of maintaining professional development while fulfilling daily obligations [37]. Challenges such as professional identity development (63.2%) and navigation of promotion criteria (70.1%) were frequently cited, while the accessibility of mentorship (65.8%) and the building of professional networks (59.6%) emerged as crucial factors affecting career progression. Notably, 72.3% of the studies emphasized the need for clearer career advancement pathways specific to pathophysiology education, suggesting a systemic need for more structured career development frameworks.

Impact of disciplinary characteristics

The prevalence of disciplinary characteristic-related challenges [38], reported in 87.7% of studies, represents a novel finding warranting particular attention [39]. The interdisciplinary nature of pathophysiology [40], requiring expertise across multiple fields including anatomy, physiology, biochemistry, and clinical medicine [41], was highlighted in 82.5% of studies. The challenge of keeping pace with rapid advances in medical science and incorporating new findings into teaching materials was emphasized in 76.8% of studies [42]. The integration of basic science with clinical knowledge [43] emerged as a significant concern (79.3%), while laboratory demonstration complexity (71.2%) and abstract concept visualization (68.9%) were also frequently cited challenges [42]. Clinical case integration was mentioned in 65.4% of studies, further underscoring the unique challenges of pathophysiology education [44]. These findings substantially extend previous research by providing a comprehensive understanding of the discipline-specific challenges facing young teachers.

Support strategies and institutional response

Our analysis of support strategies reveals a more comprehensive approach than previously documented. The emphasis on enhancing research support, mentioned in 96.5% of studies, aligns with the recommendations of Li et al. [45]. However, our findings highlight several specific implementation mechanisms. In terms of teaching support, which is noted in 93.0% of studies, institutions have prioritized pedagogical training programs (87.2%) and technology integration workshops (82.5%). Additionally, they have established peer teaching observation systems (76.4%) and teaching resource sharing platforms (71.9%) [46]. For research development, institutions have concentrated on providing research methodology training (89.5%) and grant writing workshops (84.2%). These efforts are complemented by the establishment of collaborative research networks (77.8%) and the facilitation of laboratory resource sharing (73.6%) [47]. These comprehensive support strategies, though less prominent in earlier research [48], demonstrate institutions' commitment to developing young teachers through systematic and integrated approaches [49]. Furthermore, 89.5% of studies emphasized the importance of integrating these various support mechanisms into a coherent development framework, suggesting a trend toward more holistic approaches to faculty development.

Limitations

Our study has several notable limitations. Relying solely on published literature may overlook



ongoing initiatives or informal practices. Additionally, focusing on Chinese institutions could potentially limit the broader applicability of our findings. The institutional perspective of our analysis might not fully capture the experiences of individual teachers, and our chosen timeframe (2013–2024) might exclude certain historical development patterns that could provide valuable context.

Implications

Based on our comprehensive analysis, addressing the challenges faced by young pathophysiology teachers in Chinese medical schools requires a multi-faceted approach. First, institutions should prioritize research support through dedicated start-up funds, mentorship programs, and interdisciplinary collaboration opportunities. Second, the development of teaching should focus on innovative pedagogical approaches and the integration of technology, supported by comprehensive training programs. Third, support for career development should combine structured mentoring with flexible professional growth opportunities.

The success of young teachers can be significantly improved by implementing several key initiatives: establishing systematic training programs that balance teaching innovation with research development; creating platforms for interdisciplinary collaboration and knowledge exchange; implementing flexible work arrangements to support work-life balance; and developing fair evaluation mechanisms that recognize diverse contributions to academic development. Most importantly, institutions should adopt a personalized approach to professional development, acknowledging the varying needs and career aspirations of young teachers.

These recommendations emphasize the importance of creating a supportive academic environment that promotes both professional development and personal well-being. Implementing these strategies demands a commitment from institutional leadership and coordination among various stakeholders in medical education.

Suggestion for further studies

Future research should focus on evaluating the long-term effectiveness of these strategies, exploring the impact of cultural and institutional factors on the development of young teachers, and investigating how the rapid advancement of medical knowledge and technology continues to shape the landscape of pathophysiology education both in China and globally.

Conclusion

This review highlights the critical requirements for nurturing young pathophysiology instructors at Chinese medical institutions. Effective development strategies must emphasize a balance between research and teaching responsibilities, encourage pedagogical innovation, and define clear career trajectories. Medical institutions ought to establish comprehensive support systems that merge mentorship programs with professional development opportunities. Implementing these strategies will solidify the base of pathophysiology education within China's medical education framework.

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Conflict of interest

No potential conflict of interest relevant to this article was reported.

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Data availability

Data files are available from Harvard Dataverse: https://doi.org/10.7910/DVN/WF05P6

Dataset 1. Data file used to create the 4 figures in Excel format

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Supplementary materials

Supplementary materials are available from: https://doi.org/10.12771/emj.2024.e76.

Supplement 1. List of 49 studies organized according to the main themes identified in our analysis



References

- Marya RK. Pathophysiology: missing link in basic-clinical meshing in medical curriculum in India. South-East Asian J Med Educ 2018;12(1):56-58.
 - https://doi.org/10.4038/seajme.v12i1.43
- 2. Sentí M, Miralles R, Bigorra J, Girvent M, Minguella J, Samsó E, et al. A collaborative project to bridging the gap between basic and clinical teachers: the opinion of medical students. *J Biomed Educ* 2015;2015(1):620348.
 - https://doi.org/10.1155/2015/620348
- 3. Lubarsky S, Dory V, Audétat MC, Custers E, Charlin B. Using script theory to cultivate illness script formation and clinical reasoning in health professions education. *Can Med Educ J* 2015;6(2):e61-e70.
 - https://doi.org/10.36834/cmej.36631
- Gaggini M, Pingitore A, Vassalle C. Plasma ceramides pathophysiology, measurements, challenges, and opportunities. *Metabolites* 2021;11(11):719. https://doi.org/10.3390/metabo11110719
- Acosta A, Dayyeh BKA, Port JD, Camilleri M. Recent advances in clinical practice challenges and opportunities in the management of obesity. *Gut* 2014;63(4):687-695. https://doi.org/10.1136/gutjnl-2013-306235
- Yang Y, Liu X, Gardella Jr. JA. Effects of professional development on teacher pedagogical content knowledge, inquiry teaching practices, and student understanding of interdisciplinary science. *J Sci Teach Educ* 2018;29(4):263-282. https://doi.org/10.1080/1046560x.2018.1439262
- 7. Meng R, Yang R. Teaching reform of pathophysiology experiment based on clinical practice. In: Zhou H, Kang Q, Chen Y, editors. Proceedings of the 1st International Conference on Business, Economics, Management Science (BEMS 2019); 2019 Apr 20-21; Hangzhou. Amsterdam (NL): Atlantis Press; 2019. p.635-638.
- 8. Wu J. Research on the path of integrating curriculum civics into the teaching of pathology and pathophysiology in higher vocational education. *The Educ Rev USA* 2024;8(1):57-61. https://doi.org/10.26855/er.2024.01.008
- Yang W, Zhang X, Chen X, Lu J, Tian F. Based case based learning and flipped classroom as a means to improve international students' active learning and critical thinking ability. BMC Med Educ 2024;24(1):759.
 - https://doi.org/10.1186/s12909-024-05758-8
- An J. Physiological pharmacology education: the effects of acombined problem-based learning and flipped classroom teaching method. Res Square 2024;62(1):1-17. https://doi.org/10.21203/rs.3.rs-3908442/v1
- 11. Kleuskens DG, Gonçalves Costa F, Annink KV, Van den Hoogen A, Alderliesten T, Groenendaal F, et al. Pathophysiology of cerebral hyperperfusion in term neonates with hypoxic-ischemic encephalopathy: a systematic review for future research. *Front Pediatr* 2021;9:631258.
 - https://doi.org/10.3389/fped.2021.631258
- 12. Lu G, Du R. Temporomandibular joint disorder: an integrated study of the pathophysiology, neural mechanisms, and therapeutic strategies. *Arch Oral Biol* 2024;164:106001. https://doi.org/10.1016/j.archoralbio.2024.106001
- 13. Zhang X, Cui X, Cheng M. Strategies and effectiveness of cultivating young teachers'



- teaching abilities in physiology. In: Zhao H, editor. Proceedings of the 2018 2nd International Conference on Economic Development and Education Management (ICEDEM 2018); 2018 Dec 29-30; Dalian. Amsterdam (NL): Atlantis Press; 2018. p.409-411.
- Fernández Ros N, Lucena F, Iñarrairaegui M, Landecho M, Sunsundegui P, Jordán-Iborra C, et al. Web-based formative assessment through clinical cases: role in pathophysiology teaching. *BMC Med Educ* 2021;21(1):249. https://doi.org/10.1186/s12909-021-02691-y
- 15. Colsch R, Lehman S, Tolcser K. State of pathophysiology in undergraduate nursing education: a systematic review. *J Nurs Educ Pract* 2020;11(3):11-16. https://doi.org/10.5430/jnep.v11n3p11
- Li YY, Li K, Yao H, Xu XJ, Cai QL. Reform in teaching preclinical pathophysiology. *Adv Physiol Educ* 2015;39(4):254-258.
 https://doi.org/10.1152/advan.00165.2014
- 17. Gopalan V, Kasem K, Pillai S, Olveda D, Ariana A, Leung M, et al. Evaluation of multidisciplinary strategies and traditional approaches in teaching pathology in medical students. *Pathol Int* 2018;68(8):459-466.
 - https://doi.org/10.1111/pin.12706
- 18. Li J, Wang J, Liang LL, Li YX, Feng XP, Luo Y, et al. Theory-practice integration for Chinese postgraduates in pathophysiology: innovative teaching strategies. *South-East Asian J Med Educ* 2024;18(1):98-103.
 - https://doi.org/10.4038/seajme.v18i1.592
- 19. Qi F, Gan Y, Wang S, Tie Y, Chen J, Li C. Efficacy of a virtual reality–based basic and clinical fused curriculum for clinical education on the lumbar intervertebral disc. *Neurosurg Focus* 2021;51(2):E17.
 - https://doi.org/10.3171/2021.5.focus20756
- 20. Wei X, Xu T, Guo R, Tan Z, Xin W. Physiology education in China: the current situation and changes over the past 3 decades. *BMC Med Educ* 2024;24(1):408. https://doi.org/10.1186/s12909-024-05395-1
- 21. Guo J, Li L, Bu H, Feng M, Yang Y, Zhang Y, et al. Effect of hybrid teaching incorporating problem-based learning on student performance in pathophysiology. *J Int Med Res* 2020;48(8):1-6.
 - https://doi.org/10.1177/0300060520949402
- 22. Yao L, Li K, He J, Liu L. Pathophysiology teaching reform during the COVID-19 pandemic. *Adv Physiol Educ* 2021;45(4):779-785.
 - https://doi.org/10.1152/advan.00031.2021
- 23. Huang TH, Liu F, Chen LC, Tsai CC. The acceptance and impact of Google Classroom integrating into a clinical pathology course for nursing students: a technology acceptance model approach. *PLoS one* 2021;16(3):e0247819.
 - https://doi.org/10.1371/journal.pone.0247819
- 24. Chen J, Loyeung B, Zaslawski C, Liang F, Li W. Comparison of traditional Chinese medicine education between mainland China and Australia: a case study. *J Integr Med* 2016;14(4):291-296.
 - https://doi.org/10.1016/s2095-4964(16)60259-5
- 25. Lin H, Zeng X, Zhu J, Hu Z, Ying Y, Huang Y, et al. Application of the inverted classroom model for teaching pathophysiology to Chinese undergraduate medical students: usability study. *JMIR Med Educ* 2021;7(2):e24358.



- https://doi.org/10.2196/24358
- 26. Lu P, Sodhi CP, Jia H, Shaffiey S, Good M, Branca MF, et al. Animal models of gastrointestinal and liver diseases. Animal models of necrotizing enterocolitis: pathophysiology, translational relevance, and challenges. *Am J Physiol Gastrointest Liver Physiol* 2014;306(11):G917-G928. https://doi.org/10.1152/ajpgi.00422.2013
- 27. Liu A, Liu N, Wang A. Why can't rural schools retain young teachers? An analysis of the professional development of rural school teachers in China: taking teachers in rural western China. Soc Sci Humanit Open 2022;5(1):100238.
 - https://doi.org/10.1016/j.ssaho.2021.100238
- 28. Gong Y, MacPhail A, Young AM. Chinese higher education-based physical education teacher educators' professional learning needs for involvement in research activities. *Prof Dev Educ* 2024;50(4):638-654.
 - https://doi.org/10.1080/19415257.2021.1895286
- 29. Gong Y, MacPhail A, Guberman A. Professional learning and development needs of Chinese university-based physical education teacher educators. *Eur J Teach Educ* 2023;46(1):154-170.
 - https://doi.org/10.1080/02619768.2021.1892638
- 30. Wang D, Zhou J, Wu Q, Sheng G, Li X, Lu H, et al. Enhancement of medical students' performance and motivation in pathophysiology courses: shifting from traditional instruction to blended learning. *Front Public Health* 2022;9(1):813577.
 - https://doi.org/10.3389/fpubh.2021.813577
- 31. Luo Z, Wang Z, Song Z, Wang W. Based on the concept of translational medicine in the exploration and practice of teaching reform of pathophysiology. *New Century Science Press* 2015;3(3):15-19.
 - https://doi.org/10.14725/gjicmwm.v3n3a1349
- 32. Shen J, Qi H, Liu G, Li X, Fang Y. The impact of a curriculum-based research training program on medical students' research productivity and future research interests: a longitudinal study. BMC Med Educ 2024;24(1):836.
 - https://doi.org/10.1186/s12909-024-05841-0
- 33. Gong Y, Young AM, MacPhail A. The complexity of professional identity: Chinese university teachers teaching in physical education teacher education (PETE) programmes. *Eur J Teach Educ* 2023;46(4):707-726.
 - https://doi.org/10.1080/02619768.2021.1972967
- 34. Huang Y, Xiang Y, Zhou W, Li G, Zhao C, Zhang D, et al. Long working hours and all-cause mortality in China: a 26-year follow-up study. *Scand J Work Environ Health* 2023;49(8):539-548.
 - https://doi.org/10.5271/sjweh.4115
- 35. Li S, Yancey KB, Cruz PD Jr, Le LQ. Training physician—scientists for careers in investigative dermatology. *JID Innov* 2022;2(1):100061.
 - https://doi.org/10.1016/j.xjidi.2021.100061
- 36. Li Y, Wang S, Li J, Dong BR, Li ZX, Yu JM, et al. A survey of physicians who care for older persons in Southwest China. *J Nutr Health Aging* 2013;17(2):192-195. https://doi.org/10.1007/s12603-012-0086-0
- 37. Gao Z, Zorychta E, Karamchandani J, Michel RP, Brimo F, Telleria C, et al. Revitalising an academic pathology department: lessons learnt. *J Clin Pathol* 2019;72(3):213-220. https://doi.org/10.1136/jclinpath-2018-205516



- 38. Hu X, Liu F, Yuan Y. Research on talent training mode of interdisciplinary integration in colleges and universities. *Int J Educ Humanit* 2021;1(1):28-35. https://doi.org/10.54097/ijeh.v1i1.198
- 39. Wu Z, Fu J. The effects of professional identity on retention intention of international Chinese language teachers in Guizhou colleges and universities: the chain mediating role of job satisfaction and career commitmen. *Salud Cienc Tecnol* 2024;3:989. https://doi.org/10.56294/saludcyt2024989
- 40. Cong X, Zhang Y, Xu H, Liu LM, Zheng M, Xiang RL, et al. The effectiveness of formative assessment in pathophysiology education from students' perspective: a questionnaire study. *Adv Physiol Educ* 2020;44(4):726-733. https://doi.org/10.1152/advan.00067.2020
- 41. Jiang H, Wang K, Wang X, Lei X, Huang Z. Understanding a STEM teacher's emotions and professional identities: a three-year longitudinal case study. *Int J STEM Educ* 2021;8(1):51. https://doi.org/10.1186/s40594-021-00309-9
- 42. Mo S, Huang S, Wang J, Huang J, Li H, Wu R, et al. Reform and practice of medical fundamental curriculum system based on "three-early education": a case study on Youjiang Medical University for nationalities located in the Minority Areas of Southwest China. *Creative Educ* 2020;11(2):115-125. https://doi.org/10.4236/ce.2020.112009
- 43. Zhang D, Li K, Liu Y, Xia Y, Jiang Q, Chen F, et al. Comparison between the blended teaching practice and traditional teaching of pathophysiology based on the cultivation of medical thinking ability. *Creat Educ* 2022;13(10):3182-3190. https://doi.org/10.4236/ce.2022.1310202
- 44. Zhao ML, Lu ZJ, Yang L, Ding S, Gao F, Liu YZ, et al. The cardiovascular system at high altitude: a bibliometric and visualization analysis. *World J Cardiol* 2024;16(4):199-214. https://doi.org/10.4330/wjc.v16.i4.199
- 45. Li J, Shi Z, Xue E. The problems, needs and strategies of rural teacher development at deep poverty areas in China: rural schooling stakeholder perspectives. *Int J Educ Res* 2020;99:101496.
 - https://doi.org/10.1016/j.ijer.2019.101496
- 46. Liu Z, Shi D, Cai Y, Li A, Lan G, Sun P, et al. Pathophysiology characterization of Alzheimer's disease in South China's aging population: for the Greater-Bay-Area Healthy Aging Brain Study (GHABS). *Alzheimers Res Ther* 2024;16(1):84. https://doi.org/10.1186/s13195-024-01458-z
- 47. Feng H, Wang Y. Physiology education and teaching in Chinese mainland medical schools: the status quo and the changes over the past two decades. *Adv Physiol Educ* 2023;47(4):699-708.
 - https://doi.org/10.1152/advan.00020.2023
- 48. Qian H, Walker A. How principals promote and understand teacher development under curriculum reform in China. *Asia-Pac J Teach Educ* 2013;41(3):304-315. https://doi.org/10.1080/1359866x.2013.809050
- 49. Yin H, Huang S, Wang W. Work environment characteristics and teacher well-being: the mediation of emotion regulation strategies. *Int J Environ Res Public Health* 2016;13(9):907. https://doi.org/10.3390/ijerph13090907

Original Article



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No difference in inflammatory mediator expression between mast cell-rich and mast cell-poor rosacea lesions in Korean patients: a comparative study

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Cathelicidins: Interleukin-6: Mast cells: Tumor necrosis factor-alpha: Rosacea

Objectives: This study aimed to evaluate the correlation between mast cell (MC) density in rosacea-affected skin and the expression of key inflammatory mediators, including IL-6, TNF-α, and cathelicidin LL-37. By comparing lesions rich in MCs with those having fewer MCs, we sought to elucidate the role of MCs in the inflammatory mechanisms underlying rosacea pathogenesis.

Methods: Specimens were collected from 20 patients diagnosed with rosacea who attended the outpatient clinic between 2008 and 2013. Each specimen underwent staining using hematoxylin/ eosin, Giemsa, IL-6, LL-37, and TNF-α for both histopathological and immunohistochemical analyses. The number of stained cells was counted across 10 randomly selected dermal layers at a magnification of ×400 using light microscopy. The results were categorized based on the number of MCs counted: more than 10 MCs were classified as MC-rich, and 10 or fewer MCs as MC-poor.

Results: Among the 20 patients (10 MC-rich and 10 MC-poor), the MC-rich group demonstrated significantly higher MC counts than the MC-poor group (P<0.001). However, there were no significant differences in the expression levels of IL-6, LL-37, or TNF-a between the two groups. Additionally, MC density did not show any significant associations with patient demographics, clinical characteristics, or systemic comorbidities.

Conclusion: Increased MC density was not associated with differences in IL-6, TNF-α, or LL-37 expression in rosacea lesions. These findings suggest that MC infiltration may not directly influence the inflammatory mediator profile in rosacea. Further research is required to identify distinctive pathological features or markers that can elucidate the mechanisms of rosacea.

Introduction

Background

Rosacea is a chronic inflammatory disorder primarily affecting the central facial region, characterized by periods of exacerbation and remission. It manifests as four clinically recognized subtypes: erythematotelangiectatic, papulopustular, phymatous, and ocular rosacea, each with distinct clinical features [1]. Although the precise etiology of rosacea remains unclear, its

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pathogenesis is thought to involve an interplay of environmental triggers, vascular dysfunction, alterations in dermal matrix composition, and genetic predisposition.

Emerging studies have focused on the role of inflammatory responses in chronic skin conditions, with mast cells (MCs) receiving particular attention due to their involvement in various inflammatory skin diseases. MCs are known for their contribution to localized vasodilation and angiogenesis and are considered a key player in inflammatory cascades [2]. In rosacea, MCs are postulated to interact with stimuli such as cathelicidin peptides and neuropeptides (NPs), potentially contributing to hallmark symptoms such as erythema and flushing [2,3]. MCs release a range of inflammatory mediators, including TNF, IL-6, and other pro-inflammatory cytokines, which may exacerbate the inflammatory state in rosacea [3]. Although previous studies have identified increased MC counts in rosacea-affected skin, the exact contribution of MCs to the condition's pathogenesis, particularly their influence on inflammatory mediator expression, warrants further exploration [4].

Objectives

This study aimed to assess the relationship between MC presence and the expression of specific inflammatory mediators in rosacea-affected skin. By analyzing these interactions, we sought to clarify further the potential role of MCs in the inflammatory processes underlying rosacea.

Methods

Ethics statement

This study received approval from the Institutional Review Board (IRB) of Ewha Womans University Mokdong Hospital (IRB No. EUMC 2024-11-001). A waiver of informed consent was granted, owing to the utilization of pre-existing databases and skin biopsy results.

Study design

This was a comparative study using biopsy samples from rosacea patients.

Setting

Rosacea patients who visited the outpatient clinic of the Department of Dermatology, Ewha Womans University Mokdong Hospital, and Ewha Womans University Seoul Hospital between 2008 and 2014 were included in this study. A 4-mm punch biopsy was taken from a facial lesion of these patients. The skin biopsy samples were used for MC quantification and immunohistochemical analysis of inflammatory mediators. Clinical data such as age, gender, duration of disease (in months), specific sites of facial involvement, clinical manifestations, and comorbidities were extracted from electronic medical records. Systemic comorbidities were confirmed through medical records and documentation of current medications.

Participants

This study included twenty patients, each diagnosed with rosacea by dermatologists. However, the analysis did not categorize or differentiate between specific rosacea subtypes, and no patients were excluded.

Variables

The outcome variables included MC counts, clinical data, and the expression of inflammatory



mediators such as IL-6, TNF- α , and LL-37.

Data sources/measurement

Mast cell quantification

Tissue specimens were fixed in 10% buffered formalin, embedded in paraffin, and sectioned at a thickness of 4 µm. The sections were stained with hematoxylin and eosin for routine histological examination and with Giemsa stain for MC visualization. Two independent observers, who were blinded to the clinical data, counted the MCs using an Olympus light microscope at 400× magnification. In each specimen, MCs were counted in 10 HPFs that were randomly selected and distributed across different dermal layers: four fields in the papillary dermis, three in the mid-reticular dermis, and three in the bottom reticular dermis. Only cells displaying both a distinct nucleus and metachromatic granules were included in the count. The final MC count was determined by averaging the counts from both observers.

The compartments were divided into 22 sections to ensure a systematic and reproducible method for MC counting. This approach facilitated a comprehensive assessment of MC distribution throughout the tissue, minimizing bias due to regional variations in cell density. By dividing the area into smaller sections, the counting process was standardized, leading to more accurate and consistent results across various samples.

Specimens were categorized based on MC density, using well-defined criteria for different density groups. A threshold of 10 MCs per HPF was established from the MC counts, indicating that 10 MCs per HPF is an appropriate cutoff to differentiate areas of high MC density from those with low density. This threshold allowed us to classify the samples into MC-rich and MCpoor groups, reflecting a significant variation in MC abundance. Images were captured with a Jenoptik ProgRes GRYPHAX Subra Microscope HD Camera.

Immunohistochemical analysis for inflammatory mediators

Immunohistochemical staining was conducted following standard protocols. The process began with deparaffinization of the sections, followed by antigen retrieval using citrate buffer at a pH of 6.0. This was succeeded by blocking endogenous peroxidase activity with 3% hydrogen peroxide. Primary antibodies targeting IL-6, TNF-α, and LL-37, all at a dilution of 1:100, were then applied. The intensity of the staining was assessed by two observers who were blinded to the sample identities. They used a semi-quantitative scoring system with the following scale: 0 (negative), 1 (weak), 2 (moderate), and 3 (strong). To ensure consistency, the scoring methodology was standardized across both observers, and an average score was calculated for each section. Both positive and negative controls were included to confirm the specificity of the staining.

Bias

There was no selection bias among the target subjects, as all cases were included that had histological confirmation.

Study size

No sample size estimation was done since all target subjects were included.

Statistical methods

Data analysis was conducted using IBM SPSS Statistics v.22.0 (IBM, Armonk, NY, USA).



Continuous variables, such as MC counts, are presented as mean±SD, while categorical variables, including immune mediators, are reported as frequencies and percentages. Comparisons between groups were performed using the independent samples t-test. Correlations between MC counts and immunohistochemical markers were evaluated using Spearman's correlation coefficient. Statistical significance was established at P<0.05.

Results

Participants

This study encompassed 20 rosacea patients aged between 23 and 75 years, with an average age of 53.1±13.2 years. The cohort was evenly divided between sexes, comprising 10 men and 10 women. The duration of disease among participants varied widely, ranging from 1 month to 15 years, with a median duration of 32.6 months. The most frequently affected areas were the forehead (45%), nose (35%), and cheeks (20%). Additional details on patient characteristics are provided in Table 1.

Clinicopathological and immunohistochemical results

Based on MC counts, patients were divided into two groups: the MC-rich group, which included individuals with 10 or more MCs per HPF (n=10), and the MC-poor group, which included individuals with fewer than 10 MCs per HPF (n=10). Representative high-magnification images of MC distribution for each group are displayed in Figs. 1, 2, There was a significant difference in the mean MC count between the groups, with the MC-poor group averaging 3.15± 0.87 MCs per HPF and the MC-rich group averaging 10.8±2.58 MCs per HPF (P<0.001; Table 1).

In terms of clinical characteristics, there were no significant demographic differences between the MC-poor and MC-rich groups. Both groups had similar ages (52.8±14.18 years vs. 53.3±12.89 years, P=0.935) and an equal distribution of genders. Additionally, there were no significant differences in the severity of clinical features, including affected sites and the incidence of pruritus, although pruritus was more commonly reported in the MC-poor group, though not to a statistically significant extent. Regarding systemic comorbidities, prevalent conditions included diabetes mellitus, hypertension, dyslipidemia, liver disease, gastritis, and peptic ulcer. While these comorbidities appeared more frequently in the MC-rich group, the difference was not statistically significant. Furthermore, no meaningful correlation was found between MC counts and systemic comorbidities (Table 1).

Distribution patterns of inflammatory mediators within various skin compartments

Immunohistochemical analysis was performed to evaluate the expression of inflammatory markers in the epidermal and dermal layers, as well as in the skin appendages. The semiquantitative analysis revealed no statistically significant differences in marker expression between the two groups. Specifically, IL-6 levels were 1.32±0.71 in the MC-rich group and 1.56 ±0.91 in the MC-poor group (P=0.519); LL-37 levels were 0.8±0.55 in the MC-rich group and 1.0 ±0.59 in the MC-poor group (P=0.443); TNF-α levels were 0.84±0.65 in the MC-rich group and 1.04±0.32 in the MC-poor group (P=0.400). Table 2 provides additional details on the distribution patterns of these markers across different skin compartments.



Table 1. Clinicopathological and immunohistochemical results of two groups

	Mast cell (MC)-rich group	MC-poor group	P-value
Demographics			
Sex (female)	6 (60)	4 (40)	0.328
Age ¹⁾	52.8±14.18	53.3±12.89	0.935
Past history	7 (63.64)	4 (36.36)	0.370
Diabetes mellitus	3 (75)	1 (25)	0.582
Hypertension	4 (57.14)	3 (42.86)	1.000
Dyslipidemia	1 (50)	1 (50)	1.000
Liver disease	1 (50)	1 (50)	1.000
Gastritis, peptic ulcer	2 (66.67)	1 (33.33)	1.000
Site			
Forehead, glabella	7 (46.67)	8 (53.33)	1.000
Periorbital	1 (33.33)	2 (66.67)	1.000
Cheeks	6 (46.15)	7 (53.85)	1.000
Nose, perinasal	6 (42.86)	8 (57.14)	0.628
Chin	4 (33.33)	8 (66.67)	0.170
Perioral, lip	3 (100)	0 (0)	0.211
Signs and symptoms			
Erythematous papules	5 (38.46)	8 (61.54)	0.350
Erythematous patches	6 (46.15)	7 (53.85)	1.000
Telangiectasia	3 (75)	1 (25)	0.582
Itching	2 (25)	6 (75)	0.170
Immunohistochemical parameters ¹⁾			
Mast cells	10.8±2.58*	3.15±0.87*	<0.001*
IL-6	1.32±0.71	1.56±0.91	0.519
LL37	0.8±0.55	1±0.59	0.443
TNF-α	0.84±0.65	1.04±0.32	0.400

LL-37, cathelicidin LL-37; MC-rich group: the number of counted MCs was 10 or more; MC-poor group: the number of counted MCs was fewer than 10.

Discussion

Key results

This study aimed to elucidate the role of MCs in the pathophysiology of rosacea and to investigate the relationship between MC density and mediator release in affected skin. We observed distinct differences in MC counts among patients, allowing us to categorize them into MC-poor and MC-rich groups. Although there were increased MC counts, these did not correlate with significant differences in clinical characteristics or biological markers, such as IL-6, LL-37, and TNF-α. These findings underscore the complexity of the cytokine network in rosacea and suggest that MC infiltration alone may not be sufficient to fully drive clinical manifestations.

Data are presented as mean±SD, while other data are expressed as number (%).

^{*} Indicates statistically significant differences (P<0.05).



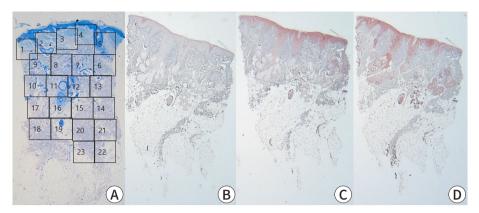


Fig. 1. Histopathological and immunohistochemical analysis in mast cell-rich group. (A) Histopathology of the lesional skin in MC-rich group patient. Numbers show the counting methods in MC numbers (Giemsa, ×40). (B-D) Immunohistochemical analysis (×40). (B) IL-6 staining, (C) LL-37 staining, (D) TNF-α staining.

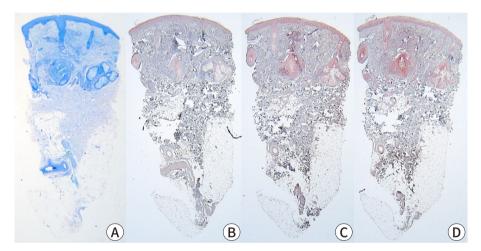


Fig. 2. Histopathological and immunohistochemical analysis in mast cell-poor group. (A) Histopathology of the lesional skin in the MC-poor group patient (Giemsa, ×40). (B-D) Immunohistochemical analysis (×40). (B) IL-6 staining, (C) LL-37 staining, (D) TNF- α staining.

Interpretation/comparison with previous studies

The pathogenesis of rosacea is not fully understood; however, MCs are known to enhance various inflammatory processes and are linked to angiogenesis, which is relevant to the pathophysiology of rosacea [1]. Cathelicidin, highly expressed in rosacea, releases its cleavage product LL-37. This, in conjunction with heightened serine protease activity, triggers inflammatory cascades, including the activation of MCs [5,6]. Additionally, dysregulated immune responses and neurovascular dysfunctions are implicated as contributing factors in rosacea [7].

MCs can be activated through various pathways. Beyond the IgE-mediated degranulation pathway [2], activation can also occur via pathogen- and pattern-recognition receptors, including Toll-like receptors. TNF-α is known to trigger the activation of the NLRP3 inflammasome pathway and also activates NF-κB in MCs [8]. Additionally, other receptors such as MRGPRX2, complement receptors, and NP and neurotransmitter receptors can influence MC activation in response to LL-37 and NPs [9,10]. The diversity of these pathways highlights the complexity of MC activation mechanisms, which may explain why MC density alone did not



Table 2. Comparison between mast cell-rich group (mast cell-rich group) and mast cell-poor group (mast cell-poor group) in the number of mast cells, IL-6, LL-37, TNF-α (number/HPF [×400])

	Slide number	Mast cells	IL-6	LL37	TNF-α
Mast cell-rich group	1	12.93	1	0.4	0.2
	2	8.45	0.8	0.8	0.6
	3	12.53	1	0.4	0.6
	4	16.2	1.8	0.2	0.2
	5	10.4	0.4	0.4	0.8
	6	11.55	0.8	0.6	0.4
	7	8	0.8	0.6	0.4
	8	9.13	2.2	1.2	2
	9	10.5	2.4	1.6	1.6
	10	8.3	2	1.8	1.6
Mast cell-poor group	1	3.1	1.2	0.4	0.6
	2	1.1	0.4	0.6	1.4
	3	4.35	0.6	1.2	1
	4	2.9	2.4	0.8	1
	5	4.05	1.2	2.4	1.6
	6	2.95	0.6	0.8	0.8
	7	3.45	1.4	1.4	0.8
	8	3.15	2.8	0.4	0.8
	9	3	2.6	1	1
	10	3.45	2.4	1	1.4

LL-37, cathelicidin LL-37.

correlate with specific clinical or inflammatory features in our cohort [11,12].

Furthermore, rosacea is associated with a variety of comorbidities, including allergies, respiratory and gastrointestinal disorders, metabolic and cardiovascular diseases, and certain malignancies [4,13]. It has been suggested that shared genetic and environmental factors, along with immune regulatory processes, may underlie these associations [13]. In our study, patients exhibited systemic comorbidities such as diabetes mellitus, hypertension, and dyslipidemia. However, no significant association was found between MC counts and the prevalence of systemic comorbidities, likely due to the small sample size.

Limitations

The limitations of this study include a small sample size and variability in disease duration and previous treatments among patients, which could influence MC density, cytokine expression, and clinical characteristics. Additionally, the absence of standardized laboratory data on systemic comorbidities limits our ability to interpret potential correlations between these comorbidities and MC count or activity. Moreover, variations in histopathological characteristics and types of rosacea lesions were not thoroughly analyzed, potentially affecting the intensities of MC and cytokine expression. Methodological constraints, such as possible recall and response biases, along with a lack of control for detection and measurement biases in MC counting, may also have impacted the results.



Suggestion for further studies

Future studies should consider using larger, well-characterized samples from multiple centers, along with standardized protocols for quantifying MC activity and inflammatory markers in different rosacea subtypes and lesion characteristics.

Conclusion

MCs play a significant role in the pathogenesis of rosacea through mechanisms involving innate immune responses, neurogenic inflammation, angiogenesis, and fibrosis [1]. However, this study found no significant association between MC count, cytokine levels, and the clinical features of rosacea. Our findings suggest that MC activity may be a more valuable indicator than MC count alone for evaluating the biological behavior of rosacea. Additionally, relying solely on IL-6, LL-37, and TNF-α staining may not adequately capture MC activity. It is possible that MCs impact the surrounding skin tissue indirectly, without directly influencing the specific biological markers evaluated in this study.

The pathology of rosacea likely involves multiple factors, indicating complex interrelationships among its contributing elements. This study failed to establish a clear correlation between the clinical characteristics of rosacea and either MC count or cytokine levels. Therefore, further research is crucial to identify distinct pathological markers that could elucidate the mechanisms underlying rosacea. Future studies should also concentrate on examining the complex relationship between MCs and the multifaceted nature of this condition to improve our understanding and management approaches.

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Funding acquisition: not applicable Writing – original draft: Lee JJ

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Conflict of interest

Ji Yeon Byun has been the associate editor of the Ewha Medical Journal since 2018. However, she was not involved in the peer review process or decision-making. Otherwise, no potential conflict of interest relevant to this article was reported.

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References

- 1. Aroni K, Tsagroni E, Kavantzas N, Patsouris E, Ioannidis E. A study of the pathogenesis of rosacea: how angiogenesis and mast cells may participate in a complex multifactorial process. Arch Dermatol Res 2008;300:125-131.
 - https://doi.org/10.1007/s00403-007-0816-z
- 2. Muto Y, Wang Z, Vanderberghe M, Two A, Gallo RL, Di Nardo A. Mast cells are key mediators of cathelicidin-initiated skin inflammation in rosacea. J Invest Dermatol 2014;134(11):2728-2736. https://doi.org/10.1038/jid.2014.222
- 3. Aksoy B, Ekiz Ö, Unal E, Ozaydin Yavuz G, Gonul M, Kulcu Cakmak S, et al. Systemic comorbidities associated with rosacea: a multicentric retrospective observational study. Int J Dermatol 2019:58(6):722-728.
 - https://doi.org/10.1111/ijd.14353
- 4. Mascarenhas NL, Wang Z, Chang YL, Di Nardo A. TRPV4 mediates mast cell activation in cathelicidin-induced rosacea inflammation. J Invest Dermatol 2017;137(4):972-975. https://doi.org/10.1016/j.jid.2016.10.046
- 5. Yamasaki K, Di Nardo A, Bardan A, Murakami M, Ohtake T, Coda A, et al. Increased serine protease activity and cathelicidin promotes skin inflammation in rosacea. Nat Med 2007;13:975-980.
 - https://doi.org/10.1038/nm1616
- 6. Marchitto MC, Chien AL. Mast cell stabilizers in the treatment of rosacea: a review of existing and emerging therapies. Dermatol Ther 2021;11:1541-1549.
 - https://doi.org/10.1007/s13555-021-00597-7
- 7. Wang L, Wang YJ, Hao D, Wen X, Du D, He G, et al. The theranostics role of mast cells in the pathophysiology of rosacea. Front Med 2019;6:324.
 - https://doi.org/10.3389/fmed.2019.00324
- 8. Nakamura Y, Franchi L, Kambe N, Meng G, Strober W, Nunez G. Critical role for mast cells in interleukin-1β-driven skin inflammation associated with an activating mutation in the Nlrp3 protein. Immunity 2012;37(1):85-95.
 - https://doi.org/10.1016/j.immuni.2012.04.013
- 9. Subramanian H, Gupta K, Ali H. Roles of Mas-related G protein-coupled receptor X2 on mast cell-mediated host defense, pseudoallergic drug reactions, and chronic inflammatory diseases. J Allergy Clin Immunol 2016;138(3):700-710. https://doi.org/10.1016/j.jaci.2016.04.051
- 10. Rosa AC, Fantozzi R. The role of histamine in neurogenic inflammation. Br J Pharmacol 2013;170(1):38-45.
 - https://doi.org/10.1111/bph.12266



- Gupta K, Subramanian H, Ali H. Modulation of host defense peptide-mediated human mast cell activation by LPS. *Innate Immun* 2016;22(1):21-30. https://doi.org/10.1177/1753425915610643
- 12. Mukai K, Tsai M, Saito H, Galli SJ. Mast cells as sources of cytokines, chemokines, and growth factors. *Immunol Rev* 2018;282(1):121-150. https://doi.org/10.1111/imr.12634
- Holmes AD, Spoendlin J, Chien AL, Baldwin H, Chang ALS. Evidence-based update on rosacea comorbidities and their common physiologic pathways. *J Am Acad Dermatol* 2018;78(1):156-166. https://doi. org/10.1016/j.jaad.2017.07.055

Original Article



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Effectiveness of a multidisciplinary pulmonary rehabilitation program at Ewha Womans University Mokdong Hospital, Korea

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Keywords

Occupational therapists: Physical therapists; Physical therapy modalities; Pulmonary medicine; Quality improvement **Objectives:** This study aimed to evaluate the effectiveness of a multidisciplinary pulmonary rehabilitation program at Ewha Womans University Mokdong Hospital, Korea that was designed to augment respiratory function, promote patient recovery, and improve discharge outcomes.

Methods: This study was conducted as part of quality improvement activities from March to August 2023. A multidisciplinary pulmonary rehabilitation team was established, comprising specialists in rehabilitation medicine, pulmonology, and thoracic surgery, as well as physical and occupational therapists, and the nutrition team. We developed a comprehensive rehabilitation program that included stretching, strengthening exercises, aerobic training, and respiratory retraining, supplemented by individualized treatments such as bedside and ambulatory physical therapy. Evaluations before and after rehabilitation were performed using the Modified Medical Research Council Dyspnea Scale and the Chronic Obstructive Pulmonary Disease Assessment Test. The primary indicators of success were an increase of over 10% in pulmonary rehabilitation consultations and an improvement in dischargeto-home rates.

Results: The total number of pulmonary rehabilitation cases rose by 79.16%, from 24 to 43, while consultations saw a 21.15% increase, from 52 to 63. Of the 63 pulmonary rehabilitation cases, 32 (50.8%) were transferred to other hospitals, 25 (39.7%) were discharged home, and 6 (9.5%) remained hospitalized.

Conclusion: The study demonstrated the effectiveness of a multidisciplinary pulmonary rehabilitation approach in improving program participation and achieving meaningful discharge outcomes. These findings underscore the potential for expanding multidisciplinary efforts and highlight the need for further studies to increase discharge-to-home rates and evaluate the long-term impacts of such programs.

Introduction

Background

Pulmonary rehabilitation is a critical therapeutic and rehabilitative process aimed at improving and maintaining respiratory function. It encompasses a comprehensive and intensive treatment approach that includes education, various techniques, and devices to alleviate and manage

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symptoms of respiratory diseases, as well as to help prevent complications associated with these disorders. Pulmonary rehabilitation enhances respiratory function, strengthens respiratory muscles, and improves breathing techniques, ultimately optimizing oxygen delivery. The goal of pulmonary rehabilitation is to enhance patients' physical capacity and psychological stability, enabling them to achieve optimal functional performance in their daily lives.

Pulmonary rehabilitation is particularly crucial for patients with diminished respiratory capacity, including those suffering from chronic obstructive pulmonary disease, restrictive lung disease, tuberculosis-related lung conditions, or pulmonary arterial hypertension. It is equally crucial for patients recovering from lung cancer surgery, lung volume reduction surgery, or thoracic surgery, as well as for those in intensive care units. Although pulmonary rehabilitation has been proven effective in treating various respiratory diseases, its application in clinical practice is still not widespread [1–3]. Research on the current state and development of pulmonary rehabilitation in clinical settings has been conducted in several countries, including the United States. However, in Korea, such research is scarce, primarily due to a lack of awareness about the program [4-9]. A 2011 study revealed that only 20.9% of institutions in Korea offered pulmonary rehabilitation [9]. However, since 2017, when the National Health Insurance Service (NHIS) began covering pulmonary rehabilitation, there has been an increase in its institutional implementation [10]. Despite this progress, the practice is mainly carried out by departments of internal medicine or rehabilitation medicine, without a comprehensive, multidisciplinary approach. At the tertiary university hospital where this study was conducted, there were only 26 multidisciplinary pulmonary rehabilitation consultations in the six months prior to the study, from March to August 2022.

Objectives

The aim of this study was to evaluate the effectiveness of a pulmonary rehabilitation program, which involves a multidisciplinary team comprising individuals from the departments of rehabilitation medicine, respiratory medicine, thoracic surgery, and the nutrition team.

Methods

Ethics statement

This study evaluates a new program in the Department of Rehabilitation at Ewha Medical University Mokdong Hospital. Only the number of patients was counted from the electronic medical records; therefore, neither approval by the institutional review board nor informed consent was required.

Study design

This was a case series analysis.

Setting

This study was carried out as part of the 2023 Quality Improvement (QI) activities at Ewha Womans University Mokdong Hospital. It targeted inpatients at the hospital from March to August 2023.

Subjects were patients who participated in the pulmonary rehabilitation program from March to August 2023.



Interventions

Multidisciplinary pulmonary rehabilitation program

To establish a multidisciplinary pulmonary rehabilitation program, a dedicated team was formed that included physicians from the Departments of Rehabilitation Medicine, Pulmonology, and Thoracic Surgery, along with physical therapists, occupational therapists, and nutritionists. Efforts to promote this team were implemented throughout the hospital to enhance awareness of the multidisciplinary approach to pulmonary rehabilitation. As part of these promotional efforts, the program was highlighted as the theme for the hospital's 2023 QI activities. Information about the program was disseminated within the hospital to increase visibility. Additionally, networking opportunities and collaborative meetings were organized to foster stronger cooperation among the medical staff from the departments of pulmonology, rehabilitation medicine, and thoracic surgery.

Furthermore, a comprehensive respiratory rehabilitation program was developed, incorporating various components including stretching, strengthening exercises, aerobic exercise, respiratory retraining, and equipment-based training. Rehabilitation treatments were tailored to each patient's condition, offering diverse approaches such as bedside pulmonary physical therapy and ambulatory physical therapy. Additionally, regular multidisciplinary patient meetings and follow-up consultations were conducted.

An evaluation protocol for pre- and post-rehabilitation therapy was established. Specifically, the protocol was enhanced by including not only the conventional manual muscle test but also the Modified Medical Research Council (mMRC) Dyspnea Scale and the Chronic Obstructive Pulmonary Disease Assessment Test (CAT). This enhancement facilitated a more comprehensive evaluation and treatment of respiratory conditions.

Outcomes

The key indicators for this QI activity were defined as an increase of more than 10% in the number of pulmonary rehabilitation consultations compared to the same period in the previous year, and an enhancement in the discharge-to-home rate.

Data sources/measurement

Data were obtained from the electronic medical records of pulmonary rehabilitation cases before and after the introduction of the multidisciplinary pulmonary rehabilitation program. The patient count was recorded.

Bias

Bias was not considered reportable because the findings were derived from electronic medical records before and after the intervention.

Study size

All patients were included during the observational period; no sample size estimation was conducted.

Statistical methods

A descriptive analysis was conducted to compare the total number of pulmonary rehabilitation cases before and after the intervention.



Results

As a result of this QI activity, the total number of pulmonary rehabilitation cases increased by 79.16%, from 24 to 43 cases, and the number of pulmonary rehabilitation consultations rose by 21.15%, from 52 to 63 cases (Fig. 1). Of the 63 pulmonary rehabilitation cases, 32 (50.8%) were transferred to other hospitals, 25 (39.7%) were discharged home, and 6 (9.5%) remained hospitalized.

Discussion

Key results

The number of pulmonary rehabilitation consultations exceeded the target of a 10% increase, reaching a 21.15% increase and thereby achieving the goal.

Interpretation/comparison with previous studies

There was a significant increase of over 20% compared to 2022, a year that already had a high number of respiratory-related inpatient cases due to COVID-19. Additionally, this initiative provided an opportunity to enhance awareness of the importance of pulmonary rehabilitation among other healthcare professionals in the hospital, who previously had limited understanding of its significance.

As of 2019, approximately 6,200 people in Korea died annually from chronic lower respiratory diseases, which accounted for 2.1% of all deaths [11]. The mortality rate for these diseases was 12.0 per 100,000 population, ranking them 9th among causes of death [11]. According to the World Health Organization (WHO), chronic diseases are responsible for 71% of deaths globally, with chronic respiratory diseases contributing to 5% of the total. This indicates that chronic respiratory diseases account for 7% of deaths attributable to chronic diseases worldwide [12]. The prevalence and mortality rates of respiratory diseases are on the rise. Pulmonary rehabilitation is crucial in managing chronic lung diseases and offers significant benefits.

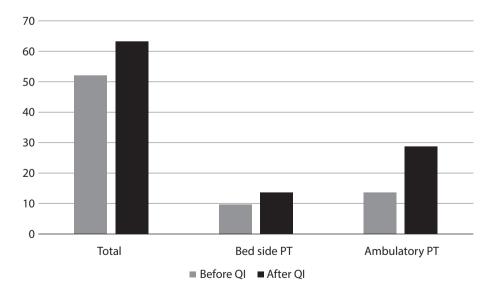


Fig. 1. The number of pulmonary rehabilitation consultations and the number of bedside and ambulatory pulmonary rehabilitation cases. PT, physical therapy; QI, quality improvement.



These include reducing exercise intolerance, improving health-related quality of life, and alleviating dyspnea. It is recognized as a highly effective therapeutic approach for enhancing the overall well-being of patients with respiratory conditions [13]. A 2011 study in Korea found that only 20.9% of 43 tertiary and general hospitals offered pulmonary rehabilitation [9]. When implemented, most programs focused primarily on respiratory education, and it was very rare for them to include the high-intensity pulmonary rehabilitation programs recommended by guidelines [10]. However, pulmonary rehabilitation should encompass more than just respiratory education. It should also include exercise training, behavioral modifications, and education aimed at improving both the physical and psychological conditions of patients with chronic respiratory diseases.

According to the "Evaluation of the Effects and Improvement Plans for the Phase 2 Pilot Program of Rehabilitation Medical Institution Fees" conducted by the Health Insurance Review and Assessment Service (HIRA) in 2022, the discharge-to-home rates were 66.1% for moderate patients, 39.8% for severe patients, and 13.4% for very severe patients [14]. This study also included patients from the intensive care unit, which likely influenced the overall discharge-to-home rate, estimated at 39.7%.

Limitations

First, the duration of the study was limited to only six months, which hindered a clear evaluation of its long-term effects. Future research should extend over a longer period, ideally on an annual basis. Second, there is a growing trend in international studies toward outpatient or home-based pulmonary rehabilitation. Consequently, future studies should concentrate on enhancing the quality of home-based pulmonary rehabilitation for outpatient patients. Third, the study did not evaluate quality of life, depression, or anxiety, focusing solely on mMRC and CAT scores. Additional research in these areas would be valuable.

Conclusion

This study demonstrated a 79.16% increase in total pulmonary rehabilitation cases, rising from 24 to 43, and a 21.15% increase in consultations, from 52 to 63, surpassing the target of a 10% improvement. However, the discharge-to-home rate was 39.7%, which was lower than the 50.8% transfer-to-other-hospitals rate. This indicates that while the multidisciplinary pulmonary rehabilitation approach effectively increased participation, further efforts are necessary to improve discharge-to-home outcomes. The significance of this study lies in its implementation of a comprehensive, multidisciplinary approach to pulmonary rehabilitation. Future interventions should focus on early rehabilitation and targeted strategies to facilitate transitions back to home environments, which could potentially improve these outcomes.

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Authors' contributions

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Writing - original draft: Suh JH

Writing - review & editing: Han SJ, Suh JH

Conflict of interest

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References -

- Foster S, Thomas HM 3rd. Pulmonary rehabilitation in lung disease other than chronic obstructive pulmonary disease. *Am Rev Respir Dis* 1990;141(3):601-604. https://doi.org/10.1164/ajrccm/141.3.601
- 2. Holland AE, Wadell K, Spruit MA. How to adapt the pulmonary rehabilitation programme to patients with chronic respiratory disease other than COPD. *Eur Respir Rev* 2013;22(130):577-586.
 - https://doi.org/10.1183/09059180.00005613
- 3. Rokach A, Romem A, Arish N, Azulai H, Chen C, Bertisch M, et al. The effect of pulmonary rehabilitation on non-chronic obstructive pulmonary disease patients. *Isr Med Assoc J* 2019;21(5):326-329.
- 4. Brooks D, Sottana R, Bell B, Hanna M, Laframboise L, Selvanayagarajah S, et al. Characterization of pulmonary rehabilitation programs in Canada in 2005. *Can Respir J* 2007;14(2):87-92.
 - https://doi.org/10.1155/2007/951498
- 5. Yohannes AM, Connolly MJ. Pulmonary rehabilitation programmes in the UK: a national representative survey. *Clin Rehabil* 2004;18(4):444-449.
 - https://doi.org/10.1191/0269215504cr736oa
- Garvey C, Casaburi R, Spruit MA, De Brandt J. Survey of exercise prescription in US pulmonary rehabilitation programs. *J Cardiopulm Rehabil Prev* 2020;40(2):116-119. https://doi.org/10.1097/HCR.00000000000000467
- 7. Johnston CL, Maxwell LJ, Alison JA. Pulmonary rehabilitation in Australia: a national survey. *Physiotherapy* 2011;97(4):284-290.
 - https://doi.org/10.1016/j.physio.2010.12.001
- 8. Bickford LS, Hodgkin JE, McInturff SL. National pulmonary rehabilitation survey. Update. *J Cardiopulm Rehabil* 1995;15(6):406-411.
 - https://doi.org/10.1097/00008483-199511000-00002



- 9. Lee YS, Park YB, Oh YM, Lee SD. Survey on the reality of pulmonary rehabilitation in Korea. *Obstr Lung Dis* 2013;(1):4-7.
- 10. Kim HJ, Choi HE, Jang HJ, Kim HK, Park JH, Lee JH, et al. Current status and trends of pulmonary rehabilitation in South Korea: national level data analysis using Health Insurance Review and Assessment Service (HIRA) database from 2016 to 2018. *Medicine* 2022;101(41):e31085.
 - https://doi.org/10.1097/MD.000000000031085
- 11. GBD 2015 Chronic Respiratory Disease Collaborators. Global, regional, and national deaths, prevalence, disability-adjusted life years, and years lived with disability for chronic obstructive pulmonary disease and asthma, 1990-2015: a systematic analysis for the Global Burden of Disease Study 2015. *Lancet Respir Med* 2017;5(9):691-706. https://doi.org/10.1016/S2213-2600(17)30293-X
- 12. Cho KS. Current status of chronic obstructive pulmonary disease (COPD) in the Republic of Korea. *Public Health Wkly Rep* 2021;14(16):943-951.
- 13. Osadnik CR, Singh S. Pulmonary rehabilitation for obstructive lung disease. *Respirology* 2019;24(9):871-878.
 - https://doi.org/10.1111/resp.13569
- 14. Shin HI, Oh IH, Kim DA, Kim TW, Kim HB, You SD, et al. Evaluation of the effects and improvement plans for the phase 2 pilot program of rehabilitation medical institution fees. Wonju: Health Insurance Review and Assessment Service (HIRA); 2022.

Original Article



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Health rights of inmates in correctional facilities in Korea as of 2016: a cross-sectional study

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*This paper is a secondary publication based on the authors' report titled "2016 National Human Rights Commission of Korea's Survey on the Health Rights of Inmates in Correctional Facilities" (Publication registration No.: 11-1620000-000628-01), specifically an abridged English translation. Dr. Seung-Sup Kim declined to be a co-author of this translated work; therefore, he is not listed in this article, despite his role as a co-researcher in the original report.

Keywords

Health rights; Correctional facilities; Prisoner; Inmates; Republic of Korea



Objectives: This study aimed to assess the health rights of inmates in correctional facilities from the perspective of unmet needs and to explore institutional improvement plans that could yield substantial qualitative and quantitative advancements.

Methods: Data on capacity and actual occupancy, external and internal medical services, the number of inmates with mental health conditions, and cell area were obtained from the Ministry of Justice. Overall, 1.057 inmates were surveyed, representing 1.84% of the total inmate population of 57.560 as of September 30, 2016. A structured questionnaire was distributed to these inmates, and upon collection, the responses were analyzed. Furthermore, a request was submitted to the Ministry of Justice to survey the status of healthcare personnel and medical services across 52 correctional facilities nationwide.

Results: Between 2014 and 2015, the Ministry of Justice in South Korea allocated approximately 14 to 22 billion Korean won for healthcare services in correctional facilities. The major facilities with the most inmates with mental health conditions had 160 such inmates in 2014 and 161 in 2015. Overcrowding and insufficient cooling pose ongoing health risks. Inmates face challenges accessing medical care, with unmet needs for dental and psychiatric services.

Conclusion: Strategies to improve inmates' health rights include establishing a primary healthcare system, improving governance, alleviating overcrowding, and introducing mental health programs. Emphases are placed on managing severe illnesses such as cancer, strengthening emergency care, and ensuring oversight by the National Human Rights Commission. Regular education of prison staff is also recommended to improve inmate health management.

Introduction

Background

Assessing potential human rights violations in the context of inmate health is challenging when considering only the medical interventions provided to individual prisoners. Thus, it is essential to comprehensively review existing correctional healthcare policies and to develop guidelines that align with international human rights standards while reflecting the characteristics of the society.

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This approach is intended to propose alternatives to more effectively safeguard the health rights of inmates.

Objectives

This research aims to examine the status of health rights for inmates within correctional facilities, which serve as a barometer of human rights in a democracy governed by the rule of law. The goal is to assess these rights in terms of unmet needs and to explore institutional improvement plans that could yield substantial qualitative and quantitative advancements.

Methods ·

Ethics statement

Before the questionnaires were distributed to participants, they were informed of the following regarding consent: "Your personal information will not be disclosed without your consent. The findings of this study will be reported in a de-identified format, such as through distribution tables or statistics. If you encounter difficulty answering any questions, you are not obligated to respond."

Setting

Prior to the site visits, the National Human Rights Commission requested relevant data from the Ministry of Justice. The Ministry provided information on several facilities, specifically Seoul Detention Center, Anyang Correctional Institution, Daejeon Correctional Institution, Jinju Correctional Institution, Gyeongbuk Northern Correctional Institution No. 1, and Mokpo Correctional Institution. These data included details on capacity and actual occupancy, external and internal medical services, the number of inmates with mental health conditions, and cell area.

Participants

The field research involved visits to correctional facilities to assess the status of their medical facilities. Of 52 correctional facilities across the country, 10 (19.2%) were selected for the survey. From each facility, a basic sample size of 100 inmates was chosen. In total, 1,057 inmates were surveyed, accounting for 1.84% of the total inmate population of 57,560 as of September 30, 2016 (Table 1).

Variables

The variables under investigation were all questionnaire items presented to participants.

Data sources and measurement

A structured questionnaire was distributed to inmates, then collected and analyzed. Furthermore, a request was submitted to the Ministry of Justice to conduct a survey on the status of healthcare personnel and medical services available to inmates across 52 correctional facilities nationwide.

Bias

Bias may have been present in participant selection, as individuals were not randomly allocated, but rather determined by each facility.

Study size

The basic sample size consisted of 100 inmates from each of 10 facilities. Participants were



Table 1. Number of survey participants by facility

	Capacity	Current number of inmates	Participants	%
Gyeongbuk Northern Correctional Institution No. 1	1,270	1,347	100	9.5
Daejeon Correctional Institution	2,060	2,935	133	12.6
Mokpo Correctional Institution	1,040	1,295	108	10.2
Seoul Detention Center	2,200	3,521	100	9.5
Anyang Correctional Institution	1,700	1,900	100	9.5
Yeoju Correctional Institution	1,610	1,603	101	9.5
Jinju Correctional Institution	1,050	1,003	112	10.6
Cheonan Correctional Institution	1,060	1,225	101	9.5
Cheongju Correctional Institution	750	1,079	100	9.5
Cheongju Women's Correctional Institution	610	750	102	9.6
Total	13,350	15,364	1,057	100

selected by the respective correctional facilities; consequently, no additional sample size estimation was performed.

Statistical methods

Descriptive statistics were used.

Results

General status data

General status

The total budget allocated by the Ministry of Justice for healthcare across all detention facilities was 14,565.36 million Korean won (KRW) in 2014 and 15,393.87 million KRW in 2015. Healthcare expenditures for these facilities were 16,029.2 million KRW in 2014 and 22,282.28 million KRW in 2015.

External medical consultations

When an inmate in a correctional facility requests a medical consultation through correctional staff in the housing or work areas, the assigned medical officer conducts either a rotating or accompanied consultation. Based on the medical officer's recommendation, the inmate may be authorized to receive treatment at an external medical facility, which could include telemedicine services or in-person visits. The average monthly numbers of external consultations by facility were as follows: Seoul Detention Center, 239.3 inmates sent for external consultations; Anyang Correctional Institution, 372.5; Daejeon Correctional Institution, 288.0; Gyeongbuk Northern Correctional Institution No. 1, 110.2; Mokpo Correctional Institution, 248.3; and Jinju Correctional Institution, 87.1 (Table 2).

Internal medical consultations

When an inmate requests a medical consultation or medication through correctional staff in



Table 2. Number of external medical consultations by facility (May 1, 2015-April 30, 2016)

Time	Seoul Detention Center	Anyang Correctional Institution	Daejeon Correctional Institution	Gyeongbuk Northern Correctional Institution No. 1	Mokpo Correctional Institution	Jinju Correctional Institution
15.5	239	356	256	123	221	92
15.6	295	401	255	114	199	99
15.7	293	461	281	110	222	100
15.8	309	426	199	94	194	88
15.9	212	395	231	114	265	103
15.10	239	360	375	108	246	87
15.11	212	378	322	125	286	75
15.12	233	350	231	125	289	78
16.1	202	303	295	93	241	71
16.2	213	334	287	106	250	62
16.3	222	351	327	107	303	108
16.4	202	355	397	103	264	82
Total	2,871	4,470	3,456	1,322	2,980	1,045

the housing or work areas, the medical officer reviews the request. The officer then identifies inmates who require consultations or medications and escorts those needing consultations to the medical department for treatment. Medications are prepared and dispensed to the inmates in need, beginning in the afternoon of the same day. The average monthly numbers of internal consultations by facility were as follows: Seoul Detention Center, 11,484.7 internal consultations; Anyang Correctional Institution, 17,664.8; Daejeon Correctional Institution, 46,830.4; Gyeongbuk Northern Correctional Institution No. 1, 14,703.7; Mokpo Correctional Institution, 13,804.4; Jinju Correctional Institution, 7,439.8 (Table 3).

Inmates with mental health conditions

In 2014, Seoul Detention Center reported a total of 160 inmates with mental health conditions, while Daejeon Correctional Institution and Jinju Correctional Institution had 123 and 119, respectively (Table 4). At Seoul Detention Center, the most common mental illness was depression, affecting 67 inmates; 39 had anxiety disorders, and 23 had schizophrenia. At Daejeon Correctional Institution, 52 inmates had depression, 30 had anxiety disorders, and 18 had schizophrenia. Jinju Correctional Institution reported 76 inmates with schizophrenia and 36 with depression. In 2015, Mokpo Correctional Institution had the highest number of inmates with mental health conditions, totaling 161. This was followed by Seoul Detention Center, with 140, and Jinju Correctional Institution, with 123. Of the inmates at Mokpo Correctional Institution, 70 were affected by sleep disorders, 52 by depression, and 27 by anxiety disorders (Table 5).

Inmate deaths

The survey of correctional facilities conducted in 2014 and 2015 reported a total of 11 deaths. Of these, Seoul Detention Center accounted for two deaths, Daejeon Correctional Institution for six, Gyeongbuk Northern Correctional Institution No. 1 for one, and Jinju Correctional Institution for two.



Table 3. Number of internal medical consultations by facility (May 1, 2015-April 30, 2016)

Time	Seoul Detention Center	Anyang Correctional Institution	Daejeon Correctional Institution	Gyeongbuk Northern Correctional Institution No. 1	Mokpo Correctional Institution	Jinju Correctional Institution
15.5	10,390	16,600	44,317	14,281	11,700	6,960
15.6	11,150	19,320	43,383	13,576	10,764	7,794
15.7	12,170	19,612	43,557	12,984	11,181	7,455
15.8	10,632	17,127	42,435	12,944	11,705	6,145
15.9	11,122	16,767	46,720	13,148	11,742	7,323
15.10	12,787	18,906	50,297	14,031	13,334	7,152
15.11	11,618	19,020	48,244	14,512	14,215	7,018
15.12	12,874	19,388	51,958	15,166	15,376	8,345
16.1	11,248	17,324	51,678	15,035	15,261	7,919
16.2	10,155	15,134	47,353	14,692	16,864	7,337
16.3	11,660	17,238	48,244	16,591	17,334	8,775
16.4	11,470	15,542	43,778	19,484	16,177	7,045
Total	137,816	211,977	561,965	176,444	165,653	89,277

Table 4. Number of inmates with mental health conditions (2014)

	Total	Behavior disorders (F10-F19)	Schizophrenia (F20-F29)	Depression (F30-F39)	Anxiety disorders (F40-F49)	Sleep disorders (F50-F99)	Etc.	
Seoul	160	6	23	67	39	5	20	
Anyang	114		37	43			34	
Daejeon	123	3	18	52	30	14	6	
Kyungpook	82	7	26	18	17	10	5	
Mokpo	103	2	10	49	13	25	4	
Jinju	119		76	36			7	

Table 5. Number of inmates with mental health conditions (2015)

			, ,				
	Total	Behavior disorders (F10-F19)	Schizophrenia (F20-F29)	Depression (F30-F39)	Anxiety disorders (F40-F49)	Sleep disorders (F50-F99)	Others
Seoul	140		24	33	35	3	45
Anyang	110	5	30	29	17	29	
Daejeon	107	3	18	46	21	14	5
Kyungpook	93	3	19	20	29	15	7
Mokpo	161	3	8	52	27	70	1
Jinju	123	24	86	11			2

Inmates with health-related sentence suspensions

In 2014 and 2015, a total of 92 inmates from the surveyed correctional facilities had their sentences suspended for health reasons. The breakdown of these numbers by facility is as follows: Seoul Detention Center, 20, Anyang Correctional Institution, 20, Daejeon Correctional Institution,



28, Gyeongbuk Northern Correctional Institution No. 1, six, Mokpo Correctional Institution, seven, and Jinju Correctional Institution, 11.

Inmate housing conditions

The range of cell area by facility is as follows:

Seoul Detention Center: The area of shared cells for male prisoners ranges from 8.96 to 12.84 m², while that of shared cells for female patients ranges from 5.16 to 17.52 m².

Anyang Correctional Institution: The area of shared cells for male prisoners ranges from 3.6 to $24.4 \, \text{m}^2$.

Daejeon Correctional Institution: The area of shared cells for male prisoners ranges from 6.7 to 33.27 m², while that of shared cells for female patients ranges from 59 to 88.5 m².

Gyeongbuk Northern Correctional Institution No. 1: The area of shared cells for male prisoners ranges from 6.72 to 10.08 m².

Mokpo Correctional Institution: The area of shared cells for male prisoners ranges from 10.8 to 17.3 m², while that of shared cells for female patients ranges from 10.8 to 14.0 m².

Jinju Correctional Institution: The area of shared cells for male prisoners ranges from 10.8 to 17.3 m², while female shared cells range from 10.8 to 18.9 m².

Field research results

General situation

The average age of respondents was 43.8 years (SD, 10.5 years), and the median age was 45 years. Most respondents—762 individuals (95.4%)—were in their 20s to 50s. Prior to incarceration, 436 respondents (42.3%) were married. In terms of administrative classification, the largest group was classified as grade 3 (411 respondents, 41.5%), followed by grade 2 (378 respondents, 38.1%), grade 1 (187 respondents, 18.9%), and grade 4 (15 respondents, 1.5%). Most participants (786 inmates, 95.9%) were housed in shared accommodations, and 774 inmates (77.9%) were assigned to work-release cells. Regarding criminal history, 641 respondents (64.2%) were firsttime offenders, while 358 (35.8%) were repeat offenders. The average sentencing period was 6.3 years (SD, 5.1 years), and the average time served was 4.2 years (SD, 4.0 years). On average, respondents spent 55,000 KRW per month on personal medical expenses (SD, 120,000 KRW).

Living environment: residential conditions and overcrowding

Regarding heating in the winter, out of 1,021 respondents to the item, 356 inmates (34.9%) reported that it was "very cold," while 419 individuals (41.0%) described it as "cold." Conversely, during the summer, 705 inmates (68.5%) characterized their living quarters as "very hot," while 288 (28.0%) reported them to be "somewhat hot." Of 1,031 inmates who responded to the survey regarding ventilation, a total of 638 (61.9%) reported issues with ventilation in their rooms. Concerning the lighting conditions for sleep, out of 1,026 respondents, 252 (24.6%) indicated that lights were on during sleep time, whereas 293 respondents (28.6%) reported that lights were not on during this period.

Regarding access to shower facilities, 465 of 958 respondents (48.5%) reported being unable to use showers, while 378 respondents (45.3%) indicated that they primarily used showers during the summer. Furthermore, 772 respondents (84.1%) stated that hot water was available only in the winter.

When asked about their laundry habits, 745 respondents (80.6%) reported washing their clothes



in the bathroom rather than in a laundry room. Regarding washing methods, 755 respondents (81.9%) indicated that they hand-washed their clothes.

When asked whether clothing was distributed on time, 875 of 1,020 respondents (85.8%) answered in the affirmative. However, regarding satisfaction with the quality of the clothing, 464 of 1.008 respondents (46.0%) expressed dissatisfaction.

Concerning the allocation and cleanliness of bedding, 670 of 1,021 respondents (65.6%) reported receiving one mattress per person. Additionally, 557 respondents (55.0%) indicated they were provided with two blankets each, and 939 respondents (92.2%) confirmed receiving one pillow per person. In terms of the cleanliness and suitability of the bedding, 328 out of 1,014 respondents (32.3%) described the bedding as not clean or suitable for use, while 169 respondents (16.7%) stated that it was not at all clean.

Regarding compliance with the planned diet in the correctional facility, 816 out of 1,041 respondents (78.4%) reported that the facility adhered to the planned menu. However, when asked about satisfaction with the meals, 345 out of 1,038 respondents (33.2%) indicated dissatisfaction. Regarding the quality of purchased supplementary food (self-funded), 571 out of 1,039 respondents (55.0%) expressed dissatisfaction.

Concerning daily exercise duration, 507 out of 1,036 respondents (48.9%) reported exercising for 15 to 30 minutes a day, while 390 respondents (37.6%) indicated that they exercised for 30 to 45 minutes daily.

Emotional state

Depression: The 11-item Center for Epidemiologic Studies Depression Scale was administered to assess the presence of depression among the inmates. Scores of 21 to 24 indicated mild depression, while scores of 25 or higher indicated severe depression. Of 1,003 respondents, 115 (11.5%) were identified as having mild depression and 199 (19.8%) severe depression. Consequently, a total of 314 participants (31.3%) were classified as experiencing depression.

Sleep disorders: Among 938 respondents, the average time to fall asleep was 33.2 minutes (SD, 28.0 minutes), and the median time was 30 minutes. The shortest time recorded to fall asleep was 5 minutes, while the longest was 250 minutes. A total of 652 respondents (69.5%) took between 10 minutes and 1 hour to fall asleep. On average, respondents woke up 3.4 times per night (SD, 2.1 times), and the median number of awakenings was three. The maximum number of awakenings reported by a respondent in a night was 20, and 35 respondents (3.8%) reported waking up more than 10 times. On average, respondents had trouble sleeping 2.8 days per week (SD, 2.2 days), and the median was 2 days. The maximum number of days per week with sleep difficulties was seven, with 99 respondents (12.5%) indicating they had trouble sleeping every night. Additionally, 194 respondents (24.4%) reported having difficulty sleeping at least one night per week, while 180 respondents (22.6%) experienced difficulty sleeping for two nights per week.

Intentional self-harm: Of 846 respondents, 118 inmates (13.9%) reported having considered intentional self-harm within the past year. Among these individuals, 31 inmates (3.7%) indicated that they had formulated a suicide plan during the past year, and 11 inmates (1.3%) reported that they had attempted suicide.

General health condition

Over the past year, the most frequently reported health issues were headaches and eye fatigue, affecting 740 respondents (15.1%). This was followed by muscle pain in the shoulders, neck, and arms, reported by 708 respondents (14.5%). Muscle pain in the lower body, including the hips and



legs, affected 588 respondents (12.0%). Among the 93 respondents (2.4%) who reported other health issues, conditions mentioned included chronic prostatitis, colds, acute pyelonephritis, toothaches, cystitis, ascites, rhinitis, asthma, pulmonary fibrosis, and endometriosis. When asked if they had developed new health problems after being incarcerated, 541 out of 727 respondents (60.4%) answered "yes." Furthermore, when asked whether pre-existing health issues had worsened since entering the correctional facility, 420 out of 831 respondents (50.5%) answered in the affirmative.

Medical utilization: internal/infirmary care and external medical services

Internal medical care: Out of 978 respondents, 619 (63.3%) reported that they had urgently needed to visit the medical department due to illness. When 606 inmates were questioned about the feasibility of being escorted to the infirmary, 336 (55.4%) indicated it was "somewhat possible." In contrast, 179 (29.5%) found it "somewhat difficult," 48 (7.9%) stated it was "not at all possible," and 43 (7.1%) considered it "very possible." Overall, 227 respondents (37.4%) expressed difficulty in being escorted to the infirmary.

When asked about their visit to the infirmary, 785 out of 968 respondents (81.1%) reported that they were examined by a doctor (Table 6). Additionally, 869 of 1,016 respondents (85.6%) confirmed that they had received medical treatment from a healthcare professional within the facility.

Of 956 respondents, 277 (29.0%) reported being asked to cover personal medical expenses within the facility. Among those inmates, 83 respondents (30.6%) said they had been unable to receive treatment due to the inability to pay for medical expenses (Table 7).

When asked whether they had ever desired dental treatment, 733 out of 1,015 respondents (72.2%) answered "yes." Of the 693 respondents who provided further details, 104 (15.1%) reported being unable to receive any dental treatment, and 514 (74.2%) indicated that they had received treatment but experienced an excessive wait time.

Concerning the desire for psychiatric treatment, 166 out of 997 respondents (16.6%) reported

Table 6. Medical personnel who conducted medical examinations

2016		2010		2022	
Number	%	Number	%	Number	%
785	81.1	634	81.3	543	71.0
38	3.9	37	4.7	58	7.6
90	9.3	65	8.3	119	15.6
4	0.4	3	0.4	35	4.6
51	5.3	41	5.3	10	1.3
968	100	780	100	765	100
	785 38 90 4 51	Number % 785 81.1 38 3.9 90 9.3 4 0.4 51 5.3	Number % Number 785 81.1 634 38 3.9 37 90 9.3 65 4 0.4 3 51 5.3 41	Number % Number % 785 81.1 634 81.3 38 3.9 37 4.7 90 9.3 65 8.3 4 0.4 3 0.4 51 5.3 41 5.3	Number % Number % Number 785 81.1 634 81.3 543 38 3.9 37 4.7 58 90 9.3 65 8.3 119 4 0.4 3 0.4 35 51 5.3 41 5.3 10

Table 7. Inmates experiencing inability to receive medical treatment due to medical expenses

	2016		2010		2022	
	Number	%	Number	%	Number	%
Yes	83	30.6	66	47.8	127	49.2
No	188	69.4	89	52.2	131	50.8
Total	271	100	155	100	258	100



wanting such treatment. Among the 133 inmates who gave additional details, 46 (33.1%) reported being unable to receive any psychiatric treatment, while 52 (37.4%) indicated that they had received treatment but experienced an excessive wait time.

When asked to prioritize the top three most essential healthcare services in the facility (calculated using weighted averages), participants ranked "dental consultation and treatment" as the most necessary, followed by "regular health check-ups" in second place and "increased use of external hospital services" in third.

Infirmary admission: Of 885 respondents, 52 (5.9%) reported having applied for admission to the infirmary. Of these, 36 inmates (66.7%) were successfully admitted, indicating that approximately one in three inmates who applied were not admitted. The average time from application to admission was 13.4 days (SD, 26.9 days). Among the 37 inmates who gained admission to the infirmary, five respondents (13.5%) reported that gaining admission was somewhat difficult, while 11 (29.8%) described it as very difficult.

Of the 24 respondents who reported being denied admission to the infirmary, 12 inmates (50.0%) indicated that they were refused without receiving a medical examination. This suggests that half of the refusals occurred without a proper medical evaluation.

External medical treatment: Among 866 respondents, 204 inmates (23.6%) reported having wanted to receive treatment at an external hospital but being unable to apply. Additionally, 140 out of 823 respondents (17.0%) indicated that their requests for external hospital treatment had been denied. Among 125 inmates who had been denied external treatment and provided further details, 24 (19.2%) reported being denied without receiving a medical examination.

Regarding the cost of external hospital treatment, 155 out of 216 respondents (71.8%) reported that they had to cover the full cost themselves. The average time elapsed from applying for external hospital treatment to receiving it was 41.0 days (SD, 82.2 days).

When inmates were transferred to external hospitals, they were accompanied by an average of four correctional officers (SD, 0.8). The median number of officers present during these transfers was also four, with a range of two to six officers and a mode of four officers.

Health check-ups

Of 1,027 respondents, 825 (80.3%) reported receiving a health check-up upon admission to the facility. When asked whether they received follow-up care after the check-up, 293 out of 791 respondents (37.0%) answered in the affirmative, while 311 (39.4%) indicated they did not receive follow-up care.

Only 99 of 797 respondents (12.4%) reported having undergone a mental health check-up at admission. Among 76 inmates who experienced a mental health check-up, only 13 respondents (17.1%) were examined by a psychiatrist.

Regarding general health check-ups during incarceration, 842 out of 1,003 respondents (83.9%) reported receiving one. Among 792 respondents queried about follow-up care after the check-up, 281 (35.5%) confirmed they had received care, while 320 (40.4%) indicated they had not.

Additionally, 70 out of 790 respondents (8.9%) reported having received a mental health checkup while incarcerated. Among 55 of the respondents who indicated having received a mental health check-up, 16 (29.1%) reported being examined by a psychiatrist.

Medication usage

Out of 922 respondents, 345 inmates (37.4%) reported obtaining medication through selffunded purchases, while 324 inmates (35.1%) indicated they received medication via prescription



following a medical consultation. Furthermore, 172 inmates (18.7%) reported acquiring medication by submitting a request form without a doctor's visit.

Of 915 respondents, 439 inmates (48.0%) indicated having been prescribed medication without meeting with a doctor. On average, inmates took medication 4.4 days per week (SD, 0.6 days).

Among 879 respondents, 72 inmates (8.2%) reported having been refused when applying to purchase self-funded medication. Of 947 respondents, 806 inmates (85.1%) had experience with purchasing self-funded medications. The most frequently purchased self-funded medications were vitamins and supplements like calcium (673 inmates, 31.6%), followed by skincare medications (445 inmates, 20.9%) and analgesics (328 inmates, 15.4%).

Emergency situations

Of 747 respondents, 157 inmates (21.0%) reported having requested a consultation with a doctor or nurse at night or on Saturday afternoons, Sundays, or public holidays due to illness. Among 151 inmates who requested a consultation, 48 (31.8%) were able to meet with a doctor or nurse, while 103 inmates (68.2%) were unable to do so.

The average waiting time for inmates to see medical staff after submitting a request was 3.5 days (SD, 2.9 days). The median waiting time was 1 day. Of the 54 inmates who provided detailed information, 20 (37.0%) were able to meet with medical staff within 1 to 3 days.

Medical complaints

Out of 826 respondents, 18 inmates (2.2%) reported having filed complaints or petitions concerning medical issues. Among these 18 inmates, eight (44.4%) stated that they experienced interference from the correctional facility when filing their complaint. After the petitions were processed, only two inmates (12.5%) out of 16 who reported further information indicated that the desired action was taken.

Status of medical staff and facilities across correctional institutions

Medical staff and inmate demographics across correctional facilities

As of September 30, 2016, a total of 57,541 inmates were housed across 52 correctional facilities in South Korea. The breakdown by gender and age revealed that 27.9% (16,072 inmates) were in their 40s, followed by 25.2% (14,526 inmates) in their 50s and 21.5% (12,398 inmates) in their 30s. The inmate population was 71% male and 29% female, with 70% of the inmates between 30 and 50 years old.

Regarding the medical staff available in these facilities, as of September 30, 2016, the staffing fulfillment rates in comparison to the required personnel were as follows: doctors at 79%, pharmacists at 85%, nurses at 98%, and medical technicians at 100%.

Average daily number of patients and prescriptions in correctional facilities

The average daily medical consultation rate varied significantly across correctional facilities, ranging from 3.1% to 30.0%. The Pyeongtaek Branch of Suwon Detention Center reported the highest consultation rate at 30.0%. This was followed by Chuncheon Correctional Facility at 20.9% and the Seosan Branch of Hongseong Correctional Facility at 20.3%. In contrast, Pohang Correctional Facility had the lowest daily consultation rate at 3.1%.

Regarding the daily number of prescriptions issued, as of September 30, 2016, Daejeon Correctional Facility recorded the highest figure, with 3,677 prescriptions. This was followed by



Daegu Correctional Facility, with 2,313 prescriptions, and Seoul Detention Center with 1,386 prescriptions.

Discussion -

Directions for improving health rights

Inmates in correctional facilities face considerable barriers to accessing essential healthcare services, resulting in serious violations of their right to health and meaningful disparities in health determinants. From a human rights standpoint, inmates retain the right to health, and correctional institutions are intended to facilitate social reintegration. Supporting inmates in adopting healthy behaviors can positively influence community health, underscoring the importance of improving health rights for inmates [1–3].

Strategies for key tasks

Establishing a primary healthcare system and community linkages within correctional facilities

While recent investigations indicate an increase in healthcare staff and a rise in the frequency of in-person doctor consultations, many inmates continue to receive exclusively medication-focused treatments, without the benefit of direct consultations. Deficiencies remain in comprehensive services, such as counseling, health education, psychological support, and ongoing monitoring. Notably, dental and mental health services face a substantial unmet demand. Therefore, it is essential to ensure that sufficient healthcare personnel are available to address the gaps in primary healthcare services within correctional facilities. Additionally, a medical information system must be established that maintains continuity of care before and after an inmate's admission. This should be complemented by the standardization of operational manuals for medical services in these facilities, as well as the development of comprehensive healthcare programs that encompass screening, consultation, and management. Furthermore, efforts must be directed toward medical officers in correctional facilities, focusing on improving their capabilities and education in human rights. For medical officers who repeatedly violate human rights, the adoption of a "three-strike rule" is recommended to prevent them from continuing to provide medical services.

Establishment of a healthcare control tower and governance system in correctional facilities

Establishing a high-quality primary healthcare system within correctional facilities and integrating it with the community healthcare system is a complex task that cannot be accomplished solely through the efforts of individual facilities. The specialized nature of healthcare means that addressing healthcare issues within correctional facilities through the standard correctional administration framework is structurally limited. To ensure the robustness of primary healthcare within these facilities and to facilitate a seamless connection with community healthcare services, it is necessary to create a dedicated healthcare service system within the Ministry of Justice. This system should be separate from the regular correctional administration. Such an approach would enable medical offices in each facility to be directly managed by the Ministry of Justice, rather than being subordinate to the individual correctional facilities.

If a separate healthcare service organization is not created, a control tower should instead be implemented within the Ministry of Justice. This Correctional Healthcare Support Unit could monitor and evaluate the medical offices within each correctional facility.

Additionally, the formation of a Primary Healthcare Enhancement Committee for Correctional



Facilities is recommended. This governance body should include members from human rights organizations, representatives from regional public hospitals, community representatives, and experts. The existence of this committee would promote open communication and oversight. Furthermore, improvements to the official Borami system should be made to enable medical officers to access inmates' medical information from before their incarceration. This access would facilitate improved healthcare management within correctional facilities.

Plans regarding the general environment and medical facilities in correctional institutions

With overcrowding, many inmates who previously lived alone are now struggling to adapt to confined spaces where six or more individuals share a small cell. Such an environment has been identified as a cause of increased conflict among inmates. Additionally, surveys reveal that cooling facilities are notably lacking compared to heating, creating heightened health risks during the summer due to overcrowding, inadequate cooling, and limited water supply.

To address these issues, it is essential to assess whether the capacities of the facilities are set appropriately. Initially, a minimum living space should be established that does not adversely affect the basic quality of life and health of inmates, and the current facility capacities should be adjusted accordingly. Furthermore, to alleviate overcrowding, early release options should be implemented for minor offenders.

Cooling and water supply must be consistently provided during the summer, rather than being restricted to certain times. Ensuring access to adequate cooling and water for bathing is not only a basic human right but also crucial for infection prevention and the management of inmate health during the hotter months. Finally, for patients requiring dialysis, such as those with chronic renal failure, inmates should be housed in designated facilities within regional correctional jurisdictions. This and similar approaches would improve the quality of medical services provided for specific health conditions.

Introduction of mental health programs in correctional facilities

A survey revealed that inmates exhibit significantly higher levels of stress and depression compared to the general population. Poor mental health among the incarcerated not only diminishes their overall health status but also contributes to adverse outcomes, including conflicts, violence, and self-harm. These findings underscore the importance of proactive mental health management. Correctional facilities might benefit from adopting a mental health program akin to that of Jinju Correctional Institution, which focuses on managing psychiatric disorders.

An initial mental health evaluation by a psychiatrist should be incorporated into the intake health screening process. Individuals identified as high-risk should receive psychiatric care, whereas other inmates should have access to mental health programs, such as those offered at Jinju Institution. The mental health of inmates should be regularly assessed, with mental health nurses and clinical psychologists available on-site in collaboration with psychiatrists. For inmates with high depression scores, targeted psychological support should be provided, and measures should be taken to mitigate or eliminate exacerbating factors.

Post-release, these mental health programs should continue in partnership with community mental health centers, such as regional and metropolitan facilities, as integral components of community mental health initiatives. This approach includes the provision of training and support for program coordinators to establish a robust support system. For a detailed description of the program, refer to Supplement 1.



Management plan for severe illnesses, such as cancer, and emergency medical systems in correctional facilities

A robust healthcare management system is crucial in correctional facilities, especially for managing severe illnesses such as cancer and for establishing an effective emergency medical response. For conditions like cancer, thorough monitoring should commence at intake via the cross-referencing of health insurance records, ensuring that undiagnosed cases are not overlooked. When new cases of cancer or other severe illnesses are identified within a correctional facility, it is crucial to coordinate closely with public health centers and community medical institutions to ensure patients are registered for specialized care. Those registered with cancer must receive proactive management both within the facility and through external healthcare services.

Within correctional facilities, patients with cancer and other severe illnesses must be immediately assigned to medical units, with specialized medical rounds tailored to their needs. Effective management of these patients and the ability to respond to potential emergencies necessitate ongoing training to improve the skills of medical officers, as well as the securing of sufficient medical personnel. This goal also entails minimizing delays in emergency medical services that may result from staffing shortages, especially on weekends and holidays.

For cases in which adequate care cannot be provided within the facility, a robust protocol should be in place to secure external treatment from community healthcare institutions. Active medical intervention from these external facilities should be readily accessible to manage severe conditions effectively.

Ongoing efforts by the National Human Rights Commission

The National Human Rights Commission should conduct periodic investigations into the cases of inmates with suspended sentences, deceased inmates, and individuals who frequently file health-related complaints. Additionally, it is necessary to conduct a comprehensive health rights survey encompassing all inmates in correctional facilities across the country every 3 to 5 years. Finally, health rights-focused human rights education must be provided to prison wardens, medical officers, and key senior staff members. Since the primary responsibility for upholding inmate health rights rests with the management of these facilities, particularly the prison wardens, medical officers, and senior officials, their awareness of health rights is directly linked to the protection of these rights among inmates within their respective institutions. Therefore, as a component of the Commission's human rights education initiatives, it is vital to deliver targeted health rights education to these key supervisory figures.

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Conflict of interest

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Data availability

Not applicable.

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Not applicable.

Supplementary materials

Supplementary materials are available from: https://doi.org/10.12771/emj.2024.e75.

Supplement 1. Original Korean report of this article

Editor's note

Inmates may represent a marginalized group within healthcare.

References -

- Choi YS, Lee SH, Yoon OK, Keum YM. Study on advancing correctional protection to prevent recidivism - detailed research topic 1: a study on international standards related to correctional treatment. Seoul: Korean Institute of Criminology and Justice; 2014.
- 2. Keum YM. Study on international rules for the treatment of prisoners. *Correct Res* 2016;71:161-190.
 - https://doi.org/10.14819/krscs.2016.26.2.7.161
- 3. Park YK. Medical treatment for prisoners. Correct Rev 2010;48:73-105.

Case Report



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Determining the timing and extent of amputation in symmetrical peripheral gangrene: a report of three cases from Korea

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Keywords

Amputation; Antiphospholipid syndrome; Disseminated intravascular coagulation; Diabetes mellitus; Gangrene



Symmetrical peripheral gangrene is a severe condition marked by symmetric acral necrosis without obstruction of the major blood vessels. This case report examines the critical decisions involved in choosing between early and delayed amputation, as well as determining the extent of the necessary amputation. We present three cases: one involving antiphospholipid syndrome, another with disseminated intravascular coagulation, and a third associated with diabetes mellitus. All three cases ultimately required amputation due to symmetrical peripheral gangrene. In the first two cases, amputation was delayed, which is typically advantageous as it allows for the clear demarcation of necrotic tissue. However, in the third case, where infection was evident, immediate amputation was necessary despite the patient's overall poor health.

Introduction

Symmetrical peripheral gangrene (SPG) is a devastating condition characterized by symmetric acral necrosis without large vessel obstruction, often associated with septicemic conditions [1] and disseminated intravascular coagulation (DIC) [2]. In this case report, we describe three cases: one of antiphospholipid syndrome, one of DIC, and one of diabetes mellitus, all of which resulted in amputation due to SPG. Our primary protocol is to delay amputation until the gangrene is well established. However, should signs of infection appear, early amputation is recommended.

Case presentation

Ethics statement

This case report was approved by the institutional ethics committee (IRB NO: KNUH 2021-10-026). Consent for publication was obtained from the patients or their family members.

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Case 1

Patient information and clinical findings

A 76-year-old woman presented to the emergency department with pain in her bilateral fingers and toes, which began 1 day prior to admission.

Diagnostic assessment and final diagnosis

Photoplethysmographic examination revealed no flow in both the toes and fingers, with the exception of the right thumb. The patient's coagulation profile indicated a d-dimer level of 24.63 mg/dL and antithrombin III at 64.6%. A lupus anticoagulant value of 1.21 was also detected. Based on these findings, the patient was diagnosed with antiphospholipid syndrome.

Therapeutic intervention

Given the patient's high risk of developing sepsis, a central line was placed. The patient was treated with alprostadil and underwent heparinization. A dark discoloration appeared and progressed symmetrically up to the middle phalanges (Fig. 1). Within 3 days after admission, the patient stabilized, and a clear demarcation line was established, leading to a series of amputations.



Fig. 1. A 76-year-old woman with sharp aggravating pain and cyanotic changes on the tips of fingers and toes. She was diagnosed with antiphospholipid syndrome and later experienced dark discoloration with symmetric progression up to middle phalanges. The patient then underwent a series of amputations involving the fingers and toes on both sides.



Follow-up and outcomes

The patient tolerated the procedures well and did not experience any recurrence.

Case 2

Patient information and clinical findings

A 49-year-old man diagnosed with rectal carcinoma (stage T3N2M0) underwent laparoscopic anterior resection of the colon. Three days post-surgery, the patient experienced anastomotic leakage. As his clinical condition worsened, he underwent an emergency segmental resection of the colon, coloanal anastomosis, and loop ileostomy. Following these procedures, he was transferred to the intensive care unit and placed on a mechanical ventilator. Blood cultures revealed the presence of *Escherichia coli*, and his hemoglobin level dropped to 5.9 g/dL. Treatment included a dobutamine drip and a norepinephrine drip, stabilizing his blood pressure at 100/60 mmHg.

Diagnostic assessment

Laboratory analysis indicated signs of DIC, with fibrinogen levels at 216 mg/dL, antithrombin III at 31.9%, D-dimer at 1,216 mg/dL, PT at 35.2%, PTT at 57.6 seconds, INR at 2.15, and a platelet count of 70,000/cc.

Therapeutic intervention

Sixty units of platelets, two pints of packed blood cells, and 10 units of fresh frozen plasma were transfused. Treatment with vasopressors was continued, as both hands and feet became cold, and blue discoloration appeared. Within 2 days, dry gangrene appeared on the digits of all four limbs and symmetrically progressed up to the bilateral wrists and distal calves (Fig. 2). Once the patient's overall condition and the gangrene stabilized, bilateral open below-knee and below-elbow amputations were performed.

Follow-up and outcomes

The patient tolerated the procedures well and did not experience any recurrence.

Case 3

Patient information

A 53-year-old woman with end-stage kidney disease, who was undergoing dialysis, and had a long-standing history of diabetes mellitus, was admitted to the hospital. She had been receiving hemodialysis three times a week and had been on insulin injections for two years prior to her admission.

Clinical findings

One year before admission, the patient underwent percutaneous transluminal angioplasty in the right forearm, which was followed by the development of distal gangrene. Treatment included acetylsalicylic acid, clopidogrel, and warfarin. Six months before hospital admission, gangrene with infection appeared at the fourth fingertip of the right hand and on both feet (Fig. 3). Cultures from wound pus identified methicillin-resistant *Staphylococcus aureus* (MRSA), leading to the administration of oxacillin and vancomycin. A phase bone scan indicated a soft tissue infection in the left foot.





Fig. 2. A 49-year-old man who later showed a septic manifestation and consumptive coagulopathy. On the second day of inotropic use, dry gangrene of the digits developed and progressed symmetrically up to (A) the bilateral wrists and (B) distal calf, including the ankles and feet.



Fig. 3. A 53-year-old woman with end-stage kidney disease on dialysis and a long history of diabetes mellitus had gangrene with infection at the fourth fingertip of her right hand and both feet. Due to the presence of an infection, the patient underwent prompt amputation.

The patient's condition continued to deteriorate, characterized by persistent fever and poor oral intake. Concurrently, the CRP levels consistently rose, reaching values above 30.79 mg/dL.

Therapeutic intervention

Amputation was initially performed on the right hand and fourth finger, followed by the amputation of the first toe on the right foot, and subsequently, the fourth finger of the left foot.



A stronger antibiotic, meropenem, was administered, along with regular incision and drainage procedures. Despite these measures, wound healing remained poor.

Follow-up and outcomes

The patient's general condition kept worsening until her death 3 months after admission.

Discussion -

In the first case, antiphospholipid syndrome was identified as the underlying cause of gangrene. Lupus anticoagulants are associated with an odds ratio for thrombosis that is 5 to 16 times higher than that of controls. This increased risk applies regardless of the thrombosis's location and type, and whether systemic lupus erythematosus is present [3]. The "two-hit" model of thrombosis associated with antiphospholipid syndrome proposes an initial "first hit" that disrupts the endothelium, followed by a "second hit" that promotes thrombus formation [4]. The presence of sepsis in this patient exacerbated the reduction in blood supply to the most distal parts of the body. Heparinization was implemented to prevent further clot formation, although it could not reverse the existing damage.

The second patient had a neoplastic condition with *E. coli* isolated from the blood culture. *E. coli* contains lipopolysaccharide in its outer layer, which can trigger endotoxic shock. This, in turn, activates the coagulation system, leading to consumptive coagulopathy. Fibrin thrombi were observed in skin biopsy specimens or those from various organs with a history of SPG during the postmortem examination, suggesting DIC [2].

Despite recognizing the inotropic agent as the cause of gangrene progression in the second case, the cost of discontinuing the treatment was deemed too high. A prompt surgical approach was only considered once the patient's general condition had stabilized. It is also advisable to wait until a clear demarcation line of gangrene is established, as viable tissues may exist beneath the necrotic skin [5]. The extent of the early symptoms will likely decrease after revascularization around the gangrene. Therefore, early amputation could potentially extend the gangrene or lead surgeons to overestimate the necessary level of amputation.

In the third patient, the cause of gangrene was undetermined. However, the patient had diabetes mellitus. Microangiopathy in patients with diabetes mellitus impairs blood flow, especially to the most distal parts, and initially creates dry gangrene [6]. Additionally, diabetes mellitus increases susceptibility to infections [7].

In the third case, early amputation was warranted because the increasing CRP indicated infection. For patients with diabetes, many authors advocate early surgery since infections may further disturb local microcirculation and antibiotics cannot penetrate the site of infection [8,9]. Wound culture also revealed infection by MRSA, which is associated with worse outcomes in patients with diabetic foot infections.

The patients in the first two cases tolerated the procedures well and experienced no recurrence. With the aid of suitable prostheses, they were able to carry out their daily activities. Therefore, these cases highlight the importance of tailored assessments that consider the underlying condition, the progression of necrosis, and the status of infection to enhance outcomes and minimize morbidity in the management of SPG.

In conclusion, SPG is a severe complication that necessitates careful consideration of both the timing and level of amputation. The cases discussed here demonstrate that a delayed approach to amputation is generally advantageous in instances of antiphospholipid syndrome and DIC,



as it allows for a well-demarcated border of necrosis to form. However, early amputation is imperative in the presence of infection, such as in diabetes mellitus with MRSA infection, to prevent further systemic deterioration. The decision on the appropriate level of amputation hinges on achieving clear demarcation of necrotic tissue to avoid unnecessary removal of viable tissue, while also taking into account the patient's overall condition and response to revascularization efforts. In situations where infection impairs local blood flow or where antibiotics are ineffective in penetrating the affected area, early intervention at a higher level of amputation may be necessary to control the infection and improve the potential for healing.

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References -

 Goodwin JN. Symmetrical peripheral gangrene. *Arch Surg* 1974;108(6):780-784. https://doi.org/10.1001/archsurg.1974.01350300022006



- 2. Parmar MS. Symmetrical peripheral gangrene: a rare but dreadful complication of sepsis. *CMAJ* 2002;167(9):1037-1038.
- 3. Gonzalez ME, Kahn P, Price HN, Kamino H, Schaffer JV. Retiform purpura and digital gangrene secondary to antiphospholipid syndrome successfully treated with sildenafil. *Arch Dermatol* 2011;147(2):164-167.
 - https://doi.org/10.1001/archdermatol.2011.4
- 4. Sheng GH, Aronowitz P. The lesser known side-effect of warfarin: warfarin-induced venous limb gangrene. *Mayo Clin Proc* 2014;89(5):E47. https://doi.org/10.1016/j.mayocp.2013.05.037
- 5. McGouran RC, Emmerson GA. Symmetrical peripheral gangrene. *Br Heart J* 1977;39(5):569-572.
 - https://doi.org/10.1136/hrt.39.5.569
- 6. Singh S, Chand G, Charan S, Arora S, Singh P. Peripheral arterial disease and digital gangrene: a rare presentation of diabetic hand syndrome. *J Clin Diagn Res* 2013;7(1):2286-2287.
 - https://doi.org/10.7860/JCDR/2013/5584.3498
- 7. Schlienger JL. Complications du diabète de type 2. *Presse Med* 2013;42(5):839-848. https://doi.org/10.1016/j.lpm.2013.02.313
- 8. Frykberg RG, Wittmayer B, Zgonis T. Surgical management of diabetic foot infections and osteomyelitis. *Clin Podiatr Med Surg* 2007;24(3):469-482. https://doi.org/10.1016/j.cpm.2007.04.001
- Aragón-Sánchez J, Quintana-Marrero Y, Lázaro-Martínez JL, Hernández-Herrero MJ, García-Morales E, Beneit-Montesinos JV, et al. Necrotizing soft-tissue infections in the feet of patients with diabetes: outcome of surgical treatment and factors associated with limb loss and mortality. *Int J Low Extrem Wounds* 2009;8(8):141-146.
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A day in the life of a public health center director in a rural area, Korea

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Chanbyoung Park Buan-gun Health Center, 124 Orijeongro, Buan 56314, Korea E-mail: bluecow49@korea.kr On Monday mornings, I arrive earlier than usual (Fig. 1). At 8:30, there is a senior staff meeting at the county office. Over the weekend, I review any changes to the report for that meeting, which was originally sent out the previous week, and plan how to explain everything concisely. This habit applies to other weekdays as well, as I also arrive at work by eight. On days without meetings, I sit quietly in my office and scan the morning papers—one national and one regional—looking for articles related to health centers. Additionally, I open a file containing every local article about Buan County.

Responsibilities extending beyond medical issues

A public health center's responsibilities extend beyond medical issues. Social, cultural, and even political events can influence our tasks. Over time, I have trained myself to gather as much information as possible. Our rapid-response unit has recently required close attention. Just as I



Fig. 1. Photo of the author, Dr. Chanbyoung Park, in front of the Buan-gun Health Center on January 15, 2025 (provided by the author).

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began writing this piece, a Jeju Air plane crash occurred at Muan Airport in Jeollanam Province (December 29, 2024). Our emergency contact system was activated, and the county office asked us to determine whether any county employees or residents were affected. I relayed directives to the health center managers and discussed the possibility of deploying our unit with the team leader. Although the accident site was far away, a large-scale disaster could still necessitate additional support. We also decided to review the local health center's response later—assessing what was done well, what was lacking, and how to improve. In a mass-casualty situation, the fire station responds first. If they request our assistance, the rapid-response team and a disaster medical assistance team from a university hospital work together on-site. We set up a field station, triage patients, provide first aid, and coordinate hospital transfers. As the health center director, I oversee these operations. Remaining prepared and well-trained is vital for coordinating with the fire station promptly when needed. Checking the disaster-response group chat has become second nature.

Back at the public health center, I lead a meeting with team leaders. I communicate the county mayor's directives, highlight important tasks from other departments, and listen to each team's work plans for the week. If any issues are complex or require more in-depth discussion, we address them afterward.

Isolation of an active tuberculosis patient -

Today (January 13, 2025), the Infectious Disease Prevention Team convened to discuss a critical case. An elderly patient in a nursing facility tested positive for tuberculosis bacteria in a sputum culture, indicating a high risk of transmission. We must arrange for this patient's admission to a hospital designated for tuberculosis isolation; however, the guardian is not cooperating. The patient denies having tuberculosis, complicating enforcement even with an available isolation bed. Additionally, his limited mobility necessitates a caregiver. For two days, the team leader and staff negotiated by phone with the guardian, the hospital, and a caregiver agency. Ultimately, they used government funds to cover transportation and caregiving costs, and by evening, we successfully arranged the isolation admission. Tomorrow, we will conduct an epidemiological assessment of 75 close contacts.

County official's proposal and backup by a healthcare specialist

Ever since local elections granted greater authority to county officials, they have proposed health policies that prioritize residents' needs. In our county, these initiatives include free herpes zoster vaccinations, subsidized knee replacement operations, and increased childbirth stipends. Herpes zoster vaccination is already a routine procedure for many middle-class individuals, so providing it at no cost to those over 50 seems both fair and beneficial for lower-income populations. However, subsidizing knee replacement surgeries raises concerns about potential overtreatment. Nevertheless, for low-income groups, covering out-of-pocket expenses that insurance or medical aid does not fully cover is a significant relief. Childbirth stipends present an even more complex issue. Many municipalities offer these stipends, but the amounts vary widely. Some officials believe that increasing the payments will boost birth rates and revitalize declining areas; however, a one-time payment is not a comprehensive solution. The Ministry of Health and Welfare attempts to mitigate reckless competition through the Social Security



Review Committee. Consequently, we decided to replace our existing policy with a postpartum care subsidy. After receiving approval from the mayor and endorsement from the county council, we launched the new plan. These initiatives intertwine medical, legal, policy, and political considerations. It required several days of discussions with my department chief, team leaders, and staff, along with visits to the ministry and budget negotiations with the mayor and council, to move forward effectively.

Online meetings and a decision as a government official

In our era of advanced information technology, video conferences, which surged during the COVID-19 pandemic, have become commonplace. Our county established a dedicated system on our official network, which is now used once or twice a week. Early in the pandemic, I participated in video calls led by the Prime Minister or the Health Minister to reduce face-to-face contact. More recently, the discussions have centered on the medical community's protests regarding the increase in medical school admissions for 2025. The resignation of medical residents primarily affects large urban hospitals, so rural health centers are less impacted. However, if collective action occurs, my dual role as a public official and a member of the Korean Medical Association puts me in a difficult position. While individual members have the option to join the association's protests, fulfilling my official responsibilities is mandatory, which makes the implications of these decisions quite clear.

One Health concept -

That afternoon, the leader of our Infectious Disease Response Team reported an outbreak of avian influenza at a duck farm with 30,000 ducks. We encounter situations like this almost every winter due to the number of local duck farms. The Livestock Division prepared for a culling operation, established a quarantine perimeter, and restricted traffic in the area. Our health center trained the 50 workers involved in the culling on infection prevention, vaccinated them against influenza, and recorded their contact information. Shortly afterward, the provincial research laboratory confirmed a highly pathogenic strain, heightening our concerns. Fatalities have occurred in other countries due to such strains [1]. We dispatched staff to monitor the culling process, ensure that protocols were followed, and remind workers to report any flu-like symptoms. In 2023, we also encountered an outbreak of lumpy skin disease in cattle [2], which is transmitted by bloodsucking insects and carries a high fatality rate. Alongside the Livestock Division's disinfection and quarantine measures, we mobilized the health center and local offices to reduce mosquitoes and other biting insects. This incident underscored the One Health concept: the health of humans, animals, and the environment is interconnected and must be safequarded collectively.

The leader's burden for the staff's peace of mind

Finally, dusk approaches, reminding me that it is time to head home. I check tomorrow's schedule in my planner: there is a meeting with the local National Health Insurance branch manager, along with several major agenda items I need to review for the county council. Additionally, I am rotating all 111 employees. Trying to place everyone appropriately while honoring their preferences weighs heavily on my mind. I recall the adage that a leader should



bear the burdens so the staff can find peace. Holding that thought, I leave the office, my steps feeling heavier than I would like.

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References -

- 1. Zhuang Y, Wang M, Liang L, Mao Y, Wang K, Yang S, et al. First known human death after infection with the avian influenza A/H3N8 virus: Guangdong Province, China, March 2023. Clin Infect Dis 2024;78(3):646-650.
 - https://doi.org/10.1093/cid/ciad462
- 2. Ra D, Kim HS, Jeong C, Yoo D, Cho HS, Oh Y. Lumpy skin disease outbreak and quarantine in the Incheon area. Korean J Vet Serv 2024;47(3):179-183.
 - https://doi.org/10.7853/kjvs.2024.47.3.179