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## From The Editor In Chief

The global demographic shift toward an aging population has profound implications for healthcare systems, public policy, and societal well-being. In this context, the importance of rigorous, multidisciplinary research in geriatrics and clinical gerontology cannot be overstated.

These fields are essential for developing effective strategies to address the complex and interrelated health, functional, and psychosocial needs of older adults.

Geriatrics provides the clinical framework for managing multimorbidity, polypharmacy, frailty, cognitive decline, and functional impairment—conditions that disproportionately affect the aging population.

Clinical gerontology, on the other hand, encompasses broader aspects of aging, including biological, psychological, and social dimensions, offering insights into preventive care and health promotion across the lifespan.

Despite the growing urgency, geriatrics and gerontology remain underrepresented in national and international research agendas. This gap limits the development of innovative, evidence-based interventions that could improve quality of life, reduce healthcare costs, and promote independence among older individuals. Moreover, addressing the heterogeneity of the older population requires personalized approaches informed by solid scientific data.

Investment in these fields will not only enhance clinical practice and care delivery but also inform ethical and policy frameworks for long-term care, caregiver support, and aging in place.

As longevity increases, the societal demand for well-coordinated, compassionate, and effective care for older adults will continue to grow.

Research in geriatrics and clinical gerontology is therefore not a luxury—it is a necessity for ensuring the health and dignity of aging populations.

Yeşim GÖKÇE KUTSAL

INVITED REVIEW ARTICLE

# BEYOND THE BONE: RETHINKING SPINE SURGERY THROUGH THE LENS OF SARCOPENIA

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## Abstract

Historically, spinal surgery has prioritized bone integrity, often overlooking the biomechanical significance of the paraspinal muscles. Sarcopenia, an age-related decline in muscle mass, strength, and function, has emerged as a critical modifier of spinal pathology and surgical outcomes. Sarcopenia is characterized by progressive myosteatosis, particularly in the multifidus and erector spinae, which contributes to spinal imbalance, chronic pain, and functional decline. Fatty infiltration, a key marker of muscle degeneration, is strongly associated with frailty, reduced mobility, and impaired quality of life.

Spinal musculature plays an essential role in maintaining posture, segmental control, and load-bearing capacity. Muscle deterioration exacerbates spinal deformities and degrades surgical outcomes, particularly during procedures involving extensive dissection or fusion. Even minimally invasive techniques may result in scarring and atrophy, increasing the risk of complications, such as nonunion, adjacent segment disease, or implant failure.

As spinal sarcopenia becomes increasingly prevalent in aging populations, surgical strategies must evolve accordingly. Minimally invasive motion-preserving approaches, along with targeted rehabilitation, are essential for preserving muscle function. Radiological assessments should routinely include muscle density and bone metrics, and sarcopenia should be integrated into surgical planning as well as risk stratification.

Recognizing the spinal musculature as a dynamic, modifiable structure—rather than a passive one—is imperative. Addressing sarcopenia through a comprehensive preoperative evaluation, intraoperative techniques, and postoperative rehabilitation may significantly enhance patient outcomes and long-term spinal health.

***Keywords:*** Spine; Aging; Sarcopenia.

## INTRODUCTION

In the last part of the past century, spine surgeons' primary focus was traditionally centered on bone integrity. Their training, which was rooted in anatomical dissections and static radiological imaging, did not emphasize the dynamic nature of human movement or the biomechanical role of soft tissues, particularly the spinal musculature. Consequently, the paraspinal muscles that stabilize the spine have often been compromised during spinal surgical procedures, leading to unintended long-term consequences.

Despite showing optimal radiological outcomes postoperatively, many patients continued to experience diminished quality of life. They were often discharged with a simple set of illustrated exercises and then referred for physical therapy and rehabilitation. Through the subsequent efforts of physical therapy researchers, the crucial role of muscle function, especially as it relates to aging and spinal pathology, has been brought to the forefront.

This shift in understanding led to the conceptualization of sarcopenia, defined as the age-related loss of muscle mass, strength, and function. The etiology of sarcopenia remains multifactorial and has not yet been completely elucidated. A confluence of determinants, including suboptimal nutritional status, sedentary behavior, and the presence of age-associated chronic illnesses,contributes to the progressive decline in skeletal muscle mass and function observed with advancing age (1).

Several interrelated pathophysiological mechanisms have been implicated in the onset and progression of this degenerative condition, including chronic low-grade inflammation, mitochondrial dysfunction, oxidative stress, resistance to insulin and anabolic stimuli, and alterations in endocrine function (2). A diagram of the pathogenesis of sarcopenia during aging is shown in Figure 1. Different physiological and pathological factors contributing to muscle protein breakdown and ultimately resulting in sarcopenia should also be considered (Figure 2) (3).

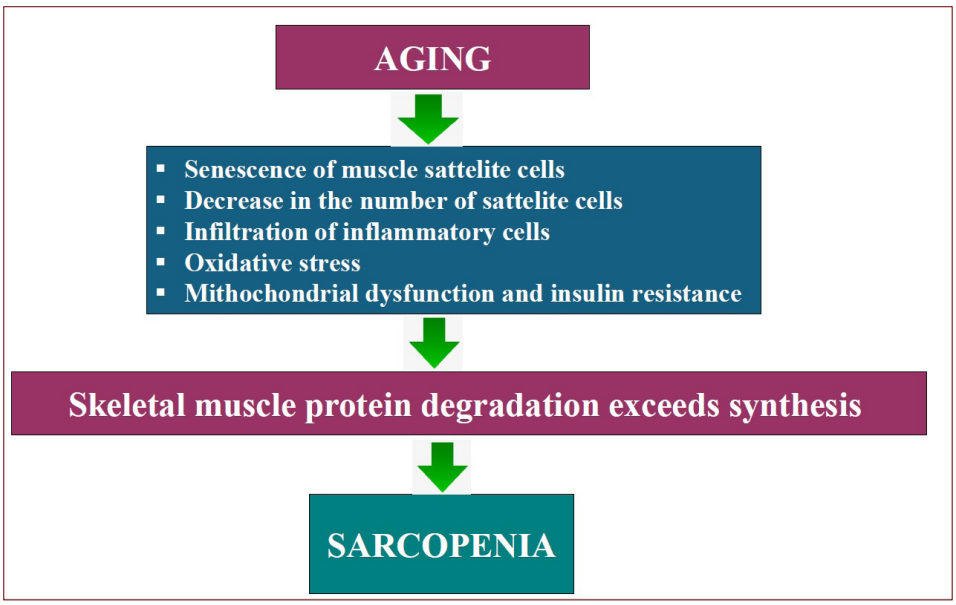



**Figure 1.** Schematic diagram of the pathogenesis of sarcopenia during the aging process.

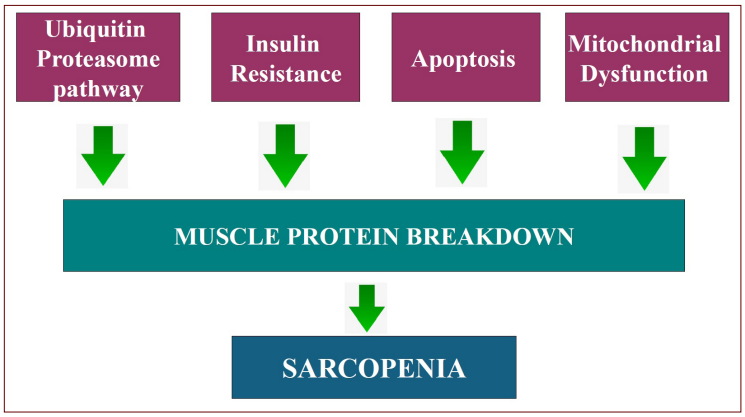



**Figure 2.** Various physiological and pathological factors contribute to muscle protein breakdown, ultimately resulting in sarcopenia.

## Spinal Myosteatosis

Muscle mass peaks in early adulthood and gradually declines after 50 years of age. Age-related atrophy is associated with structural alterations, including the replacement of muscle tissue with adipose tissue, increased intramuscular fat and connective tissue, muscle fiber-type transformation, and localized inflammation (4). In recent decades, research on sarcopenia has emphasized that the paraspinal muscle volume and strength are significantly reduced in affected individuals, directly affecting spinal function (1).

Myosteatosis, a fatty degeneration characteristic of spinal sarcopenia, has been increasingly observed in older, obese (5), and postmenopausal women (6), with a progressive increase in fat infiltration from the cranial to the caudal spine (7). The multifidus muscle showed the most significant decline (8). Definitions of sarcopenia have become closely associated with frailty syndrome, which is typically characterized by unintentional weight loss, self-reported exhaustion, muscle weakness (e.g., reduced grip strength), slow walking speed, and reduced physical activity.

To mitigate back pain, patients often reduce the movement of painful areas, which leads to disuse and subsequent muscle atrophy. This promotes anterior trunk tilt, increased intramuscular pressure, and ischemic progression. The resulting ischemic pain leads to further disuse, creating a vicious cycle in which pain leads to increased fat infiltration, postural imbalance, and exacerbated pain (9).

Fat infiltration is a widely used marker of muscle degeneration (10). Objective quantification systems such as those developed by Kjaer, Goutallier, and Kalichman provide grading scales for fatty infiltration, primarily using CT and MRI, the current gold standards for evaluating the multifidus, erector spinae, and psoas muscles (10,11,12).

## Spinal Dynamics

The erector spinae muscles are arranged vertically like the ropes of a mast, maintain both sagittal and coronal balance by resisting external trunk loads, and preserve upright posture. They function as global tension bands that regulate spinal movement and bear axial pressure on the lumbar spine (13).

The multifidus is the most medially located deep paraspinal muscle with the broadest muscle attachment across the spinal segments. Vertical and transverse fiber orientations play a key role in proprioception and the fine-tuning of segmental mobility. The multifidus spans two to five motion segments, with the shortest fascicles attaching deeply to the spinous processes and helping distribute stress during trunk stabilization and rotation (14). A moderate correlation has been reported between the multifidus cross-sectional area and the global spinal or spinopelvic alignment.

The psoas muscle, particularly its intermediate and superficial fascicles, is the only paraspinal muscle that connects the spine directly to the lower limbs. It contributes significantly to postural stability by increasing lumbar stiffness via axial compression and supports ambulation through its relatively short moment arms and equal-length fascicles (15).

Muscle density is as critical as bone density in determining spinal endurance. Paraspinal muscle quality is closely linked to lumbar vertebral bone mineral density (BMD), aligning with the "musculoskeletal unit" theory. This theory suggests that reducing paraspinal muscle fatty infiltration—for example through targeted exercise—could lead to improvements in lumbar BMD, possibly revealing a reciprocal relationship between sarcopenia and osteopenia (6).

Well-conditioned spinal musculature can effectively compensate for minor sagittal or coronal imbalances, resulting in fewer symptoms. Conversely, poor muscle quality often results in significant symptoms, even with moderate misalignment (16). Extensive muscle degeneration is implicated in flat back syndrome, and there is a linear correlation between fat infiltration and the severity of spinal curvature deformities (17). Spinal sagittal imbalance cannot be fully explained by the vertebral or disc height alone, and muscle quality is a significant determinant. Accordingly, lumbar muscle fat infiltration is recognized as an independent factor associated with reduced quality of life (18).

The detrimental effects of sarcopenia progress slowly and insidiously, unlike the acute muscle loss observed in malnutrition, sepsis, and cancer. Therefore, its clinical impact may require considerable time.

## Surgical Implications

Painful spinal syndromes in elderly patients are often treated surgically when conservative treatment options are exhausted or ineffective. However, surgical spinal fusion techniques have long been known to damage paravertebral muscles. This is almost unavoidable in procedures involving osteotomies to correct sagittal or coronal imbalance (19). Even with minimally invasive techniques, muscle specimens often exhibit extensive scarring postoperatively (20).

Studies have demonstrated that paraspinal muscle volume diminishes following spinal surgery, including anterior stand-alone fusion (21). Furthermore, dysfunctional motion segments and mechanical instability were more pronounced after fusion than decompression-only procedures (22).

Surgical dissection and the resulting scarring contribute to long-term muscle dysfunction and complications such as nonunion (23), adjacent segment degeneration (24), and proximal junctional failure (25). These complications compromise patient satisfaction and quality of life, and may culminate in failed back surgery syndrome (26). Recent studies have associated increased fat infiltration in the lumbar paraspinal region with poor outcomes after surgery (27). Just as spinal implants in osteoporotic bone are more prone to failure, those placed in atrophic musculature are also at a higher risk of dislodgement, particularly in long-level fusions (28).

This necessitates a shift toward minimally invasive and motion-preserving hybrid dynamic techniques. As the prevalence of spinal sarcopenia increases in tandem with the aging population, preserving paraspinal muscle integrity during surgery is paramount. Similarly, mitigating intramuscular fat accumulation in older adults should be prioritized.

Postoperative rehabilitation should include structured physical activity, particularly resistance and multicomponent exercise training targeting the paravertebral muscles both selectively and unilaterally, based on the patient's functional deficits (29). Additionally, it is essential to reestablish the muscle balance between the trunk flexors and extensors (e.g., rectus abdominis vs. erector spinae, external/internal obliques vs. multifidus, and

erector spinae vs. psoas) through core stabilization programs (30).

## CONCLUSION

Given the significance of paraspinal muscle function, muscle atrophy assessments should become standard components of radiology reports along with bone density measurements. Spine surgeons must be cognizant of these parameters during preoperative planning.

A critical gap is the omission of muscle density as a modifier in surgical decision-making algorithms. Further studies investigating the prognostic value of paraspinal muscle atrophy on postoperative outcomes are urgently needed. Such insights can support surgical decision-making and improve treatment strategies.

Only through such integrative approaches can the spinal musculature be preserved—not as a passive structure, but as a dynamic, functional system essential to spinal biomechanics and long-term patient outcomes.

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ORIGINAL ARTICLE

# EFFECTS OF PREOPERATIVE SUPRA-INGUINAL FASCIA ILIACA BLOCK APPLIED TO PATIENTS OVER 65 YEARS OLD WITH HIP FRACTURES

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## Abstract

**Introduction:**A large number of patients are hospitalized each year due to hip fractures in the elderly population. Conventional pain management is difficult in this age group. Ineffective pain management and side effects of analgesics may increase morbidity and prolong the hospital stay. Ultrasound-guided Supra-inguinal fascia iliaca block(SFICB)are useful in these cases.

**Materials and Method:** Patients aged 65 years and older who presented to the hospital emergency department due to hip fracture, were scheduled for arthroplasty surgery, were able to answer the survey questions, and were not undergoing surgery within the first 24 hours were included in the study. Group B included patients who underwent SFICB for analgesia and Group C included patients who received conventional intravenous dexketoprofen, paracetamol, tramadol.

**Results:**In the block group, visual analog scale values at the 1st and 8th hours were statistically significantly lower. The values at the 16th and 24th hours were not significantly. All subscale scores of the 36-item short form quality of life scale except mental health, were found to be higher in the block group, and the differences were close to significance only for pain, role limitations due to physical health and general health. There were no differences between the groups in terms of State Trait Anxiety Inventory and 1- and 3-month mortality rates.

**Conclusion:**Preoperative SFICB provided effective early pain management and improved certain areas of quality of life in patients hospitalized with hip fracture. This simple, superficial block can be safely performed by the physician who first sees the patient.

***Keywords:*** Hip Fractures; Aged; Nerve Block; Quality of Life; Test Anxiety Scales.

## INTRODUCTION

In the elderly population, a large number of patients are admitted to the hospital every year due to hip fractures. Traditional pain management in this age group is difficult due to physiological changes and comorbidities. The side effects of analgesics are high. Ineffective pain management increases the risk of atelectasis, pneumonia, deep vein thrombosis, and may increase the length of hospital stay. Ultrasound (USG)-guided fascia iliaca block can be used for postoperative pain management or for analgesia while waiting for surgery in those receiving anticoagulant therapy in the preoperative period (1,2). Nerve blockade also makes it easier to position if the surgery is to be performed with regional anesthesia. Multimodal analgesia techniquessuch as systemic NSAIDs, paracetamol, opioids are applied in patients with or without regional block. It was reported that in patients with hip fractures, preoperative fascia iliac block reduces pain, morbidity and mortality. (3,4). The supra-inguinal fascia iliaca compartment block (SFICB) was described by Hebbard et al(5). SFICB has been used in hip surgery in adults (6). SFICB aims to block the femoral, lateral femoral cutaneous and obturator nerves (7).

In this study, our primary aimwas to investigate the effectiveness of SFICB in terms of pain scores in patients with hip fractures. Our secondary aim was to investigate the effects on anxiety control, quality of life, length of hospital and intensive care unit stay, and early mortality.

## MATERIALS AND METHOD

After obtaining Ethics Committee approval from our hospital (24.01.2022, 129/15), a prospective randomized controlled study was conducted in accordance with the standards specified in the Declaration of Helsinki.Patients over the age of 65 who were admitted to the hospital emergency department due to hip fracture and were to undergo arthroplasty between June 2022 and May 2023 were included in the study. All patients signed and informed consent form and were able to answer the survey questions.

Patients with chronic pain problems, multiple fractures, a history of surgery for spine or extremity fractures, a history of psychiatric illness, who did not accept to participate, and who would undergo surgery in the first 24 hours were excluded.

Preoperative evaluation was done in the emergency room; patients were informed about the study those who accepted participation were randomized into two groups according to their analgesia preference to receive either SFICB(Group B)or conventional intravenous (iv) analgesics including paracetamol, tramadol and dexketoprofen with standard dose and regimen (Group C). All blocks were performed by the same experienced anesthesiologist in the emergency department without sedation.

In the block group, while the patient was in the supine position, the anterior superior iliac spine was determined, a high-frequency (12 MHz) linear USG probe (LOGIQ P9, GE Ultrasound) was moved medially and inferiorly, and the internal oblique muscle in the cranial direction, the sartorius muscle in the caudal direction, the bow tie shape formed by these muscles, the underlying iliacus muscle and the fascia iliaca surrounding it were seen lateral, 50 mm needle as in plane it was directed medially, the iliac fascia was passed and 0.5ml/kg 0.25% bupivacaine was given underneath. The control group was treated with intravenous dexketoprofen, paracetamol and tramadol. Low molecular weight heparin (LMWH) treatment was started in patients receiving anticoagulants, and surgery was commenced within three days.

Visual analogue scale (VAS: 0-10) and block complications (hematoma, hemorrhage and local anesthetic systemic toxicity-LAST) were evaluated on the 1$^{st}$, 8$^{th}$, 16$^{th}$, and 24$^{th}$ hours after the block was performed. In patients receiving iv. analgesia



pain and complications(nausea, vomiting, dizziness, abdominal pain etc.) were evaluated at the same time points. If VAS ≥4 paracetamol iv 1 gram was added to the treatment as rescue analgesia.

State Trait Anxiety Inventory (STAI I-II) and 36-item short form quality of life scale questionnaires were administered to the patients at 4 hours after the procedure and the first analgesic intake. The STAI, which we used in the assessment of anxiety, was developed by Spielberger et al. in 1970. It was adapted to Turkish by Öner et al. in 1983 and its validity-reliability study was conducted (8).

STAI is a "Likert-type self-assessment" scale consisting of twenty-item state (STAI-I) and trait (STAI-II) anxiety scales. The total score ranged from 20 to 80, and a score of 52 and above was defined as "clinically significant state anxiety". If the state anxiety score is 52-56, it is classified as slightly high, if it is 57-61, it is high, and if it is 62 or above, it is classified as very high. Trait anxiety, on the other hand, is the scale that shows that there is an anxious life that does not occur according to a certain time and situation.

The SF-36 scale is aquality-of-life assessment scale designed to be used in clinical practice and research, evaluation of health policies in intensive care units and general population reviews. The validity and reliability study of the Turkish version was carried out by Koçyiğit et al. in 1999 (9). The scale, which contains thirty-six statements, is in the form of a multi-headed scale that evaluates 8 health areas. As the score increases, the quality-of-life increases. Physical function (10 items), social function (2 items), role limitations due to physical problems (4 items), role limitations due to emotional problems (3 items), mental health (5 items), energy/vitality (4 items), pain (2 items) and general perception of health (5 items). The 3 major health areas in SF-36 are "Functional status, well-being and general health understanding".

The primary outcome measure of the study was VAS pain scores,and secondary outcome measures were, anxiety and quality of life scores, length of stay in intensive care unit and hospital, and 1 and 3-month mortality results were compared.

### Statistical Analysis

Continuous variables were expressed as mean ± standard deviation or median (min-max), categorical data were expressed as numbers and percentages. The conformity of the data to the normal distribution was evaluated by the Kolmogorov Smirnov goodness of fit test. Student's T Test was used to compare the data that were suitable for the normal distribution between the groups, and the Mann Whitney U Test was used for the data that were not suitable. Comparisons of categorical data were made with the Chi-Square Test or Fisher's Exact Test. The analysis was performed with IBM SPSS version 27.0 (IBM Corporation, Armonk, NY, USA). Statistical significance level was considered as $p<0.05$.

*Sample size:*

Before the data collection phase, the number of samples required for the study was determined using the G*Power 3.1 (10) program. According to the previous study, when the VAS score of Group 1 was taken as 3, the VAS score of Group 2 was taken as 4 and the standard deviation was taken as 1; when the effect size was taken as 1.0, the alpha level as .05 and the power as 80%, the number of samples was found to be 17 for each group and 34 in total; when the power was taken as 95%, the number of samples was found to be 27 for each group and 54 in total. (11).

## RESULTS

Results were analyzed 56 patients, 34 patients in the block group and 21 patients in the iv. analgesia group. Patients who accept to participate in the study freely choose their analgesic regimen. Thus, all patients knew that they could opt for a block or intravenous analgesia. The patients were

randomly divided into study groups according to their analgesic regimen preferences. Before the procedure, some patients changed their minds and 7 patients in Group C asked for blocks. Since we had already included the patients in the study, we did not ask them to exclude them and included these patients in the block group (Group B), so the study groups do not include the same number of patients. The mean age of the patients included in the study was 78.27, 80.35% had American Society of Anesthesiologist (ASA)physical status classification III and 57.1% were female. There was no significant difference between the control and block groups in terms ofpatient characteristics, length of hospital and intensive care unit stay($p>0.05$) (Table 1).The depth of the block was similar in patients who received and did not receive anticoagulants and acetylsalicylic acid.

In the block group, 10 patients were on asetyl salicylic acid, and 11 patients were on anticoagulant drugs. There was no hematoma, bleeding and LASTin any of the cases after the procedure.

Patients were followed in the ward till the surgery. While the baseline VAS values (VAS 0) did not make

**Table 1.** Socio-demographic and Clinical Parameters of the Groups

| | Control group (n=21) | Block group (n=35) | p |
|---|---|---|---|
| **Age (years) (mean±SD)** | 76.66±9.95 | 79.88±9.32 | 0.228* |
| **BMI (kg/m2) (mean±SD)** | 25.40±2.92 | 24.52±3.51 | 0.342* |
| **ASA (II/III)** | 7/14 | 4/31 | 0.058** |
| **Block depth (cm) [median (min-max)]** | - | 0.9 (0.7-1.15) | - |
| **Length of hospital stay (day) [median (min-max)]** | 5 (2-29) | 4 (2-69) | 0.883* |
| **ICU length of stay (day) [median (min-max)]** | 1 (0-7) | 1 (0-17) | 0.928*** |
| **Gender (n, %)** | | | |
| Female | 12 (%57.1) | 20 (%57.1) | 1.000*** |
| Male | 9 (%42.9) | 15 (%42.9) | |
| **Use of acetylsalicylic acid (n, %)** | | | |
| No | 17 (%81.0) | 25 (%71.4) | 0.532**** |
| Yes | 4 (%19.0) | 10 (%28.6) | |
| **Use of anticoagulants (n, %)** | | | |
| No | 14 (%66.7) | 24 (%68.6) | 0.883*** |
| Yes | 7 (%33.3) | 11 (%31.4) | |
| **Mortality** | | | |
| 1st month | 1 (4.8) | 1 (2.9) | 0.614**** |
| 3rd month | 2 (9.5) | 4 (11.4) | 0.599**** |

ASA: American Society of Anesthesiologists, ICU:Intensive Care Unit

* Student's T Test

** Mann Whitney U Test

***Chi-square Test

**** Fisher's Exact Test



a significant difference between the control and block groups (8.95±0.80 and 8.68±0.83, p=0.245, respectively), the 1st hour and 8th hour VAS values were statistically significantly lower in the block group (2.14±1.19 and 1.88±0.90, respectively) compared to the control group (3.42±0.97 and 2.85±0.85, respectively) (p<0.001 and p<0.001, respectively), It was determined that the differences at 16th and 24th hours were not significant between the groups (p=0.541 and p=0.917, respectively) (Table 2).Rescue analgesia was used in 5 patients in both groups.

There was no significant difference between the STAI-I and STAI-II scale scores between the control and block groups (p=0.286 and p=0.853, respectively).

It was found that all subscale scores in the SF-36 quality of life scale, except MH, were generally lower in the control group than in the block group, and only the differences for pain, RLP and GH were close to the significance level (p=0.070, p=0.093 and p=0.081, respectively) (Table 3). High pain scores reflect the absence of pain or pain-related limitations.

**Table 2.** Comparison of VAS Scores of Groups

| | Control group (mean±SD) (n=21) | Block group (mean±SD)(n=35) | p |
|---|---|---|---|
| **VAS 0** | 8.95±0.80 | 8.68±0.83 | 0.245* |
| **VAS 1** | 3.42±0.97 | 2.14±1.19 | **<0.001*** |
| **VAS 8** | 2.85±0.85 | 1.88±0.90 | **<0.001*** |
| **VAS 16** | 2.52±0.81 | 2.37±0.94 | 0.541* |
| **VAS 24** | 2.61±0.74 | 2.60±0.60 | 0.917* |

* Student's T Test, VAS:Visual Analogue Scale

**Table 3.** STAI I-II and SF-36 Quality of Life Subscale Scores of the Groups

| | Control group (mean±SD) (n=21) | Block group (mean±SD) (n=35) | p |
|---|---|---|---|
| **STAI I** | 56.90±6.09 | 54.54±8.84 | 0.286* |
| **STAI II** | 47.66±6.72 | 47.34±6.06 | 0.853* |
| **P** | 29.28±19.02 | 40.00±23.99 | 0.070* |
| **PF** | 28.14±29.48 | 35.00±35.16 | 0.443* |
| **RLP** | 16.42±33.72 | 34.52±45.05 | 0.093* |
| **RLE** | 23.80±40.88 | 26.98±42.97 | 0.784* |
| **SF** | 28.92±23.24 | 31.54±18.79 | 0.664* |
| **V** | 26.20±13.93 | 31.19±19.80 | 0.274* |
| **MH** | 51.17±22.62 | 44.00±13.79 | 0.196* |
| **GH** | 27.97±12.39 | 35.71±20.26 | 0.081* |

* Student's T Test

STAI:State-trait Anxiety Inventory, pain (P), Physical function (PF), role limitations due to physical problems (RLP), role limitations due to emotional problems (RLE), social function (SF), energy/vitality (V), mental health (MH) and perception of general health (GH)

At the end of the 1st month, the mortality rates were similar to 4.8% (n=1) in the control group and 2.9% (n=1) in the block group (p=0.614), and at the end of the 3rd month, it was 9.5% (n=2) in the control group and 11.4% (n=4) in the block group and there was no significant difference (p=0.599) (Table 1).

## DISCUSSION

We evaluated the effects of SFICB on pain control, anxiety level, quality of life, length of intensive care and hospital stay, and early mortality in the preoperative period of patients scheduled for surgical treatment for hip fracture. Pain scores on the 1st and 8th hours were significantly lower in the patients who underwent block. Pain, RLP, and GH were higher in the block group as measured with the SF-36 quality of life scale. There was no difference between the groups in anxiety, length of intensive care unit and hospital stay, or early mortality.

In this study, the block was administered with the SFICB approach at the dose proven to be effective and with the recommended approach (12,13). Studies on the preoperative analgesic efficacy of FIB have shown that it reduces dependence on opioids in acute pain management and is an effective and safe supplement (1). In acetabular fractures, SFICB has been shown to provide a position for more effective analgesia and spinal anesthesia than fentanyl (14).

In a study by Azizoğlu et al. comparing SFICB and patient-controlled analgesia in major hip surgery, VAS values at rest during the first 6 hours postoperatively and during movement for up to 24 hours were significantly lower in the SFICB group (15). As in our study, it has been shown that there is a significant reduction in pain levels with SFICB, especially in the first 8 hours (3,16). The decrease in the difference in pain scores between the groups at 16 and 24 hours in this study resulted from the decreasing effects of the local anesthetic, and additional analgesic treatments or catheter applications may be needed (17). However, in their study, Garlichk et al. did not find a decrease in late-stage pain levels with catheter administration but observed less opioid consumption without an increased risk of complications. Preoperative analgesia is a key factor that can improve perioperative outcomes in geriatric hip fracture patients (18).

FIB application has been found to be more effective than parenteral or oral opiates and sedative agents alone in reducing pain scores in the preoperative period (19). Studies have also reported that it provides effective analgesia but causes muscle weakness after surgery (20). USG-guided FIB application is now included in the procedure specific postoperative pain management (PROSPECT) recommendations because it reduces opioid-related side effects and sedation in hip fractures and shortens the duration of spinal anesthesia with ease of position. A catheter is also recommended in appropriate cases (21).

With the introduction of USG into clinical practice, side effects, such as adjacent organ injury and hematoma, are no longer seen. USG is recommended to be performed in the emergency room, ambulance, or even at home by the physician who sees the patient for the first time (2). In the literature, it has been shown that FIB with a continuous infusion catheter is safe in patients using anticoagulants and/or antiplatelet drugs (22). We safely applied this block, which is considered a superficial block, at an average depth of 0.9 cm. No side effects, such as hematoma, bleeding, or LAST, were observed in any of the patients' using anticoagulants and/or ASA.

It has been determined that being single, having chronic disease and advancing age influence patients' surgery-specific anxiety, perceived stress and fear of surgery. Long-term chronic diseases can negatively affect individuals' anxiety levels (23).

Jung et al. found that one-third of geriatric patients undergoing hip fracture surgery experienced clinically significant anxiety, with a mean STAI score



of 47.2.The rate of anxiety was found to be higher in these patients than in patients with chronic hip disease, and the reason for this was sudden movement restrictions, accompanying excessive pain, and the thought that the patient would undergo surgery in a short time (24).The anxiety levels we found using STAI-I and II were similar between the two groups, but we did not have information about the patients' previous anxiety statuses. In our study, it was determined that FIB did not have a significant effect on anxiety levels. However, it is also known that pain management has an indirect effect on the psychological well-being of patients. Therefore, there is a need for studies that evaluate the relationship between pain management and anxiety in more detail and include larger samples.

The SF-36 quality of life scale, which provides information about general health status, includes eight domains. Aziz et al. found a significant decrease in quality of life on the SF-36 scale 6 months after hip fracture surgery (25). In our study, the SF-36 scale results were higher in the FIB group, especially in terms of pain, PF and limitations due to FRG. This suggests that effective pain management can contribute to overall functional recovery by increasing patients'postoperative mobilization.

In the other SF-36 domains, higher scores were obtained in the FIB group in terms of RLE, social function, vitality, and GH although the results were not statistically significant. Although this suggests that FIB provides a significant improvement in quality of life, additional interventions, such as physical therapy or psychosocial support, may be necessary to make a difference in some domains. The MH scores did not differ between the two groups. In a study measuring the quality of life in hip fractures, it was shown that only one-third of patients could return to their previous physical health, and this occurred within 3–12 months, and MH did not change much (26).

Some studies have shown that facia iliaca block shortens the length of hospital stay and reduces mortality (3,4). In our study, no significant difference was found between the groups in terms of length of stay in the intensive care unit and hospital. The average number of hospitalization days in the block group was 4–5 days, like the results in the literature. David et al., on the other hand, showed that continuous FIB reduced the length of hospital stay but did not affect mortality (27).

Hip fractures are a health problem with high mortality rates, especially in the population of the elderly. During the hospitalization process, one patient in the block group died due to postoperative Covid-19 infection. In our study, there was no significant difference between the groups in the one- and three-month mortality rates, which is like what has been observed in literature. It has been suggested that FIB reduces complication rates by promoting early mobilization and, therefore, may be associated with lower mortality in the long term (28). Therefore, there is a need for studies with longer follow-up periods.

This study has some limitations. Continuous catheterization or block repetition was not applied until the surgery. The relatively small sample size and the fact that the study was conducted in a single center limit the generalizability of the results. Longer-term (6–12 months) follow-up studies are required to evaluate the long-term functional and psychosocial effects of FIB. SF-36 and STAI tests should be repeated in the future to more comprehensively evaluate the effects of FIB on patients' long-term quality of life and anxiety levels. Repeating the STAI test will allow analysis of patients' preoperative psychological status and postoperative changes.

## CONCLUSION

SFICB applied in the preoperative period provided effective pain management in the early period and improved certain quality of life domains in patients admitted to the hospital due to hip fracture. SFICB, a

simple, superficial block, can be safely administered by the first physician to see the patient.

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ORIGINAL ARTICLE

# PULSED RADIOFREQUENCY WITH TRANSFORAMINAL EPIDURAL STEROID INJECTION FOR LUMBAR DORSAL ROOT GANGLION: A RETROSPECTIVE STUDY COMPARING GERIATRIC AND YOUNGER PATIENTS WITH RADICULAR PAIN

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## Abstract

**Introduction:** Radicular lower extremity pain is a major cause of disability among geriatric individuals. Pulsed radiofrequency treatment to the dorsal root ganglion and transforaminal epidural steroid injection are minimally invasive therapies. This study evaluated the effectiveness of combination treatments for lower-extremity radicular pain in both geriatric and younger patients and evaluated the effect of paraspinal muscle degeneration on treatment success.

**Materials and Method:** A retrospective analysis of 123 patients with lower extremity radicular pain treated with pulsed radiofrequency treatment to the dorsal root ganglion and transforaminal epidural steroid injection was performed. Patients were assigned to younger (18–64 years) and geriatric (≥ 65 years) groups based on age. Pain intensity was assessed using Numeric Rating Scale before the procedure and at the 12-week follow-up. Fatty infiltration was assessed by lumbar magnetic resonance imaging using the Goutallier classification. Treatment success was defined as a ≥50% reduction in the baseline Numeric Rating Scale score.

**Results:** No postoperative complications were observed. The treatment success rates were 50.7% and 46.4% in the younger and geriatric groups, respectively (p=0.633). Geriatric patients exhibited significantly more fatty degeneration and a longer duration of pain than younger patients. However, these differences did not exhibit an effect on treatment success between the groups.

**Conclusion:** Pulsed radiofrequency treatment combined with transforaminal epidural steroid injection appears to be an effective and safe treatment option for radicular pain regardless of age. Although paraspinal muscle fatty degeneration is more pronounced in older adults, it does not negatively affect the early clinical outcomes.

***Keywords:*** Injections, Epidural; Geriatric Assessment; Magnetic Resonance Imaging; Pain Measurement; Pulsed Radiofrequency Treatment; Radiculopathy.

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## INTRODUCTION

Radicular leg pain affects 13-40% of adults and is associated with degenerative spinal abnormalities such as lumbar disc herniation and spinal canal or foraminal stenosis which are highly prevalent in the general population (1,2). These conditions are associated with significant functional impairment, diminished quality of life, and high healthcare costs (3). Radicular pain is caused by mechanical compression and inflammation of the dorsal root ganglion (DRG) or spinal nerve, resulting in nociceptive signaling(1).

Initial management typically includes non-interventional approaches, such as medications (e.g., nonsteroidal anti-inflammatory drugs, gabapentinoids, and serotonin-norepinephrine reuptake inhibitors), combined with physical therapy to improve function and relieve pain. Lifestyle modifications and ergonomic education are also recommended to limit symptom progression (2). Minimally invasive interventional procedures are recognized as alternatives to surgery for patients with severe symptoms (2).

Pulsed radiofrequency (PRF) of the DRG is a promising modality for treating radicular pain. PRF delivers short bursts of radiofrequency energy at subneuroablative temperatures, altering pain transmission pathways without causing permanent nerve damage (4). This selective neuromodulation may suppress nociceptive input through functional changes in the DRG(5). PRF is more selective and has fewer side effects than conventional radiofrequency ablation (RFA), and it can be performed even in patients with neuropathic or highly neural-sensitive conditions(6).

The efficacy of PRF has been demonstrated clinically (7,8);however, outcomes may vary across patient populations. Recent studies have examined the musculoskeletal system, particularly, the role of lumbar paravertebral muscle structure in spinal column stability and the pathophysiology of chronic pain(9). The Goutallier classification is an MRI-based system that categorizes the fat content of the paravertebral muscles on a scale from 0 to 4. It serves a reliable prognostic tool for evaluating spinal pathology and sarcopenia (10). This classification has previously been used to evaluate the lumbar erector spinae plane block in patients with axial back pain (11). However, its role in predicting the success of PRF treatment for radicular pain remains unclear.

No study to date has compared the efficacy of PRF for lower extremity radicular pain between geriatric and younger populations or investigated the impact of paraspinal muscle structure. This study aimed to compare the efficacy of PRF treatment between geriatric and younger patients and to evaluate treatment success according to the Goutallier classification and post-procedure opioid use.

## MATERIALS AND METHOD

### Study Design and Approval

This retrospective observational study was approved by the local ethics committee (Approval No: 2024-1140) and registered with ClinicalTrials.gov (NCT06903949). The study analyzed the records of patients who underwent PRF and transforaminal epidural steroid injection (TFESI) targeting to the lumbar dorsal root ganglia under fluoroscopic guidance for the treatment of chronic lower extremity radicular pain between October 1, 2023, and October 1, 2024.

### Participants and Data Collection

Electronic medical records were reviewed to identify patients who received PRF and TFESI under fluoroscopic guidance to the lumbar DRG. Patients were categorized into geriatric (≥65 years) and younger (18–64 years) groups (Figure 1). Extracted data included demographic characteristics, pain scores, and lumbar MRI findings. Inclusion criteria were: age ≥18 years, chronic lower extremity radicular pain, failure of conservative treatment

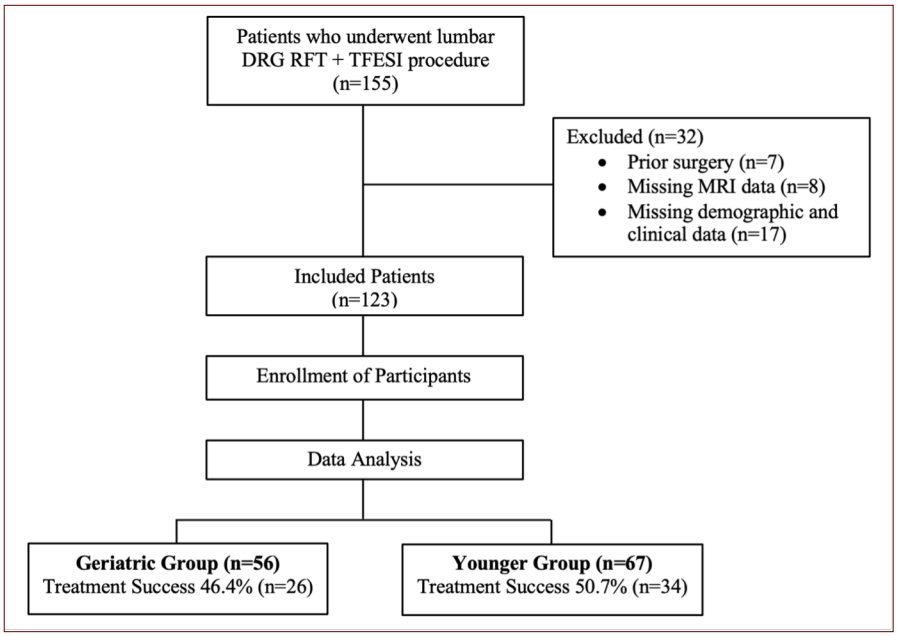



**Figure 1.** Design of the study

(medical or physical therapy) for at least 3 months, and availability of complete clinical and radiological records, including a lumbar spine MRI performed within 1 year before the procedure. Patients were excluded if their clinical or radiological records were incomplete or missing, or if they had a history of lumbar spine surgery or interventional procedures.

### Pulsed Radiofrequency and Transforaminal Epidural Steroid Injection Application

All interventions were performed under fluoroscopic guidance by four interventional pain physicians, each with at least 3 years of experience. Patients were placed in the prone position, and sterile technique was maintained. Fluoroscopy (General Electric OEC One CFD C-Arm; Beijing, China) was used to target the lumbar DRG. A 20-gauge, 10-cm radiofrequency cannula with a 10-mm active tip (TOP Neuropole Needle; TOP Corporation, Japan) was inserted via a transforaminal approach using an ipsilateral oblique trajectory to enhance needle accuracy (Figure 2). Needle placement was confirmed using motor and sensory stimulation. PRF was applied at 5 Hz, 50 V, 20 milliseconds for 240 s at 42°C using an RF generator (TOP Lesion Generator; TOP Corporation, Japan). Following PRF, an injectate consisting of 5 mg bupivacaine (0.5% concentration), 4 mg dexamethasone, and isotonic saline (total volume: 3 mL) was administered. All patients were monitored for complications post-procedure; no adverse events were reported.

Data collected included demographic and clinical variables such as age, sex, body mass index (BMI, kg/m$^2$), comorbidities, duration of radicular pain (months), and post-procedural opioid use. Pain intensity was measured using a Numerical Rating Scale (NRS) ranging from 0 (no pain) to 10 (worst pain possible).

NRS scores were recorded before the procedure and 12 weeks post-procedure. Treatment success was defined as a ≥50% reduction in NRS score at 3 months post-procedure. Radiological assessment focused on paraspinal muscle fat infiltration on lumbar MRI at the third vertebral level.

The degree of infiltration was assessed using the Goutallier classification: grade 0 (no fat), grade 1

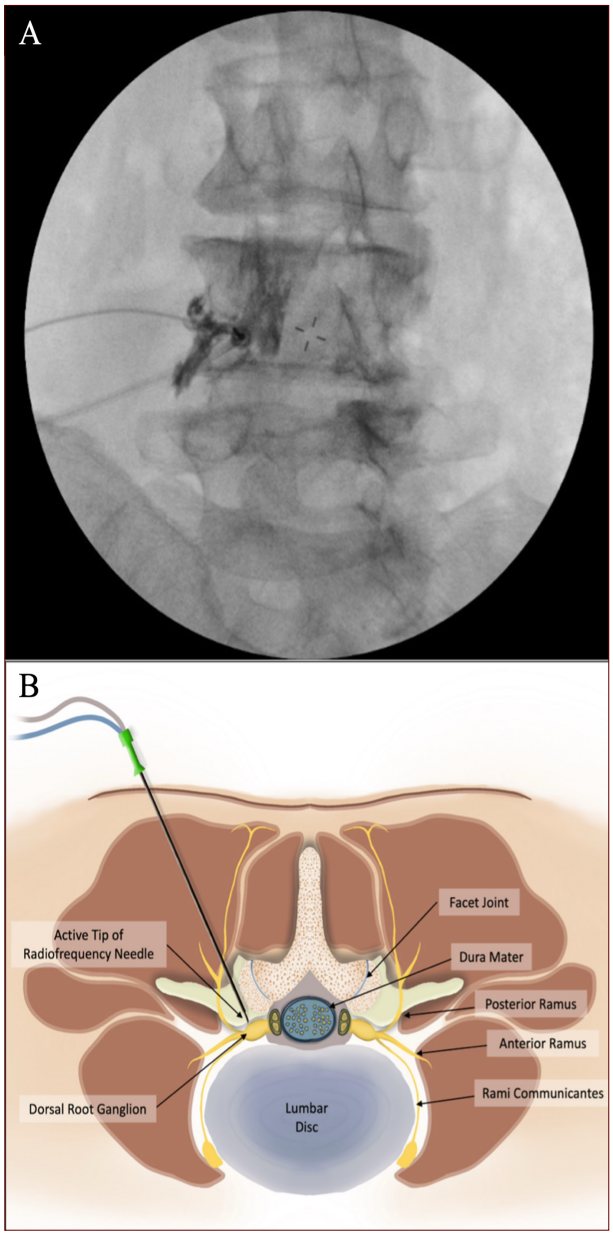



**Figure 2.** A: Oblique fluoroscopic image showing ipsilateral lumbar DRG needle positioning and contrast spread pattern indicating correct anterior epidural placement
B: Axial view showing the technique of lumbar transforaminal injection with radiofrequency needle targeting lumbar DRG (illustrated by Ufuk Turan)

(DRG: Dorsal Root Ganglion)

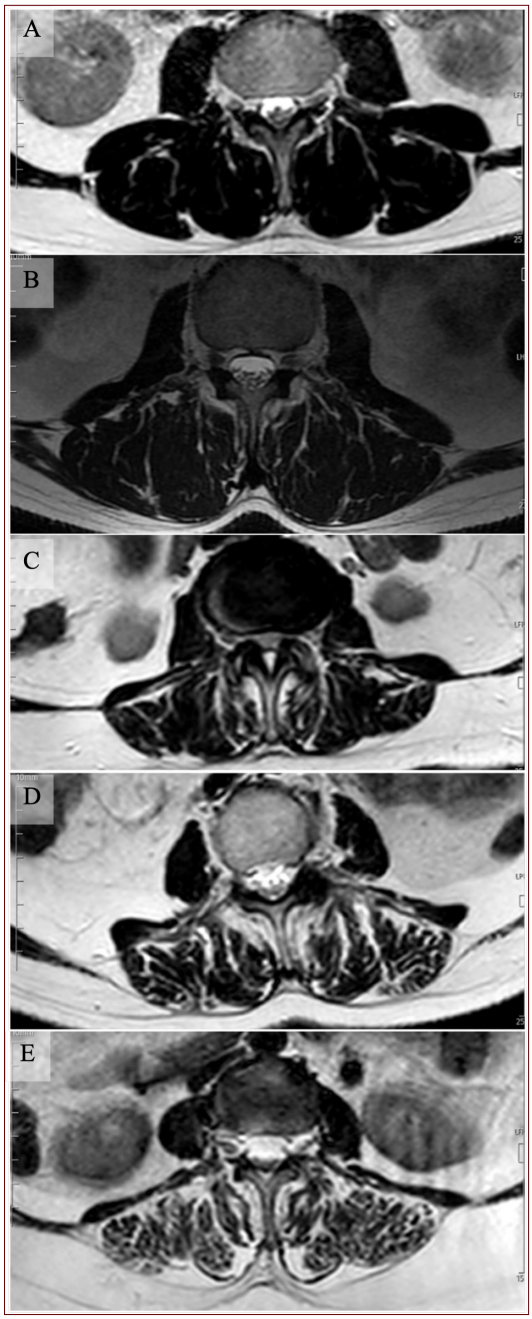



**Figure 3.** T2-weighted axial sections at the third lumbar vertebra level. The Goutallier classification: (A) Grade 0, no visible fat streaks; (B) Grade 1, minimal fat streaks; (C) Grade 2, more muscle than fat; (D) Grade 3, equal fat and muscle; (E) Grade 4, more fat than muscle.

(minimal fatty streaks), grade 2 (more muscle than fat), grade 3 (equal muscle and fat),and grade 4 (more fat than muscle). Patients were categorized as having mild (grades 0–1), moderate (grade 2), or severe (grades 3–4) infiltration (Figure 3).

### Statistical Analysis

Data analysis was performed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics included mean ± standard deviation (SD), median with interquartile range (Q1–Q3), frequencies, and percentages. Comparisons between geriatric and younger groups were made using the Mann–Whitney U test for continuous variables and Pearson's chi-square test or Fisher's exact test for categorical variables. Spearman's correlation test was used for correlation analyses. Univariate binary logistic regression was performed to identify factors associated with treatment success. A p-value <0.05 was considered statistically significant.

## RESULTS

This retrospective study included 123 patients. The mean age was 59.38 ± 14.67 years, with 67 patients in the younger group and 56 in the geriatric group. The geriatric group was significantly older than the younger group (p<0.001), as age served as the criterion for classification (Table 1). There was no significant difference in BMI between the groups (p=0.534).

**Table 1.** Comparison of Demographic, Clinical, and Procedural Characteristics Between Younger and Geriatric Patient Groups

| Variable | | All Participants (n=123) | Younger Group (n = 67) | Geriatric Group (n = 56) | p-value |
|---|---|---|---|---|---|
| **Continuous Variables (Mean ± SD)** | | | | | |
| Age (years) | | 59.38 ± 14.67 | 48.72 ± 10.87 | 72.14 ± 5.44 | <0.001* |
| BMI (kg/m²) | | 24.07 ± 2.36 | 24.18 ± 2.30 | 23.95 ± 2.44 | 0.534* |
| **Continuous Variables (Median [Q1-Q3])** | | | | | |
| Pain Duration (months) | | 15 [10-20] | 12 [9-18] | 18 [12-24] | 0.001* |
| Number of DRG Levels | | 2 [1-2] | 2 [1-2] | 2 [1-2] | 0.397* |
| Baseline NRS | | 6 [5-7] | 6 [5-7] | 6 [5-7] | 0.831* |
| Control NRS | | 3 [2-5] | 3 [2-5] | 3 [2-5] | 0.996* |
| Goutallier Grade | | 2 [1-2] | 2 [1-2] | 2 [2-3] | <0.001* |
| -Mild (0-1) | | 34 (27.6%) | 29 (43.2%) | 5(8.9%) | |
| -Moderate (2) | | 64 (52%) | 36 (53.7%) | 28 (50%) | |
| -Severe (3-4) | | 25 (20.3%) | 2 (3%) | 23 (41.1%) | |
| **Categorical Variables n (%)** | | | | | |
| Gender | Male | 44 (35.7%) | 29 (43.3%) | 15 (26.8%) | 0.087§ |
| | Female | 79 (64.2%) | 38 (56.7%) | 41 (73.2%) | |
| Comorbidity (present) | | 83 (67.4%) | 35 (52.2%) | 48 (85.7%) | **<0.001§** |
| Opioid Consumption | | 22 (17.8 %) | 9 (13.4%) | 13 (23.2%) | 0.241§ |
| Unilateral DRG Intervention | | 117 (95.1%) | 64 (95.5%) | 53 (94.6%) | 1.000§ |
| Successful Treatment | | 60 (48.7%) | 34 (50.7%) | 26 (46.4%) | 0.633§ |

Values are presented as mean ± standard deviation (SD), median [first and third quartile] or number (percentage). BMI = Body Mass Index, DRG: Dorsal Root Ganglion, NRS: Numeric Rating Scale. Bold p-values indicate statistical significance (p<0.05). *Mann–Whitney U test, §Chi-square test.



**Table 2.** Spearman Correlation Coefficients Between Variables and Binary Logistic Regression Analysis of Factors Associated with Treatment Success

| Correlation Variables | | Goutallier Grade | Control NRS | Basal NRS | Age | BMI | Pain Duration | DRG Level Number |
|---|---|---|---|---|---|---|---|---|
| Goutallier Grade | r | 1 | 0.158 | **0.257** | **0.623** | 0.004 | **0.343** | 0.041 |
| | p | - | 0.080 | **0.004** | **0.000** | 0.964 | **0.000** | 0.649 |
| Control NRS | r | | 1 | **0.365** | 0.066 | **0.188** | 0.012 | -0.061 |
| | p | | - | **0.000** | 0.466 | **0.037** | 0.891 | 0.500 |
| Basal NRS | r | | | 1 | 0.05 | 0.082 | 0.116 | **0.195** |
| | p | | | - | 0.579 | 0.365 | 0.201 | **0.03** |
| Age | r | | | | 1 | -0.107 | **0.352** | 0.072 |
| | p | | | | - | 0.238 | **0.000** | 0.428 |
| BMI | r | | | | | 1 | -0.05 | -0.04 |
| | p | | | | | - | 0.586 | 0.659 |
| Pain Duration | r | | | | | | 1 | 0.136 |
| | p | | | | | | - | 0.132 |
| DRG Level Number | r | | | | | | | 1 |
| | p | | | | | | | - |

| Binary Logistic Variables | B | OR | 95% CI | | p | Reference Category |
|---|---|---|---|---|---|---|
| | | | Lower | Upper | | |
| Age | 0.015 | 1.015 | 0.99 | 1.04 | 0.238 | - |
| Age Group | 0.173 | 1.189 | 0.584 | 2.42 | 0.633 | Younger Group |
| BMI (kg/m$^2$) | 0.128 | 1.137 | 0.974 | 1.327 | 0.104 | - |
| Comorbidity (Yes/No) | 0.072 | 1.075 | 0.505 | 2.286 | 0.851 | Comorbidity Presence |
| Gender (Male/Female) | 0.360 | 1.433 | 0.684 | 3.005 | 0.341 | Male |
| Pain Duration (Months) | 0.009 | 1.009 | 0.976 | 1.042 | 0.605 | - |
| DRG Level Number | -0.473 | 0.623 | 0.302 | 1.286 | 0.201 | - |
| Basal NRS | 0.253 | 1.288 | 0.924 | 1.798 | 0.136 | - |
| Control NRS | 2.958 | 19.262 | 5.846 | 63.472 | **<0.001** | - |
| Goutallier Grade | 0.319 | 1.376 | 0.818 | 2.314 | 0.229 | - |

B: Regression Coefficient, CI: Confidence Interval, OR: Odd's Ratio, r: Spearman's Correlation Coefficient, BMI: Body Mass Index; DRG: Dorsal Root Ganglion; NRS: Numeric Rating Scale. Bold p-values indicate statistical significance (p<0.05).

The duration of radicular pain was significantly longer in the geriatric group (p=0.001). The number of DRG levels treated, as well as baseline and post-procedure NRS scores, were similar between groups (p>0.05). All procedures were well tolerated, with no complications during the procedure or follow-up.

Goutallier grading was significantly higher in the geriatric group (p<0.001). Mild fat infiltration

(grades 0–1) was observed in 43.2% of the younger group, compared to 8.9% in the geriatric group. Advanced fat infiltration (grades 3–4) was found in 3% of the younger group and 41.1% of the geriatric group.

Comorbidities were significantly more common in the geriatric group ($p<0.001$). There were no significant differences between groups in sex, post-procedural opioid use, or laterality of DRG PRF and TFESI interventions ($p>0.05$).

Treatment success, defined as a ≥50% reduction in the baseline NRS score, was achieved in 50.7% of the younger group and 46.4% of the geriatric group, with no statistically significant difference ($p=0.633$).

Spearman correlation analysis showed a significant positive correlation between Goutallier grade and age ($p<0.001$), pain duration ($p<0.001$), and baseline NRS score ($p=0.004$) (Table 2). A borderline positive correlation was also observed between Goutallier grade and follow-up NRS score ($p=0.08$). Third-month NRS scores were positively correlated with baseline NRS scores ($p<0.001$) and BMI ($p=0.037$) (Table 2).

Univariate binary logistic regression analysis showed that follow-up NRS score was significantly associated with treatment success ($p<0.001$). No other variables were significantly associated with treatment success ($p>0.05$).

## DISCUSSION

This study evaluated the safety and effectiveness of PRF and TFESI treatments applied to the lumbar DRG in geriatric and younger patients. In this regard, it offers a novel contribution to the literature. The data analysis revealed similar treatment success rates between the two groups. However, age and paraspinal muscle fatty infiltration were significantly associated with pain duration and intensity. Nonetheless, the Goutallier score did not predict the success of PRF and TFESI treatment.

Degenerative conditions such as disc herniation and spinal stenosis severely affect quality of life. While conservative, non-surgical approaches are generally the first line of treatment, minimally invasive procedures are often necessary in long-standing or refractory cases(12). PRF and TFESI targeting the DRG are commonly employed in this setting. PRF induces neuromodulation via pulsed currents at tissue temperatures ≤42°C, providing a safer profile than conventional radiofrequency (neurolysis), which uses higher heat(13). It modulates nociceptive transmission by affecting conduction in the C and A-delta fibers(8,14). In a 1-year follow-up study, pain reduction of was observed in 45.9% of cases(15). Our study's success rate of 48.72% is consistent with existing literature.

Although our study used a combination of DRG PRF and TFESI, it is important to note the clinical results when each modality is applied individually must be taken into account. There have been rather many studies involving the application of PRF and TFESI as isolated interventions. For instance, PRF has been reported to induce long-term effects in chronic radicular pain, but TFESI appears to be more effective at the subacute phases (12). A randomized controlled trial comparing PRF and TFESI did not demonstrate a statistically significant difference in pain or disability scores, leading to the conclusion that PRF may be a viable alternative to corticosteroid injections for radicular pain, particularly in patients who are not appropriate candidates for corticosteroid injections (16). In contrast, favorable outcomes have been documented with the combined use of PRF and TFESI, including prolonged pain relief and functional improvement observed over a 12-month follow-up period (17). In a randomized controlled trial patients who failed to respond to repeated TFESI demonstrated substantial clinical improvement with high-voltage PRF (18). These results are consistent with the overall therapeutic literature that there could be some synergistic effect of combined treatment interven-



tion, particularly in patients chosen appropriately. This prospective effect shall be further investigated by randomized monotherapy versus combination treatment patterns in age or pathology-stratified patient groups to identify a more defined treatment pathway.

The influence of age on PRF and TFESI outcomes has been reported with varying results. One study comparing different PRF voltage levels found age was not a determining factor in treatment success(13). Another study combining PRF with TFESI showed better outcomes in patients aged 55 and older compared to those receiving only TFESI(19). However, other studies did not find a significant link between age and treatment response(20). Similarly, our analysis did not identify age as an independent predictor of treatment success, suggesting that the combination of PRF and TFESI may be effective regardless of age-related anatomical changes.

Fatty infiltration of the paraspinal muscles is a degenerative change that increases with age. Originally developed for assessing rotator cuff muscles, the Goutallier classification has been adapted to evaluate lumbar muscle degeneration(21). Mandelli et al. demonstrated a moderate-to-strong correlation between Goutallier grades and quantitative MRI-based fat measurements(10). Tamai et al. found that fatty infiltration correlates with age and decreased lumbar lordosis(9). Such age-related muscle degeneration can be observed even in otherwise healthy individuals(22). Importantly, fatty infiltration is not merely structural but is also linked to Modic changes, increased pain, and functional decline(23).

In our study, while the Goutallier grade correlated with age, pain duration, and baseline NRS scores, it was not predictive of treatment success. This suggests that paraspinal muscle degeneration may not adversely affect outcomes following PRF and TFESI. In the geriatric population, such degeneration is often part of sarcopenia and should be addressed with a multidisciplinary approach, not solely interventional pain treatments(24).

Evans et al. emphasized that in older adults, assessing muscle quality, not just mass, is crucial(24). Functional assessment, in addition to volume measurement, is necessary for a comprehensive understanding(24). In one study on chronic low back pain in older adults, sarcopenia prevalence reached 40%, supporting the high Goutallier scores observed in our geriatric group(25). The fact that these structural changes did not alter PRF and TFESI outcomes implies that neuromodulation may act independently of muscle quality.

Overall, our findings suggest that PRF and TFESI are safe and effective for managing radicular pain, even in older patients with structural paraspinal muscle changes. This supports their use as a promising alternative for older patients who are not surgical candidates or who have failed conservative treatments. Additionally, considering the potential functional limitations owing to diminished muscle quality, integrating post-PRF rehabilitation and exercise programs may further enhance treatment outcomes.

One of the strengths of this study is its evaluation of treatment effectiveness across age groups while incorporating morphological factors such as paraspinal muscle fat infiltration. The comparison between geriatric and younger patients provides valuable insight into the applicability of PRF and TFESI across diverse populations.

However, this study also has several limitations. Its retrospective design limits the ability to establish causality. The 12-week follow-up period may be insufficient to evaluate the long-term effectiveness of the treatment. Additionally, the Goutallier classification was evaluated using a single MRI slice; this could be improved with quantitative imaging techniques such as Dixon or IDEAL (Iterative Decomposition of Water and Fat with Echo Asymmetry and

Least-Squares Estimation). Another limitation is that treatment efficacy was assessed solely using the NRS. Future studies should incorporate functional scoring systems, such as the Oswerty Disability Index and the 36-Item Short Form Survey, to provide a more comprehensive evaluation of clinical impact.

Randomized controlled trials are needed to further investigate the effects of PRF parameters (e.g., voltage, frequency, and duration) tailored to age and muscle quality, as well as to evaluate the role of post-procedural rehabilitation strategies in optimizing outcomes.

## CONCLUSION

The combination of PRF and TFESI appears to be a safe and effective treatment option for managing lower-extremity radicular pain, even in the context of age-related degenerative changes. Fatty infiltration of the paraspinal muscles in geriatric patients did not significantly impact short-term treatment response. Nevertheless, because of the potential effects of muscle degeneration on balance and functional capacity, PRF and TFESI should be integrated into a broader, multidisciplinary treatment approach. Future research focusing on personalized PRF protocols and interventions aimed at improving muscle quality may further enhance clinical outcomes.

### Conflict of Interest

The authors declare that they have no conflict of interest related to this study.

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ORIGINAL ARTICLE

# TURKISH ADAPTATION OF THE REHABILITATION COMPLEXITY SCALE-EXTENDED: VALIDITY AND RELIABILITY STUDY IN STROKE PATIENTS

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## Abstract

This study aimed to adapt the Rehabilitation Complexity Scale-Extended (RCS-E) for use in Turkish and assess its validity and reliability in patients with hemiplegia due to vascular stroke. We reviewed the medical records of 102 patients hospitalized for rehabilitation following ischemic or hemorrhagic stroke. The complexity of rehabilitation needs was assessed using the RCS-E. Validity was determined by analyzing correlations between RCS-E scores and the mBarthel Index, mRankin Scale, and Functional Independence Measure (FIM) scores. Intrarater and interrater reliability were evaluated using the intraclass correlation coefficient (ICC) and Cronbach's alpha. Two experienced rehabilitation specialists performed assessments one week apart. The ICC values for the RCS-E subscales ranged from 0.960 to 0.985, with a total score ICC of 0.987, indicating excellent intra-rater reliability. The inter-rater reliability ICCfor the total score was 0.858, reflecting high reliability. The Cronbach's alpha value for the total score was 0.870, signifying high internal consistency. Significant positive correlations were found between the RCS-E scores and mBarthel Index ($r = -0.611$), motor FIM ($r = 0.659$), cognitive FIM ($r = -0.481$), and total FIM ($r = -0.661$) scores, while a negative correlation was observed with the mRankin Scale ($r = 0.647$; $p < 0.001$ for all).The Turkish version of the RCS-E is a valid and reliable tool for assessing rehabilitation needs in stroke patients with hemiplegia. It effectively guides rehabilitation planning and improves service quality.

***Keywords:*** Rehabilitation; Stroke; Hemiplegia;Validation Study.

## INTRODUCTION

Stroke is a significant disease that causes disability worldwide. In 2019, the prevalence of stroke in Turkey was reported as 1.3%. Of those who experienced a stroke, 58.5% were under the age of 70, and 54.3% were women. The rate of ischemic stroke was 65.1%, while 24% were intracerebral hemorrhages, and 10.9% were subarachnoid hemorrhages. In the same year, stroke-related deaths ranked second after cardiovascular system diseases (1).

Stroke patients experience motor and sensory losses, as well as cognitive and emotional changes, as a result of cerebral damage. Therefore, stroke rehabilitation is a highly complex process. The severity of the disease varies depending on the location and size of the lesion in the brain (2). Some individuals may experience severe impairments. In addition, the clinical presentation can be influenced by whether the right or left side of the brain is affected. Left hemisphere lesions can lead to aphasia (3),while right hemisphere lesions may result in issues such as neglect and cognitive impairments (4). There are modifiable risk factors associated with stroke, such as diabetes mellitus, hypertension, ischemic heart disease, and smoking, as well as non-modifiable factors such as age, gender, race, and the side of the lesion. A previous study reported that having more than two comorbidities in stroke patients negatively affects rehabilitation outcomes (5).

The severity of hemiplegia due to stroke may vary among patients. Some individuals may experience severe motor loss on one side of the body, along with complications such as aphasia, dysphagia, neglect, spasticity, pain, urinary and fecal incontinence, cognitive impairments, heterotopic ossification, and pressure ulcers, leading to a more severe clinical presentation (4). These individuals require increased care and rehabilitation. A study conducted in Japan involved 50 patients with vascular stroke (26 women [52%], 24 men [48%]; median age, 70.5 years; IQR, 60.8–78.0 years) with Brunnstrom motor stages I/II. The study suggested that good prognostic indicators included hemorrhagic stroke, age under 70 years, absence of cortical lesions, and early and intensive inpatient rehabilitation (6).

The rehabilitation program for a hemiplegic patient varies depending on the severity of the disease and accompanying problems. It is crucial to identifythe initial functional level and rehabilitation needs during the treatment to observe progress in later stages and manage the treatment effectively (7).In hemiplegic patient groups, scales such as the modified Barthel Index (mBI) (8),the modified Rankin Scale (mRS) (9),and the Functional Independence Measure (FIM)(10) are frequently used to assess disability levels and functional status. Another important factor in this process is the complexity of rehabilitation needs. The assessment of complexity is generally based on physical factors and functional status, often overlooking the patient's therapy needs, nursing care requirements, cognitive and psychological aspects. To address these factors, the Rehabilitation Complexity Scale (RCS) was developed in 2007, and its extended version (RCS-E) was created in 2012(11, 12).

The RCS is valuable for documenting the services provided to patients undergoing inpatient neurological rehabilitation in specialized and complex units. It also aids in documenting rehabilitation interventions. Assessing the complexity of healthcare services required during a patient's inpatient stay at the rehabilitation hospital and after discharge when home healthcare services are required is essential for maintaining rehabilitation continuity. This method helps reduce the financial burden on healthcare services and ensures that qualified healthcare personnel are allocated effectively to where they are most needed. Consequently, it supports the efficient use of resources, allowing patients to receive timely and appropriate levels of healthcare. Moreover, by planning and monitoring rehabilitation processes in a more systematic manner, patients' functional

recovery is optimized, and overall efficiency in healthcare services is improved. It has been observed that RCS scores are ≥9 in half of the patients receiving inpatient treatment in complex specialized services (12).The extended version of the RCS (RCS-E) was published in 2012 (11).

The RCS-Eis a valuable tool that offers an easy and practical assessment to assist in determining a patient's rehabilitation needs. Identifying the necessary rehabilitative interventions also guides the development of a suitable treatment program for the patient. To the best of our knowledge, no similar study has been conducted in Turkey. The aim of this study is to adapt the RCS-E for use in Turkish (RCS-ET) and to assess the validity of the RCS-ET in patients with hemiplegia caused by a vascular stroke.

## MATERIALS AND METHOD

The study was conducted at the Health Science University,Istanbul Physical Therapy and Rehabilitation Training and Research Hospital between 10/08/2024 and 31/12/2024.Ethical approval was obtained from the Ethics Committee of Istanbul Physical Therapy and Rehabilitation Training and Research Hospital(protocol no.:2024-51).

The medical records of 102 patients hospitalized in the palliative care unit and stroke unit of our tertiary rehabilitation hospital for rehabilitation due to ischemic or hemorrhagic vascular stroke-related hemiplegia were reviewed. Both female and male patients with hemiplegia due to vascular lesionswere included in the study. Exclusion criteria were hemiplegia due to tumors or traumatic lesions.

Demographic data of the patients were obtained from patient records. Brunnstrom motor staging was used to determine the patients' motor status, while the mBI was used for activities of daily living. In addition, the mRS and FIM were utilized for functional status assessment. The RCS-E v13 was used to assess the complexity of patients' rehabilitation needs. Test applications were performed by two independent specialists experienced in rehabilitation, with each practitioner conducting two evaluations at one-week intervals. During the inter-rater reliability assessment, the two evaluators performed their ratings independently and in a blinded manner, without access to each other's scores, in order to minimize observer bias.

### Rehabilitation Complexity Scale

The first version of the RCSconsists of four subscales and is a 15-point scale (12). These subscales include basic care and support needs (range 0–3), nursing interventions (range 0–3), intensity of total therapy intervention (range 0–6), and medical intervention (range 0–3). In a study involving 179 individuals with complex neurological diseases, the test–retest reliability of the RCS revealed a kappa value ranging from 0.93 to 0.96, indicating the test's repeatability. In addition, the coefficient alpha was found to be 0.76 in the same study, with reported inter-item correlations of >0.50. A strong relationship was demonstrated between the RCS basic care and nursing subparameter scores (Spearman rho -0.65 to -0.79) and motor FIM and mBIscores. However, a weaker relationship was found between the RCS therapy (rho -0.26) and medical (rho -0.28 to -0.33) sections and the motor FIM and Barthel scores (13). The RCSv2 was expanded in 2012 to create the RCS-E for patients requiring complex rehabilitation.[11] It consists of five domains: basic care or risk (0–4 points), special nursing needs (0–4 points), medical needs (0–4 points), therapy needs (number of required disciplines and intensity; 0–8 points), and equipment/facilities (0–2 points). The total score is 22, with higher scores indicating a greater need for intervention.

With the RCS-Ev13, it is possible to assess an individual's basic care and support needs, cognitive/behavioral needs, skilled nursing needs, medical needs, therapy disciplines, therapy intensity,



and equipment needs. In a prospective study conducted on 331 patients hospitalized in a tertiary neurorehabilitation unit, the RCS-E was reported to demonstrate complex treatment needs more effectively than the RCSv2. However, the same study suggested that the RCS-E did not demonstrate superiority over the RCSv2 in identifying complex care and nursing needs. As a result, it was concluded that the RCS-E is comparable to the RCSv2 in representing rehabilitation complexity, but may be more beneficial in determining complex treatment and equipment needs. The RCS-E features a two-factor structure, encompassing nursing/medical care and equipment/therapy (11).

**Preparation of RCS-ET**

The RCS-Ev13 was translated into Turkish by an individual with strong English proficiency, whose native language is Turkish, and who has experience in the field of rehabilitation. Permission was obtained from the developer of the scale before the translation process began. Following this, a doctor, whose native language is English, conducted a back-translation. Cultural and linguistic variances were carefully considered throughout the translation process. After being reviewed by four senior rehabilitation specialists, the final version of the RCS-ET was created.

**Translation and Cross-Cultural Adaptation**

During the Turkish translation and cross-cultural adaptation of the RCS-E, certain modifications were made to account for variations in culture, language, and rehabilitation practices.

Adjustments were necessary in the "skilled nursing needs" section. The term "rehab-trained nurse"was changed to "experienced rehabilitation nurse" since there is no specific nurse with that title in Turkey. Similarly, "specialist neurology nurse" was changed to "experienced neurology nurse."In the mental health category, instead of a nurse specifically assigned to this area, the term was altered to "psychologist," as psychologists are typically involved in rehabilitation units in Turkey. In addition, a "wound care nurse"was included in the relevant section, recognizing their important role in patient care in Turkish rehabilitation units. Since no Turkish translation of the Northwick Park Therapy Dependency Assessment (NPTDA) has been undertaken, this reference was omitted from the therapy section. In the therapy disciplines section, the term "rehabilitation engineer" was removed because there is no equivalent profession in Turkey.

**Statistical Method**

Descriptive statistics were used to analyze the data, including mean, standard deviation, median, minimum, maximum, frequency, and percentage values. The distribution of variables was assessed using the Kolmogorov–Smirnov test. The Wilcoxon test was used to analyze non-normally distributed dependent quantitative data. To evaluate the convergent validity of the RCS-ET scale, Spearman correlation coefficients were calculated between the RCS-ET total and subparameter scores and the scores of established functional outcome measures, including the FIM, mBI, and mRS.

Inter-observer correlation and test–retest reliability were analyzed. Intraclass correlation coefficient (ICC) and Cronbach's alpha values with 95% confidence intervals were reported. Due to differences in the scoring ranges of the items, z-score transformation was applied prior to the Cronbach's alpha calculation.Cronbach's alpha values between 0.6 and 0.7 were considered acceptable, while values ≥0.7 were regarded as satisfactory (14). ICCvalues were interpreted based on widely accepted criteria: values below 0.40 indicated poor reliability, values between 0.40 and 0.74 reflected moderate reliability, values between 0.75 and 0.90 demonstrated high reliability, and values above 0.90 indicated excellent reliability (15).To evaluate the construct validity of the Turkish version of the RCS-E,

both exploratory and confirmatory factor analyses (CFA) were performed. Prior to factor analysis, the Kaiser-Meyer-Olkin (KMO) test and Bartlett's test of sphericity were conducted to assess the suitability of the data. Exploratory factor analysis (EFA) was conducted using principal component extraction and Varimax rotation. CFA was conducted to test the model fit of the factor structure derived from the EFA. Model fit was evaluated using the chi-square test ($\chi^2$), degrees of freedom (df), Comparative Fit Index (CFI), and Root Mean Square Error of Approximation (RMSEA). A p-value <0.05 was considered statistically significant. All analyses were performed using the SPSS 28.0 and Jamovi 2.6.44 program.

## RESULTS

The demographic and clinical characteristics of the patients are presented in Table 1. Nearly half of the patients were female, with a mean age of 68.31±7.38. While 77.5% of the patients had an ischemic etiology, 30.4% had a hemorrhagic etiology. The etiology was unknown in one patient. Polypharmacy was present in 87 patients (85.3%). Aphasia was observed in 27.5%, pressure ulcers in 10.8%, dementia in 3.9%, and dysphagia in 16.7% (Table 1).

The RCS-ET subscale scores are presented in Table 2. In terms of nursing disciplines, 62.7% of patients required general registered nursing, 77.5% required rehabilitation nursing, 8.8% required psychological support (provided by psychologists in the local setting), 17.6% required palliative care nursing, 25.5% needed assistance from a specialist neurology nurse, and 3.9% had other specialized nursing needs. Regarding medical needs, nearly half of the patients (49.0%) required care from a specialist physician and/or psychiatric treatment. Additionally, 10.8% of patients required no active medical intervention, while 37.3% needed basic investigation, monitoring, or treatment. More than 90% of the patients required blood tests, 81.4% required medication adjustment or monitoring, and 53.9% were referred to a specialist physician. Other medical procedures were needed in 20.6% of cases, and 20.6% of patients had medico-legal or capacity-related issues.

In terms of therapy needs, more than half of the patients (51.0%) required two to three different therapy disciplines, 25.5% required four to five, and 7.8% required six or more. The most commonly needed discipline was physiotherapy (95.1%), followed by orthotics/prosthetics (54.9%), psychology (44.1%), social work (33.3%), and dietetics (20.6%). Speech and swallowing therapy was required in 19.6% of patients, counseling in 7.8%, and alternative therapies such as music or art therapy in 1.0%. In terms of therapy intensity, 48.0% of patients received low-intensity therapy, 37.3% moderate intensity, and 8.8% high intensity. Very high-intensity therapy was required by only one patient (1.0%). Regarding equipment needs, 89.2% of patients required basic special equipment, while 1.0% needed highly specialist equipment. The most frequently used devices were off-the-shelf orthotics (53.9%), wheelchairs or specialized seating systems (24.5%), special mattresses (22.5%), pressure cushions (13.7%), and standing frames (12.7%). Other equipment needs were present in 35.3% of the patients (Table 2).

The results regarding the intra-rater reliability of the RCS subscales, performed one week apart, are presented in Table 3. The *r* values ranged between 0.960 and 0.985 ($p$=0.001). The ICC value representing the test–retest reliability for the total scores was found to be 0.987, evaluated as excellent. Internal consistency of the Turkish version of the RCS-E was assessed using Cronbach's alpha. Since the items had different scoring ranges, all items were transformed into standardized z-scores prior to analysis. The standardized Cronbach's alpha was 0.870, indicating satisfactory internal consistency according to the ≥0.70 threshold. When individual items were removed, alpha values ranged from 0.825



**Table 1.** Descriptive statistics

| | | | |
|---|---|---|---|
| **Age** | 68.31±7.38 | | |
| **Gender** | Female | 43 | 42.2% |
| | Male | 59 | 57.8% |
| **Marital status** | Married | 68 | 66.7% |
| | Single | 31 | 30.4% |
| | Unknown | 3 | 2.9% |
| **Paralytic side** | Right | 53 | 52.0% |
| | Left | 44 | 43.1% |
| | Bilateral | 4 | 3.9% |
| | Unknown | 1 | 1.0% |
| **Number of CVA** | I | 85 | 83.3% |
| | II | 14 | 13.7% |
| | III | 1 | 1.0% |
| | Unknown | 2 | 2.0% |
| **CVA duration (months)** | 152.0 (30.0-732.0) | | |
| **Etiology** | Ischemic | 79 | 77.5% |
| | Hemorrhagic | 31 | 30.4% |
| | Unknown | 1 | 1.0% |
| **Modified Rankin Scale** | No significant disability | 1 | 1.0% |
| | Slight disability | 2 | 2.0% |
| | Moderate disability | 27 | 26.5% |
| | Moderately severe disability | 45 | 44.1% |
| | Severe disability | 27 | 26.5% |
| **Brunnstrom Upper Extremity Stages** | Stage I | 27 | 26.5% |
| | Stage II | 27 | 26.5% |
| | Stage III | 11 | 10.8% |
| | Stage IV | 9 | 8.8% |
| | Stage V | 14 | 13.7% |
| | Stage VI | 14 | 13.7% |
| **Brunnstrom Lower Extremity Stages** | Stage I | 18 | 17.6% |
| | Stage II | 27 | 26.5% |
| | Stage III | 16 | 15.7% |
| | Stage IV | 15 | 14.7% |
| | Stage V | 17 | 16.7% |
| | Stage VI | 9 | 8.8% |
| **Ambulation** | Wheelchair | 34 | 33.3% |
| | Therapeutic Ambulation | 27 | 26.5% |
| | Indoor Ambulation | 26 | 25.5% |
| | Community Ambulation | 10 | 9.8% |
| | Unknown | 5 | 4.9% |

| **Table 1.** Continued... | | | |
|---|---|---|---|
| Device Used for Ambulation | AFO | 23 | 22.5% |
| | Ambulatory | 2 | 2.0% |
| | Cane | 5 | 4.9% |
| | Non-ambulatory | 22 | 21.6% |
| | Other | 49 | 48.0% |
| | Unknown | 1 | 1.0% |
| Spasticity | None | 69 | 67.6% |
| | Upper extremity | 15 | 14.7% |
| | Lower extremity | 9 | 8.8% |
| | Unknown | 9 | 8.8% |
| Spasticity severity | I | 6 | 18.2% |
| | II | 19 | 57.6% |
| | III | 8 | 24.2% |
| Aphasia | | 28 | 27.5% |
| Pressure Ulcer | | 11 | 10.8% |
| Neglect | | 0 | 0% |
| Dementia | | 4 | 3.9% |
| Dysphagia | | 17 | 16.7% |
| Comorbidities | (-) | 4 | 3.9% |
| | HT | 65 | 63.7% |
| | CAD | 42 | 41.2% |
| | DM | 34 | 33.3% |
| | AF | 2 | 2.0% |
| | Other | 67 | 65.7% |
| Polypharmacy | (+) | 87 | 85.3% |
| | (-) | 13 | 12.7% |
| | Unknown | 2 | 2.0% |
| Modified Barthel Index Score | | 35.0 (0-100) | |
| Modified Rankin Scale | | 4.0(1.0-5.0) | |
| Motor FIM Score | | 41.5(0.0-97.0) | |
| Cognitive FIM Score | | 26.0(5.0-35.0) | |
| Total FIM Score | | 66.0(18.0-130.0) | |

SD: Standard deviation, CVA: Cerebrovascular accident, HT: Hypertension, DM: Diabetes mellitus, CAD: Coronary artery disease, AF: Atrial fibrillation, AFO: Ankle-Foot Orthosis, FIM: Functional Independent Measure. Quantitative variables with normal distribution are presented as mean ± standard deviation, while non-normally distributed variables are presented as median (minimum–maximum). Categorical variables are presented as number (percentage). For the etiology variable, more than one etiology could be marked per patient; therefore, the total frequency may exceed the number of participants.

to 0.891, demonstrating that each item contributed meaningfully to the reliability of the scale.

The relationship between RCS subscales and mBI, mRS, and FIM scores is presented in Table 4. The RCS total scores were significantly positively correlated with mBI ($r$=-0.611, $p$=<0.001), motor FIM ($r$=-0.659, $p$=<0.001), cognitive FIM ($r$=-0.481, $p$=<0.001), and total FIM ($r$=-0.661, $p$=<0.001)

**Table 2.** RCS-E Subparameters and Distribution of Patient Needs

| | n | % |
|---|---|---|
| **Basic care and support needs** | | |
| Largely independent | 5 | 4.9% |
| Requires help from 1 person | 49 | 48.0% |
| Requires help from 2 people | 23 | 22.5% |
| Requires help from ≥3 people | 23 | 22.5% |
| Requires constant 1:1 supervision | 2 | 2.0% |
| **Risk-Cognitive/Behavioural Needs** | | |
| No risk | 2 | 2.0% |
| Low risk | 50 | 49.0% |
| Medium risk | 27 | 26.5% |
| High risk | 20 | 19.6% |
| Very high risk | 3 | 2.9% |
| **Skilled nursing needs** | | |
| No needs for skilled nursing | 14 | 13.7% |
| Requires intervention from a qualified nurse | 23 | 22.5% |
| Requires intervention from nursing staff who are trained and experienced in rehabilitation | 44 | 43.1% |
| Requires highly specialist nursing care | 21 | 20.6% |
| **Medical needs** | | |
| No active medical intervention | 11 | 10.8% |
| Basic investigation / monitoring / treatment | 38 | 37.3% |
| Specialist medical / psychiatric intervention | 50 | 49.0% |
| Potentially unstable medical /psychiatric condition | 3 | 2.9% |
| **Therapy Disciplines** | | |
| No therapist involvement | 5 | 4.9% |
| 1 discipline only | 11 | 10.8% |
| 2-3 discipline | 52 | 51.0% |
| 4-5 discipline | 26 | 25.5% |
| ≥ 6 discipline | 8 | 7.8% |
| **Therapy Intensity** | | |
| No therapy intervention | 5 | 4.9% |
| Low level | 49 | 48.0% |
| Moderate level | 38 | 37.3% |
| High level | 9 | 8.8% |
| Very high level | 1 | 1.0% |
| **Equipment needs** | | |
| No needs for special equipment | 10 | 9.8% |
| Basic special equipment | 91 | 89.2% |
| Highly specialist equipment | 1 | 1.0% |

**Table 3.** Test-Retest Reliability and Intra-Class Correlation of RCS-ET Subscales

| | Test 1 | Test 2 | p [1] | ICC (%95 CI) | p |
|---|---|---|---|---|---|
| | Median | Median | | | |
| **Basic care and support needs** | 1.00 | 1.00 | 0.655 [W] | 0.985(0.978-0.990) | **<0.001** |
| **Risk-Cognitive/Behavioural Needs** | 1.00 | 1.00 | 0.655 [W] | 0.984(0.977-0.990) | **<0.001** |
| **Skilled nursing needs** | 2.00 | 2.00 | 0.429 [W] | 0.963(0.945-0.975) | **<0.001** |
| **Medical needs** | 2.00 | 2.00 | 0.480 [W] | 0.960(0.940-0.973) | **<0.001** |
| **Therapy disciplines** | 2.00 | 2.00 | 0.763 [W] | 0.967(0.951-0.978) | **<0.001** |
| **Therapy intensity** | 1.00 | 1.00 | 1.000 [W] | 0.974(0.961-0.982) | **<0.001** |
| **Equipment needs** | 1.00 | 1.00 | 1.000 [W] | 0.948(0.924-0.965) | **<0.001** |
| **Total scores** | 11.00 | 11.00 | 0.824 [W] | 0.987(0.981-0.991) | **<0.001** |

p[1] [W] Wilcoxon test / p[ICC] (Intra Class Correlation) CI: Confidence Interval

**Table 4.** Relationship of RCS-E Subscales with Barthel, Rankin, and FIM Scores

| | | Basic care and support needs | Risk-Cognitive/ Behavioural Needs | Skilled nursing needs | Medical needs | Therapy disciplines | Therapy intensity | Equipment needs | Total scores |
|---|---|---|---|---|---|---|---|---|---|
| **Modified Barthel Index Score** | rs | -0.632 | -0.615 | -0.626 | -0.423 | -0.476 | -0.245 | -0.173 | -0.611 |
| | p | **<0.001** | **<0.001** | **<0.001** | **<0.001** | **<0.001** | **0.013** | 0.082 | ***<0.001*** |
| **Modified Rankin Scale** | rs | 0.669 | 0.654 | 0.634 | 0.476 | 0.475 | 0.266 | 0.257 | 0.647 |
| | p | **<0.001** | **<0.001** | **<0.001** | **<0.001** | **<0.001** | **0.007** | **0.010** | **<0.001** |
| **Motor FIM Score** | rs | -0.680 | -0.645 | -0.621 | -0.499 | -0.537 | -0.291 | -0.189 | -0.659 |
| | p | **<0.001** | **<0.001** | **<0.001** | **<0.001** | **<0.001** | **0.003** | 0.057 | **<0.001** |
| **Cognitive FIM Score** | rs | -0.458 | -0.479 | -0.505 | -0.385 | -0.443 | -0.130 | -0.208 | -0.481 |
| | p | **<0.001** | **<0.001** | **<0.001** | **<0.001** | **<0.001** | 0.193 | **0.036** | **<0.001** |
| **Total FIM Score** | rs | -0.672 | -0.652 | -0.645 | -0.502 | -0.545 | -0.260 | -0.215 | -0.661 |
| | p | **<0.001** | **<0.001** | **<0.001** | **<0.001** | **<0.001** | **0.008** | **0.030** | **<0.001** |

rs: Spearman's rank correlation coefficient.

scores, and negatively correlated with mRS ($r$=0.647, $p$=<0.001) scores.

Inter-rater reliability results are presented in Table 5. The $r$ values ranged between 0.364 and 0.853 for the seven subscales ($p$=0.001). The ICC value evaluating the inter-rater reliability for the RCS total scores was found to be 0.858.

To evaluate the construct validity of the Turkish version of the RCS-E, both exploratory and confirmatory factor analyses were performed. Before the exploratory factor analyses, the Kaiser–Meyer–Olkin (KMO) test and Bartlett's test of sphericity were conducted to evaluate sampling adequacy and factorability. The KMO value was 0.836,

**Table 5.** Inter-rater reliability of RCS-E Subparameters

| | Observer 1 | Observer 2 | p [1] | ICC | |
|---|---|---|---|---|---|
| | Median | Median | | r (%95 CI) | $p^{ICC}$ |
| **Basic care and support needs** | 1.00 | 1.50 | 0.054 [W] | 0.809(0.718-0.871) | **<0.001** |
| **Risk-Cognitive/Behavioural Needs** | 1.00 | 2.00 | 0.068 [W] | 0.853(0.782-0.900) | **<0.001** |
| **Skilled nursing needs** | 2.00 | 2.00 | 0.304 [W] | 0.829(0.746-0.884) | **<0.001** |
| **Medical needs** | 2.00 | 2.00 | 0.061 [W] | 0.743(0.619-0.826) | **<0.001** |
| **Therapy disciplines** | 2.00 | 2.00 | 0.051 [W] | 0.756(0.638-0.835) | **<0.001** |
| **Therapy intensity** | 1.00 | 1.00 | 0.356 [W] | 0.364(0.059-0.570) | **0.012** |
| **Equipment needs** | 1.00 | 1.00 | 0.782 [W] | 0.692(0.544-0.792) | **<0.001** |
| **Total scores** | 11.00 | 11.00 | 0.783 [W] | 0.858(0.789-0.904) | **<0.001** |

$p^{1\,W}$ Wilcoxon test / $p^{ICC}$ (Intra Class Correlation) CI: Confidence Interval

**Table 6.** Exploratory Factor Analysis Results Showing Unrotated and Varimax-Rotated Loadings for Each Domain of the Turkish RCS-E

| | Unrotated principal component loading | | Varimax rotation orthogonal factor loading | |
|---|---|---|---|---|
| **Domains** | **Principal component 1** | **Principal component 2** | **Rotated component 1** | **Rotated component 2** |
| Basic care and support needs | 0.795 | −0.223 | 0.824 | 0.054 |
| Skilled nursing needs | 0.850 | −0.197 | 0.867 | 0.096 |
| Medical needs | 0.907 | 0.069 | 0.833 | 0.366 |
| Therapy disciplines | 0.821 | -0.129 | 0.817 | 0.150 |
| Therapy intensity | 0.762 | -0.030 | 0.729 | 0.225 |
| Equipment needs | 0.474 | 0.868 | 0.159 | 0.976 |

Eigenvalues of principal component 1 and principal component 2 were 3.657 and 0.864, respectively. The percentage of total variance explained by principal component 1 and component 2 was 60.95% and 14.39%, respectively. The total variance explained by the two-component structure was 75.35%.

indicating a meritorious level of sampling adequacy. Bartlett's test was statistically significant ($\chi^2$=302.03, $p < .001$), supporting the suitability of the data for factor analysis. Exploratory factor analysis revealed two components that together explained 75.35% of the total variance. Although the eigenvalue of the second component (0.864) was slightly below the Kaiser criterion of 1, the rotated factor matrix demonstrated a clear and interpretable structure, with the "Equipment Needs" item loading exclusively onto the second factor. Considering the high cumulative variance explained, the conceptual clarity of the factor structure, and consistency with previous adaptation studies, a two-factor solution was retained for interpretation (Table 6).

Confirmatory factor analysis (CFA) was conducted to evaluate the two-factor model derived from the exploratory factor analysis. The model demonstrated an acceptable level of fit based on selected indices: $\chi^2(9)$=84.3, $p < 0.001$, CFI=0.827,

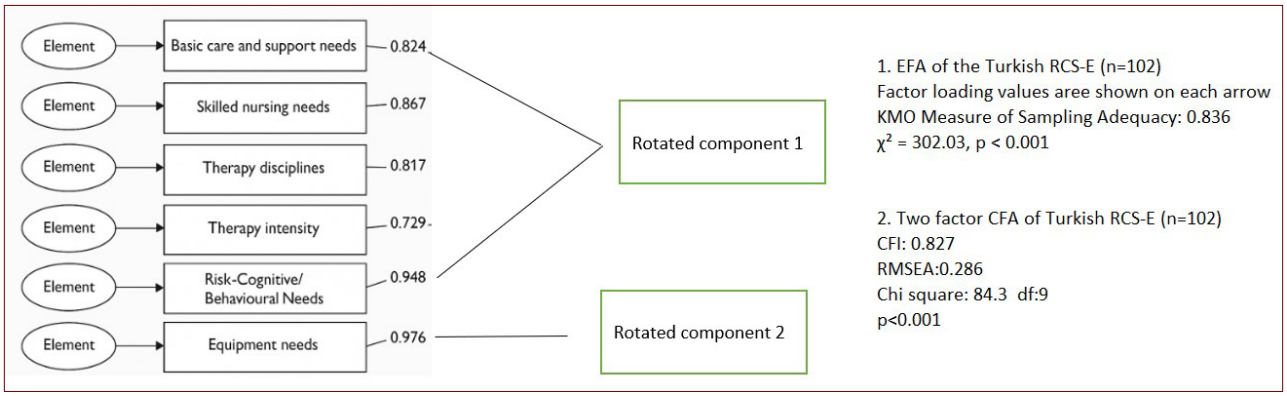



**Figure 1.** Exploratory and Confirmatory Factor Analysis Results for the Turkish Version of the Rehabilitation Complexity Scale–Extended (RCS-E)

The diagram illustrates the two-factor structure derived from exploratory factor analysis (EFA) using principal component extraction and Varimax rotation. Factor loading values are displayed on the arrows. Rotated Component 1 includes basic care and support needs, skilled nursing needs, therapy disciplines, therapy intensity, and cognitive/behavioral risk. Equipment needs loaded strongly on Rotated Component 2. Confirmatory factor analysis (CFA) was conducted to verify the structure, with model fit indices indicating moderate fit (CFI = 0.827, RMSEA = 0.286, $\chi^2$ = 84.3, df = 9, $p < 0.001$).

RMSEA=0.286. While some fit indices did not meet ideal thresholds, the overall model supported the proposed two-factor structure of the Turkish RCS-E, reflecting the conceptual distinction between clinical/therapeutic complexity and equipment-related needs (Fig 1).

## DISCUSSION

In this study, the Turkish adaptation of the RCS-E was conducted, and its validity and reliability were assessed. The ICC values for the subscales ranged between 0.960 and 0.985, while the RCS-ET total score had an ICC value of 0.987, indicating excellent intra-rater reliability. The ICC value calculated for inter-rater reliability of the total RCS-ET score was 0.858, which was considered highly reliable. The Cronbach's alpha value for the RCS-ET was 0.870, indicating satisfactory internal consistency.

During the preparation of the Turkish adaptation of the RCS-E, the subscales were successfully translated into Turkish and re-evaluated through back-translation, following international guidelines (16).Since the Northwick Park Therapy Dependency Assessment (NPTDA) had not been translated into Turkish, it was not included in the Turkish adaptation of the scale. In addition, the nursing definitions in the nursing subscale were revised to better align with the rehabilitation units in Turkey. Moreover, the term "rehabilitation engineer" was omitted, as there is no equivalent profession in Turkey.

In a previous study, Turner-Stokes et al. applied the RCSv2 to patients with complex neurological disabilities and found the internal consistency of the scale to be moderate (Cronbach's alpha: 0.76). In the test–retest evaluation conducted two hours apart, the kappa values ranged between 0.93 and 0.96, indicating excellent agreement (13). Lee et al. conducted an adaptation and validity study of the Korean version of the RCS-Ev13 in various neurological diagnostic groups, reporting test–retest reliability ICC values for the RCS-E subparameters between 0.69 and 0.84. For total RCS-E scores, the ICC was reported as 0.86, with a Cronbach's alpha value of 0.63. The test–retest interval was determined to be between three and four weeks (17). In a separate study involving patients with brain injury due to traumatic and vascular causes, the Danish



version of the RCS-Ev13 was assessed by experts and found to have excellent face validity (18).Roda et al. developed the Italian version of the RCS-E and reported an ICC value of 0.903 for test–retest reliability (indicating good reliability) and a Cronbach's alpha value of 0.702 for internal consistency. In this study, assessments were conducted by the same observer with a one-week interval. In addition, the face validity assessment yielded generally positive feedback (19). In another study involving the Italian adaptation of the RCS-Ev12, the ICC value demonstrating inter-rater reproducibility for total scores was found to be 0.882. The intra-rater reliability for two different raters was reported as 0.93 and 0.77, respectively. Test–retest reliability was determined through measurements taken three months apart (20).Consistent with the literature, the test–retest reliability of the RCS-ET in stroke patients in our study was found to be excellent for the subscales (ICC: 0.960–0.985) and the total score (ICC: 0.987). The Cronbach's alpha value was calculated as 0.870. In addition, the study demonstrated a high level of inter-rater reliability (ICC: 0.858).

During the rehabilitation of individuals with hemiplegia, it is necessary to conduct a clinical evaluation of motor losses, cognitive status, and activities of daily living. For this purpose, scales such as Brunnstrom, motor and cognitive FIM, Rankin, and Barthel are frequently utilized. The inclusion of these scales is particularly important for managing the rehabilitation process and monitoring progress in patients with complicated strokes. In a study by Turner-Stokes et al., the total scores of RCSv2 in patients with neurological disabilities indicated a significant negative correlation with the Barthel Index scores ($r$=-0.67), FIM motor scores ($r$=-0.72), and FIM cognitive scores ($r$=-0.47) (13). In a separate study by Lee et al. on the Korean version of the RCS-E, a significant negative correlation was found between mBI and RCS-E scores in patient groups with cerebrovascular accident, traumatic brain injuries, and other acquired brain injuries ($r$=-0.53). However, this relationship was not observed in patient groups with lower extremity amputation and arthroplasty (17).In a study conducted on patients with stroke and total hip replacement, the Italian version (12th version) of the RCS-E demonstrated a significant negative correlation between total RCS-E scores and both FIM motor ($r$=-0.75) and FIM cognitive ($r$=-0.65) scores (20).In our study, the validation of RCS-ET scores was assessed by examining their correlation with the FIM, mBI, and mRS. The RCS-ET scores indicated a significant positive correlation with the mBI ($r$=-0.611), motor FIM ($r$=-0.659), cognitive FIM ($r$=-0.481), and total FIM ($r$=-0.661) scores, and a negative correlation with the mRS ($r$=0.647) scores. In this regard, our results are consistent with the literature.

This study has both limitations and strengths. The RCS-E is a simple and practical assessment tool that helps determine the clinical complexity of rehabilitation and guide the treatment process. In this study, we conducted the Turkish adaptation of the RCS-E, which had not been previously applied in the literature, along with its validity and reliability assessment. Unlike many studies that include patients from various diagnostic groups, only patients with ischemic or hemorrhagic stroke were included in this research. This approach allowed for a more homogeneous and precise analysis. For the test–retest reliability assessment, the interval between the two assessments was set at one week. This duration was chosen to be long enough to reduce the likelihood of the evaluator recalling previous responses, but short enough to avoid significant changes in the patient's functional status during the rehabilitation process. In addition, both evaluators were experienced specialists in stroke rehabilitation and performed the assessments independently in a blinded manner, without access to each other's scores, which supports the objectivity of the reliability analysis.

One limitation of this study is the relatively small sample size and the single-center design,

which may limit the generalizability of the findings. Including researchers and participants from different rehabilitation centers could have increased sample diversity and external validity. Another limitation is that the evaluations were based on patient files. Face-to-face assessments could have provided a more comprehensive understanding of the patients' actual rehabilitation needs. In addition, due to the retrospective nature of the study and the use of pre-existing medical records, there is a potential for selection bias in the sample. Finally, the study did not include longitudinal follow-up data, which prevents the evaluation of the scale's responsiveness to clinical change over time. Nevertheless, the results of our study demonstrated satisfactory correlations between the RCS-ET and established functional assessment tools, supporting the relevance and clinical applicability of the scale.

In conclusion, this study demonstrated that the Turkish translation of the RCS-E is a valid, reliable, and practical tool for determining the complexity of rehabilitation needs in hemiplegic patients. The scale's high test–retest and inter-observer agreement values support its reliability as an assessment tool in clinical practice. It can serve as a significant guide in objectively identifying patient needs in all kind of rehabilitation units, not only in stroke units, optimizing treatment plans, and planning post-discharge rehabilitation.

This scale can greatly assist clinicians in various areas such as determining the need for home physiotherapy, conducting cost-effectiveness analyses, utilizing resources more efficiently, deciding which patients should receive home healthcare services, and directing rehabilitation services to appropriate patients. Furthermore, it provides decision-makers with valuable information for reducing healthcare costs and effectively allocating qualified healthcare personnel. Consequently, it enables more effective management of patients' functional recovery processes, as well as an improvement in the quality and continuity of rehabilitation services.As the population ages and the number of geriatric patients increases, the demand for rehabilitation services also rises. In this context, RCS-E emerges as a valuable tool in geriatric rehabilitation. In particular, the RCS-ET is an important tool for developing rehabilitation service delivery models and making decisions regarding resource allocation, thereby supporting the principle of providing the right patient with the right treatment at the right time in healthcare services.

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ORIGINAL ARTICLE

# THE IMPACT OF AGE ON INTERNATIONAL PROSTATE SYMPTOM SCORE AND QUALITY OF LIFE SCORES AFTER OPEN PROSTATECTOMY ELDERLY PATIENTS

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## Abstract

**Introduction:** Benign prostatic hyperplasia is a common condition in elderly men and can significantly impair quality of life. Open prostatectomy remains a valuable surgical option for patients with large prostate volumes, particularly in centers where minimally invasive techniques are not available. However, there is limited data regarding the influence of patient age on surgical outcomes. This study aimed to evaluate the effect of age on International Prostate Symptom Score and quality of life outcomes following open prostatectomy.

**Materials and Method:** This retrospective study included 53 patients who underwent open prostatectomy for benign prostatic hyperplasia with large prostate volumes between 2015 and 2020. Patients were divided into two groups based on age: younger than 70 years and 70 years or older. Preoperative and postoperative International Prostate Symptom Score and quality of life scores were compared between the groups.

**Results:** The mean age of the patients was 70.4 years. Both younger and older patients achieved marked improvements in postoperative International Prostate Symptom Score and quality of life scores. Although elderly patients exhibited slightly higher postoperative scores, the magnitude of improvement was comparable across groups. Complication rates were low and did not differ significantly between age groups, demonstrating that advanced age does not compromise surgical safety or effectiveness.

**Conclusion:** Open prostatectomy provides substantial and consistent symptomatic and quality of life benefits for patients with large-volume benign prostatic hyperplasia, independent of age. These findings affirm that open prostatectomy remains a highly reliable treatment option for elderly patients, offering effective and safe outcomes comparable to those observed in younger individuals.

***Keywords:*** Prostatic Hyperplasia; Prostatectomy; Quality of Life; Aging.

## INTRODUCTION

Benign prostatic hyperplasia (BPH) is a non-malignant enlargement of the prostate gland, with its prevalence increasing with age. It represents one of the most common causes of lower urinary tract symptoms (LUTS) in older men (1). Although it is not life-threatening, LUTS—characterized by symptoms such as difficulty urinating, nocturia, increased urinary frequency, and a sensation of incomplete bladder emptying—can significantly impair patients' quality of life (2).

When assessing BPH, the International Prostate Symptom Score (IPSS) and Quality of Life (QoL) score have become essential tools for evaluating patients with LUTS and/or BPH. These validated instruments are suggested as effective methods for diagnosing and monitoring treatment outcomes in this patient group (3). As out comes reported by patients themselves, they are crucial in clinical decision-making, especially for gauging how subjective symptoms respond to therapy. Aging-related physiological changes, such as decreased detrusor contractility, impaired neurogenic control, and bladder comorbidities, have been identifiedas factors that can worsen LUTS (4).

While the initial management of BPH typically involves medical therapy, this approach often proves insufficient for patients with prostate volumes greater than 80 mL, which necessitates surgical intervention. According to the 2025 guidelines of the European Association of Urology (EAU), open prostatectomy (OP) remains one of the recommended surgical options for patients in whom endoscopic enucleation is not feasible (5). Despite the increasing use of minimally invasive techniques such as Holmium Laser Enucleation of the Prostate (HoLEP) and Robot-Assisted Simple Prostatectomy (RASP), OP continues to be widely performed in developing countries due to limited access to advanced technology (6).

Although previous studies have demonstrated the overall surgical efficacy of OP in improving IPSS and QoL scores, data on variations in these outcomes with age remain limited. However, age-related physiological changes in the lower urinary tract may directly influence surgical outcomes.

This study retrospectively analyzed changes in IPSS and QoL scores following OP in patients with large-volume (>80 mL), medically refractory BPH. The study aimed to compare the changes in these subjective scores across age groups (≥70 years vs. <70 years) and assess the impactof age on clinical outcomes following OP.

## MATERIALS AND METHOD

In this retrospective study, 53 patients were selected from a total of 855 who underwent surgery for BPH between 2015 and 2020 at a university hospital recognized as one of the national reference centers for BPH surgery. Demographic data, clinical follow-up parameters, IPSS, and QoL scores were obtained comprehensively from the hospital information management system and patient records. Ethical approval for the study was granted by our university's Clinical Research Ethics Committee (Decision No: 803, dated 26.11.2020).

Patients included in the study were over 45 years old, had prostate volumes greater than 80 $cm^3$ as measured by transrectal ultrasonography, had not responded to medical treatment, and had surgical indications due to recurrent urinary retention and/or bladder stones. Patients diagnosedwith prostate cancer, a history of previous prostate surgery, urethral stricture, neurogenic bladder dysfunction, bladder tumors, coagulopathy, or those unableto safely discontinue anticoagulant therapy were excluded from the study.

### Surgical Procedure and Clinical Follow-Up

Antiplatelet medications were discontinued one week before surgery. Under general or spinal anesthesia, urethrocystoscopy was initially performed to inspect the urethra and bladder. The

bladder was then filled with saline, and a midline suprapubic incision was made to access the bladder. Two traction sutures were placed on the anterior wall of the bladder, which was subsequently opened. An incision was made on the bladder neck mucosa according to the prostatic shape at the bladder neck, and digital enucleation was initiated from the anterior aspect of the prostate. After completing the enucleation, the bladder neck was sutured using continuous 2-0 Vicryl (polyglactin 910, Ethicon, NJ, USA) between the 3 and 9 o'clock positions to achieve hemostasis and fix the trigone to the prostate capsule.After bladder neck suturing, a 22F urethral Foley catheter was inserted, and the bladder was closed in two layers with 2-0 Vicryl. Before the anterior bladder wall was closed entirely, an 18F Foley catheter was inserted suprapubically to establish a cystostomy. Following closure, the bladder was filled with saline to check for leakage along the suture line. In the absence of leakage, a prevesical drain was placed, and the rectus muscle, fascia, subcutaneous tissue, and skin were closed in layers.

In the postoperative period, continuous bladder irrigation was administered through the cystostomy catheter for 24 hours. When the mixture of urine and irrigation fluid became clear, the irrigation was stopped, and the cystostomy catheter was clamped.Once clear urine flow was confirmed, the cystostomy catheter was removed. In three patients, the catheter was removed on the 6th postoperative day due to urethral irritation and urine leakage around the catheter. The catheter was removed in the remaining 50 patients on postoperative day 7.

At three months postoperatively, patients were evaluated for IPSS and QoL scores. They were divided into two age groups: those aged ≥70 and those under 70.Although the ≥65 age threshold is commonly used to define older adults in the geriatric literature, a cutoff of 70 years was chosen in this study to ensure better statistical group balance and to more accurately reflect the physiological changes associated with advanced age. IPSS, QoL scores, surgical indications, and complications were compared between the two age groups.

### Statistical Analysis

Statistical analyses were performed using SPSS software version 27.0.1. The normality of the distribution of variables was assessed using the Shapiro-Wilk and Kolmogorov-Smirnov tests. Descriptive analyses were presented as mean and standard deviation for normally distributed variables, and as median with minimum and maximum values for non-normally distributed and ordinal variables. The Mann-Whitney U test was utilized for non-normally distributed variables. The Chi-square test was applied to categorical variables, including surgical indications and complications. A p-value of $<0.05$ was deemed statistically significant in all analyses.

A post-hoc power analysis based on a high effect size (Cohen's d=0.8) indicated that a minimum sample of 26 patients would be sufficient for 80% power at a 5% significance level. Therefore, the current sample size (n=53) is considered statistically adequate.

## RESULTS

The study included 53 patients agedbetween 52 and 89,with a mean age of 70.4 years.In terms of age distribution, 12 patients (22.6%) were younger than 65 years, 15 patients (28.3%) were between 65 and 69 years, and 26 patients (49.1%) were 70 years or older. Overall, 41 patients (77.4%) were aged 65 years and above.The mean prostate volume for the entire cohort was 164.1 mL. The duration of surgery was measured from the time of skin incision to the completion of wound closure, yielding a mean of 44.2 minutes. In the postoperative period, the average duration of cystostomy was 2.1 days, while the average duration of urethral catheterization was 6.9 days (Table 1).

When comparing the patient groups based on age, the cohort was divided into those under 70 (n=27) and those aged 70 years or older (n=26). The median prostate volume in patients under 70 was 140 mL, while in patients older than 70, it was 170 mL. This difference was statistically significant, as determined by the Mann-Whitney U test (p=0.004).

Preoperative IPSS scores had a median of 28 in the younger and 31 in the older groups, indicating a statistically significant difference (p=0.005). Preoperative IPSS scores were evaluated in terms of both voiding and storage symptoms across the two age groups, and were found to be higher in the elderly group. Voiding symptom scores had a median of 17 in patients <70 years and 18 in those ≥70 years, with a statistically significant difference (p=0.008). Similarly, storage symptoms were significantly more pronounced in the elderly group(p=0.006).Similarly, preoperative QoL scores had a median of 5 in patients under 70 and 6 in those aged 70 or older. (p=0.014).

Following surgery, a marked reduction in IPSS scores was observed in both age groups. For voiding symptoms, the postoperative median score was 4 in patients <70 years and 5.5 in those ≥70 years (p < 0.005). A similar improvement was noted in storage symptoms, with a median postoperative score of 3 in the younger group and 4 in the elderly group (p < 0.005). Additionally, postoperative QoL scores improved markedly, with medians of 1 and 1.5 for the younger and older groups, respectively. This difference was also statistically significant (p=0.013).

Changes between preoperative and postoperative values were analyzed to better assess

**Table 1.** Demographic and Clinical Characteristics

| Variable | Mean±SD |
|---|---|
| **Age (years)** | 70.4±7.9 |
| **Prostate Volume (mL)** | 164.1±46 |
| **Surgical Procedure Time (minutes)** | 44.2±9.4 |
| **Cystostomy Duration (days)** | 2.1±0.4 |
| **Catheterization Duration (days)** | 6.9±0.4 |

**Table 2.** Distribution of Clinical and Functional Outcomes by Age Group

| Variable | < 70 Years (n:27) Median (IQR) | ≥ 70 Years (n:26) Median (IQR) | p |
|---|---|---|---|
| **Prostate Volume (mL)** | 140 (110–360) | 170 (110–330) | 0.004 |
| **Preoperative IPSS** | 28 (25–35) | 31 (26–35) | 0.005 |
| **Preoperative IPSS (Voiding)** | 17 (14–20) | 18(15–20) | 0.008 |
| **Preoperative IPSS (Storage)** | 12 (11–15) | 13 (11–15) | 0.006 |
| **Postoperative IPSS** | 7 (4–18) | 9.5 (5–19) | 0.002 |
| **Postoperative IPSS (Voiding)** | 4 (2–10) | 5.5 (3–11) | <0.005 |
| **Postoperative IPSS (Storage)** | 3 (2–8) | 4 (2–8) | <0.005 |
| **IPSS Improvement** | 22(11-28) | 21(12-29) | 0.23 |
| **IPSS Improvement (Voiding)** | 13(7-16) | 12(7-17) | 0.13 |
| **IPSS Improvement (Storage)** | 9(4-12) | 9(5-12) | 0.65 |
| **Preoperative QoL** | 5 (4–6) | 6 (4–6) | 0.014 |
| **Postoperative QoL** | 1 (1–4) | 1.5 (1–3) | 0.013 |
| **QoL Improvement** | 4(1-5) | 4(2-5) | 0.68 |

p: Mann-Whitney U, IQR: Interquartile Range

surgical efficacy. The change in IPSS score (ΔIPSS) was calculated as a median of 22 in patients under 70 and 21 in patients aged 70 or older. Although both groups demonstrated significant symptom relief, the difference in the degree of change between groups was not statistically significant (p=0.236).The median ΔIPSS for voiding symptoms was 13 in patients <70 years and 12 in those ≥70 years, indicating no statistically significant difference between the age groups (p=0.13). Similarly, the median ΔIPSS for storage symptoms was comparable between the two groups (p=0.65).Similarly, changes in QoL scores showed improvement in both groups, with a median change of 4 in both age categories. This difference was also insignificant (p=0.686) (Table 2).

When the indications for surgery were examined, the distribution across age groups revealed noteworthy patterns. A total of 36 patients (67.9%) underwent surgery due to medically refractory BPH:19 in the <70 years group and 17 in the ≥70 years group. The number of patients who underwent surgery for acute urinary retention was 2 in the younger group and 3 in the older group, accounting for 5 patients (9.4%). Surgery due to lower urinary tract symptoms associated with bladder stones was performed in 6 patients from each age group, totaling 12 patients (22.6%). The distribution of surgical indications between the two age groups was not statistically significant (p=0.864) (Table 3).

In addition to surgical indications, we analyzedpostoperative complications acrossdifferent age groups. Outof 53 patients, six individuals (11.3%) experiencedcomplications.The prevalent complication was bladder neck contracture, seen in 4 patients (7.5%). Additionally, 2 patients (3.7%) needed blood transfusions because of postoperative bleeding. The remaining 47 patients (88.7%) reported no postoperative complications.

When the distribution of complications was evaluated by age group, two cases of bladder neck contracture and one case of bleeding were recorded in the <70 years group. Similarly, in the ≥70 years group, two cases of bladder neck contracture and one case of bleeding were observed. There was no statistically significant difference between the groups regarding complication rates (p=0.999) (Table 4).

These findings demonstrate the efficacy of OP across all age groups. Further evaluations on this topic will be discussed in the Discussion section.

**Table 3.** Distribution of Surgical Indications by Age Group

| Surgical Indication | < 70 Years (n:27,%) | ≥ 70 Years (n:26,%) | p |
|---|---|---|---|
| **Medically Refractory BPH** | 19(%70.4) | 17(%47.2) | 0.86 |
| **Acute Urinary Retention** | 2(%7.4) | 3(%11.5) | |
| **Bladder Stone** | 6(%22.2) | 6(%23.1) | |

p: Chi Square

**Table 4.** Distribution of Postoperative Complications by Age Group

| Complication | < 70 Years (n:27,%) | ≥ 70 Years (n:26,%) | p |
|---|---|---|---|
| **No Complication** | 24(%88.9) | 23(%88.5) | 0.99 |
| **Bladder Neck Contracture** | 2(%7.4) | 2(%7.6) | |
| **HemorrhageRequiring Transfusion** | 1(%3.7) | 1(%3.8) | |

p: Chi Square



## DISCUSSION

This study observed significant improvements in IPSS and QoL scores following OP in patients with large-volume BPH. One of the most notable findings is that these improvements occurred at similar rates in both age groups (<70 and ≥70 years). Despite a greater preoperative symptom burden in the older group, the postoperative improvement was similar to that of younger patients, reinforcing the effectiveness of OP as a viable treatment option for elderly individuals.

The marked improvements in IPSS and QoL scores at the third postoperative month represent the primary clinical outcomes of this study. Our findings align with those reported in similar studies with comparable follow-up durations in the literature. In a prospective study by Geavlete et al., the mean IPSS decreased from 28 to 7, and the QoL score from 5.1 to 1.3 following OP (7). Similarly, in a randomized controlled trial by Rao et al., mean IPSS scores dropped from 24.5 to 5.4 and QoL scores from 5.1 to 2.3 at the 3-month mark after OP (8). Although slight differences in postoperative scores were observed between age groups in our study, the degree of improvement in IPSS and QoL was not significantly influenced by age. This further demonstrates that OP is effective across different age groups. Moreover, as noted in previous studies, these improvements are maintained with long-term follow-up and are not diminished by advancing age.

Regarding complications, a study published by Kalfazade et al. reported higher rates of preoperative acute retention in patients aged ≥80 years, but no significant differences in intraoperative blood loss, transfusion requirements, or Clavien-Dindo ≥3 complications between age groups (9). Similarly, our study found no significant differences in the total complication rates between patients under and over 70. The complication-free rates were notably high in both groups (88.8% and 88.4%, respectively). The most common complication was bladder neck contracture, while the need for transfusion due to bleeding was infrequent, indicating that age does not increase the risk of complications. These findings support that OP can be safely performed in elderly patients with careful selection.

In a study by Ou et al. comparing surgical techniques in patients with large prostates, the average operative times were similar between the TURP and OP groups. However, the amount of resected tissue was significantly higher in the OP group, and improvements in IPSS and QoL scores at 3 months were more pronounced (10). In another study by Ahyai et al., the mean operative time was slightly longer in the HoLEP group compared to the OP group in patients with large prostates (11). These findings suggest that OP remains an effective and viable surgical option for patients with prostates larger than 80 mL (12). Furthermore, the risk of urethral stricture associated with prolonged endoscopic procedures continues to make OP a preferred approach in selected cases.

The scarcity of studies comparing IPSS and QoL scores by age group in patients undergoing OP adds to the importance of our research. Moreover, the single-center design and the standardized surgical technique used by the same surgical team enhance the internal consistency of the data.

Nonetheless, our study has several limitations. Its retrospective design required evaluating data collected in the past, which may have introduced selection bias. Additionally, as endoscopic enucleation techniques became more prevalent in our clinic after 2020, patients undergoing OP during that period were excluded to avoid bias due to the concurrent use of laser-based alternatives. This decision further limited the sample size. Furthermore, objective uroflowmetric parameters such as Qmax and post void residual volume could not be included, restricting the study's outcomes to subjective assessments. However, this aligns with the study's methodological framework, which explicitly focused on age-related changes in subjective IPSS and QoL scores.

While many studies evaluate objective parameters after BPH surgery, there is a lack of research comparing symptom severity and quality of life scores across age groups. This study aims to provide meaningful insights to the current literature by focusing on symptom changes based on patient-reported outcomes.

## CONCLUSION

This study evaluated changes in IPSS and QoL scores by age group in patients who underwent OP for large-volume BPH. The findings demonstrate that significant improvements in both symptoms and quality of life were achieved postoperatively in both age groups. Despite a higher baseline symptom burden among elderly patients, the degree of postoperative improvement was comparable to that of younger patients. Furthermore, the similar complication rates across age groups support the notion that OP is a safe surgical option even in older individuals. In clinical settings where access to minimally invasive techniques is limited, OP remains an effective and valid treatment option for patients with large prostate volumes.

Future multicenter prospective studies comparing open prostatectomy with minimally invasive techniques, such as laser enucleation or bipolar TUR-P, could provide a clearer understanding of age-related differences in surgical outcomes. Incorporating both subjective and objective measures would offer a more comprehensive evaluation of efficacy, safety and postoperative recovery in elderly patients.

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**Conflict of Interest**
The authors declare no conflictof interest.

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ORIGINAL ARTICLE

# EVALUATION OF ELDERLY CASES WITH NON-FATAL TRAUMATIC INJURIES

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## Abstract

**Introduction:** As the global population ages, there has been a concomitant increase in the number of geriatric forensic trauma cases.This study aims to determine the causes of trauma, sociodemographic and injury characteristics of elderlyforensic cases with non-fatal traumatic injuries.

**Materials and Method:** In the study, 201 geriatric cases were examinedretrospectively. The cases were reviewed in terms of variables such as gender, age group, incident origin, cause of the incident, medical diagnosis, body part injured, type of fractured bone (if any), whether they were treated as inpatients, length of hospital stay (if any), severity of injury, and injury severity score.

**Results:** Out of the patients,73.1% (n=147) of the cases were male and 26.9% (n=54) were female. The cases were most frequently in the 65-74 age group with a rate of 77.6% (n=156). It was determined that 55.7% of the cases were traumatized by intentional incidents. Battery was the most common with 105 cases (52.2%). Bone fractures ($p<.001$, Cramer's V: .452) and hospitalizations ($p<.001$, Cramer's V: .444) were more common in accidental injuries. Additionally, the injury severity score was higher for accidental injuries (d: 0.63, $t(91.5) = -4.3$, $p<0.001$).

**Conclusion:** Morbidity and mortality rates can be reduced by implementing measures to make social living spaces safer and more suitable for the geriatric population. This includes optimizing ergonomic conditions in the home and providing essential training for all individuals on how to assist the elderly in traffic, such as being cautious and allowing elderly pedestrians to cross the road safely.

***Keywords:*** Geriatrics; Wounds and Injuries; Forensic Medicine; Accidents.

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## INTRODUCTION

Old age is a natural stage of human life,marked by physiological and psychological changes that must be considered within a sociocultural framework. Chronologically, old age is defined as beginning at 65 years of age. In the field of geriatric health and disease, individuals aged 65–74 are classified as the "young-old," those aged 75–84 as the "middle-old," and those aged 85 and over as the "oldest-old" (1).

According to the Turkish Statistical Institute (TurkStat), the population aged 65 and older in Turkey was 6,651,503 in 2016, increasing by 24.0% over five years to reach 8,245,124 in 2021. The proportion of elderly individuals within the total population rose from 8.3% in 2016 to 9.7% in 2021. In 2021, 44.3% of the elderly population in Turkey were male, while 55.7% were female. Population projections suggest that the proportion of elderly individuals is expected to double over the next 50 years. Globally, 9.8% of the population was classified as elderly in 2021, placing Turkey at a median level with 9.7%(2).

Advancements in modern medicine and healthcare services, along with improved living conditions and increased life expectancy, have led to a growing number of geriatric trauma cases(1,3). Compared to younger individuals with similar injuries, elderly patients experience higher rates of mortality, morbidity, hospitalization, and complications(3-7).

In cases where bodily integrity is violated—whether intentionally, negligently, or by omission—legal proceedings are initiated against those responsible.Forensic cases include all types of trauma caused by external factors that may result in injury or death, such as assaults, traffic accidents, falls, firearm injuries, and stab wounds.In addition to providing medical care, physicians have a legal duty to recognize and report forensic cases, inform judicial authorities, and prepare detailed forensic reports(8).

This study aims to evaluate the characteristics and trends of non-fatal trauma among the geriatric population in a Turkish sample and to identify preventive strategies to reduce trauma risk in elderly individuals.

## MATERIALS AND METHOD

### Sampling, setting, and procedure of the study

This study initially examined the cases of elderly individuals who underwent medicolegal evaluation due to judicial proceedings between January 1, 2017, and September 1, 2021,at the Forensic Medicine Outpatient Clinic of Adiyaman Training and Research Hospital,located in the southeastern region of Türkiye.Our clinic evaluates only those cases that have been officially classified as forensic by judicial authorities.A retrospective analysis was conducted of the forensic medical reports of 201 cases who had suffered forensic trauma, as well as their electronic medical data within the hospital system. Reports that were limited to a specific subject, preliminary in nature and lacking sufficient medical information, or missing relevant study data were excluded from the study.

The cases were reviewed in terms of variables such asgender, age at the time of the incident, age group, date of the incident (month and season), cause of injury (type of incident), origin of the incident, medical diagnosis, injured body site, presence of bone fractures, type of fractured bone (if any), whether inpatient treatment was received, length of hospital stay (if any), the clinic where inpatient treatment was received, whether consultations from any specialty were requested during treatment, type of treatment (conservative or surgical), severity of injury, and injury severity score (ISS).

The cases were categorized into three groups: youngest-old age (65-74 years), middle-old age (75-84 years), and oldest-old age (85+ years). Following the evaluation of medical anamnesis,

forensic investigation documents, and medical records, the cause and origin of the incident were determined. The incident origin was analyzed as injuries caused by accidents and intentional. Injuries caused by battery, sharp objects, and firearms were categorized as intentional, while those resulting from traffic accidents, occupational incidents, and falls were considered accidental.A patient who was found to have injured themselves with a sharp object with suicidal intent was not included in the study. There was no case of intentional jumping from a height.Traffic accidents were analyzed as in-vehicle, motorcycle/bicycle, and out-of-vehicle accidents. An in-vehicle traffic accident (IVTA) involves the driver and all passengers in the vehicle, while an out-of-vehicle traffic accident (OVTA) involves pedestrians.

### Trauma severity assessment instrument

In trauma cases, the severity of trauma and mortality prediction are measured by scoring systems. These scoring systems require the assessment of physiological data, anatomical localization of the injury in the body, or a combination of both. Abbreviated Injury Scale (AIS) and injury severity score (ISS) are anatomical scoring systems. The AIS is a scale with scores from 1 (minor) to 6 (fatal) according to the severity of the wounds. When assessing ISS, the body is divided into six regions: head and neck, face, thorax, abdominal and pelvic organs, extremities/pelvic bones, and soft tissue/skin. ISS is obtained by summing the squares of the AIS scores of the three most severely injured regions. The score ranges between 1-75. An ISS score of 16 and above indicates a major trauma(4, 9, 10).In the study, the AIS and ISS trauma scoring systems were used to assess the injury score and severity of injury by grouping the cases according to the anatomical regions of the trauma.

### Statistical analyses

Categorical variables were presented as frequency and percentage, and descriptive statistics and continuous variables were presented as mean±standard deviation. Categorical variables were grouped, percentages were calculated, and Pearson's chi-square or Fisher's exact test was used to compare frequencies, as appropriate. In order to determine the difference between groups in multiple groups, post hoc analysis methods for the chi-square test and Bonferroni correction were applied. We calculated Cramer's V for categorical comparisons as measures of effect size. Strength of association was reported using Cramer's V. Cohen(11) suggested the following guidelines for interpreting Cramer's V; if df=1; Small>0.1, Medium (Moderate)>0.3, and Large>0.5. The Kolmogorov Smirnov test was used for normality in continuous variables ($p > 0.05$). Kurtosis - skewness values were also evaluated. In comparison of the mean values between the two groups, the independent samples t-test was used for the data showing normal distribution and the Mann Whitney U test was used for the data not showing normal distribution. All statistical analyses and tables were performed and created using SPSS 22 (IBM Corp, Armonk, NY). $P < 0.05$ was considered statistically significant in all analyses. The statistical relationship between the variables was examined.

### Ethical Statement

The privacy rights of human subjects were respected during the implementation of study by the authors. For the implementation of the study, ethical approval was obtained from the local Ethics Committee with the decision dated 09/21/2021 and numbered 2021/07-28.This study was performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments.

## RESULTS

During the study period, a total of 6,961 forensic traumatic cases were evaluated in our clinic, of

which 2.9% (n=201) were in the geriatric age group. An analysis of the distribution of geriatric cases by year of admission revealed an increasing trend from 2017 to 2019, peaking in 2019, followed by a subsequent decline (Figure 1). The geriatric age group included 2.8% of the male patients (n=5,201) and 3.1% of the female patients (n=1,760).

147 (73.1%) of the patients were male and 54 (26.9%) were female. Among the cases, the minimum age was 65 years, the maximum was 97 years, and the mean age was 71.0±5.6 years. Among the cases, 77.6% (n=156) were in the youngest-old age group (65-74 years), 19.4% (n=39) were in the middle-old age group (75-84 years) and 3.0% (n=6) were in the oldest-old age group (85+ years). The mean age was 71.2±5.7 years in male patients and 70.3±5.5 years in female patients, and the mean ages of both genders were similar (Z=-1.203, p=.229). The gender distribution of the age groups was similar (p=.798) (Table 1). Regarding the season, it was determined that geriatric traumas occurred most frequently in summer with 74 cases (36.8%), and most frequently in August with 30 cases (14.9%).

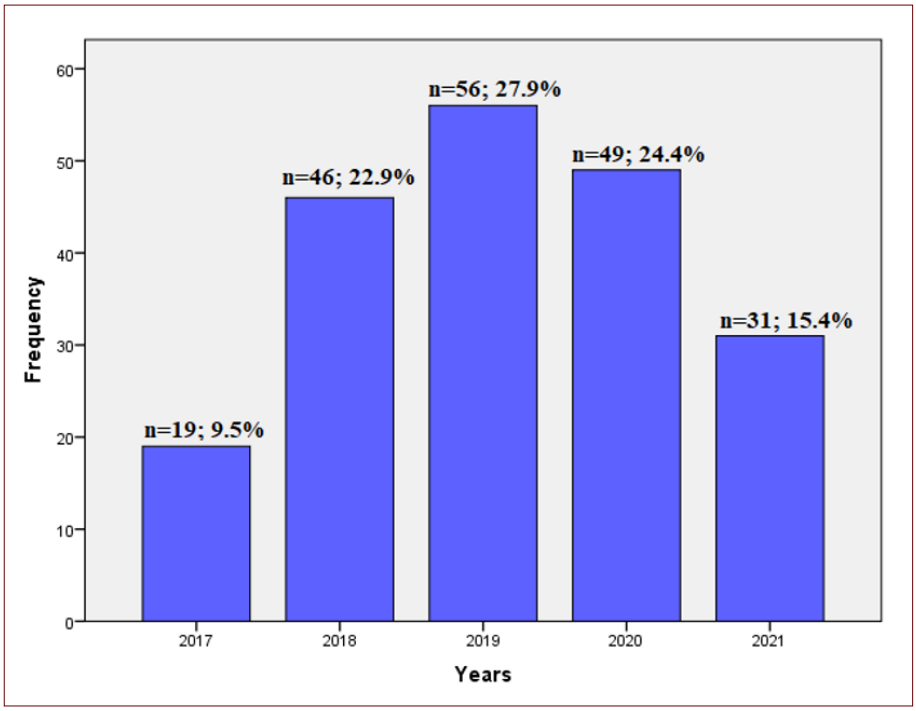



**Figure 1.** Distribution of cases by year.

*: Data from the first eight months of 2021 were incorporated into the study

**Table 1.** Distribution of the cases according to age groups and gender.

| | | Male[α] | Female[α] | Total[α] |
|---|---|---|---|---|
| Age Group | 65-74 | 113 (76.9%) | 43 (79.6%) | 156 (77.6%) |
| | 75-84 | 30 (20.4%) | 9 (16.7%) | 39 (19.4%) |
| | 85 and over | 4 (2.7%) | 2 (3.7%) | 6 (3.0%) |
| Total | | 147 (73.1%) | 54 (26.9%) | 201 (100.0%) |

[α]Percentages were calculated by column.

Regarding the type of the incident, battery was the most common type of incident with 105 cases (52.2%) (Table 2). An analysis of the incidents caused by traffic accidents (n=72) according to the type of occurrence revealed that 34 were IVTA, 28 were OVTA (Table 2). Fourteen cases (13.3%) were observed to be victims of domestic violence. 112 (55.7%) were injured by intentional acts and 89 (44.3%) were injured by accidental trauma. The distribution of the incident origin by gender was similar (p=.503)(Table 3). Moreover, the distribution of incident origin was found to be consistent across the years (p=.282).Due to the small number of cases, when the middle and oldest-old age periods were analyzed together, it was found that accidental incidents were more common in the advanced age group (middle and oldest-old age) ($\chi^2$: 2.988, SD: 1, p=.044, Cramer's V: .122) (Table 3). It was observed that intentional incidents were more likely to occur in warm seasons and accidents in cold seasons ($\chi^2$: 4.480, SD: 1, p=.034, Cramer's V: .149).

Among the medical diagnoses of the injuries, the most common diagnosis was skin/soft tissue trauma (n=114, 56.7%). The second most common one was only bone fracture(s) (n=54, 26.9%)(Table 4). Fourteen patients had skull fractures and/or intracranial trauma. Regarding the sites of injury, the

**Table 2.** Distribution of the cause of the incident according to age group

| | | Aged 65-74 | Aged 75-84 | Aged 85 + | Total |
|---|---|---|---|---|---|
| The cause of the incident | Battery | 85 (54.5%) | 18 (46.2%) | 2 (33.3%) | 105 (52.2%) |
| | IVTA | 29 (18.6%) | 5 (12.8%) | - (-) | 34 (16.9%) |
| | OVTA | 15 (9.6%) | 9 (23.1%) | 4 (66.7%) | 28 (13.9%) |
| | FFH | 8 (5.1%) | 3 (7.7%) | - (-) | 11 (5.5%) |
| | MA | 5 (3.2%) | 2 (5.1%) | - (-) | 7 (3.5%) |
| | OA | 5 (3.2%) | 1 (2.6%) | - (-) | 6 (3.0%) |
| | FI | 5 (3.2%) | - (-) | - (-) | 5 (2.5%) |
| | BA | 2 (1.3%) | 1 (2.6%) | - (-) | 3 (1.5%) |
| | SOI | 2 (1.3%) | - (-) | - (-) | 2 (1.0%) |
| Total | | 156 (77.6%) | 39 (19.4%) | 6 (3.0%) | 201 (100.0%) |

IVTA: In-vehicle traffic accidents, OVTA: Out-of-vehicle traffic accidents,FFH: Falling from a height, MA: Motorcycle accident, OA: Occupational accident, FI: Firearm injuries, BA: Bicycle accident, SOI: Sharp objectinjuries.

**Table 3.** Distribution of Non-accidental and Accidental Cases by Age Group and Gender.

| | | Non-accidental | | | Accidental | | |
|---|---|---|---|---|---|---|---|
| | | Male | Female | Total* | Male | Female | Total* |
| Age Group α | 65-74 | 69 (75.0%) | 23 (25.0%) | 92 (82.1%) | 44 (68.8%) | 20 (31.2%) | 64 (71.9%) |
| | 75-84 | 15 (83.3%) | 3 (16.7%) | 18 (16.1%) | 15 (71.4%) | 6 (28.6%) | 21 (23.6%) |
| | 85 and over | - (-) | 2 (100.0%) | 2 (1.8%) | 4 (100.0%) | - (-) | 4 (4.5%) |
| Total | | 84 (75.0%) | 28 (25.0%) | 112 (55.7%) | 63 (70.8%) | 26 (29.2%) | 89 (44.3%) |

α: Percentages were calculated by line.

*:Percentages were calculated by column.

**Table 4.** Distribution of medical diagnoses of cases

| Medical diagnoses | n | % |
|---|---|---|
| **Skin/soft tissue trauma** | 114 | 56.7 |
| **Only bone fracture** | 54 | 26.8 |
| **Only skull fracture and/or intracranial trauma** | 12 | 6.0 |
| **Only intrathoracic trauma** | 11 | 5.5 |
| **Multiple trauma** | 3 | 1.5 |
| **Dental Injuries** | 2 | 1.0 |
| **Others*** | 5 | 2.5 |
| **Total** | 201 | 100.0 |

*: Other diagnoses were only intra-abdominal trauma, spinal cord injury, eye injury and amputations.

**Table 5.** Distribution of the cases according to injury regions.

| Injury Region | n | % |
|---|---|---|
| **Head/Face/Neck** | 62 | 30.8 |
| **Head/Face/Neck + Extremity/Pelvic** | 46 | 22.9 |
| **Extremity/Pelvic** | 45 | 22.4 |
| **Head/Face/Neck + Thorax + Extremity/Pelvic** | 10 | 5.0 |
| **Thorax** | 9 | 4.5 |
| **Head/Face/Neck + Thorax** | 7 | 3.5 |
| **Abdomen** | 7 | 3.5 |
| **Others** | 15 | 7.5 |
| **Total** | 201 | 100.0 |

most common site of injury was the head/neck/face with 131 cases (65.2%), followed by the extremities/pelvis with 113 cases (56.2%) (Table 5).

Eighty-one patients (40.3%) were observed to have a fracture/fractures in any part of their body. Out of 81 patients, 42 had single bone fractures and 39 had multiple bone fractures. 19 patients had rib fractures, 19 had fascial fractures, 15 had tibia/fibula fractures, 10 had vertebral fractures, and 9 had cranial fractures. Bone fractures were significantly more common in accidental injuries ($\chi^2$: 41.063, SD: 1, p<.001, Cramer's V: .452). The presence of bone fractures was similarly distributed according to age groups (p=.765).

148 patients (73.6%) were discharged after treatment in the emergency department, while 53 patients (26.4%) were hospitalized in a hospital clinic. Significantly higher rates of hospitalization were observed in accidental injuries (48.3%) compared to injuries caused by intentional action (8.9%) ($\chi^2$: 39.623, SD: 1, p<0.001, Cramer's V: .444). It was found that 58 cases were consulted to the Orthopedics clinics, and 38 cases were consulted to the Neurosurgery clinics. Inpatients (n=53) were most commonly treated in orthopedics (n=26, 49.1%) and neurosurgery (n=12, 22.6%) clinics. These patients were followed up in the hospitalized clinics for a minimum of 1 and a maximum of 70 days ($\bar{x}$=11.5±13.3). Conservative treatment was applied

in 170 cases (84.6%), and surgical and conservative treatment was combined in 31 cases (15.4%).

Regarding the injury severity score, 92.5% and 7.5% of the patients had minor and major injuries, respectively. Fisher's exact test showed a similar ratio of the severity of injuries in both genders (p=.237). The mean injury severity scores of both genders were found to be similar (p=.342). Accidental injuries (M=8.4) had a significantly higher injury severity score than intentional actions (M=1.9) (d: 0.63, t(91,5)=-4.3, p<0.001). The Chi-square test revealed that cases had a significantly higher rate of major injuries in accidental incidents (15.7%) compared to those resulting from intentional actions (.9%) ($\chi^2$: 15.810, SD: 1, p < 0.001, Cramer's V: .280).

## DISCUSSION

In Turkey and across the world, the elderly population is rapidly increasing. Therefore, it is crucial to identify the causes of forensic traumatic events in elderly individuals, determine the clinical characteristics of these cases, and implement necessary measures. As people age, they experience reductions in various functions such as perception, attention, mental and motor activity, vision, and hearing, along with slower reflexes and deterioration of the musculoskeletal system. These pathophysiological changes result in more frequent traumas among elderly individuals, leading to serious injuries and deaths(12).

In this study, 72.0% of the cases were male, aligning with findings from studies on geriatric forensic trauma cases in Turkey, which reported male prevalence rates between 68.9% and 69.2%(6, 13).This higher proportion of male cases in Turkey is often attributed to their greater participation in the workforce, daily social activities, and trafficexposure. In contrast, other studies conducted in Turkey, Italy, Trinidad and Tobago, Australia and Bolivia reported a higher prevalence of female patients(7,14-17). This discrepancy is attributed to these studies examining the general geriatric population, where the proportion of elderly women is higher globally. This discrepancy is likely due to the focus of these studies on the general geriatric population, in which the proportion of elderly women is globally higher.

The mean age of the patients was 71.0 years and the most common age group was 65-74 years, consistent with similar studies(1,9).It was attributed to several factors, including the greater mobility of individuals in the youngest-old age group and their more frequent participation in active lifestyles compared to other age groups. A study conducted in Italy reported that, although individuals aged 75–84 experienced the highest overall exposure to trauma, gender-based comparisons showed that women had a higher prevalence of trauma within this age group, while men were more frequently affected in the 65–74 age group (14).Inanother study conducted in Norway, the median age of geriatric patients was 76 years, higher than that of our study (3). These datamay be related to the different rates of the elderly population and life expectancy in different societies. Additionally, the economic and socio-cultural characteristics of societies may also influence the age variable in geriatric trauma cases.

In our study, it was observed that the number of geriatric trauma cases increased from 2017 to 2019, followed by a downward trend thereafter. In a study conducted by Can et al. in the Aegean region of Turkey, which investigated trauma patients presenting to the emergency department during the COVID-19 pandemic restriction period, a decrease in forensic cases and traffic accident-related admissions was reported, along with a marked reduction in geriatric trauma cases (18). Similarly, our study identified a downward trend in the number of cases during the COVID-19 restriction period in 2020 and 2021. It is considered that the decline in geriatric cases during the pandemic period may be attributed to the restrictions imposed on daily life activities.

In a study on geriatric forensic cases admitted to the emergency department, it was reported that

admissions decreased during the winter months and continued to increase from spring to the end of the summer season (6).Similarly, in our study, the number of cases was observed to be at the lowest level in the winter months and continued to increase in the spring and summer months. Concerns regarding illness and the increased risk of falls on icy surfaces may lead elderly individuals to avoid going outdoors during winter.Furthermore, a previous study conducted at the same center where our research was carried out found that forensic trauma cases presenting to emergency services were reported most frequently during the warmer months and least frequently during colder months, which is consistent with our findings (19).

In our study, it was found that the most common causes of injury were found to be battery and traffic accidents, respectively. These results are consistent with studies conducted in Turkey's Mediterranean, Marmaraand Eastern Anatolia regions (5,13,20). However, Guler et al. found that traffic accidents were the most common cause of injury in the Aegean region (1).In studies conducted in Turkey, Italy, Australia, Trinidad and Tobago, Bolivia, and Norway in which geriatric trauma cases were examined, it was reported that falls and traffic accidents were observed at the highest rates in the study samples, respectively (3,7,14-17). On the other hand, motor vehicle accidents, pedestrian accidents, and falls were found to be the most frequent forensic diagnoses in a study conducted inAnkara, the capital city of Turkey located in the Central Anatolia region (21). Elderly individuals' participation in daily life, the respect and appreciation they receive, compliance with traffic rules, traffic density, and the socioeconomic and sociocultural differences of societies may vary across regions and countries.Falls may be attributed to the individual's conditions such as dementia, diabetes, or hypertension, or their carelessness, and thus might not be considered forensic events due to the lack of intentional or accidental external influence from another person. Consequently, falls are often reported at lower rates in studies examining geriatric forensic cases. It was noted that there were fourteen cases of elder abuse among the cases of battery in our study. Elderly individuals are often subjected to physical abuse due to factors such as their dependence on others for care and chronic illnesses (6).Therefore, it is crucial for physicians to carefully examine elderly patients for signs of physical abuse.

The percentage of cases involving intentional actions (55.7%) in our study was similar to the study conducted by Sener and Kilinc (53.8%) but lower than the study conducted by Durak et al. (71.5%) (5,13). Elderly abuse rates are reported to be between 4%-10% in Canada and 15.4% in Turkey (5,22).Our study found a similar rate of 13.3% for elderly physical abuse. It has been reported that older individuals may suffer physical abuse from family or caregivers, emphasizing the necessity of detailed physical examinations during service visits (5).Our study's result that accidental events increase with age is consistent with a similar study (13). Accidents become more common with age due to deterioration in cognitive functions, the presence of chronic diseases, and decline in musculoskeletal functions.

In a study conducted in the Western Black Sea region of Turkey, which examined geriatric emergency department admissions before and after the COVID-19 pandemic, a similar ratio was identified between the periods in terms of the types of injuries (23). Additionally, no significant temporal differences were observed in the distribution of admissions due to traffic accidents, assaults, or firearm-related injuries (23). This study further demonstrated that the pattern of trauma origins among geriatric patients showed no significant variation over the years. This may be attributed to the relatively stable lifestyle patterns of geriatric individuals, who tend to spend more time at home, often live alone, and maintain routine daily habits,

along with reduced social contact during the pandemic period.

Studies examining geriatric trauma cases admitted to emergency departments in Turkey have found that soft tissue injuries are the most common trauma-related injuries among the elderly, followed by extremity fractures (16, 21). Similarly, studies on geriatric forensic trauma cases conducted in the Central Anatolia and Eastern Anatolia regions of Turkey have reported that the most common injuries are superficial injuries involving the skin and subcutaneous tissue (6, 13). Consistent with previous findings, the most frequent medical diagnoses in our study were soft tissue trauma and bone fractures. The majority of cases involved minor traumas, with superficial injuries being more common. Minor traumas are often associated with physical assault, while major traumas are more frequently linked to traffic accidents. Since elderly individuals are physically more vulnerable, perpetrators may prefer to use a minimal level of force to achieve intimidation or coercion. The primary intent of such violence is often not to cause fatal or severe injury, but rather to exert control, impose pressure, or inflict emotional harm.Traffic accidents cause high-energy trauma, resulting in a higher number of bone fractures, more major trauma, and longer hospital stays (13).Consistent with the literature, our study showed that duration of hospitalization, incidence of bone fractures, and injury severity scores were significantly higher for injuries resulting from accidents compared to intentional injuries. Notably, almost all cases of intentional injuries involved minor traumas.

The most commonly injured body areas were the head/neck and extremities, consistent with other studies (3,14,17,24).Additionally, the fact that most cases were treated in the orthopedics clinic aligns with previous studies (1,16).These body areas are expected to be more frequently injured due to their exposure to impact. In previous studies, similar to our study, the average duration of hospitalization of elderly individuals after trauma was 8 to 11.5 days (9,25,26). Physiological, metabolic, and pharmacodynamic changes with age negatively affect clinical prognosis (6). Therefore, a multidisciplinary approach to treating elderly trauma cases is considered more appropriate.

### Limitations and Advantages

Our study on elderly individuals with non-fatal traumatic injurieshad several limitations. First, we did not have information on comorbid conditions that could affect the morbidity of the participants. Second, there was a lack of data on the identity of the perpetrators and the degree of their relationship with the victims. Lastly, there are general limitations due to its retrospective design. The advantage of this study is that it examines forensic geriatric non-fatal trauma cases.

## CONCLUSION

Traumatic injuries in elderly individuals can cause significant physical, emotional, and financial damage to the person, their family, and the country. Geriatric forensic traumatic admissions continue to increase due to the growing elderly population in Turkey. Due to age-related pathophysiological changes, elderly individuals often experience higher rates of mortality and morbidity, longer hospital stays, and more complications compared to younger individuals with similar injuries. A multidisciplinary approach is more appropriate in the treatment of elderly trauma cases.

Healthcare professionals should be aware of the characteristics of elderly physical abuse and approach cases with caution. It is important to remember the legal and social responsibility of reporting forensic traumas to relevant authorities (police, prosecutors, etc.) to prevent repeated elderly abuse.Preventive measures are vital for preventable events such as traffic accidents, domestic accidents and falls from heights. It is



believed that morbidity and mortality rates can be reduced by implementing measures to make social living spaces safer and more suitable for the geriatric population. This includes optimizing ergonomic conditions in the home and providing essential training for all individuals on how to assist the elderly in traffic, such as being cautious and allowing elderly pedestrians to cross the road safely.

### Conflict of Interest

The authors state that there is no conflict of interest.

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ORIGINAL ARTICLE

# CANCER RATE IN PULMONARY EMBOLISM DIAGNOSED CASES: A SINGLE-CENTER, RETROSPECTIVE STUDY

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## Abstract

**Introduction:** The aim of this study was to evaluate the incidence of pulmonary embolism in relation to age, cancer, and other comorbidities; to assess clinical, laboratory, and radiological findings; and to examine the associated mortality rate.

**Materials and Method:** Patients diagnosed with pulmonary embolism were included in this single-center retrospective study. The patients were divided into two age groups: < 60 and > 60 years. The incidence of pulmonary embolism; presence of deep vein thrombosis, cancer, surgical history; other comorbidities; mortality rate; prevalence of embolism; and C-reactive protein and D-dimer levels were evaluated according to age group and sex.

**Results:** Of the 1,281 patients who underwent pulmonary computed tomography angiography for suspected pulmonary embolism, 235 were diagnosed with pulmonary embolism. Of these, 114 were female and 121 were male. The mean age was 62.3 ± 16.8 years. In the ≥60 age group, the proportion of females was significantly higher than that of males ($p < 0.05$). Cancer prevalence and C-reactive protein and D-dimer levels were also significantly higher in this group ($p < 0.05$). No statistically significant differences were observed between the age groups for the other evaluated parameters.

**Conclusion:** The incidence of pulmonary embolism is higher in the elderly population, and the presence of additional conditions, particularly cancer, further increases the risk of pulmonary embolism. Careful monitoring of elderly patients for comorbidities, risk factors, and complications—such as pulmonary embolism—is crucial. Early diagnosis and timely treatment play vital roles in reducing mortality and significantly improving quality of life.

***Keywords:*** Pulmonary Embolism; Aged; Mortality; Neoplasms.

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## INTRODUCTION

According to the World Health Organization (WHO), the number of people aged 60 years and older is expected to reach 1.2 billion. The elderly population is also increasing in our country (1), leading to a growing proportion of elderly patients in clinical settings. Early diagnosis and treatment of potential pathologies are crucial to reduce mortality, improve quality of life, and minimize healthcare costs in this patient group.

Pulmonary embolism (PE) is a life-threatening global health problem caused by the obstruction of the pulmonary arteries by thromboembolic materials (2). It most commonly results from thrombi in the deep veins of the lower extremities, which obstruct blood flow to the pulmonary arteries (3). Its incidence increases in the presence of malignancy, sepsis, trauma, prior surgery, and immobilization (4). Studies have shown that the frequencies of deep vein thrombosis (DVT) and PE increase with age. As both conditions significantly increase 1-year mortality, early diagnosis and prompt treatment are vital (5).

Pulmonary multidetector computed tomography angiography (MDCTA) plays a critical role in the diagnosis and follow-up of PE. Advances in CT technology now allow for the detection of even small segmental emboli, which are seen as contrast-filling defects within the vessel lumen. Additionally, MDCTA can help rule out other cardiac and pulmonary pathologies that present with similar clinical features. However, excessive use of this imaging modality exposes patients to unnecessary ionizing radiation; therefore, MDCTA should be reserved for cases in which clinical findings and laboratory tests such as D-dimer levels support a preliminary diagnosis (6).

The aim of this study was to determine the incidence of PE according to age group and to identify factors affecting mortality in patients aged > 60 years who underwent pulmonary MDCTA with a prediagnosis of PE at our institution.

## MATERIALS AND METHOD

The study was approved by the Istanbul Okan University Non-Interventional Clinical Research Ethics Committee (decision number 36, meeting number 169; October 18, 2023).As this study was retrospective in nature, informed consent was not required. The study was conducted in accordance with the principles outlined in the Declaration of Helsinki.

We retrospectively screened patients who underwent pulmonary MDCTA for suspected PE at our hospital between January 2018 and March 2022. Demographic data were obtained from the electronic medical records of the hospital.

All examinations were performed using a 64-slice CT scanner (Optima CT 660; General Electric Medical Systems, Milwaukee, Wisconsin, USA). A water-soluble, nonionic intravenous contrast agent (350–370 mg/mL iodine) was administered using an automatic dual-head injector system at a dose of 1 mL/kg (90–100 mL total) at an injection rate of 3–5 mL/s via an 18-gauge cannula placed in the antecubital vein. Image acquisition began 12 s after injection, with contrast timing planned using the bolus monitoring technique.

Two- and three-dimensional maximum intensity projection (MIP) images were generated from pulmonary phase MDCTA images. MDCTA images and reports were retrospectively reviewed by an experienced radiologist (D.D.). Cases of PE were identified and classified as unilateral, bilateral, or massive embolisms based on the MDCTA findings.

The incidence of embolism according to age and sex; history of deep vein thrombosis (DVT), cancer, prior surgery, other comorbidities; and the relationship between C-reactive protein (CRP) and D-dimer levels and age and thrombus burden were analyzed. Additionally, the factors contributing to mortality were reviewed.

## RESULTS

PE was diagnosed in 235 of the 1,281 patients who underwent pulmonary MDCTA for suspected PE. Of these, 114 (48.5%) were female and 121 (51.5%) were male. Ninety-six patients (40.9%) were aged ≤ 59 years, and 139 patients (59.1%) were aged ≥ 60 years. The mean age was 62.3 ± 16.8 years.

A total of 105 patients (44.7%) had comorbid conditions, such as diabetes mellitus, hypertension, or chronic obstructive pulmonary disease. In terms of embolism distribution, 121 (51.5%) patients had unilateral PE (Figure 1), 81 (34.5%) had bilateral PE (Figure 2), and 33 (14.0%) had massive PE (Figure 3).

DVT was detected using Doppler ultrasonography in 95 (40.4%) patients. Malignancy was present in 38 patients (16.2%), and 53 patients (22.6%) had a history of surgery. A total of 27 patients (11.5%) died. The mean CRP level was 2.4 mg/dL, and the mean D-dimer level was 0.9 µg/mL (Table 1). No significant differences ($p > 0.05$) were observed between the ≤ 59 and ≥ 60 age groups in terms of comorbidity rate, embolism localization, DVT rate, or history of surgery (Table 2). The proportion of female patients was significantly higher in the ≥ 60 age group compared to the ≤ 59 age group ($p < 0.05$) (Table 2). Similarly, the cancer rate was significantly higher in the ≥ 60 age group ($p < 0.05$) (Table 2). CRP and D-dimer levels were significantly higher in patients

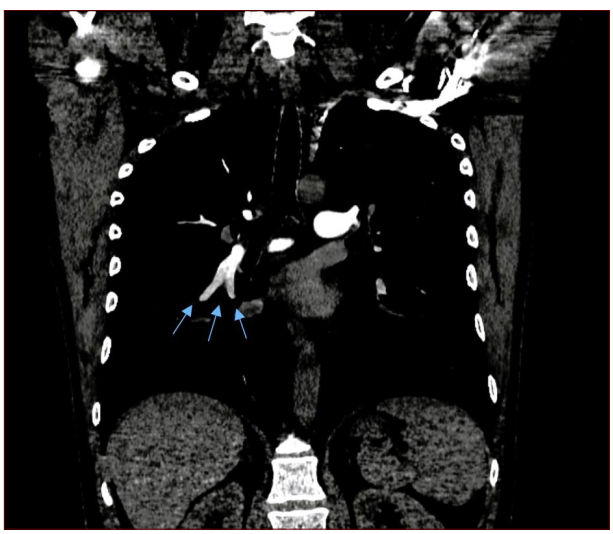


**Figure 1.** MDCTA coronal sections showing hypodense areas compatible with thrombus in the segmental branches of the right pulmonary artery to the lower lobe (small blue arrows).

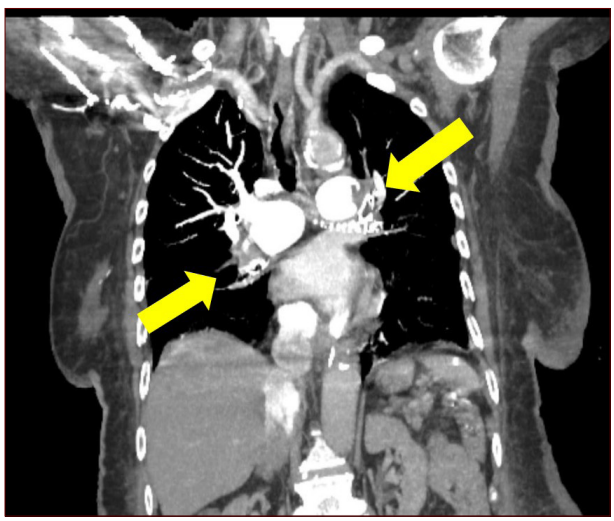


**Figure 2.** MDCTA coronal sections showing hypodense foci compatible with thrombus in bilateral pulmonary artery branches (thick yellow arrows)

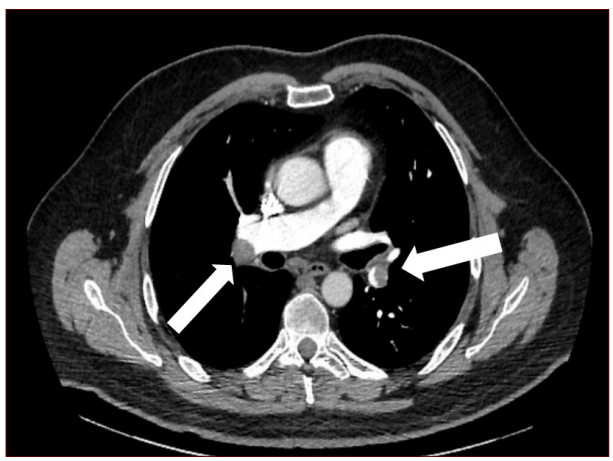


**Figure 3.** MDCTA axial sections showing hypodense filling defects in bilateral main pulmonary arteries consistent with massive pulmonary embolism (thick white arrows).

**Table 1.** Demographic, clinical and laboratory findings of patients

| | | Min-Max | | | Median | Mean ± SD/n (%) | | |
|---|---|---|---|---|---|---|---|---|
| **Age** | | 20.0 | – | 95.0 | 65.0 | 62.3 | ± | 16.8 |
| **Age** | ≤59 | | | | | 96 | | 40.9% |
| | ≥60 | | | | | 139 | | 59.1% |
| **Gender** | Female | | | | | 114 | | 48.5% |
| | Male | | | | | 121 | | 51.5% |
| **Comorbid Disease** | (-) | | | | | 130 | | 55.3% |
| | (+) | | | | | 105 | | 44.7% |
| **Localization** | Unilateral | | | | | 121 | | 51.5% |
| | Bilateral | | | | | 81 | | 34.5% |
| | Massive | | | | | 33 | | 14.0% |
| **Deep vein thrombosis** | (-) | | | | | 140 | | 59.6% |
| | (+) | | | | | 95 | | 40.4% |
| **Cancer** | (-) | | | | | 197 | | 83.8% |
| | (+) | | | | | 38 | | 16.2% |
| **Operation history** | (-) | | | | | 182 | | 77.4% |
| | (+) | | | | | 53 | | 22.6% |
| **CRP** | | 0.1 | – | 32.2 | 2.4 | 6.0 | ± | 7.4 |
| **D-Dimer** | | 0.1 | – | 10.0 | 0.9 | 2.8 | ± | 3.4 |
| **Mortality (Exitus)** | (-) | | | | | 208 | | 88.5% |
| | (+) | | | | | 27 | | 11.5% |

aged ≥ 60 years compared to those aged ≤ 59 years ($p < 0.05$). There was no significant difference in mortality rates between the age groups ($p > 0.05$) (Table 2).

Of the 235 patients with PE, 38 (16.17%) had an underlying malignancy. Lung cancer was the most common cancer type, detected in 17 patients (44.7%; 7.23% of all PE patients). 31.2% of this group was female and 68.8% was male. Pancreatic cancer was the second most common cancer, detected in 5 patients (13.2%); 80% of these patients were female and 20% were male. Renal cell carcinoma (RCC) and rectal cancer were detected in two patients (5.3%) each. Glioblastoma multiforme (GBM) was seen in four patients (10.5%). Other cancer types seen were small cell lung cancer, osteosarcoma, pleural sarcoma, astrocytoma, cardiac angiosarcoma), cholangiocarcinoma and cervical cancer.

Regarding cancer staging, 25.0% of lung cancers were Stage I, 12.5% Stage II, 12.5% Stage III, and 50% Stage IV. Of pancreatic cancer patients, 20% were Stage II, 20% Stage III, and 60% Stage IV. Half of rectal cancer patients were Stage III, while the other half were Stage IV. All GBM and RCC patients were Stage IV. Sarcomas and astrocytomas were cases with systematic metastases. These findings indicate that malignancy-associated PE cases mostly occur in advanced-stage cancers.

**Table 2.** Demographic, clinical and laboratory findings of patients under and over 60 years of age

| | | Age ≤59 (n = 96) | | Age ≥ 60 (n = 139) | | p | |
|---|---|---|---|---|---|---|---|
| | | Mean ± SD/n (%) | Median | Mean ± SD/n (%) | Median | | |
| **Gender** | Female | 37 | 38.5% | 77 | 55.4% | 0.011 | $X^2$ |
| | Male | 59 | 61.5% | 62 | 44.6% | | |
| **Comorbid Disease** | (-) | 52 | 54.2% | 78 | 56.1% | 0.768 | $X^2$ |
| | (+) | 44 | 45.8% | 61 | 43.9% | | |
| **Localization** | Unilateral | 51 | 53.1% | 70 | 50.4% | 0.638 | $X^2$ |
| | Bilateral | 34 | 35.4% | 47 | 33.8% | | |
| | Massive | 11 | 11.5% | 22 | 15.8% | | |
| **Deep vein thrombosis** | (-) | 55 | 57.3% | 85 | 61.2% | 0.553 | $X^2$ |
| | (+) | 41 | 42.7% | 54 | 38.8% | | |
| **Cancer** | (-) | 88 | 91.7% | 109 | 78.4% | 0.007 | $X^2$ |
| | (+) | 8 | 8.3% | 30 | 21.6% | | |
| **Operation history** | (-) | 79 | 82.3% | 103 | 74.1% | 0.140 | $X^2$ |
| | (+) | 17 | 17.7% | 36 | 25.9% | | |
| **CRP** | | 3.9 ± 6.0 | 1.1 | 7.4 ± 8.0 | 4.2 | 0.000 | m |
| **D-Dimer** | | 2.2 ± 3.2 | 0.5 | 3.2 ± 3.5 | 1.6 | 0.003 | m |
| **Mortality (Exitus)** | (-) | 86 | 89.6% | 122 | 87.8% | 0.668 | $X^2$ |
| | (+) | 10 | 10.4% | 17 | 12.2% | | |

Mann-Whitney U test / $X^2$ Chi-square test

Different comorbidities were detected in patients diagnosed with pulmonary embolism. The most common were pneumonia (36 patients, 15.3%; mean age 65.5 years; 36.1% female, 63.9% male), chronic obstructive pulmonary disease (COPD) (35 patients, 14.9%; mean age 69.7 years; 25.7% female, 74.3% male), and COVID-19 infection (28 patients, 11.9%; mean age 56.9 years; 35.7% female, 64.3% male). Less common comorbidities included hypertension (6 patients, 2.6%), diabetes mellitus (5 patients, 2.1%), congestive heart failure (6 patients, 2.6%), coronary artery disease (3 patients, 1.3%), interstitial lung disease (3 patients, 1.3%), arrhythmia (4 patients, 1.7%), protein S deficiency and hyperhomocysteinemia (3 patients, 1.3%), sepsis (2 patients, 0.9%), cerebrovascular accident (2 patients, 0.9%), and Castleman disease (1 patient, 0.4%).

### Statistical Method

Mean, standard deviation, median, minimum, maximum, frequency, and percentage values were used for descriptive statistics. The distribution of variables was assessed using the Kolmogorov-Smirnov and Shapiro-Wilk tests. The Mann-Whitney U test was used to compare quantitative independent variables that did not follow a normal distribution. The chi-square test was used to analyze qualitative independent variables. All statistical analyses were performed using SPSS software (version 27.0; IBM Corp., Armonk, NY, USA).

## DISCUSSION

Venous thromboembolism (VTE), including deep vein thrombosis (DVT) and pulmonary embolism (PE), is a serious public health concern that can result in death. PE is the most common cause of mortality in hospitalized patients. Risk factors for VTE include hospitalization, immobilization, prior surgery, cancer, oral contraceptive use, pregnancy, and hormone replacement therapy.

DVT typically presents with clinical signs, such as pain, redness, edema, and increased warmth in the lower extremities. Doppler ultrasonography (US) generally reveals noncompressible thrombosed venous segments in the deep veins of the legs. In cases of PE, clinical findings may include dyspnea, syncope, hypotension, tachypnea, tachycardia, and hypoxia (7).

Pulmonary MDCTA should be performed to confirm the diagnosis, particularly when D-dimer levels are elevated. However, diagnosis may be delayed in elderly patients because of overlapping clinical features with other cardiopulmonary diseases, atypical presentations (such as altered mental status), and the lower diagnostic utility of D-dimer in this population (8).

D-dimer is produced through the degradation of cross-linked fibrin by plasmin and serves as a marker of intravascular clot formation. Therefore, it plays a key role in the diagnosis of VTE. However, D-dimer levels may also increase during infections and various inflammatory conditions (9). The normal blood level is generally considered to be ≤ 0.5 µg/mL.

CRP is an acute-phase reactant that reflects inflammation and tissue damage. The normal blood concentration range is 0–5 mg/L. Tumor necrosis factor (TNF) is produced by the liver in response to cytokine stimulation, primarily by interleukin-6 (IL-6) and interleukin-1 (IL-1), and has a half-life of 4–6 h. CRP levels can also increase due to physical activity, smoking, alcohol use, diabetes mellitus, hypertension, and hormone therapy. Studies have shown that CRP levels are elevated during the acute phase of PE (10). It is thought that CRP levels increase as a result of exacerbation of hemorrhagic necrosis and the associated inflammatory response. Moreover, other studies have indicated that patients with PE and elevated CRP levels have higher mortality rates, suggesting that CRP could serve as an early predictor of mortality (11). In our study, both the average D-dimer and CRP levels were significantly higher in the ≥ 60 age group compared to the younger group.

The incidence of PE is known to increase in patients with cancer owing to various pathophysiological mechanisms. In this population, PE is the second most common cause of death after cancer itself (12). Therefore, prophylactic anticoagulant therapy is recommended after an acute PE episode in patients with cancer to reduce the risk of recurrence and mortality (13). In our study, the cancer rate was significantly higher in older age groups.

Based on the extent of embolism, PE can be classified as massive, submassive, or low-risk (segmental). Massive PE is characterized by systemic hypotension (systolic blood pressure < 90 mm Hg or a reduction of ≥ 40 mm Hg from baseline for at least 15 minutes not due to arrhythmia) or shock. Additional signs may include altered consciousness, oliguria, and evidence of tissue hypoperfusion and hypoxia (e.g., cold, clammy extremities). The diagnosis of massive PE relies on clinical findings supported by transesophageal echocardiography, pulmonary CTA, and laboratory data (14).

In a study of patients with a mean age of 65 years, mortality rates were 71.4% for massive PE, 44.5% for submassive PE, and 28.1% for low-risk PE ($p < 0.001$) (15). Pulmonary CTA revealed massive PE in 14% of patients, bilateral/submassive PE in 34.5%, and unilateral/low-risk PE in 51.5% of patients. No



significant differences in the extent of embolism or mortality rates were observed between age groups.

Studies have shown that the incidence of PE is higher in older populations, and the mortality rate of PE is significantly greater in patients aged 65 years and older compared to younger individuals (16,17). Consistent with the literature, PE was observed more frequently in elderly patients in our study. However, no significant difference in mortality rates was detected between the age groups. This highlights the importance of rapid diagnosis and timely treatment in reducing mortality.

In conclusion, the incidence of PE continues to increase in the elderly population. Particularly in elderly patients with comorbidities, such as cancer, PE can lead to longer hospital stays, higher healthcare costs, and increased mortality. Therefore, elderly patients should be closely monitored, and clinicians should maintain a high index of suspicion for PE when symptoms such as dyspnea or chest pain occur.

**Limitations of the Study:** The single-center, retrospective design limits the generalizability of our results. Multicenter, prospective studies would be beneficial to generalize the results to larger and more diverse populations. Furthermore, we believe that prospective studies with long-term follow-up and the ability to assess PE risk and mortality by specific cancer types will further clarify the issue of PE in elderly cancer patients.

**Conflict of Interest:** The authors declare that they have no conflicts of interest related to this study.

**Availability of Data and Materials:** The data supporting the findings of this study are available from the corresponding author upon reasonable request.

**Compliance with Ethical Standards:** This study was conducted in accirdance with the principles of the Declaration of Helsinki and current ethical regulations. The study was approved by theIstanbulOkan University Non-Interventional Clinical Research Ethics Committee (decision number 36, meeting number 169; October 18, 2023).

**Informed Consent:** Since this was a retrospective study, informed consent was not required.

**Consent for publication:** The authors agree to the publication of this study in the journal.

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ORIGINAL ARTICLE

# THE IMPACT OF SARCOPENIA AND VISCERAL OBESITY ON IN-HOSPITAL MORTALITY IN ELDERLY PATIENTS PRESENTING TO THE EMERGENCY DEPARTMENT WITH SEPSIS

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## Abstract

**Introduction:** Sepsis remains a leading cause of morbidity and mortality in elderlyadults, with early risk stratification posing a significant challenge. This study aims to investigate the association between sarcopenia and visceral obesity and in-hospital mortality in elderly septic patients.

**Materials and Method:**This retrospective single-centre study included patients aged ≥65 years who presented to the emergency department with suspected infection and met the Sepsis-3 criteria. Data collected included demographics, comorbidities, infection site, body mass index, lactate and procalcitonin levels, Acute Physiology and Chronic Health Evaluation II scores, and Sequential Organ Failure Assessment scores. Abdominal computed tomography scans at admission were analysed to assess sarcopenia, defined by the Skeletal Muscle Index, and visceral obesity, determined by an elevated visceral-to-subcutaneous adipose tissue ratio.

**Results:** 453 patients were included (mean age, 67.8 ± 1.8 years; 55.2% female), with an in-hospital mortality rate of 42.9%.Non-survivors had significantly elevated Acute Physiology and Chronic Health Evaluation II scores, Sequential Organ Failure Assessment scores, serum lactate levels, and procalcitonin levels (all $p < 0.001$).Non-survivors also had significantly lower Skeletal Muscle Index and higher visceral-to-subcutaneous adipose tissue ratio values than survivors ($p < 0.001$). The optimal cut-off values for predicting mortality were $<32.65$ cm²/m² for Skeletal Muscle Index and >2.15 for visceral-to-subcutaneous adipose tissue ratio.Logistic regression showed that diabetes mellitus and malignancy were independent predictors of mortality.

**Conclusion:** Computed tomography-derived sarcopenia and visceral obesity are independent predictors of in-hospital mortality in elderly septic patients. These parameters may enhance early risk stratification in the emergency department.

***Keywords:*** Sepsis; Sarcopenia; Intra-Abdominal Fat; Tomography; Aged; Mortality.

## INTRODUCTION

The word sepsis is derived from the Greek term sepo, meaning "to rot."It is a life-threatening clinical condition characterised by an aberrant and overwhelming host response to infection, resulting in acute dysfunction of one or more vital organs (1,2).

Its global burden is escalating, largely driven by demographic ageing and the associated increase in frailty and chronic illnesses, which enhance infection susceptibility among elderlyindividuals. Epidemiological data indicate that over 60% of sepsis cases occur in persons aged 65 years and above (3,4).Mortality associated with sepsis has increased more significantly in this age group than in younger populations.The heightened vulnerability of older adults to sepsis is attributed to age-related immunosenescence, chronic low-grade inflammation, and malnutrition, all of which impair immunity and increase infection risk (1).

Sarcopenia, defined as the progressive loss of skeletal muscle mass and strength, is increasingly recognized as a major contributor to a range of adverse health outcomes. These include frailty, increased risk of falls and fractures, functional impairment, cognitive decline, and a markedly elevated risk of both morbidity and mortality (5).

Sarcopenia is commonly evaluated using the Skeletal Muscle Index (SMI), typically measured at the level of the third lumbar vertebra (L3) via computed tomography (CT) and calculated by dividing the cross-sectional area of skeletal muscle identified on CT images by the square of the individual's height (5).

Visceral adipose tissue (VAT), a metabolically active fat depot located within the abdominal cavity surrounding internal organs, plays a key role in systemic metabolic regulation. It secretes various adipokines that influence inflammatory pathways, insulin sensitivity, and cardiovascular function (6).In contrast, subcutaneous adipose tissue (SAT), predominantly located beneath the dermis, is primarily involved in energy storage, thermoregulation, and endocrine activity (7). The VAT-to-SAT ratio is a clinically relevant indicator of adipose tissue distribution, with visceral obesity defined by an elevated ratio. CT imaging has become a standard method for assessing this distribution, particularly in diagnosing visceral obesity based on the VAT/SAT ratio.

Identifying risk factors associated with mortality in patients with sepsis is essential for early risk stratification and the formulation of targeted therapeutic strategies (8).

This study aims to investigate the impact of CT-measured sarcopenia and visceral obesity on in-hospital mortality among elderly patients presenting to the emergency department (ED) with sepsis.

## MATERIALS AND METHODS

### Study Design and Participants

Following approval from the local ethics committee of Ankara Etlik City Hospital (Approval No: 2025-0195), a retrospective analysis was conducted on patients aged patients aged ≥65 years who presented to the ED with suspected infection between 1 January 2023 and 30 December 2023. Patients were eligible for inclusion if they fulfilled the Sepsis-3 diagnostic criteria and had undergone abdominal CT imaging at the time of ED admission (9).

Exclusion criteria encompassed patients whose CT scans failed quality assurance checksdue to factors such as motion artefacts, incomplete imaging of relevant muscle or adipose tissue, or inadequate tissue differentiation, as well as those who were discharged or referred to another healthcare facility.

Data collected included demographic information (age, gender, body mass index), comorbid conditions, site of infection, initial lactate and procalcitonin levels in the ED, Acute Physiology

and Chronic Health Evaluation II (APACHE II) scores, Sequential Organ Failure Assessment (SOFA) scores, and in-hospital mortality outcomes.

### Computed Tomography Measurements

Abdominal CT scans were performedusing multi-slice CT scanner systems (GE Revolution EVO, GE Medical Systems, Milwaukee, WI, USA) at the time of admission. CT images were obtained from the institutional Picture Archiving and Communication System (PACS) and analysed using AW Volume Server 7 3.2 software (GE Medical Systems S.C.S.). For each patient, a single axial slice was selected at the level of the L3 vertebra, which serves as a validated anatomical landmark for body composition analysis (10,11).

The total cross-sectional area of skeletal muscle (SMA) was quantified ($cm^2$) using established Hounsfield Unit (HU) thresholds ranging from −29 to +150 HU (11). The skeletal muscles evaluated in the region of interest included the m. obliquus internus abdominis, m. obliquus externus abdominis, m. transversus abdominis, m. rectus abdominis, m. psoas, m. quadratus lumborum, and m. erector spinae. The SMI was calculated by dividing the SMA ($cm^2$) by the square of the patient's height in metres ($m^2$) (11).

VAT ($cm^2$) and SAT areas ($cm^2$) areas were quantified from axial abdominal CT images acquired at the level of the umbilicus. Adipose tissue was segmented using a predefined HU range of −190 to −30 to identify relevant pixels within the region of interest (12).

VAT was delineated by manually tracing the intra-abdominal compartment bounded by the internal aspect of the abdominal musculature, whereas SAT was defined by tracing the area between the skin surface and the outer margin of the abdominal wall musculature on the same axial slice (Figure 1 a,b,c,d).

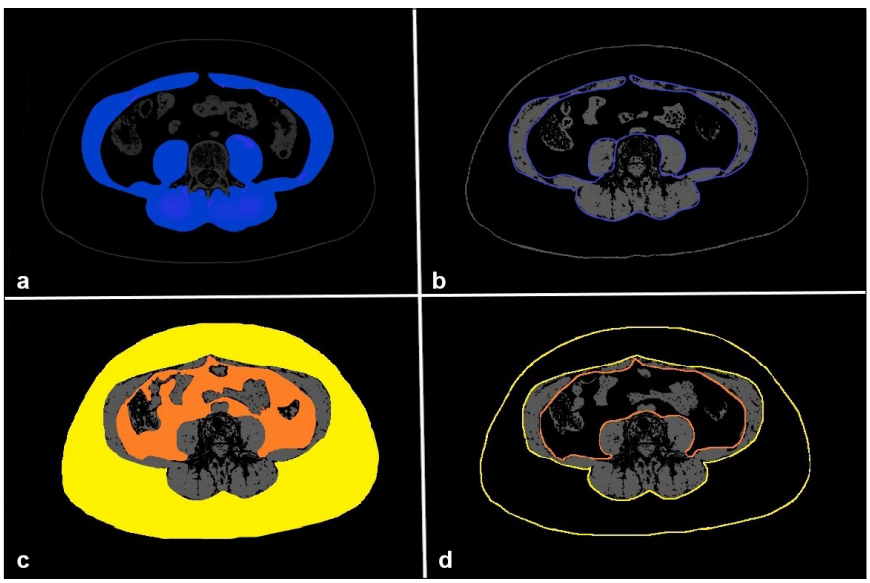



**Figure 1.** Computed tomography illustrations at the L3 vertebral level demonstrate the skeletal muscles highlighted in blue (a), at the same level, after applying a threshold range of -29 to +150 Hounsfield units, the muscle area was delineated with a blue contour and measured (b), computed tomography illustrations at the umbilical level show visceral adipose tissue in orange and subcutaneous adipose tissue in yellow (c), at this level, after applying a threshold range of –190 to –30 Hounsfield units, visceral adipose tissue was marked in orange and subcutaneous adipose tissue was outlined in yellow for area measurement (d)

All CT analyses were performed in consensus by twoexperienced radiologists (R.P.K. and İ.S.D.) who were blinded to all clinical data and outcomes.

### Statistical Analysis

Descriptive statistics for continuous variables were expressed as mean ± standard deviation or median with interquartile range (IQR; 25th–75th percentiles), as appropriate. Discrete variables were summarised as frequencies and percentages. The Kolmogorov–Smirnov test was employed to assess the normality of data distribution. Comparisons of continuous variables between survivors and non-survivors were conducted using the Mann–Whitney U test due to non-normal distribution. For comparisons involving nominal variables, the Chi-square test was applied.The diagnostic performance of SMA and the VAT/SAT ratio was evaluated using the area under the receiver operating characteristic (ROC) curve (AUC). Optimal cut-off values were determined using Youden's Index. The diagnostic accuracy of SMA and VAT/SAT values was further assessed by calculating sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV).In addition, ROC analyses were performed for the SMI within subgroups stratified by the presence or absence of comorbidities. AUC values were compared descriptively to assess whether the predictive performance of SMI varied across these subgroups. Furthermore, multivariate logistic regression analyses were conducted to evaluate the independent effects of comorbidities on in-hospital mortality.Risk factors associated with in-hospital mortality were examined using univariate logistic regression analysis. All statistical analyses were performed using IBM SPSS for Windows version 20.0 (SPSS Inc., Chicago, IL, USA), and a p-value <0.05 was considered statistically significant.

## RESULTS

The study included 453 patients, with a mean age of 67.82 ± 1.84 years (range: 65–75). Of these, 250 (55.2%) were female. The overall in-hospital mortality rate was 42.9%.Compared with survivors, non-survivors had significantly higher rates of comorbid diabetes mellitus (DM), hypertension, and malignancy (all p <0.01). Mortality was also significantly elevated among patients with abdominal infections as the primary source of sepsis (p <0.001).Non-survivors exhibited significantly higher APACHE II and SOFA scores upon admission compared to survivors (both p <0.001). Additionally, serum lactate and procalcitonin levels were markedly elevated in deceased patients (both p <0.001). Body composition analysis revealed that non-survivors had significantly lower SMA and SMI values, while their VAT/SAT ratios were significantly higher than those of survivors (all p <0.001) (Table 1).

In gender-stratified comparisons among non-survivors, both male and female patients exhibited significantly lower SMI values and higher VAT/SAT ratios compared to survivors within their respective gender groups (all p <0.001) (Table 2).

The optimal cut-off value for predicting in-hospital mortality was <32.6 for SMI and >2.15 for the VAT/SAT ratio (Table 3).

Both decreased SMI and elevated VAT/SAT values were found to be significant predictors of in-hospital mortality (p <0.001 for both) (Table 4).

ROC analyses using the SMI demonstrated reduced discriminative performance for predicting in-hospital mortality across comorbidity subgroups. In patients with DM, hypertension, chronic obstructive pulmonary disease, stroke, cancer, and dementia, AUC values were 0.825, 0.809, 0.788, 0.808, 0.804, and 0.804, respectively, compared to 0.810, 0.830, 0.836, 0.815, 0.820, and 0.820 in those without these (Table 5) conditions (Table 2) (Figure 2 a,b,c,d,e,f).



**Table 1.** Comparison of demographic and clinical characteristics between survival and non-survival patients

| | Overall Patients (n=453) | Survivor (n=230) | Non-survivor (n=223) | p value |
|---|---|---|---|---|
| **Age (years),** median (IQR) | 68 (67-69) | 67 (66-69) | 68 (67-69) | 0.052 [b] |
| **Body mass index (kg/m2)** median (IQR) | 21.9 (20.2-22.2) | 22.3 (21.1-25.6) | 22.1 (20.2-22.7) | 0.853 [b] |
| **Gender n (%)** | | | | |
| Female | 250 (55.2) | 130 (56.5) | 120 (53.8) | 0.562 [c] |
| Male | 203 (44.8) | 100 (43.5) | 103 (46.2) | |
| **Comorbidities, n (%)** | | | | |
| Diabetes mellitus | 320 (70.6) | 149 (64.8) | 171 (76.7) | **0.005** [c] |
| Hypertension | 304 (67.1) | 34 (58.3) | 170 (76.2) | **<0.001** [c] |
| Chronic obstructive pulmonary disease | 184 (40.6) | 90 (39.1) | 94 (42.2) | 0.513 [c] |
| Stroke | 18 (4.0) | 7 (3.0) | 11 (4.9) | 0.303 [c] |
| Chronic liver disease | 26 (5.7) | 6 (2.6) | 20 (9.0) | **0.004** [c] |
| Malignancy | 40 (8.8) | 14 (6.1) | 26 (11.7) | **0.037** [c] |
| Dementia | 31 (6.8) | 15 (6.7) | 16 (7.0) | 0.923 [c] |
| **Sites of Infection, n (%)** | | | | |
| Respiratory | 167 (36.9) | 92 (40.0) | 75 (33.6) | **<0.001** [c] |
| Urinary | 209 (46.1) | 120 (52.2) | 89 (39.9) | |
| Abdomen | 59 (13.0) | 14 (6.1) | 45 (20.2) | |
| Other | 18 (4.0) | 4 (1.7) | 14 (6.3) | |
| **APACHE II score** median (IQR) | 17 (11-18) | 11 (10-12) | 18 (17-19) | **<0.001** [b] |
| **SOFA score** median (IQR) | 5 (4-7) | 4 (3-4) | 7 (7-8) | **<0.001** [b] |
| **Lactate level (mmol/L)** median (IQR) | 1.55 (1.43-1.76) | 1.43 (1.33-1.48) | 1.77 (1.69-1.80) | **<0.001** [b] |
| **Procalcitonin level (ng/mL)** median (IQR) | 1.0 (0.8-1.3) | 0.8 (0.8-0.9) | 1.3 (1.2-1.4) | **<0.001** [b] |
| **Skeletal Muscle Area** median ($cm^2$) (IQR) | 88 (73-92) | 88 (85-107) | 73 (71-92) | **<0.001** [b] |
| **Skeletal Muscle Index median ($cm^2$) (IQR)** | 32.7 (28.3-36.0) | 39.3 (31.3-52.4) | 34.5 (28.3-45.8) | **<0.001** [b] |
| **VAT/SAT median (IQR)** | 2.20 (1.77-2.60) | 1.77 (1.24-1.89) | 2.56 (2.40-2.65) | **<0.001** [b] |

APACHE II: Acute Physiology and Chronic Health Evaluation II score, SOFA: Sequential Organ Failure Assessment score, VAT/SAT: visceral-to-subcutaneous adipose tissue ratio
IQR: Interquartile Range, [b] Data are presented as median (25th–75th percentile); comparisons were made using the Mann–Whitney U test, [c] Data are presented as number (percentage); comparisons were made using the Chi-square test.

**Table 2.** Comparison of Skeletal Muscle Index and Visceral-to-Subcutaneous Adipose Tissue Ratio between survivors and non-survivors in female and male patients

| | Female | | p value | Male | | p value |
|---|---|---|---|---|---|---|
| | Survivor | Non-survivor | | Survivor | Non-survivor | |
| **SMI (cm2/m2)** | 37.1 (31.3-51.8) | 33.5 (28.3-48.9) | **<0.001** [b] | 41.4 (31.9-52.4) | 35.8 (29.8-45.8) | **<0.001** [b] |
| **VAT/SAT** | 1.38 (1.23-1.89) | 2.56 (2.41-2.65) | **<0.001** [b] | 1.87 (1.36-1.89) | 2.60 (2.40-2.65) | **<0.001** [b] |

SMI: Skeletal Muscle Index, VAT/SAT:visceral-to-subcutaneous adipose tissue ratio, [b] Data are presented as median (25th–75th percentile); comparisons were performed using the Mann–Whitney U test

**Table 3.** Prognostic Performance of Skeletal Muscle Area, Skeletal Muscle Index, and Visceral-to-Subcutaneous Adipose Tissue Ratio in Predicting in-hospital mortality

| | AUC 95% CI | p | Cut off | Sensitivity 95% CI | Specificity 95% CI | PPV | NPV |
|---|---|---|---|---|---|---|---|
| **SMI (cm2/m2)** | 0.818<br>0.795-1.000 | <0.001 | **<36.65** | 0.98<br>0.95-0.99 | 0.97<br>0.94-0.98 | 0.97<br>0.95-0.98 | 0.98<br>0.96-0.99 |
| **VAT/SAT** | 0.968<br>0.949-0.988 | <0.001 | **>2.15** | 1.00<br>0.98-1.00 | 0.93<br>0.88-0.95 | 0.93<br>0.90-0.95 | 1.00<br>0.99-1.00 |

SMI: Skeletal Muscle Index, VAT/SAT:visceral-to-subcutaneous adipose tissue ratio, AUC: Area Under the Curve, PPV: Positive Predictive Value, NPV: Negative Predictive Value

**Table 4.** Univariate Logistic regression analysis of predictors of in-hospital mortality

| Variable | Regression Coefficient (SE) | OR | 95 % CI | | p value |
|---|---|---|---|---|---|
| **SMI ($cm^2/m^2$)** | -0.331 | 0.718 | 0.672 | 0.768 | **<0.001** |
| **VAT/SAT** | 9.220 (0.917) | 10094.07 | 1672.43 | 60923.43 | **<0.001** |

SMI: Skeletal Muscle Index, VAT/SAT:visceral-to-subcutaneous adipose tissue ratio

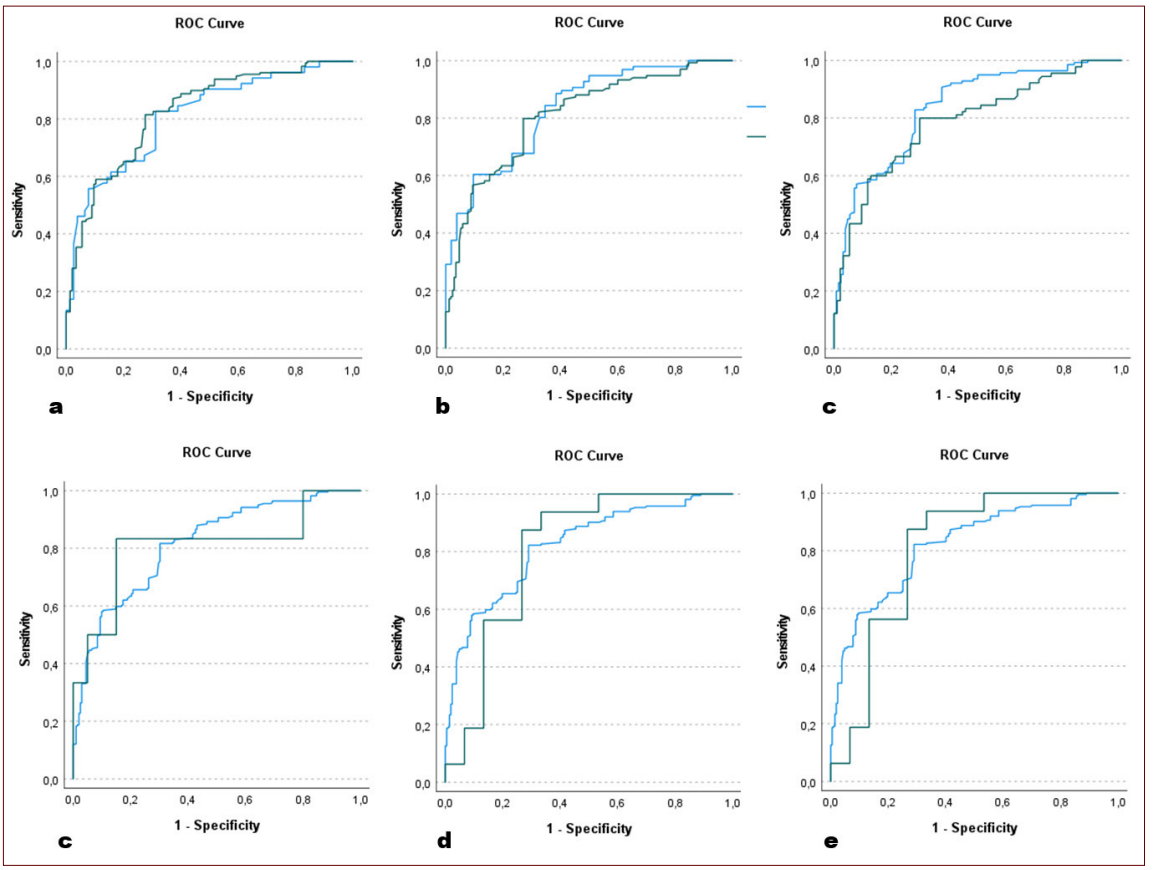



**Figure 2.** Comparative Receiver Operating Characteristic curves for Skeletal Muscle Index (SMI) by comorbidity status: diabetes mellitus (a), hypertension (b), chronic obstructive pulmonary disease (c), stroke (d), malignancy (e), and dementia (f).



**Table 5.** Discriminative performance of Skeletal Muscle Index for in-hospital mortality by comorbidity subgroups

| Comorbidity | AUC (Present) | AUC (Absent) |
|---|---|---|
| **Diabetes mellitus** | 0.825 | 0.81 |
| **Hypertension** | 0.809 | 0.83 |
| **Chronic obstructive pulmonary disease** | 0.788 | 0.836 |
| **Stroke** | 0.808 | 0.815 |
| **Malignancy** | 0.804 | 0.82 |
| **Dementia** | 0.804 | 0.82 |

Multivariate logistic regression analysis was conducted to evaluate the independent association between comorbidities and in-hospital mortality. The presence of malignancy was found to be the strongest independent predictor of mortality (OR = 1.96, p = 0.014), followed by DM (OR = 1.48, p = 0.029).

## DISCUSSION

Identifying prognostic parameters that influence mortality and incorporating them into clinical decision-making enables timely and targeted interventions, thereby improving patient outcomes.

Although current literature offers limited insight into the prognostic significance of sarcopenia and visceral obesity in elderly patients with sepsis, this study is noteworthy as the first to concurrently evaluate both parameters in the ED setting. The study also establishes threshold values for SMI and the VAT/SAT ratio associated with an increasedrisk of in-hospital mortality.

There is currently no universally accepted cut-off value for defining low muscle mass or sarcopenia.Van der Werf et al. proposed gender-specific thresholds for the skeletal muscle index at the L3-SMI based on a healthy Caucasian population, defining sarcopenia as <41.6 $cm^2/m^2$ in men and <32.0 $cm^2/m^2$ in women (13).Another study conducted in a healthy Korean liver donor cohort also established gender specific L3-SMI reference values. When defined using the standard deviation method, the sarcopenia thresholds were 39.33 $cm^2/m^2$ for men and 27.77 $cm^2/m^2$ for women; when using the fifth percentile approach, the corresponding values were 40.96 $cm^2/m^2$ and 30.60 $cm^2/m^2$, respectively (14).In contrast, a study involving hospitalised internal medicine patients adopted higher thresholds, identifying sarcopenia as an L3-SMI <53 $cm^2/m^2$ in men and <41 $cm^2/m^2$ in women (15).These discrepancies likely reflect underlying racial and ethnic differences in muscle mass and quality. Genetic factors may contribute to the greater muscle mass typically observed in Black individuals, while Asian populations generally have lower muscle mass, which may influence population-specific sarcopenia thresholds (16,17).

The association between sarcopenia and increased mortality in septic patients is multifactorial and remains incompletely understood. One contributing factor is the frequent presence of poor nutritional status among sarcopenic individuals, which predisposes them to sepsis and impairs recovery. Sarcopenia is also closely associated with immunosenescence, the age-related decline in immune function, which compromises host defences against infection. This immunological deterioration is particularly consequential in the context of sepsis, where an effective immune response is vital for pathogen clearance (18). Additionally, the ageing immune system fosters a pro-inflammatory state that accelerates muscle catabolism, potentially exacerbated by acute

physiological stressors such as infection. Sepsis-induced systemic inflammation further promotes muscle wasting through activation of proteolytic pathways, including the ubiquitin–proteasome and autophagy–lysosome systems. These pathways upregulate genes associated with muscle atrophy, thereby perpetuating the loss of muscle mass.This progressive muscular degeneration may impair essential physiological functions, such as swallowing and respiratory mechanics, predisposing patients to complications like aspiration pneumonia, ultimately contributing to increased mortality risk (18).

Sarcopenia may impair recovery in septic patients due to diminished skeletal muscle mass, which reduces the availability of amino acids required for acute-phase protein synthesis and immune cell activation (19). Furthermore, sarcopenic individuals often exhibit compromised antioxidant capacity, resulting in decreased clearance of reactive oxygen species. This oxidative imbalance can exacerbate tissue injury and further hinder recovery from sepsis (19).

The risk of developing sarcopenia is elevated in individuals with multiple coexisting chronic diseases. Chronic conditions such as malignancy and DM contribute to sarcopenia through catabolic stress, inflammation, and reduced mobility. In this study, subgroup ROC analyses showed that comorbidities diminished the discriminative ability of SMI for predicting in-hospital mortality. This suggests that overlapping pathophysiological mechanisms may reduce the prognostic utility of sarcopenia indices. Supporting this, multivariate regression analysis confirmed that comorbidities were independently associated with increased mortality, highlighting the need for comorbidity-adjusted risk models in sepsis care.

Additionally, a high VAT/SAT ratio has been associated with increased mortality in patients with sepsis. This pattern of fat distribution reflects greater metabolic activity and systemic inflammation, which may negatively influence sepsis outcomes (12,20). In the current study, a VAT/SAT ratio exceeding 2.15 was identified as the optimal threshold for predicting in-hospital mortality among elderly patients with sepsis.

VAT, located within the abdominal cavity and surrounding internal organs, exhibits high endocrine and immunological activity. It functions as a prolific source of pro-inflammatory mediators such as tumour necrosis factor-alpha and plasminogen activator inhibitor-1, both of which are elevated in septic states and have demonstrated associations with increased disease severity and mortality (21,22).In contrast, SAT, located beneath the dermis, is relatively metabolically inert and secretes lower levels of inflammatory cytokines. This difference may contribute to its proposed protective role in systemic inflammatory conditions such as sepsis (12).Moreover, during sepsis, VAT undergoes pronounced immunological activation characterised by increased macrophage infiltration and upregulation of pro-inflammatory cytokines. These changes potentiate the systemic inflammatory response, in contrast to SAT, which remains comparatively immunologically quiescent (23).Thus, an elevated VAT/SAT ratio may serve as an indicator of an amplified inflammatory milieu, offering a plausible mechanistic explanation for its association with poorer clinical outcomes in septic patients.

An elevated VAT/SAT ratio has been correlated with increased circulating levels of inflammatory biomarkers such as C-reactive protein and leptin, both of which are implicated in adverse clinical outcomes in sepsis (24).

Conversely, a lower VAT/SAT ratio has been associated with more favourable prognostic indicators, including the relative preservation of low-density lipoprotein (LDL) levels during the septic response, a factor linked to improved survival outcomes.Notably, the prognostic utility of the VAT/SAT ratio in sepsis appears to be modulated by lipid



metabolism, particularly LDL dynamics. While a low VAT/SAT ratio may confer a survival advantage via preserved LDL concentrations, this benefit can be attenuated by statin therapy, which suppresses endogenous LDLsynthesis. In contrast, individuals carrying a proprotein convertase subtilisin/kexin type 9loss-of-function genotype, which facilitates increased LDL clearance, demonstrate enhanced survival in the context of low VAT/SAT ratios (20).

These findings suggest a complex interplay between adipose tissue distribution, lipid homeostasis, and immune response regulation in pathophysiology of sepsis.

A key strength of the present study is its relatively large sample size, which enhances the statistical power and reliability of the observed associations.

### Limitations

This study has several limitations that warrant consideration. First, its retrospective design and single-centre setting may limit the generalisability of the findings. As data were extracted from existing medical records, variability in documentation and potential missing data could have introduced bias. Second, inclusion was limited to patients who underwent abdominal CT imaging, which may have led to selection bias, as these individuals could differ systematically from those who did not undergo imaging. Third, due to the retrospective nature of the study, direct assessments of physical performance and muscle strength could not be performed, restricting the evaluation to imaging-based parameters alone.Fourth, while sarcopenia is intrinsically linked to nutritional status, our study did not include validated nutritional risk assessment tools such as the Nutritional Risk Screening 2002 and the Nutrition Risk in the Critically Ill score due to the retrospective nature of the data. These tools typically require real-time clinical evaluation or comprehensive dietary intake information, which were not systematically recorded in our dataset. This represents a methodological limitation that may have influenced the full characterization of the patients' nutritional risk profiles.

## CONCLUSION

To our knowledge, this is the first study to concurrently evaluate the prognostic significance of sarcopenia and visceral obesity, as measured by CT-derived SMI and VAT/SAT ratio, in elderly patients presenting with sepsis to the ED. Our findings demonstrate that both reduced muscle mass and increased visceral fat distribution are independently associated with in-hospital mortality. Given the routine use of abdominal CT imaging in emergency settings, these parameters offer practical and objective tools for early risk stratification. In addition, logistic regression analysis showed that DM and malignancy were independent predictors of in-hospital mortality, further reinforcing the need to integrate comorbidity assessment into prognostic models. Moreover, identifying sarcopenia and visceral obesity as modifiable risk factors supports the rationale for targeted interventions, such as nutritional support and inflammation-reducing strategies,to improve outcomes in this high-risk population. Future prospective multicentre studies are warranted to validate these cut-off values and explore the integration of body composition metrics with inflammatory and metabolic biomarkers to inform personalised management approaches in geriatric sepsis care.

**Statement of ethics:** This study was approved by the Ankara Etlik City Hospital, Ankara, Turkey (approval no. 2025-0195).

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

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ORIGINAL ARTICLE

# COMPARATIVE ANALYSIS OF SLEEP DISORDER RISK ACROSS REPRODUCTIVE AGING STAGES IN WOMEN

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## Abstract

**Introduction:** To evaluate the risk of obstructive sleep apnea syndrome, insomnia, and restless legs syndrome across reproductive aging stages and assess associations with key menopausal symptoms, age, parity, multimorbidity, anxiety, and depression.

**Materials and Method:** A total of 900 women aged >18 years were included. The risks of sleep disorders were assessed using validated screening tools. Multimorbidity was defined as the presence of two or more chronic conditions based on the Charlson comorbidity index. Logistic regression analyses were conducted to calculate the crude and adjusted odds ratios for each disorder.

**Results:** The prevalence of risk for obstructive sleep apnea syndrome, restless legs syndrome, and insomnia was 19.4%, 16.6%, and 21.4%, respectively; 42% of participants were at risk for at least one of these disorders. In adjusted models, the risk of obstructive sleep apnea syndrome was associated with older age, night sweats, and depression. Insomnia was predicted by frequent urination, anxiety, depression, and parity ≥3. Restless legs syndrome was associated with urinary incontinence, anxiety, and parity ≥3. Insomnia symptoms were more common in postmenopausal women, whereas daytime symptoms were less frequent. Sleep disorder risk was elevated in the menopausal transition and postmenopausal groups.

**Conclusion:** The risk of sleep disorders is high during menopause and menopausal transition and is likely multifaceted. Multimorbidity, parity, depression, and anxiety can lead to complications. Menopausal symptoms, a common reason for gynecology visits, may be linked to these disorders, offering key opportunities to identify and support at-risk individuals.

***Keywords:*** Sleep Initiation and Maintenance Disorders; Menopause; Sleep Apnea, Obstructive; Restless Legs Syndrome; Aging.

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## INTRODUCTION

Sleep, a crucial contributor to the homeostasis of the brain and body (1), is often compromised by the high prevalence of sleep disorders in society. These conditions are associated with significant morbidity and mortality, emphasizing the need for effective interventions (2). Sleep disturbances in women are often perceived as a normal part of the menopausal transition, which may contribute to underdiagnosis in clinical practice (3).

In women, reproductive aging introduces distinct physiological challenges that affect sleep. The ovary is the first organ to show functional decline with age (4), and chronological and ovarian aging are intertwined processes that jointly shape the timing and experience of reproductive transitions (5). Based on menstrual bleeding patterns, the Staging Reproductive Aging Workshop (STRAW) criteria divides adult female life into three broad stages: reproductive (RS), menopausal transition (MTS), and postmenopausal (PMS). Two key symptoms—vasomotor symptoms (VMS) and urogenital atrophy—are incorporated as additional descriptive markers (6).

Women may experience the menopausal transition and menopause differently. The presence of some menopausal symptoms may predict an increased risk of developing other disorders. The signs and symptoms of menopause include central nervous system-related disorders (hot flashes, mood and sleep disturbances), metabolic dysfunction, cardiovascular changes, and urogenital atrophy. These changes are primarily related to estrogen deprivation but may also reflect broader neuroendocrine dysregulation (7). The menopausal transition, a human physiological transition state, involves a restructuring of regulatory systems; during this period, even minor internal or external perturbations can directly induce vulnerabilities or unmask existing ones (8). This may partly explain the variability in symptom expression and the increased risk for comorbid conditions.

The relationship between mood symptoms and sleep disturbances is bidirectional (9), and menopausal symptoms often overlap with or complicate the clinical presentation of depression (10). Multimorbidity has also been associated with sleep problems (11). Additionally, parity may play a long-term role in sleep and mood regulation. Gestation has been suggested to represent a period of significant neuroplasticity and brain remodeling in adulthood, which may have lasting implications for emotional and physiological regulation (12). This possibility underscores the importance of considering parity in evaluating sleep disorders.

Although the relationship between menopause and sleep has been widely studied, most studies have focused on general sleep complaints or sleep quality rather than disorder-specific risks. Multimorbidity, parity, and urinary symptoms have received limited attention, and night sweats are generally examined together with hot flashes as a single vasomotor symptom, rather than being considered separately. These factors may influence sleep disorders in distinct ways, and overlooking them could limit the clarity of observed associations.

Changes in hormone levels, physical health, and psychosocial status may influence the likelihood of developing sleep disorders throughout reproductive aging. As life expectancy increases globally, gaining a better understanding of potentially modifiable factors may contribute to efforts aimed at promoting healthy aging in women. This study aimed to assess the risk of common sleep disorders by examining their associations with reproductive aging stage, key menopausal symptoms, multimorbidity, depression, anxiety, and parity using validated screening tools.

## MATERIALS AND METHOD

This cross-sectional study was conducted at a gynecology clinic between 2022 and 2023

to examine the risk of sleep disorders across reproductive aging stages. Women over 18 years old and their acquaintances who voluntarily agreed to participate were included. Participants completed either a face-to-face assessment or an online survey, depending on their preference. A total of 900 volunteers participated.

Participants who did not speak Turkish or who were not eligible for STRAW classification (e.g., due to primary amenorrhea, history of hysterectomy, use of reproductive hormones within the preceding three months, current pregnancy or breastfeeding, or diagnosis of polycystic ovary syndrome) were excluded. Those who completed the sleep disorder questionnaire and provided complete information on age and reproductive aging stage were included in the analysis (Figure 1). Ultimately, 646 women met the inclusion criteria. For the risk of obstructive sleep apnea syndrome (rOSAS) analysis, participants lacking information on hypertension or body mass index (BMI) were excluded.

The study was approved by the Research Ethics Committee of my institution (Approval No: 2022/29) and conducted following the ethical principles outlined in the Declaration of Helsinki. Written informed consent was obtained from all participants, with online participants providing digital confirmation codes.

Questions on sleep disorders were adapted from the Turkish Adult Population Epidemiology of Sleep Disorders (TAPES) study, in which the scales demonstrated acceptable reliability and content validity (Cronbach's alpha > 0.70) (13).

### Sleep Disorder Assessment

Insomnia was evaluated based on the International Classification of Sleep Disorders, 3rd Edition (ICSD-3) (14). Participants were asked about difficulty initiating or maintaining sleep that occurred at least three times per week for at least three months and resulted in daytime impairment (e.g., unrefreshing sleep, fatigue, or reduced functioning).

Restless legs syndrome (RLS) was assessed using the criteria established by the International Restless Legs Syndrome Study Group (15). Participants reported unpleasant sensations (e.g., tingling, restlessness, throbbing) in their legs that occurred at rest, improved with movement, and worsened in the evening or at night. RLS was considered present if all four diagnostic criteria were met and symptoms occurred five times or more monthly. The fifth criterion—excluding other medical or behavioral causes—was not applied.

The Berlin Questionnaire was used to determine the rOSAS. This tool comprises three categories: Category 1 (snoring and witnessed apnea), Category 2 (daytime sleepiness), and Category 3 (hypertension and BMI). Participants with positive responses in at least two categories were classified as having rOSAS (16).

### Other Measures

Depression was assessed using the Beck Depression Inventory–FastScreen, a brief seven-item self-report tool designed to measure depressive symptoms without confounding with medical conditions (17). Anxiety was evaluated using the 21-item Beck Anxiety Inventory, which focuses on somatic symptoms of anxiety. The validity and reliability of the Turkish version have been previously established (18). Multimorbidity was assessed using the Charlson Comorbidity Index, which captures physician-diagnosed chronic diseases across multiple systems (e.g., cardiovascular, respiratory, endocrine, renal, and psychiatric) (19). Multimorbidity was defined as the presence of two or more chronic conditions. BMI was calculated from self-reported height and weight, with BMI ≥30 kg/m² classified as obese.

Sociodemographic variables (age, marital status, education, and employment status) were obtained



via self-report. Participants provided information on menstrual cycle characteristics, hormone use (past/current), contraceptive methods, reasons for amenorrhea, last menstrual period (natural or hormone-induced), and obstetric history.

Reproductive aging stage classification followed the STRAW+10 criteria. Based on menstrual patterns, participants selected one of the following categories: regular cycles, subtle changes in flow/length, variable cycle length with persistent ≥7-day difference, ≥60 days of amenorrhea, amenorrhea for 1–2 years, >2–3 years, >3–6 years, or >6 years. These responses were used to classify participants into RS, MTS, or PMS groups (6). Additionally, participants were asked about hot flashes, night sweats, frequent urination, and urinary incontinence.

The minimum required sample size was calculated based on the prevalence of sleep disorders in women from the TAPES study (16). A sample size of at least 248 participants is necessary to achieve a 95% confidence level and a 5% margin of error.

### Statistical Analysis

Data were analyzed using IBM SPSS Statistics version 21.0 (IBM Corp., Armonk, NY, USA). Continuous variables are presented as medians and interquartile ranges (Q1–Q3), and categorical variables as frequencies and percentages.

Associations between reproductive aging stages and sleep disorders, menopausal symptoms, multimorbidity, depression, anxiety, and parity were evaluated using the Chi-square test. Binary logistic regression analyses were conducted to examine the associations between sleep disorders and the variables of interest and to estimate crude odds ratios (ORs). Variables with p-values <0.20 in the univariate analysis were included in a multivariable logistic regression using backward stepwise selection based on the likelihood ratio test.

Because BMI is a component of the rOSAS screening algorithm, obesity was excluded from the regression model for rOSAS. The Hosmer–Lemeshow goodness-of-fit test was used to assess model fit. All logistic regression analyses were performed without imputation of missing data. The constant term was included in all models. A two-tailed p-value <0.05 was considered statistically significant.

## RESULTS

This study included 900 volunteers. After applying the exclusion criteria, 545 participants were identified for rOSAS, 644 for risk of insomnia, and 566 for RLS. Figure 1 depicts a flowchart of the study. Table 1 summarizes the characteristics of the study population. The distribution of sleep disorder risk in the study population was as follows: rOSAS was 19.4%, RLS was 16.6%, and insomnia was 21.4%. Overall, 42% of participants were at risk of at least one sleep disorder. Among participants without a known diagnosis of a sleep disorder, 18.3% had rOSAS, 16.4% had RLS, and 18.6% had insomnia.

The median age of the participants was 42 (32–49) years. According to the STRAW criteria, 64.6% (n=417), 12.8% (n=83), and 22.6% (n=146) of participants were classified into the RS, MTS, and PMS groups, respectively. Among postmenopausal women, 8.8% reported experiencing surgical menopause. Compared to the reference age group (18–34 years), all older age groups exhibited a statistically significant increase in crude ORs for the risk of rOSAS. Similarly, women in the MTS and PMS groups had significantly higher crude ORs for rOSAS compared with those in the RS group. The presence of hot flashes, night sweats, frequent urination, urinary incontinence, multimorbidity, anxiety, and depression was significantly associated with an increased risk of rOSAS in the univariate analysis. Having two or more children (parity 2 or ≥3) was also associated

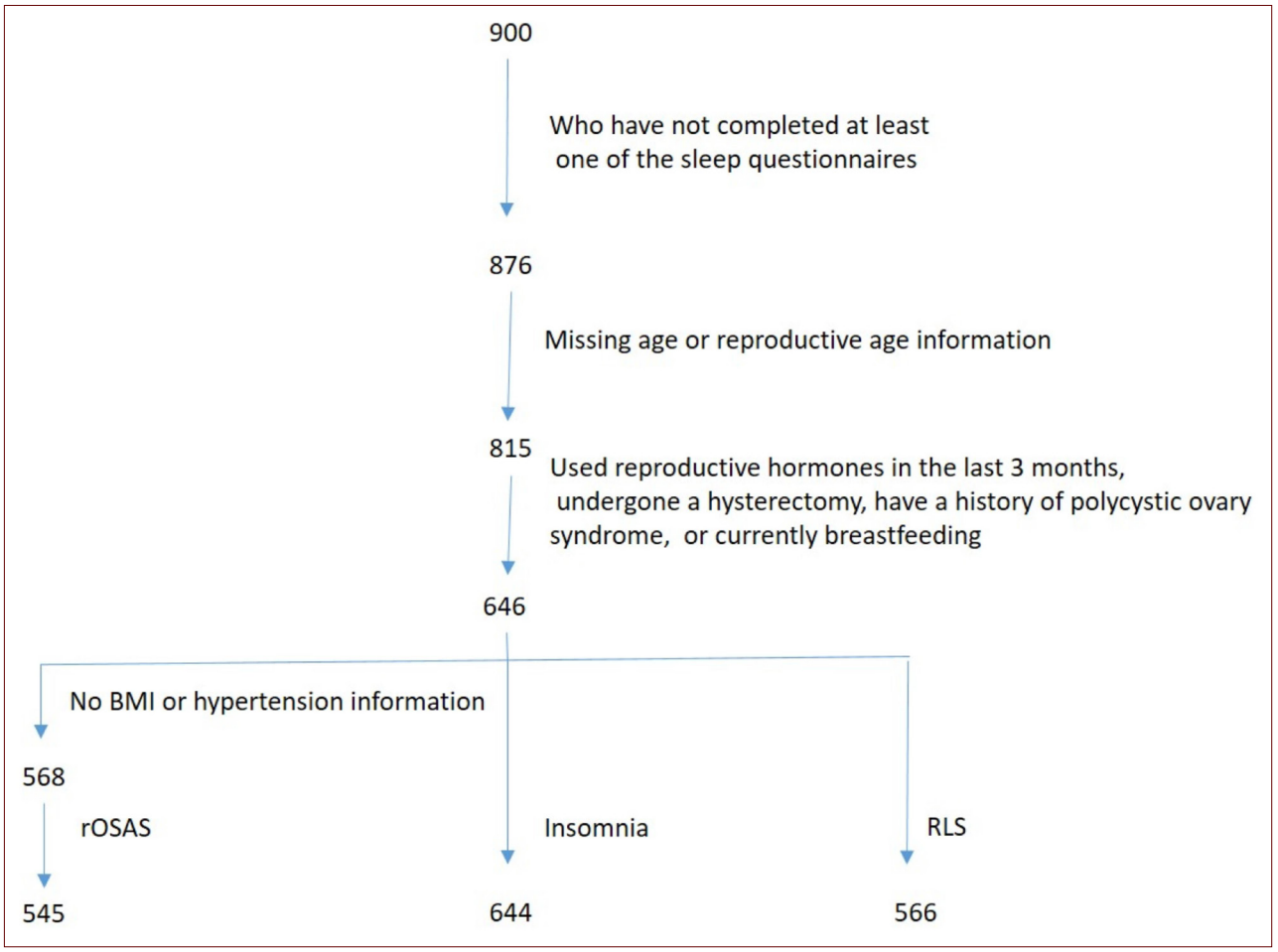



**Figure 1.** Flow diagram of the study

Abbreviations: rOSAS, risk of obstructive sleep apnea; RLS, restless legs syndrome; BMI, body mass index

with a statistically significant increase in risk. In the multivariable logistic regression analysis, older age groups, night sweats, and depression remained independently associated with a significantly increased risk of rOSAS. Although multimorbidity (p=0.051) and urinary incontinence (p=0.056) did not reach statistical significance, they were retained in the final model (Table 2).

Compared with the reference age group (18–34 years), all older age groups had significantly higher crude ORs for the risk of insomnia. In the univariate analysis, the presence of hot flashes, frequent urination, urinary incontinence, multimorbidity, anxiety, and depression was also significantly associated with increased risk of insomnia. Participants with a parity of ≥3 had a significantly increased risk compared with nulliparous women. In the multivariable logistic regression model, frequent urination, anxiety, depression, and having three or more children remained independently associated with a significantly increased risk of insomnia. Although multimorbidity did not reach statistical significance (p=0.081), it was retained in the final model step (Table 2).

**Table 1.** Characteristics of the study population

| | | n(%) |
|---|---|---|
| **Age** | 18-34 | 196(30.3) |
| | 35-44 | 189(29.3) |
| | 45-54 | 172(26.6) |
| | ≥55 | 89(13.8) |
| **Reproductive aging stage** | Reproductive | 417(64.6) |
| | Menopausal transition | 83(12.8) |
| | Postmenopause | 146(22.6) |
| **Education** | High school or less | 237(36.9) |
| | Above high school | 406(63.1) |
| **Working status** | Not working | 295(45.7) |
| | Working | 347(53.7) |
| **Marital status** | Single | 191(29.7) |
| | Married | 452(70.3) |
| **rOSAS** | absent | 439(80.6) |
| | present | 106(19.4) |
| **Insomnia** | absent | 506(78.6) |
| | present | 138(21.4) |
| **RLS** | absent | 472(83.4) |
| | present | 94(16.6) |
| **Any sleep disorder** | absent | 308(58.0) |
| | present | 223(42.0) |

rOSAS, risk of obstructive sleep apnea; RLS, restless legs syndrome; BMI, body mass index

When individual insomnia symptoms were analyzed separately according to the ICSD-3 criteria, difficulty initiating sleep was significantly more prevalent in the PMS group compared with the RS group (p=0.009; OR=1.8, 95% CI=1.2–2.9). Similarly, difficulty maintaining sleep was approximately twice as common in the PMS group (p=0.005; OR=2.0, 95% CI=1.2–3.2). In contrast, daytime insomnia-related symptoms were significantly less frequent in the PMS group compared with the RS group (p<0.001; OR=0.5, 95% CI=0.3–0.7).

Compared with the reference age group (18–34 years), participants aged 45–54 and ≥55 years had significantly higher crude ORs for the risk of RLS. In the univariate analysis, the presence of hot flashes, night sweats, urinary incontinence, anxiety, obesity, and parity of ≥3 was also significantly associated with increased RLS risk. In the multivariable logistic regression model, urinary incontinence, anxiety, and parity of ≥3 were independently associated with a significantly increased risk of RLS (Table 2).

Table 3 presents the associations between reproductive aging stages and the parameters

**Table 2.** Crude and Adjusted Odds Ratios for Sleep Disorders

| | rOSAS | | | | Insomnia | | | | RLS | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | p | Crude OR (95% CI) | p | Adjusted OR (95% CI) | p | Crude OR (95% CI) | p | Adjusted OR (95% CI) | p | Crude OR (95% CI) | p | Adjusted OR (95% CI) |
| **Age** | <0.001 | | 0.003 | | 0.013 | | | | 0.012 | | | |
| 18-34 | | ref | | ref | | ref | | ref | | ref | | ref |
| 35-44 | 0.001 | 3.5(1.7-7.2) | 0.004 | 4.6(1.6-12.9) | .003 | 2.2(1.3-3.8) | | | 0.055 | 1.9(1.0-3.7) | | |
| 45-54 | <0.001 | 4.5(2.2-9.3) | 0.016 | 3.8(1.3-11.0) | 0.006 | 2.1(1.2-3.7) | | | 0.003 | 2.7(1.4-5.1) | | |
| ≥55 | <0.001 | 7.2(3.3-15.4) | <0.001 | 8.9(2.9-28.3) | 0.018 | 2.1(1.1-4.0) | | | 0.005 | 2.9(1.4-6.0) | | |
| **Reproductive aging stage** | <0.001 | | | | 0.127 | | | | 0.143 | | | |
| Reproductive | | ref | | ref | | ref | | ref | | ref | | ref |
| Menopausal transition | 0.001 | 2.7(1.5-5.0) | | | 0.173 | 1.5(0.8-2.6) | | | 0.272 | 1.4(0.8-2.7) | | |
| Postmenopausa | 0.001 | 2.2(1.4-3.6) | | | 0.073 | 1.5(1.0-2.3) | | | 0.061 | 1.6(1.0-2.7) | | |
| **Hot flushes** | 0.001 | 2.2(1.4-3.5) | | | 0.001 | 2.0(1.3-3.0) | | | <0.001 | 2.5(1.5-4.0) | | |
| **Night sweats** | <0.001 | 2.6(1.6-4.3) | 0.025 | 2.2(1.1-4.5) | 0.115 | 1.5(0.9-2.3) | | | 0.008 | 2.0(1.2-3.4) | | |
| **Frequent urination** | 0.002 | 2.3(1.4-3.8) | | | <0.001 | 2.5(1.5-3.9) | 0.019 | 2.3(1.2-4.7) | 0.177 | 1.5(0.8-2.6) | | |
| **Urinary incontinence** | <0.001 | 4.5(2.5-8.1) | 0.056 | 2.4(1.0-4.5) | <0.001 | 2.7(1.6-4.7) | | | 0.009 | 2.3(1.2-4.2) | 0.043 | 2.5(1.0-6.0) |
| **Multimorbidity** | <0.001 | 4.3(2.7-6.8) | 0.051 | 2.0(1.0-3.9) | 0.001 | 2.1(1.3-3.2) | 0.081 | 1.8(0.9-3.4) | 0.053 | 1.7(1.0-2.8) | | |
| **Anxiety** | 0.005 | 2.1(1.2-3.5) | | | <0.001 | 3.6(2.2-5.8) | 0.003 | 2.5(1.4-4.3) | <0.001 | 3.5(2.0-5.9) | 0.001 | 2.8(1.5-5.2) |
| **Depression** | <0.001 | 4.1(2.3-7.2) | <0.001 | 5.9(2.9-12.3) | <0.001 | 2.8(1.6-4.8) | 0.008 | 2.5(1.3-4.8) | 0.089 | 1.7(0.9-3.0) | | |
| **Parity** | 0.068 | | | | 0.060 | | 0.081 | | <0.001 | | 0.002 | |
| .0 | ref | ref | | | | ref | | ref | | ref | | ref |
| 1 | 0.063 | 2.0(1.0-4.3) | | | 0.939 | 1.0(0.5-2.1) | 0.591 | 0.8(0.3-1.9) | 0.268 | 1.6(0.7-3.6) | 0.132 | 2.1(0.8-5.7) |
| 2 | 0.011 | 2.4(1.2-4.8) | | | 0.163 | 1.5(0.8-2.8) | 0.344 | 1.4(0.7-3.0) | 0.062 | 2.0(1.0-4.1) | 0.115 | 2.1(0.8-5.0) |
| ≥ 3 | 0.038 | 2.4(1.0-5.3) | | | 0.018 | 2.3(1.2-4.5) | 0.047 | 2.3(1.0-5.3) | <0.001 | 5.1(2.4-10.8) | <0.001 | 6.3(2.4-16.4) |
| **Obesity** | | | | | 0.287 | 1.3(0.8-2.2) | | | 0.028 | 1.9(1.1-3.3) | | |
| **Nagelkerke R Square** | | | | 0.269 | | | | 0.191 | | | | 0.162 |

rOSAS, risk of obstructive sleep apnea; RLS, restless legs syndrome; ref, reference;OR, odds ratio; CI confidence interval.*p* values indicate the significance level of each variable in the regression models. Variables with a *p* value < 0.20 in univariable analyses were included in the multivariable logistic regression models using backward stepwise selection (likelihood ratio).

**Table 3.** Distribution of Parameters by Reproductive Aging Stage

| | | Reproductive n(%) | Menopausal transition n(%) | Postmenopausal n(%) | p |
|---|---|---|---|---|---|
| **rOSAS** | absent | 299(85.7) | 44(68.8) | 96(72.7) | < 0.001 |
| | present | 50(14.3) | 20(31.3) | 36(27.3) | |
| **Insomnia** | absent | 337(81.0) | 61(74.4) | 108(74.0) | 0.125 |
| | present | 79(19.0) | 21(25.6) | 38(26.0) | |
| **Sleep initiation difficulty** | absent | 349(83.9) | 63(76.8) | 108(74.0) | 0.021 |
| | present | 67(16.1) | 19(23.2) | 38(26.0) | |
| **Sleep maintenance difficulty** | absent | 361(86.8) | 65(79.3) | 112(76.7) | 0.010 |
| | present | 55(13.2) | 17(20.7) | 34(23.3) | |
| **Insomnia daytime symptoms** | absent | 166(39.9) | 34(41.0) | 84(57.5) | 0.001 |
| | present | 250(60.1) | 49(59.0) | 62(42.5) | |
| **RLS** | absent | 306(85.7) | 63(80.8) | 103(78.6) | 0.140 |
| | present | 51(14.3) | 15(19.2) | 28(21.4) | |
| **Any sleep disorder** | absent | 212(64.0%) | 33(49.3%) | 63(47.4%) | 0.001 |
| | present | 119(36.0%) | 34(50.7%) | 70(52.6%) | |
| **Age** | 18-34 | 190(45.6) | 6(7.2) | 0(0.0) | < 0.001 |
| | 34-44 | 156(37.4) | 30(36.1) | 3(2.1) | |
| | 45-54 | 70(16.8) | 44(53.0) | 58(39.7) | |
| | ≥55 | 1(0.2) | 3(3.6) | 85(58.2) | |
| **Hot flushes** | absent | 326(83.2) | 41(53.2) | 81(58.3) | < 0.001 |
| | present | 66(16.8) | 36(46.8) | 58(41.7) | |
| **Night sweats** | absent | 346(88.3) | 57(74.0) | 94(67.6) | < 0.001 |
| | present | 46(11.7) | 20(26.0) | 45(32.4%) | |
| **Urinary incontinence** | absent | 363(92.6) | 66(85.7) | 116(83.5) | 0.005 |
| | present | 29(7.4) | 11(14.3) | 23(16.5) | |
| **Frequent urination** | absent | 341(87.0) | 66(85.7) | 101(72.7) | < 0.001 |
| | present | 51(13.0) | 11(14.3) | 38(27.3) | |
| **Obesity** | absent | 340(86.7) | 49(74.2) | 114(81.4) | 0.023 |
| | present | 52(13.3) | 17(25.8) | 26(18.6) | |
| **Anxiety** | absent | 170(65.9) | 39(68.4) | 63(64.3) | 0.872 |
| | present | 88(34.1) | 18(31.6) | 35(35.7) | |
| **Depression** | absent | 214(79.0) | 53(80.3) | 97(91.5) | 0.015 |
| | present | 57(21.0) | 13(19.7) | 9(8.5) | |
| **Parity** | 0 | 94(33.9) | 10(14.3) | 20(17.5) | < 0.001 |
| | 1 | 67(24.2) | 9(12.9) | 28(24.6) | |
| | 2 | 77(27.8) | 32(45.7) | 45(39.5) | |
| | ≥3 | 39(14.1) | 19(27.1) | 21(18.4) | |
| **Multimorbidity** | absent | 325(82.7) | 60(75.0) | 95(67.9) | 0.001 |
| | present | 68(17.3) | 20(25.0) | 45(32.1) | |

rOSAS, risk of obstructive sleep apnea; RLS, restless legs syndrome.*p* values were obtained using the Chi-square test to compare distributions across reproductive aging stages.

examined. Statistically significant associations were identified for rOSAS, age group, hot flashes, night sweats, frequent urination, urinary incontinence, obesity, depression, multimorbidity, and parity.

## DISCUSSION

In the study population, the risk of sleep disorders was as follows: rOSAS 19.4%, RLS 16.6%, insomnia 21.4%. The overall incidence of any sleep disorders was 42%. The rOSAS and risk of any sleep disorders were higher in the MTS group than in the RS group. The PMS group exhibited higher rOSAS, difficulty initiating and maintaining sleep, and risk of any sleep disorder compared with the RS group. In the TAPES study (13), the prevalence rates of sleep disorders in women were 16.1% for OSAS, 7.3% for RLS, and 20.2% for insomnia. The observed rate differences may be attributed to a higher likelihood of women with sleep and gynecological complaints volunteering for the study.

Although studies vary in their findings, most report an increase in insomnia symptoms during the menopausal transition period, with some noting an increase during menopause itself (20,21). The lower risk of daytime insomnia symptoms during MTS and PMS compared with that during RS may explain the lack of a statistically significant difference in the risk of insomnia between the stages. Differences in reproductive aging classification and the failure of some studies to assess daytime symptoms may also account for the inconsistencies in previous findings. Menopause is a risk factor for OSAS in women, and an exposure–response relationship between advancing menopause and OSAS has been suggested. Depression is commonly reported among those affected (14,22). Although the relationship between OSAS and urinary incontinence in women has not been widely studied, evidence of an association has been observed in the urogynecology population (23). The relationship between OSAS and multimorbidity remains inconclusive (24). Further research is needed to clarify the relationships between OSAS, multimorbidity, and urinary incontinence.

In a previous study conducted among women aged 18–64 years, the prevalence of RLS was 15.7%, with a positive association with age, no significant relationship with menopausal status, and a higher prevalence among women experiencing VMS compared with those without VMS (25). In the present study, however, the effect of VMS on RLS was not statistically significant after adjusting for other variables. Similarly, although age was associated with RLS in univariable analysis, this association did not persist in the multivariable model, suggesting potential confounding by other factors. Only 5.2% of individuals report having a sleep disorder, whereas the risk of any sleep disorder was identified in 42% of participants. Considering the significant impact of sleep on physical and mental health, our findings underscore the need for measures to improve accessibility and support for affected individuals.

Poor sleep quality at baseline is independently and collectively associated with a higher risk of progression of multimorbidity during the follow-up period, particularly among individuals younger than 65 years and female participants (24). The relationship between sleep disorders, multimorbidity, and MT underscores the critical importance of this period for early prevention and intervention.

Sleep disorders are associated with depression and anxiety. Given the multiple effects that estrogens and progesterone exert on the central nervous system, their influence on mood and sleep and the consequent reciprocal relationship between mood and sleep across female reproductive stages is not surprising (9). Parity has been found to be associated with sleep disorders; its relationship with RLS and insomnia remained significant even when adjusted for other factors. This finding warrants further investigation.

The frequency of parameters in different reproductive aging stages suggests that various interactions may play a role during different stages.



### Strengths

This study includes a detailed assessment of reproductive history. Insomnia was diagnosed using the ICSD-3 criteria, and accepted screening tests for OSA and RLS were used. The study also analyzed common symptoms of menopause and parity and considered multimorbidity, depression, and anxiety as covariates.

### Limitations

This study employed screening rather than diagnostic methods. The cross-sectional design prevents conclusions about causality. Self-reported questionnaires were used to assess sleep disorders and other variables, which may be subject to recall or reporting bias. The reliance on voluntary participation may have resulted in an overrepresentation of women with sleep issues, potentially skewing the results. The participants' high level of education may have also impacted the outcomes. Although hormonal markers were not included in the classification of menopausal stages, reproductive aging was determined using the STRAW+10 criteria, which emphasize menstrual patterns as the primary basis for staging and consider hormonal values as optional due to their intra-individual variability. Comorbid conditions were not confirmed with biological markers or clinical records, which may have introduced classification bias in the multimorbidity assessment. The final regression models did not include lifestyle-related factors such as medication use, physical activity, marital status, and working status. This limited the ability to control for potential confounding effects. The wide age range of participants may have introduced heterogeneity that could affect the interpretation of the findings. The presence of hypertension in the multimorbidity and OSAS screenings may have confounded the relationship between multimorbidity and rOSAS. Only a few menopausal participants underwent surgical menopause; this was not distinguished from natural menopause. Missing data resulted in a reduced sample size for the regression analysis. The study is prone to overfitting the models to the study population, thus requiring replication in another group. Additionally, the lack of longitudinal follow-up limits the ability to observe temporal relationships. Moreover, these results cannot be generalized beyond the study population. The findings indicate associations rather than causation.

### Conclusion

Considering the impact of sleep on physical and mental health, the high detection rate of sleep disorders emphasizes the importance of measures that will make it easier to reach individuals. The risk of sleep disorders is particularly elevated in women during the menopausal transition and menopause. This risk is complex and multifaceted, with continuous interactions among various factors contributing to its complexity. Menopausal symptoms, which are common reasons for frequent visits to gynecology clinics, as well as multimorbidity, depression, and anxiety, may be associated with sleep disorders. As the human ovary is the first organ to decline in function with age, the menopausal transition may be a critical period for healthy aging.

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ORIGINAL ARTICLE

# HYPEROXEMIA IN POTENTIALLY CRITICALLY ILL ELDERLY PATIENTS TREATED IN HOSPITAL WARDS: A RETROSPECTIVE STUDY

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## Abstract

**Introduction:** Hyperoxemia is associated with poor outcomes; however, its incidence and risk factors in elderly patients remain unclear.

**Materials and Method:** This retrospective study aimed to identify the incidence of hyperoxemia in potentially critically ill elderly patients treated in wards at an academic tertiary hospital. Elderly patients managed in wards between April 1, 2024, and January 31, 2025, were included. Patients were categorized into two groups: hyperoxemia (partial pressure of oxygen [PaO2] ≥ 120 mmHg) and normoxemia (60 mmHg ≤ $PaO_2$ < 120 mmHg). Statistical analyses were conducted using the Chi-square, Fisher's exact, and Mann–Whitney U tests. Independent risk factors for hyperoxemia were identified through regression analysis. A two-tailed p-value <0.05 was considered statistically significant.

**Results:** A total of 276 elderly patients were included. The incidence of hyperoxemia was 52.2%. Patients with hyperoxemia required intensive care unit admission more frequently and exhibited higher in-hospital and 28-day mortality rates compared to patients with normoxemia. Lymphocyte count ≤ 0.8 × $10^3$/μL (odds ratio [OR], 2.17; 95% confidence interval [CI], 1.27–3.72; *p*=0.005), atelectasis (OR, 2.03; 95% CI, 1.13–3.67; *p*=0.019), fraction of inspired oxygen ≥ 40% (OR, 2.10; 95% CI, 1.11–3.95; *p*=0.022), and type IV respiratory failure (OR, 2.34; 95% CI, 1.09–5.06; *p*=0.030) were identified as independent risk factors for hyperoxemia.

**Conclusions:** Elderly patients receiving supplemental oxygen therapy are susceptible to hyperoxemia, even when treated in general wards. Further research is warranted to develop preventive strategies for hyperoxemia in this population.

***Keywords:*** Critical Illness; Critical Care; Aged; Hyperoxia; Respiratory Therapy.



## INTRODUCTION

The administration of supplemental oxygen is a common therapeutic intervention in the management of critically ill patients (1). However, inappropriate use can lead to hyperoxemia, which is associated with poor outcomes and inefficient use of healthcare resources (2). Meanwhile, projections indicate that the proportion of the global population aged 60 years and older will exceed 20% by the year 2050 (3). Consequently, the number of elderly patients requiring critical care and the administration of supplemental oxygen therapy to this population is expected to increase over time.

Hyperoxemia has been shown to induce the production of reactive oxygen intermediates, which can overwhelm antioxidant defenses, leading to cellular damage or death (4). The administration of high concentrations of oxygen has also been demonstrated to increase the right-to-left shunt fraction, raise the dead space to tidal volume ratio, and decrease both lung compliance and diffusing capacity (5,6). Over the long term, hyperoxemia may result in interstitial fibrosis, capillary proliferation, epithelial hyperplasia, and diffuse alveolar damage (7,8). Furthermore, hyperoxemia has been associated with coronary vasoconstriction and decreased cardiac output (9), as well as an elevated risk of generalized tonic-clonic seizures (10). A previous study involving nonoperative patients in wards identified admission status, chronic kidney disease, and age as risk factors for hyperoxemia, whereas admission time, sequential organ failure assessment (SOFA) score, and reason for admission were associated with a lower risk (11). Existing literature has documented the impact of hyperoxemia on patient outcomes, particularly in critical care settings (2,12,13) and among operative patients (14–16). However, data are lacking on the effects of hyperoxemia on outcomes among potentially critically ill elderly patients receiving treatment in general wards.

Therefore, the present study was designed to determine the incidence of hyperoxemia and to identify factors associated with hyperoxemia among elderly patients treated in hospital wards who were considered potentially critically ill. Additionally, the study aimed to evaluate the effect of hyperoxemia on patient outcomes.

## MATERIALS AND METHOD

### Study design, setting, and selection of participants

This retrospective cohort study was conducted at Şişli Hamidiye Etfal Training and Research Hospital following approval by the local ethics committee (date: 02/25/2025, IRB number: 2918, document number: 4763). The study population consisted of elderly patients (aged 65 years or older) who were evaluated by an intensivist, at the request of their attending physician, to determine the need for critical care treatment between April 1, 2024, and January 31, 2025, while receiving care in hospital wards. In wards, the decision to initiate supplemental oxygen therapy and adjust oxygen levels was contingent upon the clinical methodologies employed by each ward. The patients were grouped as follows: hypoxemic, normoxemic, and hyperoxemic, according to the level of partial pressure of oxygen ($PaO_2$) in arterial blood gas analysis performed on the day of intensivist consultation. Hypoxemia was defined as a $PaO_2 < 60$ mmHg, normoxemia as 60 mmHg $\leq PaO_2 < 120$ mmHg, and hyperoxemia as $PaO_2 \geq 120$ mmHg. Patients under the age of 65, those admitted to the emergency department or secondary-level intensive care units, patients transferred to an external center, patients with hypoxemia, and those with a hospital stay of less than one day were excluded. The study was conducted in accordance with the ethical standards outlined in the Declaration of Helsinki (17). The requirement for written informed consent was waived due to the retrospective nature of the study.

### Variables

Data were collected from each patient's paper charts and electronic medical records. Patient characteristics, including demographic data, comorbidities, the presence of chronic respiratory failure requiring respiratory support, and prognostic scores such as the Glasgow Coma Scale (GCS), Charlson Comorbidity Index (CCI), Acute Physiology and Chronic Health Evaluation II (APACHE II), and Sequential Organ Failure Assessment (SOFA) scores, were recorded. The dataset also included information on the presence, type, and underlying cause of respiratory failure; the type of respiratory support provided in the ward, along with the fraction of inspired oxygen ($FiO_2$) level; and laboratory data. In addition, hospitalization characteristics—such as the reasons for hospital admission, the ward where patients were staying, length of hospital stay, and the need for treatment in critical care settings—were documented. Outcomes included in-hospital mortality and 28-day mortality rates following admission.

### Outcomes

The primary outcome of this study was to determine the incidence of hyperoxemia among elderly patients who were considered potentially critically ill and receiving treatment in hospital wards. Secondary outcomes included identifying independent factors associated with hyperoxemia and assessing the impact of hyperoxemia on patient outcomes, such as length of hospital stay, need for critical care admission, in-hospital mortality, and 28-day mortality.

### Statistical analysis

Statistical analysis was performed using IBM SPSS Statistics software (Version 29.0.1.0; Armonk, New York, IBM Corporation, USA). Categorical variables were presented as numbers and percentages, while continuous variables were expressed as medians and interquartile ranges, and/or mean ± standard deviation. The distribution of the continuous variables was analyzed by using Kolmogorov-Smirnov and Shapiro-Wilk tests. To compare continuous and categorical variables in the univariate analysis, the Mann–Whitney U test or t-test and the Chi-square or Fisher's exact tests were used, respectively. Binary logistic regression analysis was conducted to identify independent factors associated with hyperoxemia among potentially critically ill elderly patients treated in hospital wards. A model was constructed using the enter method in logistic regression analysis, incorporating variables related to hyperoxemia that could influence the results. For each independent factor, the analysis provided an adjusted odds ratio (OR) along with a 95% confidence interval (CI). A two-tailed *p*-value of less than 0.05 was considered statistically significant.

## RESULTS

### Patient characteristics

Initially, a total of 4524 consultations were screened. In the first step, 415 elderly patients were identified for analysis after excluding 2469 consultations from the emergency department, 879 consultations for patients under 65 years of age, 391 duplicate consultations, and 370 consultations from secondary-level intensive care units. Among the remaining patients, 123 were excluded due to transfer to an external center. An additional 14 patients were excluded due to hypoxemia ($PaO_2$ < 60 mmHg), and 2 patients were excluded because their hospital stay was shorter than one day. The final cohort consisted of 276 patients, of whom 144 (52.2%) exhibited hyperoxemia during their treatment in the wards.

The patient characteristics are summarized in Table 1. The mean and median age of the patients was 78 ± 9 and 77 (71–84) years, respectively, and 51.1% of them were male. Most patients (39.9%) were classified as younger elderly (65–74 years), while 37.3% were older elderly (75–84 years), and 22.8% were classified as oldest elderly (≥85 years). The median CCI was 7 (5–9), and the median GCS



**Table 1.** Patient Characteristics

| Characteristics | All (n = 276) | Hyperoxemia (n = 144) | Normoxemia (n = 132) | *P* value |
|---|---|---|---|---|
| **Age** | 77 (71–84) | 77 (70–84) | 77 (71–84) | 0.96 |
| | 78 ±9 | 78 ± 9 | 78 ± 9 | 0.97 |
| Younger elderly (65–74 years) | 110 (39.9) | 56 (38.9) | 54 (40.9) | 0.81 |
| Older elderly (75–84 years) | 103 (37.3) | 54 (37.5) | 49 (37.1) | 1.00 |
| Oldest elderly (≥85 years) | 63 (22.8) | 34 (23.6) | 29 (22.0) | 0.78 |
| **Sex, men** | 141 (51.1) | 66 (45.8) | 75 (56.8) | 0.07 |
| **CCI** | 7 (5–9) | 7 (6–9) | 7 (5–9) | 0.19 |
| **SOFA score*** | 5 (3–8) | 6 (3–9) | 4 (3–7) | **0.018** |
| **APACHE II*** | 19 (13–26) | 22 (15–29) | 17 (12–23) | **<0.001** |
| **GCS*** | 14 (10–15) | 13 (9–15) | 14 (10–15) | **0.035** |
| **Comorbidity** | 259 (93.8) | 136 (94.4) | 123 (93.2) | 0.80 |
| Hypertension | 173 (62.7) | 98 (68.1) | 75 (56.8) | 0.06 |
| Diabetes mellitus | 120 (43.5) | 71 (49.3) | 49 (37.1) | 0.05 |
| Malignancy | 94 (34.1) | 47 (32.6) | 47 (35.6) | 0.61 |
| Solid organ malignancy | 91 (33.0) | 45 (31.3) | 46 (34.8) | 0.61 |
| Hematological malignancy | 3 (1.1) | 2 (1.4) | 1 (0.8) | 1.00 |
| Coroner artery disease | 87 (31.5) | 51 (35.4) | 36 (27.3) | 0.16 |
| Chronic kidney disease | 75 (27.2) | 46 (31.9) | 29 (22.0) | 0.08 |
| Congestive heart failure | 65 (23.6) | 39 (27.1) | 26 (19.7) | 0.16 |
| Cerebrovascular disease | 52 (18.8) | 22 (15.3) | 30 (22.7) | 0.13 |
| Alzheimer's disease | 50 (18.1) | 21 (14.6) | 29 (22.0) | 0.12 |
| COPD | 48 (17.4) | 26 (18.1) | 22 (16.7) | 0.87 |
| Chronic liver disease | 29 (10.5) | 15 (10.4) | 14 (10.6) | 1.00 |
| History of thromboembolism | 5 (1.8) | 3 (2.1) | 2 (1.5) | 1.00 |
| Obesity | 4 (1.4) | 2 (1.4) | 2 (1.5) | 1.00 |
| **Respiratory support at home** | | | | |
| Home-BIPAP/CPAP | 3 (1.1) | 2 (1.4) | 1 (0.8) | 1.00 |
| Oxygen concentrator | 9 (3.3) | 5 (3.5) | 4 (3.0) | 1.00 |
| Nebulizer | 10 (3.6) | 3 (2.1) | 7 (5.3) | 0.20 |

The values are expressed as median and interquartile range, and/or mean ± standard deviation for continuous variables, and as numbers and percentages for categorical variables.

Abbreviations: CCI, Charlson comorbidity index; SOFA score, sequential organ failure assessment score; COPD, chronic obstructive pulmonary disease; BIPAP, bilevel positive airway pressure; CPAP, continuous positive airway pressure.

*Calculated on the day of consultation.

score was 14 (10–15). The median SOFA score and Acute Physiology and Chronic Health Evaluation II (APACHE II) score were 5 (3–8) and 19 (13–26), respectively. Univariate analysis revealed that patients with hyperoxemia had significantly higher SOFA and APACHE II scores compared to those with normoxemia. Additionally, the median GCS score was significantly higher in patients with hyperoxemia than in those with normoxemia. Most patients had at least one comorbidity, with the most prevalent being hypertension (67.2%), diabetes mellitus (43.5%), and malignancy (34.1%). The proportion of patients requiring respiratory support at home was notably low.

### Respiratory characteristics

The respiratory characteristics of the patients are presented in Table 2. Most patients (87.7%) exhibited respiratory failure. The most frequent type of respiratory failure was hypoxemic (type I), followed by shock-induced (type IV), perioperative (type III), and hypercapnic (type II) respiratory failure. The most common causes of respiratory failure were pneumonia (42.4%), pleural effusion (36.6%), and atelectasis (27.2%). Arterial blood gas analysis revealed a significantly higher rate of hyperoxemia in patients with respiratory failure, particularly among those with type IV respiratory failure, compared to other types. The underlying causes of respiratory failure showed no significant differences in relation to oxygenation status, except for atelectasis, where the proportion of patients with hyperoxemia was significantly higher. Conversely,

**Table 2.** Respiratory Characteristics of the Patients

| Characteristics | All (n=276) | Hyperoxemia (n=144) | Normoxemia (n=132) | *P* value |
|---|---|---|---|---|
| **Presence of respiratory failure** | 242 (87.7) | 132 (91.7) | 110 (83.3) | **0.044** |
| Type I | 129 (46.7) | 61 (42.4) | 68 (51.5) | 0.15 |
| Type II | 18 (6.5) | 11 (7.6) | 7 (5.3) | 0.47 |
| Type III | 32 (11.6) | 14 (9.7) | 18 (13.6) | 0.35 |
| Type IV | 63 (22.8) | 46 (31.9) | 17 (12.9) | **<0.001** |
| **Causes of respiratory failure** | | | | |
| Pneumonia | 117 (42.4) | 60 (41.7) | 57 (43.2) | 0.81 |
| Pleural effusion | 101 (36.6) | 57 (39.6) | 44 (33.3) | 0.32 |
| Atelectasis | 75 (27.2) | 49 (34.0) | 26 (19.7) | **0.010** |
| Pulmonary edema | 50 (18.1) | 31 (21.5) | 19 (14.4) | 0.16 |
| COPD exacerbation | 11 (4.0) | 3 (2.1) | 8 (6.1) | 0.13 |
| Pulmonary aspiration | 20 (7.2) | 8 (5.6) | 12 (9.1) | 0.35 |
| Pulmonary embolism | 4 (1.4) | 1 (0.7) | 3 (2.3) | 0.35 |
| Pneumothorax | 1 (0.4) | 1 (0.7) | 0 (0.0) | 1.00 |
| Interstitial lung disease | 2 (0.7) | 1 (0.7) | 1 (0.8) | 1.00 |
| ARDS | 2 (0.7) | 0 (0.0) | 2 (1.5) | 0.23 |
| Bronchiectasis | 2 (0.7) | 1 (0.7) | 1 (0.8) | 1.00 |
| **Type of respiratory support** | | | | |
| No respiratory support | 34 (12.3) | 0 (0.0) | 34 (25.8) | **<0.001** |
| Conventional oxygen therapy | 194 (70.3) | 107 (74.3) | 87 (65.9) | 0.15 |
| Nasal cannula | 47 (17.0) | 26 (18.1) | 21 (15.9) | 0.75 |
| Oxygen mask | 125 (45.3) | 65 (45.1) | 60 (45.5) | 1.00 |
| Mask with reservoir | 22 (8.0) | 16 (11.1) | 6 (4.5) | **0.048** |
| IMV[±] | 48 (17.4) | 37 (25.7) | 11 (8.3) | **<0.001** |
| **$FiO_2$, %** | 37.0 (29.0–47.0) | 40.0 (35.0–50.0) | 35.0 (25.0–40.0) | **<0.001** |
| **$FiO_2$ ≥ 40%** | 117 (42.4) | 79 (54.9) | 38 (28.8) | **<0.001** |

All values are expressed as median and interquartile range or as number and percentage.

Abbreviations: COPD, chronic obstructive pulmonary disease; ARDS, acute respiratory distress syndrome; IMV, invasive mechanical ventilation; $FiO_2$, fraction of inspired oxygen.

[*]Performed on the day of consultation.

[±]The patients received invasive mechanical ventilation in wards until they were transferred to an intensive care unit due to the lack of available beds in intensive care units.



patients who were not receiving respiratory support tended to exhibit normoxemia. However, patients receiving supplemental oxygen therapy via mask with reservoir or respiratory support through invasive mechanical ventilation had a significantly higher proportion of hyperoxemia. Additionally, an $FiO_2$ level of 40% or greater was associated with the occurrence of hyperoxemia.

### Laboratory data

The laboratory data of the patients are summarized in Table 3. No statistically significant differences

**Table 3.** Laboratory Findings of the Patients

| Characteristics | All (n=276) | Hyperoxemia (n=144) | Normoxemia (n=132) | *P* value |
|---|---|---|---|---|
| **WBC, × $10^3$/μL** | 11.48 (7.87–16.37) | 11.07 (8.14–16.48) | 11.77 (7.70–16.29) | 0.58 |
| **Neutrophil, × $10^3$/μL** | 9.21 (6.17–14.89) | 9.19 (6.28–15.27) | 9.36 (6.07–14.00) | 0.96 |
| **Hemoglobin, g/dL** | 9.3 (8.2–10.7) | 9.2 (8.0–10.5) | 9.6 (8.3–10.8) | 0.18 |
| | 9.6 ± 2.2 | 9.5 ± 2.1 | 9.7 ± 2.2 | 0.32 |
| **Lymphocyte, × $10^3$/μL** | 0.9 (0.6–1.36) | 0.8 (0.5–1.2) | 1.05 (0.66–1.56) | **0.002** |
| **Lymphocyte ≤ 0.8 × $10^3$/μL** | 121 (43.8) | 75 (52.1) | 46 (34.8) | **0.005** |
| **Platelet, × $10^3$/μL** | 205.0 (132.3–285.0) | 193.5 (114.5–271.0) | 237.0 (142.0–306.0) | **0.002** |
| | 215.2 ± 115.1 | 193.6 ± 107.3 | 238.9 ± 119.0 | **0.001** |
| **HS Troponin I, ng/L** | 42.0 (16.3–136.3) | 49.0 (19.1–245.9) | 32.2 (13.3–93.6) | 0.05 |
| **BUN, mg/dL** | 35.7 (22.1–57.9) | 41.1 (23.8–65.8) | 31.5 (19.7–49.8) | **0.003** |
| **Creatinine, mg/dL** | 1.36 (0.82–2.40) | 1.66 (0.98–2.90) | 1.20 (0.71–1.92) | **<0.001** |
| **Total Bilirubin, mg/dL** | 0.85 (0.51–1.44) | 0.90 (0.50–1.86) | 0.83 (0.55–1.39) | 0.66 |
| **AST, U/L** | 32 (21–78) | 33 (21–103) | 31 (20–65) | 0.48 |
| **ALT, U/L** | 21 (10–45) | 21 (10–55) | 23 (11–40) | 0.77 |
| **CRP, mg/L** | 120.0 (58.0–187.8) | 111.5 (61.0–194.5) | 125.0 (50.2–182.7) | 0.63 |
| **Procalcitonin, ng/mL** | 0.38 (0.16–2.63) | 0.30 (0.16–2.45) | 0.50 (0.16–2.74) | 0.29 |
| **Blood gas analysis** | | | | |
| pH | 7.42 (7.33–7.48) | 7.39 (7.30–7.47) | 7.45 (7.38–7.49) | **0.001** |
| $PCO_2$, mmHg | 34.0 (28.0–40.3) | 33.6 (27.3–40.8) | 35.0 (29.6–39.9) | 0.29 |
| $PaO_2$, mmHg | 122.0 (85.1–162.8) | 160.0 (138.0–190.6) | 84.5 (71.7–100.0) | <0.001 |
| $HCO_3$, mEq/L | 22.0 (17.0–26.0) | 21.0 (15.4–25.5) | 23.1 (18.5–26.9) | 0.013 |
| | 21.7 ± 7.2 | 20.7 ± 7.8 | 22.8 ± 6.3 | 0.015 |
| Base excess | -2.0 (-7.9–1.98) | -3.05 (-8.50–1.25) | -0.6 (-5.4–3.3) | 0.011 |
| Base excess ≤ -2.0 | 139 (50.4) | 83 (57.6) | 56 (42.4) | 0.016 |
| Lactate, mmol/L | 1.69 (1.20–3.18) | 1.64 (1.11–3.83) | 1.73 (1.29–2.79) | 0.61 |
| $SO_2$, % | 98.0 (96.0–99.0) | 99.0 (99.0–99.2) | 96.0 (94.0–98.0) | <0.001 |
| $PaO_2$ / $FiO_2$ | 342.9 (259.3–418.7) | 393.8 (337.7–474.0) | 273.9 (200.5–342.0) | <0.001 |
| | 347.1 ± 123.6 | 411.0 ± 112.0 | 277.4 ± 94.9 | <0.001 |

The values are expressed as median and interquartile range, and/or mean ± standard deviation for continuous variables, and as numbers and percentages for categorical variables.

Abbreviations: WBC, white blood cell; HS Troponin I, high sensitive troponin I; BNP, brain natriuretic peptide; BUN, blood urea nitrogen; AST, aspartate aminotransferase; ALT alanine aminotransferase; LDH, lactate dehydrogenase; ALP, alkaline phosphatase; CRP, C-reactive protein; $PCO_2$, partial pressure of carbon dioxide; $PaO_2$, partial pressure of oxygen; $SO_2$, oxygen saturation; $FiO_2$, fraction of inspired oxygen.

*Performed on the day of consultation.

were observed between patients with and without hyperoxemia regarding hemoglobin levels, liver function tests, cardiac injury markers, or infection markers such as C-reactive protein and procalcitonin. Patients with hyperoxemia exhibited elevated blood urea nitrogen (BUN) and creatinine levels, along with decreased platelet and lymphocyte counts. Moreover, the proportion of patients with a lymphocyte count of 0.8 × $10^3$/μL or lower was significantly higher among those with hyperoxemia compared to patients with normoxemia. In addition, patients with hyperoxemia had lower bicarbonate levels and more negative base excess values compared to those with normoxemia. Notably, patients with a base excess of −2.0 or lower demonstrated a significantly higher frequency of hyperoxemia compared to those with higher base excess values.

### Hospitalization characteristics

As shown in Table 4, neither the underlying reasons for hospital admission nor the ward where patients stayed demonstrated a significant association with oxygenation status. However, the need for treatment in critical care settings was significantly higher among patients with hyperoxemia compared to those with normoxemia (108 [75.0%] vs. 69 [52.3%], $p< 0.001$). Furthermore, both in-hospital mortality (89 [61.8%] vs. 53 [40.2%], $p< 0.001$) and 28-day mortality (62 [43.1%] vs. 37 [28.0%], $p=0.012$) were significantly higher in patients with hyperoxemia compared to those with normoxemia.

### Independent factors associated with hyperoxemia

Independent factors associated with hyperoxemia are presented in Table 5. The analysis identified a lymphocyte count of 0.8 × $10^3$/μL or lower (OR, 2.17; 95% CI, 1.27–3.72; $p=0.005$) in laboratory tests, atelectasis as an underlying cause of respiratory failure (OR, 2.03; 95% CI, 1.13–3.67; $p=0.019$), an $FiO_2$ level of 40% or higher (OR, 2.10; 95% CI, 1.11–3.95; $p=0.022$), and type IV respiratory failure (OR, 2.34; 95% CI, 1.09–5.06; $p=0.030$) as independent

**Table 4.** Hospitalization Characteristics of the Patients

| Characteristics | All (n=276) | Hyperoxemia (n=144) | Normoxemia (n=132) | *P* value |
|---|---|---|---|---|
| **Reasons for hospital admission** | | | | |
| Infection | 100 (36.2) | 57 (39.6) | 43 (32.6) | 0.26 |
| Renal/metabolic | 69 (25.0) | 37 (25.7) | 32 (24.2) | 0.89 |
| Digestive | 46 (16.7) | 24 (16.7) | 22 (16.7) | 1.00 |
| Soft tissue/skin/orthopedic | 37 (13.4) | 14 (9.7) | 23 (17.4) | 0.08 |
| Cardiovascular | 16 (5.8) | 9 (6.3) | 7 (5.3) | 0.80 |
| Neurologic | 16 (5.8) | 8 (5.6) | 8 (6.1) | 1.00 |
| **Ward where the patients stayed** | | | | |
| Medical wards | 193 (69.9) | 103 (71.5) | 90 (68.2) | 0.60 |
| Surgical wards | 83 (30.1) | 41 (28.5) | 42 (31.8) | |
| **Length of hospital stay, days** | 16 (9–31) | 16 (8-30) | 16 (10-34) | 0.19 |
| **Critical care unit admission** | 177 (64.1) | 108 (75.0) | 69 (52.3) | **<0.001** |
| **28-day mortality** | 99 (35.9) | 62 (43.1) | 37 (28.0) | **0.012** |
| **In-hospital mortality** | 142 (51.4) | 89 (61.8) | 53 (40.2) | **<0.001** |

All values are expressed as median and interquartile range or as number and percentage.



**Table 5.** Independent Factors Associated with Hyperoxemia

| Factors related to hyperoxemia | OR (95% CI) | *P* value |
|---|---|---|
| **Laboratory data** | | |
| Lymphocyte count ≤ 0.8 × $10^3$/μL | 2.17 (1.27–3.72) | **0.005** |
| Base excess ≤ -2 | 1.48 (0.86–2.56) | 0.16 |
| **Underlying reason for respiratory failure** | | |
| Atelectasis | 2.03 (1.13–3.67) | **0.019** |
| **Respiratory support** | | |
| $FiO_2$≥ 40% | 2.10 (1.11–3.95) | **0.022** |
| IMV | 1.40 (0.55–3.61) | 0.48 |
| **Type of Respiratory Failure** | | |
| Type IV | 2.34 (1.09–5.06) | **0.030** |
| **Prognostic scores** | | |
| SOFA score | 1.68 (0.86–3.29) | 0.13 |
| APACHE II score | 1.42 (0.73–2.73) | 0.30 |

Abbreviations: $FiO_2$, fraction of inspired oxygen; IMV, invasive mechanical ventilation; SOFA score, Sequential Organ Failure Assessment score; APACHE II score; Acute Physiology and Chronic Health Evaluation II score.

factors significantly associated with an increased likelihood of hyperoxemia among potentially critically ill elderly patients treated in hospital wards.

## DISCUSSION

This study examined the risk factors for hyperoxemia among elderly patients who were deemed potentially critically ill and receiving treatment in hospital wards. The analysis revealed that the incidence of hyperoxemia was 52.2%. Moreover, patients with hyperoxemia had a greater likelihood of requiring treatment in critical care settings compared with those without hyperoxemia. Furthermore, both in-hospital and 28-day mortality rates were significantly higher among patients with hyperoxemia than among those with normoxemia. The independent factors associated with hyperoxemia were identified as a lymphocyte count of 0.8 × $10^3$/μL or lower, atelectasis as an underlying cause of respiratory failure, an $FiO_2$ level of 40% or higher, and type IV respiratory failure among potentially critically ill elderly patients treated in wards.

The deterioration of ventilation-perfusion matching with age results in an increased alveolar-arterial oxygen gradient among elderly patients (18). Additionally, the age-associated increase in physiological dead space may contribute to this phenomenon (18). In contrast, a previous study examining nonoperative patients admitted to hospital wards demonstrated that age was an independent factor for hyperoxemia (11). However, the univariate analysis conducted in the present study did not reveal any significant differences in arterial oxygen content across the overall study population or among different age groups.

This study also found that neither the CCI nor any individual comorbidities influenced oxygenation status among patients. A previous study analyzing adult patients found that higher SOFA scores were associated with a lower incidence of hyperoxemia (11). However, in the present study, patients with higher APACHE II and SOFA scores— indicators of critical illness— were more likely to have hyperoxemia. Additionally, univariate analysis

revealed that patients with hyperoxemia had a significantly higher median GCS score than those with normoxemia. Yet, multivariate analysis did not confirm this association. This may suggest a prevailing tendency among caregivers to administer high concentrations or flows of supplemental oxygen to patients in clinically compromised conditions, reflected by higher APACHE II and SOFA scores and lower GCS scores, potentially contributing to the development of hyperoxemia in this population. Moreover, the administration of respiratory support at home, including the use of oxygen concentrators, was not associated with normoxemia, contrary to the anticipated outcome.

Supplemental oxygen therapy is a customary component in the management of critically ill patients, particularly those with respiratory failure (1). The present study revealed that patients with respiratory failure, especially those with type IV respiratory failure, exhibited a tendency to develop hyperoxemia rather than maintain normoxemia. In patients diagnosed with type IV respiratory failure, particularly those presenting with acute decompensated heart failure, supplemental oxygen therapy is recommended when $SpO_2$ levels fall below 90%. However, clinicians should exercise caution and avoid the routine use of oxygen therapy in patients without hypoxemia to prevent reductions in cardiac output and coronary vasoconstriction (9). Septic shock, another etiology of type IV respiratory failure, increases tissue metabolic demand, which must be counterbalanced by enhanced tissue oxygen delivery (19). Nevertheless, when hemodynamic disturbances surpass the cardiovascular system's compensatory capacity, tissue perfusion declines, leading to impaired microcirculation (19,20). As a result, the administration of oxygen at high concentrations and/or flow rates may become predominant among clinicians treating patients with septic shock, particularly those with clinical deterioration due to impaired metabolic balance associated with microcirculatory dysfunction and increased tissue oxygen demand. This phenomenon was reflected in the present study, where patients with high SOFA and APACHE II scores showed a higher incidence of hyperoxemia. Additionally, this study found that median hemoglobin levels did not differ significantly between patients with and without hyperoxemia. This finding contrasts with the well-established role of hemoglobin in facilitating oxygen delivery in critically ill patients (21). Therefore, clinicians must prioritize interventions that ensure hemodynamic stability and maintain adequate oxygen delivery to meet the patients' metabolic demands.

The present study demonstrated the expected relationship between the absence of respiratory support and normoxemia, as well as the association of respiratory support via mask with reservoir or invasive mechanical ventilation with hyperoxemia. Furthermore, the study found that respiratory support with an $FiO_2$ of 40% or greater, or the presence of atelectasis, were independently associated with hyperoxemia. For patients receiving supplemental oxygen therapy, current guidelines recommend targeting an $SpO_2$ range of 94–98%, or 88–92% in patients at risk of hypercapnic respiratory failure (22). These thresholds apply to a variety of clinical conditions, including sepsis, shock, acute coronary syndromes, stroke, pneumonia, anaphylaxis, and major trauma (22). It is important to underscore that pulse oximetry should be readily available in all settings where supplemental oxygen therapy is administered (22). Moreover, the prescription of supplemental oxygen should be guided by the target saturation range rather than the $FiO_2$ or flow rate (22). It is also crucial to emphasize that patients requiring escalating concentrations of oxygen supplementation should undergo urgent clinical reassessment (22).

Although no significant relationship was observed between cardiac enzymes, liver function



tests, and arterial oxygen content, associations were identified between certain laboratory parameters and hyperoxemia, notably elevated BUN and creatinine levels, along with lower pH, bicarbonate, and base excess levels, which may suggest acute renal failure. Hyperoxemia has previously been associated with impaired renal blood flow (22). Additionally, a prior study identified chronic kidney disease as a risk factor for hyperoxemia among nonoperative adult patients (11). The effect of hyperoxemia during cardiac anesthesia on postoperative kidney function also remains a subject of ongoing debate (16,23). Moreover, a low lymphocyte count— potentially indicative of severe infection or immunodeficiency— was identified as an independent factor associated with hyperoxemia in the study population. In this context, potentially critically ill patients experiencing tachypnea, whether due to pulmonary or non-pulmonary conditions such as renal or metabolic disorders, may be at increased risk of developing hyperoxemia induced by supplemental oxygen therapy. Consequently, it is imperative to investigate the underlying causes of tachypnea and to reassess the need for oxygen support in this patient population by carefully evaluating potential pulmonary and non-pulmonary pathologies.

The impact of hyperoxemia on patient outcomes remains a subject of debate in the literature. The findings of the present study indicated that hyperoxemia in elderly patients with potentially critical illnesses was associated with an increased need for treatment in critical care settings and a higher risk of 28-day and in-hospital mortality. Nonetheless, it can be argued that hyperoxemia may not be the primary causative factor for these outcomes. Instead, the observed associations may reflect a tendency among practitioners to administer high concentrations and flows of oxygen to patients with more severe illnesses. A systematic review demonstrated a dose-dependent increase in both early and long-term mortality among patients treated with liberal oxygen therapy. However, no significant differences were observed in disability or length of hospital stay (2). A subsequent study also revealed an association between hyperoxemia and mortality in critically ill patients, including those with both severe hyperoxemia and mild hyperoxemia or normoxemia (12). Conversely, a randomized trial found no significant differences in the number of ventilator-free days or 6-month mortality between patients receiving liberal versus conservative oxygen therapy (24). Another study showed that hyperoxemia increased the risk of in-hospital mortality by 1.8-fold among patients admitted to critical care following cardiopulmonary resuscitation (13). In the field of anesthesiology, particularly in cardiac anesthesia, existing literature suggests a correlation between hyperoxemia and perioperative pulmonary complications (14), although this association does not appear to extend to postoperative cognitive outcomes (25). Meanwhile, the impact of hyperoxemia on postoperative kidney function remains controversial (16,23). It is important to note, however, that these studies have employed heterogeneous definitions of hyperoxemia, a factor that has likely contributed to inconsistencies in reported outcomes.

## LIMITATIONS

This study has several limitations. Although the study population was defined as elderly patients deemed at risk of developing critical illness and receiving treatment in hospital wards, it included only those patients who were evaluated by an intensivist to determine the need for critical care following are quest by the attending physician. Therefore, not all elderly patients who remained in the hospital wards during the study period were included. Furthermore, the decision to initiate supplemental oxygen therapy for patients treated in hospital wards was contingent on clinical decision-making processes that exhibited

variability across different wards, as opposed to a uniform protocol. Moreover, the existence of a consensus among attending physicians regarding the utilization of target $SpO_2$ or $PaO_2$ values to adjust supplemental oxygen therapy remains to be elucidated. Additionally, the inclusion of patients from surgical wards may have introduced some heterogeneity into the study population.

Nevertheless, this study has several notable strengths. The investigation of the impact of hyperoxemia on length of hospital stay, the need for critical care admission, and both in-hospital and 28-day mortality represents a significant contribution to the field. Furthermore, the study identifies specific hyperoxemia-related factors, offering valuable insights into which patients receiving oxygen therapy and/or ventilatory support should be monitored closely by healthcare practitioners for the potential development of hyperoxemia.

## CONCLUSION

Clinicians should avoid hyperoxemia not only in patients treated in critical care settings or operating rooms but also in elderly patients with potentially critical illnesses who are treated in hospital wards. The findings of the present study indicate that patients with lymphopenia, atelectasis, type IV respiratory failure, or receiving supplemental oxygen with an $FiO_2$ level of 40% or higher are likely to have an increased risk of hyperoxemia. A proactive approach is imperative for this patient population, necessitating the determination of the target $SpO_2$ level as opposed to the prescription of the oxygen flow or $FiO_2$. This imperative is crucial for enhancing patient outcomes and ensuring the efficient utilization of healthcare resources.

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ORIGINAL ARTICLE

# INVESTIGATION OF THE RELATIONSHIP BETWEEN VITAMIN D LEVELS AND SYSTEMIC IMMUNE INFLAMMATION INDEX PARAMETERS IN PEOPLE OVER 65 YEARS OF AGE

## Abstract

**Introduction:** Vitamin D exerts anti-inflammatory effects. This study investigated the relationship between vitamin D levels and inflammatory parameters in older adults.

**Materials and Method:** This retrospective study included healthy older individuals aged >65 years treated at the Geriatrics Clinic of Ankara Bilkent City Hospital between January 1 and December 31, 2023. Based on the exclusion criteria and simultaneous measurements of vitamin D levels, complete blood count, and C-reactive protein levels, 654 patients were included in the study. Systemic immune inflammatory parameters were calculated from complete blood counts. First, the correlations among vitamin D, C-reactive protein, and systemic immune inflammation parameters were investigated. Individuals were classified according to their vitamin D levels in deficient, insufficient, or normal groups. The groups were then compared for systemic immune inflammation and C-reactive protein levels.

**Results:** C-reactive protein levels were negatively correlated with vitamin D levels and positively correlated with systemic immune inflammation parameters.Furthermore, a weak correlation was observed between systemic immune inflammation parameters and vitamin D. C-reactive protein levels were significantly higher in the deficient group than in the insufficient and normal groups. Systemic immune inflammatory parameters were significantly higher in the deficient and insufficiency groups than in the control group.

**Conclusion:** Low vitamin D levels are associated with increased inflammation. Incorporating systemic immune inflammatory parameters into routine complete blood count reports will facilitate their clinical use. In the future, we plan to investigate the molecular mechanisms underlying the relationship between vitamin D and inflammation.

***Keywords:*** Vitamin D; Inflammation; Aged.

## INTRODUCTION

Inflammation is a simple but complex physiological phenomenon, defined as a unique response of the body to tissue damage or inflammatory stimuli (1). Long-term inflammation can lead to insulin resistance, diabetes, heart disease, atherosclerosis, obesity, and metabolic syndromes. Inflammation may also play a role in the pathogenesis of many neurological diseases, including Alzheimer's disease (2). Systemic immune inflammation index parameters (SIP) are typically calculated using parameters measured during routine complete blood counts (leukocytes, lymphocytes, neutrophils platelets, and monocytes). Recently, SIP parameters have emerged as a noninvasive marker to determine the severity, prognosis, and activation of any disease, as well as to assess the degree of inflammation. Notably, in patients with high SIP values, the inflammatory response is high and disease prognosis is poor (3).

Anti-inflammatory drugs and dietary interventions are frequently used to treat chronic inflammation. Vitamin D has recently been recognized as an anti-inflammatory agent. It exhibits antiapoptotic, anti-inflammatory, and immune-regulatory properties. Owing to its pleiotropic effects, vitamin D deficiency is associated with cardiovascular and other diseases (diabetes and cancer), low resistance to infectious diseases, and the emergence of autoimmune diseases (4). Many factors, including ages, seasons, environmental factors, genetic factors, and various diseases, negatively affect vitamin D synthesis, commonly leading to deficiencies and insufficiencies.But structural changes in the dermis that occur with ageing have been reported to significantly decrease vitamin D synthesis in the skin. Consequently, a 70-year-old produces 75% less vitamin D through skin synthesis than a 20-year-old (5). According to the study by Nowak et al., vitamin D deficiency is observed in all geriatric patients, regardless of the season (6). Elderly individuals are also susceptible to vitamin D deficiency when they are not absorbing dietary supplements or animal foods adequately (7). Consequently, vitamin D insufficiency or deficiency, especially in older individuals is a global public health concern.

Vitamin D has immunomodulatory and anti-inflammatory properties (4). However, whether vitamin D deficiency occurs due to inflammation or inflammation occurs due to vitamin D deficiency remains unclear. This study aimed to investigate the correlation between vitamin D levels and SIP while excluding clinical conditions that may cause inflammation. In addition, we examined whether SIP parameters vary according to vitamin D levels categorized as deficient, insufficient, and normal.

## MATERIALS AND METHOD

This study was approved by Ankara Yıldırım Beyazıt University Health Sciences Ethics Committee on 14.03.2024 under the number 02-580. This retrospective study analyzed the data of patients who visited the Geriatrics Clinic of Ankara Bilkent City Hospital between January 1 and December 31, 2023, without any sex discrimination. Demographic information, including age, sex, educational status, chronic diseases, and simultaneous vitamin D levels, CRP,and complete blood results, was collected from the files.In hospitals, CRP levels are routinely measured in patient files, but high-sensitivity CRP (hs-CRP) is not routinely measured. Therefore, hs-CRP data were not collected because of insufficient number of hs-CRPs. As in previous studies (5, 6) the seasonal cycle was not considered when collecting data on vitamin D levels. Patients with deficiencies in blood tests, infections detected in blood and urine cultures, age <65 years, neurological diseases (Alzheimer's disease, dementia, Parkinson's disease), malignancy, inflammatory rheumatic diseases, fractures in the extremities, neuropathy, those receiving anti-inflammatory treatments, or those using antibiotics were excluded.

According to the reference ranges, vitamin D levels were classified as normal (75–375 nmol/L), insufficient (50–75 nmol/L), and deficient (<50 nmol/L). Vitamin D levels >375 nmol/L were considered toxic. We first performed correlation analysis between vitamin D and CRP levels and inflammation parameters for all data and classified the patients into three groups according to the vitamin D levels: deficient vitamin D group (DG), insufficient vitamin D group (IG), and normal vitamin D group (NG). Similarly, according to the reference ranges, normal values were defined as follows: 0–5 mg/L for CRP, 3.6–10.5 × $10^9$/L for leukocytes, 1.5–7.7 × $10^9$/L for neutrophils, 1.1–4 × $10^9$/L for lymphocytes, 0.1–0.9 × $10^9$/L for monocytes, and 160–400 ×$10^9$/L for platelets.

After manually entering the data of older adults suitable for the study into an Excel file, SIP-related calculations were performed according to the formulas below:

**SII:** (Platelet×Neutrophil/Lymphocyte Ratio) Platelet×Neutrophil/Lymphocyte

**NLR:** Neutrophil/Lymphocyte

**dNLR:** (derived NLR) Neutrophil/(Leukocyte-Lymphocyte)

**PLR:** (Platelet Lymphocyte Ratio) Platelet/Lymphocyte

**MLR:** (Monocyte Lymphocyte Ratio) Monocyte/Lymphocyte

**NLPR:** (Neutrophil Lymphocyte Platelet Ratio) Neutrophil/Lymphocyte×Platelet

**SIR-I:** Neutrophil × Monocyte/Lymphocyte)

Kolmogorov–Smirnov analysis was performed to assess the normality of the data distribution. Notably, the data were not normally distributed ($p<0.05$). Furthermore, as our sample size exceeded 50, skewness and kurtosis analyseswere performed, which also confirmed that the data were not normally distributed. Therefore, nonparametric tests were used for analysis. Spearman rank correlation analysis was used to determine the relationship between the parameters in our data. As significant correlation was observed, the data were divided into three aforementioned groups. The Kruskal–Wallis H test was used to analyze differences among three or more groups. For variables showing significant differences, the Mann–Whitney U test was conducted to identify which specific groups differed significantly. All statistical analyses were performed using the IBM SPSS Statistics version 22. Significance level was set at $p<0.05$.

## RESULTS

In this retrospective study, we obtained the records of 2,713 patients. Approximately 1,000 patients who were in follow-up and underwent examinations at defined intervals were excluded. Finally, 654 participants were included. Among the older adults included in the study, 215 were men and 439 were women. The mean age of participants was 76.9 years. Among the older adults, 9.4% were followed up with a diagnosis of hypertension (HT), were using antihypertensive drugs, and had regulated blood pressure. Furthermore, 60.1% of the older adults were followed up with a diagnosis of diabetes mellitus (DM) + HT, and 5% were followed up only with a diagnosis of DM. Based on the HbA1c levels of individuals diagnosed with DM, only those with regulated blood sugar levels (HbA1c level <47) were included in the study. Additionally, 25.5% of older adults did not have chronic diseases during the follow-up (Table 1).

We examined the correlation between vitamin D, CRP, and SIP parameters. We observed a negative correlation between vitamin D and CRP ($r(654)= -0.184$; $p<0.001$) and a weakly significant negative correlation between vitamin D and SIP parameters (SII [$r(654)= -0.268$; $p<0.001$], NLR [$r(654)= -0.287$; $p<0.001$], dNLR [$r(654)= -0.264$; $p<0.001$], PLR [$r(654)= -0.162$; $p<0.001$], MLR [$r(654)= -0.250$; $p<0.001$], NLRP [$r(654)= -0.211$; $p<0.001$], and SIR-I [$r(654)= -0.291$; $p<0.001$]). CRP exhibited varying



**Table 1.** Demographic information of older adults. DM, diabetes mellitus; HT, hypertension

| Variables | | n (%) |
|---|---|---|
| **Sex** | Women | 439 (67.1) |
| | Men | 215 (33.9) |
| **Education** | Uneducated | 97 (14.6) |
| | Less educated | 67 (10.1) |
| | Primary school | 227 (34.6) |
| | Secondary school | 86 (13.1) |
| | High school | 113 (17.1) |
| | University | 64 (9.8) |
| **Vitamin D levels** | Deficient | 245 (37.2) |
| | Insufficient | 189 (29.4) |
| | Normal | 220 (33.4) |
| **Chronic diseases** | Regulated hypertension | 62 (9.4) |
| | Regulated DM + HT | 395 (60.1) |
| | Regulated DM | 32 (5) |
| | No chronic disease | 165 (25.5) |
| **Total patients** | | 654 (100) |

degrees of positive correlation with SII, NLR, dNLR, PLR, MLR, NLPR, and SIR-I (Table 2).

The data were grouped according to vitamin D levels, and the groups were compared based on CRP levels. CRP levels of the DG group were statistically higher than in the ID and ND groups (mean±standard deviation [SD] values 9.193±13.05 mg/L, 6.635±11.47 mg/L, and 6.184±14.63 mg/L, respectively, $p<0.001$) (Table 3).

The SII values, were significantly higher in the DG (736.782±380.70) and ID groups (656.578±264.23) than in the ND group (527.145 ± 256.97) ($p<0.001$) (Table 3).

In the analyses for NLR and dNLR parameters, the values in DG, IG, and NG groups for both parameters gradually decreased, and the difference between all groups was statistically significant (NLR: 2.989 ± 1.39, 2.612 ± 0.95, and 2.170 ± 0.99, respectively, $p<0.05$), (dNLR: 1.984 ± 0.73, 1.759 ± 0.57, and 1.553 ± 0.62, respectively, $p<0.001$) (Table 3).

In PLR analysis, the lowest PLR value was observed in the NG group, and this decrease was

**Table 2.** Correlation results and significance levels between vitamin D, C-reactive protein, and systemic immune inflammation parameters.

| | Mean±SD | Vitamin D | CRP | SII | NLR | dNLR | PLR | MLR | NLPR | SIR-I |
|---|---|---|---|---|---|---|---|---|---|---|
| **Vitamin D** | 63.980± 33.94 | 1 | | | | | | | | |
| **CRP** | 7.442±13.24 | -0.184* | 1 | | | | | | | |
| **SII** | 643.083±322.90 | -0.268* | 0.263* | 1 | | | | | | |
| **NLR** | 2.605±1.20 | -0.287* | 0.224* | 0.772* | 1 | | | | | |
| **dNLR** | 1.774±0.67 | -0.264* | 0.195* | 0.754* | 0.952* | 1 | | | | |
| **PLR** | 149.877±60.90 | -0.162* | 0.129* | 0.726* | 0.511* | 0.460* | 1 | | | |
| **MLR** | 0.295±0.71 | -0.250* | 0.210* | 0.517* | 0.682* | 0.531* | 0.453* | 1 | | |
| **NLPR** | 0.011±0.01 | -0.211* | 0.128* | 0.358* | 0.845* | 0.805* | 0.192* | 0.615* | 1 | |
| **SIR-I** | 1.313±3.27 | -0.291* | 0.295* | 0.685* | 0.766* | 0.674* | 0.274* | 0.836* | 0.593* | 1 |

* $p<0.001$. CRP, C-reactive protein; NLR, neutrophil lymphocyte ratio; dNLR, derived neutrophil lymphocyte ratio; PLR,platelet lymphocyte ratio; MLR, monocyte lymphocyte ratio; NLPR, neutrophil lymphocyte platelet ratio; SIR-I, systemic inflammation response index; SII, systemic immune inflammation index. Results are presented as themean± standard deviation.

significant compared with that in the DG and IG groups (Table 3).

For MLR values, the mean ± SD in the NG group (0.263 ± 0.75) was lower than that in the ID and NG groups (p<0.001).

A significant difference was found between all groups for the NLRP level. The NLRP mean ± SD values were 0.013±0.01, 0.011±0.010, and 0.010±0.01 in the DG, IG, and NG groups, respectively (p<0.001) (Table 3).

SIR-I was 1.618 ± 4.59 in the DG group, 1.233±1.27 in the ID group, and 1.043±2.60 in the NG group, and the difference between all groups was statistically significant (p<0.001) (Table 3).

Examination of the SIR-I parameter revealed a significant difference between the groups (p<0.001). The average of individuals with normal vitamin D levels (1.043±2.60) was found to be significantly lower than that of the other groups (p<0.001). Furthermore, the average of individuals with insufficient vitamin D levels (1.233 ± 1.27) was significantly lower than the average of individuals with deficient vitamin D levels (1.618 ± 4.59) (p<0.010) (Table 3).

## DISCUSSION

This study investigated the correlation between SIPand vitamin D in older adults. SIP has recently been reported as an indicator of inflammation (8).

**Table 3.** Comparison of systemic immune inflammation index (SII) parameters and significance levels among groups.

| Variables | Deficient group (DG) (n=245) | Insufficient group (IG) (n=189) | Normal group (NG) (n=220) | Significant difference* |
|---|---|---|---|---|
| | Mean±SD | Mean±SD | Mean±SD | |
| CRP (mg/L) | 9.193±13.05 | 6.635±11.47 | 6.184±14.63 | DG>IG<br>DG>NG |
| SII | 736.782±380.70 | 656.578±264.23 | 527.145±256.97 | DG>NG<br>IG>NG |
| NLR | 2.989±1.39 | 2.612±0.95 | 2.170±0.99 | DG>IG<br>DG>NG<br>IG>NG |
| dNLR | 1.984±0.73 | 1.759±0.57 | 1.553±0.62 | DG>IG<br>DG>NG<br>IG>NG |
| PLR | 160.103±66.76 | 155.036±58.05 | 134.058±53.02 | DG>NG<br>IG>NG |
| MLR | 0.336±0.89 | 0.279±0.23 | 0.263±0.75 | DG>NG<br>IG>NG |
| NLPR | 0.013±0.01 | 0.011±0.01 | 0.010±0.01 | DG>IG<br>DG>NG<br>IG>NG |
| SIR-I | 1.618±4.59 | 1.233±1.27 | 1.043±2.60 | DG>IG<br>DG>NG<br>IG>NG |

*p<0.05, Mann–Whitney U

* p<0.001. CRP, C-reactive protein; NLR, neutrophil lymphocyte ratio; dNLR, derived neutrophil lymphocyte ratio; PLR,platelet lymphocyte ratio; MLR, monocyte lymphocyte ratio; NLPR, neutrophil lymphocyte platelet ratio; SIR-I, systemic inflammation response index; SII, systemic immune inflammation index. Results are presented as the mean±standarddeviation



First, we examined the relationship between vitamin D and CRP levels. CRP level is a potent marker of inflammation (9). Studies on CRP and vitamin D levels have indicated their possible correlation with inflammation (10). Statistical analyses revealed a weak inverse correlation between vitamin D and CRP levels in individuals aged >65 years. Therefore, we confirmed the correlation between vitamin D levels and inflammation. However, high SIP levels were observed at high CRP levels, indicating a positive correlation. These results also support the notion that SIP levels can be considered as the marker of inflammation.

Further analysis revealed a similarly weak negative correlation between vitamin D levels and SIP, and as vitamin D levels decreased, SIP levels increased. Our results are consistent with those reported by Dziedzic et al. (11). In this study, a negative correlation was observed between vitamin D levels and the SII and SIR-I levels in 699 adult patients with ischemic heart disease and acute coronary syndrome. A retrospective study by Bayramoğlu et al. involving 103 patients, which investigated the correlation between vitamin D levels and inflammatory markers (CRP, fibrinogen) in young individuals diagnosed with COVID-19, reported a strong negative correlation between vitamin D levels and inflammatory markers (12). Furthermore, adult patients with acute coronary syndrome exhibited a strong negative correlation between vitamin D, SII, and SIR-I levels (11). A study by Vurgun in 2022 involving adults aged ≥18 years revealed weak negative correlations between vitamin D levels and CRP, erythrocyte sedimentation rate, leukocyte count, and NLR parameters (13). Our findings show that variations in SIP values are associated with vitamin D levels, as reported in individuals aged ≥65 years (6), an age group in which vitamin deficiency is common. Meanwhile, in our study, inflammation was confirmed based on the CRP levels and seven different SIP markers. The consistent negative correlations observed across all parameters further strengthened our findings.

The physiological changes in the older adults result in low levels of vitamin D (5, 6). The results of the study by Nowak et al. showed that there was no significant difference in median vitamin D concentration between patients hospitalised during the four seasons. Therefore, appropriate vitamin D supplementation is recommended in the older adult regardless of the season (6).In a study that was performed in Brazil, a very sunny country, vitamin D levels were found to be significantly lower at the end of summer and at the end of winter, but there was no significant difference between the results at the end of the season. Vitamin D levels were also compared with the levels measured in a study conducted in very sunny Islamic countries. Although clothing style was emphasised in these countries, the low levels in Brazil excluded clothing style (14). It is emphasised that inadequate absorption of dietary animal foods or inadequate absorption of supplements in elderly individuals causes vitamin D deficiency regardless of the season (14). In our study, diseases that may cause inflammation were excluded and therefore, according to the results, vitamin D deficiency or insufficiency seems to trigger inflammation. In the study conducted by Konuksever et al., involving 16,312 healthy young individuals aged <18 years, classified all patient data into two groups based on vitamin D deficiency and examined the correlation between inflammatory parameters (NLR, PLR, and CRP) and vitamin D. Statistically significant correlations were observed between inflammatory markers and vitamin D (15). Consistently, our study also demonstrated a negative correlation between vitamin D levels and NLR and PLR. A cross-sectional study by Sharifan et al. assessed a correlation between depression, anxiety, stress, dietary inflammation index, healthy nutrition index, and some inflammation indices (cytokines, CRP, NLR, and PLR) in 309 adult patients. They classified

patients into two groups based on vitamin D levels and reported higher PLR, NLR, and CPR levels in the vitamin D-deficient group (16). Another cross-sectional study of patients on hemodialysis assessed the correlation between vitamin D levels and inflammatory markers (CRP, NLR, and PLR). Notably, these parameters were significantly higher in the vitamin D-deficient group (17). The results of our study are consistent with those of the aforementioned studies.

Vitamin D plays an important role as a regulator of the immune system by reducing the incidence and severity of bacterial and viral infections. Specifically, vitamin D supplementation in cases of vitamin D deficiency reduces the risk of acute respiratory tract infections (18). In a study by Başaran et al., 204 patients diagnosed with COVID-19 could be divided into three groups according to their vitamin D levels (deficient, insufficient, and normal). Inflammation may be more severe in patients with vitamin D deficiency, and CRP levels are significantly higher in the deficient vitamin D group than in the insufficient and normal groups (19), consistent with our findings.

Vitamin D exerts a direct effect on immune cells, which are critical in the pathogenesis of autoimmune diseases. Clinical studies have demonstrated a correlation between vitamin D deficiency and an increased risk of morbidity in cases of infectious diseases, as well as the onset or progression of autoimmune diseases (RA, SLE, and MS) (4).

Maintaining a balance between the pro- and anti-inflammatory components of the immune system is vital. The NLR and NLPR reflect the balance between innate and acquired immunity (20). A study by Shi et al. (21)involving 108 patients reported that high NLPR levels on day 5 in patients hospitalized in the intensive care unit, along with the sequential organ failure assessment score and patient age, could serve as predictive markers for patients with sepsis. A retrospective study by Ghobadi et al. involving 1,792 patients with COVID-19, including 710 older adults, reported similar findings. The study highlighted the utility of parameters such as NLR, PLR, MLR, dNLR, NLPR, aggregate index of systemic inflammation, SIR-I, and SII (22). Although NLPR and other SIP markers offer valuable insights into severe conditions, the relationship between vitamin D levels and SIP in geriatric populations remains unclear.

Although this was a single-center study, our data were derived from one of two geriatric polyclinics in Ankara, representing a substantial proportion of the population in the city. In the present study, we observed increased inflammation at low vitamin D levels, even in the absence of inflammatory triggers. This was determined by examining the SIP levels calculated from routine complete blood count without any additional examinations. We believe that our research will raise awareness among researchers and clinicians that vitamin D levels can be low even in the presence of inflammation. Furthermore, as only NLR values are included in our routine complete blood count reports, adding other SIP markers to the laboratory panels would facilitate their clinical utility. In future studies, we plan to investigate the molecular mechanisms underlying the relationship between vitamin D and inflammation.

**Conflict of İnterest:** The authors declare that they have no conflicts of interest.

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ORIGINAL ARTICLE

# INVESTIGATION OF THE LONG-TERM EFFECTS OF PANDEMIC VACCINES ON PHYSICAL AND COGNITIVE PERFORMANCE AFTER THE PANDEMIC

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## Abstract

**Introduction:**The present study compared the post-pandemic effects of different vaccines and vaccine combinations administered during the coronavirus disease 2019 pandemic in individuals defined as "young-elderly."

**Materials and Method:** Participants included 440 volunteers who met the inclusion criteria. They were divided into four groups based on the type of vaccine they had received. During data collection, participants completed a Personal Information Form, the Montreal Cognitive Assessment, the 36-item Short Form Health Survey, and the Alusti Test. The study was conducted between December 15, 2024, and May 29, 2025.Data were analyzed using SPSS version 28.0.

**Results:** The analyses revealed a statistically significant difference between groups in both the Alusti test (assesses physical performance) and the 36-item Short Form Health Survey (assesses quality of life) ($p<0.05$).This difference was particularly pronounced in the group that received the combination of BioNTech and Sinovac vaccines;it hadlower scores on physical performance and quality of life compared to the other groups. Cognitive performance did not differ significantly between the groups ($p>0.05$).

**Conclusion:**Therefore,the coronavirus disease vaccines may have varying long-term effects on the individual's overall health status and quality of life.

***Keywords:*** COVID-19; Physical Functional Performance; Cognition; Quality of Life; Vaccines.

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## INTRODUCTION

In December 2019, public health officials identified a new strain of coronavirus, SARS-CoV-2, in Wuhan, China, which causedan outbreak in that city.On March 11, 2020, the coronavirus disease 2019 (COVID-19) was declared a global pandemic. Local public health authorities initiated vaccine development processesto prevent the spread of the COVID-19 virus and reduce hospitalization and mortality rates (1).

Apart from the traditional methods used for vaccine production, new techniques such as mRNA technology are also being utilized in the vaccine development process. Vaccines that were developed rapidly and granted emergency use authorization began to be tested on humans in March 2020.The first vaccines to receive emergency use authorization were the Pfizer-BioNTech and Moderna vaccines, both produced using mRNA technology. Researchers announced that both types of vaccines provided over 90% protectionaccording to their phase 3 evaluations(2, 3).

In addition to the vaccines produced using mRNA technology, viral vector-based vaccines (Oxford-AstraZeneca and Sputnik V)and the inactivated virus-based Sinovac vaccine werewidely used across the world(4).

In Turkey, Sinovac and BioNTech vaccines were the first to be used against COVID-19. Additionally, a limited number of Sputnik V vaccines were administered. Although these vaccines were usedto control the spread of the pandemic in Turkey, efforts were undertaken to develop a domestic vaccine. TheTurkovac vaccine, developed by Erciyes University, received emergency use authorization in December 2021 and began to be administered (5).

Early evaluations revealed that mRNA vaccines were significantly effective in reducing pandemic-related complications. This effectiveness was associated with an increase in antibodies and T cells in the immune system(6, 7).

Apart from physiological changes, the administration of vaccines resulted in a decreased rate of transmission, the beginning of normalization, psychological relief, and positive improvements in the sense of trust and social interactions. Additionally, the decrease in mortality rates and shorter hospital stays reduced anxiety among individuals at risk (8).

Therefore, the present study aimed to evaluate the long-term effects of the vaccines administered during the COVID-19 pandemic on individuals after the pandemic. Most studies have conducted short-term evaluations and limited long-term evaluations. This delays a comprehensive understanding of the long-term effects of vaccines (9-11),demonstrating the need to examine their effects on the health status of individuals after the pandemic.

## MATERIALS AND METHOD

### Ethics

The study protocol was approved by the ArtvinÇoruh University Scientific Research and Publication Ethics Committee onDecember 12, 2024 (Approval Number: E-18457941-050.99-159686).All phases of the study were performed per the Declaration of Helsinki.

*Inclusion Criteria for the Study:*

- Voluntaryparticipation in the study
- Willingness to provide written informed consent for participation
- History of COVID-19 confirmed by PCR or antibody test
- Received at least two doses of vaccines
- Sufficient cognitive capacity to comprehend and perform the required study procedures
- No history ofserious pathological conditions (such as cancer, heart failure, etc.) that would prevent participation in the study

*Exclusion Criteria:*

- Unwillingness tooffer written informed consent for participation
- Not vaccinated or incomplete vaccination doses
- Severe neurological and/or psychiatric disorders
- History of a serious acute infection within the last six months
- Suspected pregnancy

**Sample Size Calculation**

In determining the sample size, the primary hypothesis of our study — "*There is a significant difference in physical performance among different COVID-19 vaccines and vaccine combinations*" — was taken as the basis. This hypothesis is grounded in the biological premise that different vaccine platforms (mRNA-based, inactivated virus, or their combinations) may elicit varying immune responses, inflammatory profiles, and post-vaccination symptom patterns, which in turn can influence muscle function, fatigue levels, and cardiopulmonary performance. Such physiological effects are particularly relevant in older or near-elderly populations, where baseline functional reserve is lower and immune responses may differ from those in younger individuals. This assumption is supported by previous studies conducted in older or near-elderly populations that examined differences in physical health indicators (12,13). Based on the mean differences and variances reported in these studies, Cohen's d value was estimated at 0.5, corresponding to a medium effect size. For the sample size calculation, the G*Power 3.1.9.4 software was used with an alpha level of 0.05, a power (1–β) of 0.80, and an effect size of 0.5. The calculation indicated that a minimum of 48 participants per group was required. Given that the study included four groups, the total minimum sample size was determined to be 192. Considering potential dropouts and missing data, additional participants were recruited.

**Procedure**

The present study did not include retrospective evaluation and was structured as a prospective, intergroup observational comparison. As part of the study, parents of students studying at Artvin Çoruh University's Vocational School of Health Services were contacted. Those who met the inclusion criteria were provided with detailed information and invited to participate in the study.

Subsequently, the participants were invited for face-to-face interviews.Those who provided written informed consent voluntarily were included in the study. Thedata collection was conducted in the physiotherapy laboratory, which provided an appropriate environment for administering the tests and scales. Participants' demographic characteristics were collected using a personal information form consisting of four questions (sex, age, body mass index (BMI), and education level). This was followed by the Alusti Test to evaluate their physical status. This test was conducted in the presence of an independent physiotherapist, who was not involved in the study and was not informed about the group assignments of the individuals. Subsequently, the Montreal Cognitive Assessment (MoCA) was administered by an independent researcher to assess cognitive performance, and the 36-item Short Form Health Survey (SF-36) was administered to assess quality of life

**Measures**

**Personal information form.** Researchers created this form to collectparticipants' demographic information. It included questions about their sex, age, body mass index (BMI), and education level.

**Alustitest:** This test was developed by physiotherapist Josu Alustiza Navarro to assess the physical status of geriatric individuals. Itevaluates



individuals' normal joint range of motion; muscle strength; ability to move from supine to sitting, stand up from sitting, balance while standing, stand with eyes closed, and stand on one leg with eyes closed; and walking and walking distance. Each evaluation parameter is scored according to the individual's ability to perform it.The maximum score on this test is 100.A high score indicates good physical performance. The Turkish validity and reliability of this test have been established by Kesikbaş(14).

**Montreal Cognitive Assessment Form.** This test, developed by Dr. Ziad Nasreddine to evaluate cognitive functions, allows the assessment of individuals' memory, visuospatial skills, executive function, verbal fluency, abstract thinking, attention, concentration, working memory, language, and orientation to time and place. The total score can range from 0 to 30,with a high score indicating good cognitive capacity. The Turkish validityof this scale has been established by Selekler et al. (15).

**36-itemShort Form Health Survey.** This 36-item form was developed by Ware and Sherbourne to evaluate individuals' quality of life. It is applicable to several broad areas and is not limited by factors such as age or disease. Thetotal score on this scale can range from 0 to 100, with a high score indicating better quality of life. The Turkish validity and reliability of this test have been established by Koçyiğit et al. (16).

### Statistical Analysis

The data were analyzed using IBM SPSS Statistics version 28.0. Prior to the analyses, the distribution of variables was assessed using both statistical tests and graphical methods. Since the sample size in our study exceeded 50 and the data did not deviate markedly from symmetry, the Kolmogorov–Smirnov test was applied, in conjunction with visual assessments such as histograms and outlier checks, to evaluate normality. Continuous variables with a normal distribution were presented as mean ± standard deviation, whereas non-normally distributed data were expressed as median (Q1–Q3).

For group comparisons, one-way analysis of variance (ANOVA) was used for normally distributed continuous variables, while the Kruskal–Wallis H test was applied for skewed distributions. Categorical variables were analyzed using the chi-square test or Fisher's exact test when expected frequencies were low. In cases where multiple comparisons were significant, Tukey's test or appropriate non-parametric post-hoc tests were applied.

In addition, multiple linear regression analyses were conducted using the enter method, whereby all predictor variables were entered into the model simultaneously to identify independent predictors of SF-36 and Alusti Test scores. Prior to model estimation, the assumptions of multiple linear regression — including linearity, independence of residuals (Durbin–Watson statistic), homoscedasticity, absence of multicollinearity (Variance Inflation Factor < 10), and normal distribution of residuals — were evaluated and met. The explanatory power of each model was reported using the coefficient of determination ($R^2$) and adjusted $R^2$, and statistical significance was set at $p < 0.05$.

## RESULTS

Table 1 presents the participants' demographic information. Statistically significant differences were observed among the groups in terms of age and body mass index (BMI) ($p < 0.05$), whereas no significant differences were found with respect to sex and educational status ($p > 0.05$)(Table 1).

This table presents the comparative analysis of physical performance (Alusti Test), cognitive function (Montreal Cognitive Assessment), and quality of life (SF-36) scores across the four vaccine groups. Variables with a normal distribution are expressed as mean ± standard deviation (SD) and analyzed using one-way analysis of variance (F

**Table 1.** Demographic characteristics of the participants.

| Variables | Group 1 (Unvaccinated) | Group 2 (BioNTech) | Group 3 (Sinovac) | Group 4 (BioNTech+Sinovac) | p-value |
|---|---|---|---|---|---|
| **Age** | 69.00(69.00-71.00) | 67.00 (67.00–69.00) | 69.00 (68.00–72.00) | 68.00 (66.00–69.00) | 0.010**[1] |
| **BMI** | 24.73(22.54–27.25) | 27.80 (25.30–31.10) | 26.70 (22.41–27.80) | 27.80 (24.30–32.90) | 0.020**[1] |
| **Sex, n (%)** | | | | | |
| Female | 84(76.3) | 60(54.5) | 58 (52.7) | 61(55.4) | 0.170*[2] |
| Male | 26(23.7) | 50(45.5) | 52(47.3) | 49(44.6) | |
| **Educational status, n (%)** | | | | | |
| Primary School | 88(80.0) | 68(61.8) | 84(76.3) | 88(80.0) | |
| High school | 6(5.4) | 28(25.4) | 26(23.7) | 22(20.0) | 0.331*[3] |
| University | 16(14.6) | 14(12.8) | 0(0.0) | 0(0.0) | |

Note.[1]Kruskal–Wallis H test, [2]Chi-square test, [3]Fisher's exact test,** p<0.05Abbreviations: BMI: Body Mass Index; p-value:Significance level

**Table 2.** Comparison of Physical Performance, Cognitive Function, and Quality of Life Scores by Vaccine Group

| Outcome measure | Group 1 (n=110) | Group 2 (n=110) | Group 3 (n=110) | Group 4 (n=110) | Test Statistic |
|---|---|---|---|---|---|
| **Alusti test** | 65.60 ± 19.53 | 71.12 ± 10.06 | 67.72 ± 13.91 | 57.40 ± 20.97 | F(3, 436) = 3.96, p=.033 |
| **Montreal Cognitive Assesment** | 21.00(16.00-21.00) | 23.00(20.00-26.00) | 22.00(13.00-26.00) | 17.00(11.00-26.00) | H(3) = 3.82, p=.662 |
| **SF-36** | 78.92 ± 11.20 | 80.48 ± 9.84 | 79.32 ± 11.76 | 70.44 ± 11.28 | F(3, 436) = 4.36, p=001 |

Note.SD = Standard deviation; Q1–Q3 = interquartile range; SF-36 = 36-item Short Form Health Survey; F = one-way ANOVA test statistic; H = Kruskal–Wallis test statistic. *Post-hoc comparisons indicate significant differences at p < .05.

statistic). Variables without a normal distribution are expressed as median (Q1–Q3) and analyzed using the Kruskal–Wallis test (H statistic). SF-36=36-Item Short Form Health Survey; Q1–Q3=interquartile range. Post-hoc comparisons indicate statistically significant differences at the $p < 0.05$ level. Post-hoc analysis revealed that, in the Alusti Test, the BioNTech group demonstrated significantly higher physical performance scores compared to the BioNTech+Sinovac group (p<.05), while no significant differences were observed among the other groups (p>.05). In terms of SF-36 quality of life scores, the BioNTech+Sinovac group had significantly lower scores than both the BioNTech and unvaccinated groups (p<.05). However, no significant differences were identified between the Sinovac group and the other groups (p>.05). For Montreal Cognitive Assessment scores, no significant differences were observed across the four groups (p>.05) (Table 2).

The results of the final multiple regression models with variable selection are presented in Table 3. According to the findings, the Montreal Cognitive Assessment (MoCA) score was a significant positive predictor in both models ($p < 0.001$). In the SF-36 model, both MoCA (B=0.4196, $p < 0.001$) and Alusti Test scores (B=0.2123, $p < 0.001$) contributed positively to quality of life, whereas the



**Table 3.** Multiple Regression Analysis Results for SF-36 and Alusti Test

| Variables | B (SF-36) | p (SF-36) | B (Alusti) | p (Alusti) |
|---|---|---|---|---|
| Montreal Cognitive Assessment. | 0.4196 | 0.000 | 0.5289 | 0.000 |
| Alusti Test. | 0.2123 | 0.000 | - | - |
| Vaccine Group_4 | -5.9708 | 0.033 | -7.3828 | 0.112 |
| SF-36 | - | - | 0.704 | 0.001 |

Note.B = unstandardized coefficient; p = significance level; Significant values ($p < 0.05$) are shown in bold. Model fit (SF-36): $R^2 = 0.386$, Adjusted $R^2 = 0.367$, $F(3, 96) = 20.13$, $p < 0.001$, Durbin–Watson = 1.712. Model fit (Alusti): $R^2 = 0.225$, Adjusted $R^2 = 0.217$, $F(1, 98) = 28.44$, $p < 0.001$, Durbin–Watson = 1.561.

BioNTech+Sinovac vaccine combination (Vaccine Group 4) was associated with significantly lower SF-36 scores (B=–5.9708, p=0.033). In the Alusti model, both MoCA (B=0.5289, $p < 0.001$) and SF-36 scores (B=0.704, p=0.001) significantly predicted physical performance, while none of the vaccine groups showed significant effects ($p > 0.05$). All assumptions of multiple linear regression, including linearity, independence of residuals, homoscedasticity, absence of multicollinearity, and normality of residuals, were evaluated and satisfied (Table 3).

## DISCUSSION

The present study concluded that physical performance and quality of life variables varied according to different vaccines or vaccine combinations, whereas no difference was observed in cognitive performance. Notably, both physical performance and quality of life scores were significantly lower among geriatric individuals who received the BioNTech+Sinovac vaccine combination compared to the other groups.

The literature review indicates that most studies have generally focused on immunity and general physiological parameters after vaccination.However, comprehensive studies comparing the effects of vaccines on variables such as physical performance, quality of life, and cognitive performance are scarce. Therefore, the present study is a pioneering and contributory work in this area of the literature.

A meta-analysis study conducted by Li et al. (12) investigatedthe safety of COVID-19 vaccines and their effects on the immune system in geriatric individuals. Theresults revealed that mRNA-based vaccines (such as BioNTech) demonstrated a higher level of effectiveness; however,the risk of side effects was also significantly higher. Furthermore, inactivated and vector-based vaccines provided an adequate level of protection and had lower levels of risk in terms of side effects. Moreover, the use of more than one dose was associated with a higher level of protection compared to a single dose. In another study, Babicki et al. (13)examined the COVID-19 registry system andfollowed up with individuals who had contracted COVID-19 over a 12-month period. Theresults indicated that while the vaccination had positive effects on some existing symptoms, it had no effect on symptoms such as exercise intolerance and fatigue during the 12-month follow-up period. It further concluded that these symptoms could continue over an extended period after vaccination.The evaluation of the results of both these studies highlighted that COVID-19 negatively impacted physical performance in geriatric individuals. The different efficacies of vaccines administered for COVID-19 led them to affect physical performance to varying degrees. These findings support the results of the present study, whichdemonstratedthat different types of vaccines affected physical performance to different extents.

Another study conducted by Silva et al. (17) examined the relationship between exercise habits and responses to COVID-19 vaccines in geriatric individuals aged above 60 years. The study demonstrated that individuals who developed a regular exercise habit gained stronger immunity to the CoronaVac and AstraZeneca vaccines. Althoughthis study did not directly evaluate physical performance, it assessed variables related to the immune system, which affects functional capacity. No significant difference was found among the vaccines included in the study in terms of generating an immune response.This situation underscores the importance of individuals' lifestyles in maintaining physical performance. Also falling within the scope of our study, the adverse situation observed in the BioNTech+Sinovac vaccine group suggests that the variations may have been influenced by individuals' lifestyles apart from the vaccines administered.

A review published by Soizaet al. (18) examined the efficacy and safety of vaccines among geriatric individuals. BioNTech, Moderna, and AstraZeneca vaccines were used in the study. Theresults indicated that high immune responses were obtained after vaccination. The absence of any adverse situation in both physical function and activities of daily living among vaccinated individuals was presented as the most important finding of the study.These results contradict the results of the present study. Although researchers indicate that mRNA and vector-based vaccines were safe and enhanced the immune response, studies regarding vaccine combinations are scarce.

Previous studies have also examined the effects of the pandemic vaccines onindividuals' overall quality of life. However, these studies have generally focused on single-type vaccine administrations. For example, Wu et al. (19) examined the effects of COVID-19 vaccines on the quality of life of individuals who had undergone heart transplantation. Eighty-eight patients, who had experienced heart transplantation and were included as participants, were administered the Sinovac vaccine as part of the study. The 36-item Short Form Health Survey was used to assess their quality of life. The study reported that vaccinated individuals had higher quality of life scores than unvaccinated individuals. This finding demonstrates the effect of vaccination on quality of life and supports our study's conclusion that quality of life varies according to the type of vaccination.

In another study, Yacoub et al. (20) evaluated the quality of life, psychological status, and sexual function indicators following vaccination among postmenopausal women. The results revealed that participants experienced both physical and emotional improvements and reported increased life satisfaction after vaccination.This result supports our study's conclusion that quality of life and physical performance are affected differently by different types of vaccines.

Di Fusca et al. (21) concluded that, among individuals who received the BioNTech vaccine, a reduction in symptoms was accompanied by significant improvements in both activities of daily living and quality of life.Shrestha et al. (22) investigated the efficacy of two vaccines developed using different methods—AstraZeneca and Covaxin. The study found that the overall quality of life remained unchanged,without any significant declines.In their study, Kitano et al. (23) indicated that, in addition to eliciting strong immune responses, vaccines produced using mRNA technology contributed positively to one's quality of life.Therefore,it can be concluded that different vaccines have varying effects on the quality of life. This result supports one of the main conclusions of our study, namely, that quality of life is affected differently by different types of vaccines.

The literature contains a limited number of studies investigating the effects of COVID-19 vaccines on cognitive performance in geriatric individuals. In this context, Roh et al. (24) conducted a study using

South Korea's national database to evaluate 558,017 individuals aged above65 years.In the study, they reported that 1) the risk score determined for the development of Alzheimer's disease changed significantly following the use of vaccines produced with mRNA technology and2) the risk score for mild cognitive impairment was at a more pronouncedly elevated level. However, researchers emphasized the necessity to investigate whether this situation is due to COVID-19 vaccines or to the psychological and biological impact of the pandemic.

Flegr and Latifi (25) conducted a research project utilizing the internet, in which 4,445 participants were evaluated. They reported that cognitive performance was adversely affected in cases in which individuals had experienced infection and had suffered from severe cases of COVID-19. Furthermore, they reported that vaccination had a positive effect on sub-parameters of cognitive performance, such as intelligence and information-processing speed. However, they emphasized that this effect may not be directly attributable to vaccination, but could be related to the participants' education levels.Therefore, it is suggested that COVID-19 vaccination may have an impact on cognitive performance. However, this raises the question of whether the observed effects are biologically based or stem from sociodemographic factors. This finding is consistent with the present study's findings. Our study demonstrated that different vaccine groups were able to alter physical performance and quality of life, but no significant differences were observed in cognitive performance. This indicates that it is necessary to consider the cognitive biological basis, sociodemographic factors, and lifestyle characteristics when evaluating participants' cognitive performance.

## CONCLUSION

The present study found that different types of vaccines resulted in changes in individuals' physical performance and quality of life after the pandemic; however, no changes were observed in their cognitive performance. Additionally, the group towhich both BioNTech and Sinovac vaccines were administered had lower scores in physical performance and quality of life. These results indicate that vaccine combinations affected individuals' overall health status. Therefore, future studies should comprehensively investigate the effectiveness of vaccine combinations.

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ORIGINAL ARTICLE

# SOCIAL EXCLUSION AND MEDICATION ADHERENCE IN THE OLDEST OLD: A CROSS-SECTIONAL STUDY

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## Abstract

**Introduction:** This study examined the correlation between social exclusion and medication adherence in older adults, identifying key factors influencing these concepts.

**Materials and Method:** The study was conducted between June 01, 2024, and October 31, 2024, involving face-to-face interviews with 214 individuals aged 80 years and older who volunteered for the survey at Konya City Hospital, "Sağlıklı YAŞAM" (Healthy Aging Center), and geriatrics outpatient clinics. Alongside evaluating sociodemographic characteristics, the Social Exclusion Scale for the Elderly and Modified Morisky Medication Adherence Scale were utilized. Statistical analyses were conducted using the Statistical Package for the Social Sciences program.

**Results:** The median age of the participants was 84 (80-98) years, with 62.6% being female. Among all participants, 36% (n=77) exhibited low medication adherence knowledge, while 55.1% (n=118) showed low medication adherence motivation. A moderate negative correlation was observed between the Social Exclusion Scale and Modified Morisky Medication Adherence Scale scores ($r=-0.318$; $p<0.001$). In multiple linear regression models, the total Social Exclusion Scale score was independently associated with the presence of friends, education level, physical dependency status, and total Modified Morisky Medication Adherence Scalescore (all $p<0.05$). The total Modified Morisky Medication Adherence Scale score was independently associated with crutches, lung disease, medication administration method, and total Social Exclusion Scale score in the regression models (all $p<0.05$).

**Conclusion:** This study showed that, as social exclusion increases, medication adherence decreases in older individuals, and an individual's sociodemographic characteristics may influence both social exclusion and medication adherence.

***Keywords:*** Social Isolation; Medication Adherence; Aged.

## INTRODUCTION

Aging is a multifaceted stage involving biological, psychological, and social changes experienced in the later years of an individual's life(1). Society's demographic shift towards an aging population has heightened the prevalence of social and health-related challenges among olderindividuals (2). Notably, social exclusion and consequent issues with medication adherence hold substantial importance.

Social exclusion refers to individuals' disconnection from social interactions and societal connections. Conversely, medication adherence pertains to how well an individual adheres to a treatment regimen prescribed by a physician(3,4). Among older individuals, social exclusion may heighten the risk of mental health issues and chronic diseases, while non-adherence to medication regimens can worsen the burden of illness(5,6).

In modern society, social disengagement among older individuals is associated with diverse social, economic, and cultural factors(3). This trend adversely impacts the physical and mental well-being of older adults, resulting in a decrease in their overall quality of life. The interplay between social exclusion and health significantly shapes attitudes toward treatment and compliance with prescribed therapies(7).

This study investigated the correlation between social exclusion and medication adherence in elderly individuals, identifying the primary factors that influence these phenomena.

## MATERIALS AND METHOD

Ethical approval for the study was obtained from the Hamidiye Scientific Research Ethics Committee of the University of Health Sciences on March 29, 2024, during meeting no. 2024/4, with decision no. 4/11 and registration no. 24/232. The Education Planning Committee of Konya City Hospital granted permission for the research on February 1, 2024, with decision No. 03-28.

This study utilized a descriptive cross-sectional design. Data were gathered through interviews with individuals aged over 80 years who were admitted to Konya City Hospital's Healthy Aging Center (HAC) and geriatric outpatient clinics (GOC).

HAC outpatient clinics in Türkiye offer scheduled healthcare serviceswhere elderly individuals receive home visits from a physician and gerontologist without prior requests. During these visits, necessary physical examinations, health screenings, and assessments for geriatric syndromes were conducted, and if needed, patients were referred to relevant specialties. The HAC outpatient clinic at Konya City Hospital caters to individuals aged 80 and older in the Karatay district of Konya. The study included individuals aged 80 and above from both the geriatric and HAC outpatient clinics.

*The inclusion criteria for the study are as follows:*

1.Having presented to the geriatric outpatient clinic for a medical condition.

2. Providing consent to participate in the study.

3. Being 80 years of age or older.

4. An elderly individual who was either visited at home or invited to an outpatient clinic as part of the HAC project.

*The exclusion criteria for the study are as follows:*

1. Lack of proficiency in Turkish and inability to communicate.

2. Insufficient cognitive capacity to answer the questions.

3. Presence of any physical, neurological, or psychiatric disorder that could impede the completion of the forms.

4. The patient had previously visited the geriatric outpatient clinic as a HAC outpatient or had been



evaluated at the HAC outpatient clinic as a geriatric outpatient.

The sociodemographic and medical characteristics of the participants were assessed. When evaluating the physical dependency status of individuals, the Unk "Katz Activities of Daily Living Scale for the Elderly" was used (8). The Social Exclusion Scale for the Elderly (SESE) assesses the sub-dimensions of material deprivation, informal social support, transportation and financial services, and environmental exclusion (9). The Modified Morisky Medication Adherence Scale (MMAS) measures the patients' motivation and knowledge levels (10).

### The SESE

The questionnaire comprised 22 questions. Nine questions (1, 4, 5, 7, 9, 11, 12, 14, and 16) focused on material deprivation, five questions (2, 8, 15, 17, and 19) on informal social support, four questions (6, 13, 20, and 21) on transportation and financial services, and four questions (3, 10, 18, and 22) on environmental exclusion.

### The MMAS

It comprises six questions: The questions were answered as Yes/No. "Yes" in questions 2 and 5 is 1 point; "No" is 0 points. For the other questions, "Yes" is 0 points; "No" is 1 point. The patient's motivation was assessed through questions 1, 2, and 6, while questions 3, 4, and 5 aimed to evaluatethe patient's knowledge. A total score of 0 or 1 for questions 1, 2, and 6 indicated low motivation, whereas a score>1 indicated high motivation. Similarly, a total score of 0 or 1 for questions 3, 4, and 5 indicated low knowledge, while a score>1 indicated high knowledge.

### Statistical Analysis

Statistical analyses were conducted using the Statistical Package for the Social Sciences (SPSS) version 26.0 (IBM, Armonk, NY, USA). Descriptive statistical methods included frequency (n), percentage (%), mean ± standard error, and min (minimum) – max (maximum) values. Thedistribution of numerical data was investigated using the Kolmogorov–Smirnov normality test, histogram, and skewness kurtosis tests. To compare variables between groups, Chi-square (X2), Mann–Whitney U, independent sample t, and Kruskal–Wallis tests were employed. Correlation analyses utilized Spearman's test, while linear regression analysis models estimated the independent influencing factors for the SESE and MMAS scores. All analyses were conducted with 95% confidence intervals,and statistical significance was defined as $P < 0.05$.

## RESULTS

The median age of the participants was 84 years, with 62.6% being female. Among the participants, 56.1% were single. In terms of education, 39.3% were illiterate, while 54.7% had completed primary school. Furthermore, 43.0% of participants resided with their spouses. The majority of individuals had a steady income, and 90.2% used central heating in their homes (Table 1). Of the participants, 47.7% (n=102) were entirely independent, and 59.3% (n=127) utilized a cane as an assistive device. The median number of medications regularly used by the study population was 5, ranging from 0 to 13, with hypertension being the most prevalent chronic condition (75.7%). Our analysis revealed that 65.9% (n=141) of the participants managed their medications independently, while 24.8% (n=53) had their medications administered by family members (Table 1).

When comparing the clinical conditions of participants from outpatient clinics, the SESE's subdimension "Environmental Exclusion" was notably higher in patients who participated in the GOC than in the HAC. Additionally, the subdimension "Medication Adherence Knowledge Level" and the total MMAS score were significantly

**Table 1.** Distribution of Participants' Sociodemographic Data

| Parameters (n=214) | | % (n) |
|---|---|---|
| Age, years, median (min-max) | 84 (80-98) | |
| Sex | Female | 62.6 (134) |
| Marital status | Married | 43.9 (94) |
| Education status | Not literate | 39.3 (84) |
| | Primary school | 54.7 (117) |
| | Middle school | 2.8 (6) |
| | High school | 0.9 (2) |
| | University | 2.3 (5) |
| Co-habitant | Alone | 20.6 (44) |
| | Spouse | 43.0 (92) |
| | Children | 35.0 (75) |
| | Relative | 1.4 (3) |
| | Nursing Home | 0.0 (0) |
| Having a regular family income | Yes | 98.1 (210) |
| The regular income of the individual | Yes | 78.5 (168) |
| Person using the income (n=168) | Himself | 50.6 (85) |
| | Spouse | 4.8 (8) |
| | Children | 44.0 (74) |
| | Relative | 0.0 (0) |
| | Nursing Home | 0.0 (0) |
| | Carer | 0.6 (1) |
| The heating type of the house you live in | Stove | 9.8 (21) |
| | Central heating | 90.2 (193) |
| Availability of a means of transportation | Yes | 10.3 (22) |
| Debt situation | No | 100.0 (214) |
| Presence of friends | Yes | 47.2 (101) |
| Someone who helps with needs | Neighbor | 1.9 (4) |
| | Children | 94.4 (202) |
| | Relative | 3.3 (7) |
| | Friend | 0.5 (1) |
| | None | 0.0 (0) |
| The presence of someone with whom one can share troubles and sorrows | Yes | 97.7 (209) |
| Level of physical dependence | Dependent | 6.1 (13) |
| | Partially Dependent | 46.3 (99) |
| | Completely Independent | 47.7 (102) |



**Table 1.** Continued...

| | | |
|---|---|---|
| **Use of assistive devices** | Cane | 59.3 (127) |
| | Crutch | 1.4 (3) |
| | Walker | 14.5 (31) |
| | Hearing aid | 22.0 (47) |
| **Number of medications used regularly, median (min-max)** | 5 (0-13) | |
| **History of chronic disease** | Hypertension | 75.7 (162) |
| | Diabetes mellitus | 29.0 (62) |
| | Coronary artery disease | 36.0 (77) |
| | Malignancy | 7.5 (16) |
| | Lung disease | 18.2 (39) |
| | Thyroid disease | 10.7 (23) |
| | Kidney disease | 4.7 (10) |
| | Neurological disease | 27.6 (59) |
| | Prostate disease | 38.8 (31) |
| | Hyperlipidemia | 11.7 (25) |
| | Other chronic diseases | 28.5 (61) |
| **How to take your medications** | Myself | 65.9 (141) |
| | My spouse | 7.9 (17) |
| | My family | 24.8 (53) |
| | Carer | 0.9 (2) |
| | Nursing home staff | 0.0 (0) |
| | Relative | 0.5 (1) |
| **Frequency of application to health institutions** | Several times a week | 0.5 (1) |
| | Several times a month | 25.2 (54) |
| | Several times a year | 74.3 (159) |
| **The most frequently applied institution type** | Emergency room | 8.9 (19) |
| | Family health center | 68.7 (147) |
| | Hospital polyclinics | 22. 4 (48) |

%: Frequency, Min: minimum, Max: maximum

greater in GOC patients compared to HAC patients. In terms of gender comparison, women exhibited significantly higher scores in the total SESE score and its subdimensions "Material Deprivation" and "Transportation-Financial" compared to men ($p<0.001$, $p=0.009$, and $p<0.001$, respectively) (Table 2).

The total scores achieved by participants on the "Material Deprivation" and "Transportation-Financial" subdimensions of the SESE, as well as the overall SESE score, were significantly lower among illiterate individuals ($p = 0.006$, $p = 0.001$, and $p<0.001$, respectively). When comparing the total and subdimensional scores of the MMAS between

**Table 2.** Comparison of the Scores on Scales and Subdimensions Based on Gender of Participants

| Parameters (n=214) | | Male | Female | p* |
|---|---|---|---|---|
| | | Median (min-max) | | |
| SESE Subdimensions | Material Deprivation | 16 (9-32) | 18 (9-34) | **0.009** |
| | Transportation-Financial | 16 (4-20) | 18 (5-20) | **<0.001** |
| | Environmental Exclusion | 4 (4-14) | 4 (4-16) | 0.919 |
| | Informal SocialSupport | 10 (5-21) | 11 (5-23) | 0.581 |
| **Total SESE score** | | 47 (29-84) | 51 (24-88) | **<0.001** |
| MMAS Subdimensions | Medication Adherence Motivation | 1 (0-3) | 1 (0-3) | 0.304 |
| | Medication Adherence Knowledge Level | 2 (0-3) | 2 (0-3) | 0.719 |
| **Total MMAS score** | | 3 (0-6) | 3 (0-6) | 0.426 |

p*:Mann-Whitney U test, SESE: Social Exclusion Scale for the Elderly, MMAS: Morisky Medication Adherence Scale , Min: minimum, Max: maximum

literate and illiterate participants, literate individuals scored significantly higher (Table 3). It was noted that the "Material Deprivation," "Transportation-Financial," and total SESE scores were lower among those living alone or with a spouse than among those living with others ($p<0.001$ for all measurements). Additionally, the "Medication Adherence Motivation" score was significantly higher in individuals living alone or with a spouse ($p = 0.005$) (Table 3). In individuals without friends, the "Material Deprivation," "Transportation-Financial," and total SESE scores were significantly higher ($p = 0.005$, $p = 0.001$, $p<0.001$, and $p<0.001$). Likewise, when comparing the "Medication Adherence Motivation" subdimension and total MMAS scores based on the presence of friends, those with friends had significantly higher scores ($p = 0.003$ and $p = 0.022$) (Table 3).

The scores for the "Material Deprivation," "Transportation-Financial," and "Informal SocialSupport" subdimensions were significantly higher in individuals who were fully or partially dependent compared to others (all had p-value <0.05). Additionally, fully independent individuals exhibited significantly higher scores in both the "Medication Adherence Motivation" subdimension and the total MMAS scores based on physical dependency status compared to their counterparts ($p<0.001$ and $p = 0.002$) (Table 3). The scores for the "Material Deprivation" and "Transportation-Financial" subdimensions, along with the total SESE scores, were also higher among individuals who received assistance with their medication than among those who did not (all had p-value <0.05). Furthermore, individuals who took their medication independently had higher scores in both the "Medication Adherence Motivation" subdimension and total MMAS scores compared to others ($p<0.001$ and $p<0.001$) (Table 3).

The total SESE score was higher in individuals who were older, female, illiterate, fully or partially dependent, living with children or relatives, taking medication with assistance, and lacking friends compared to others (all $p <0.001$). The total MMAS score was higher in individuals with no friends, fullsemi-addicts, and illiterates compared to others (all $p <0.05$).

A correlation analysis was performed to investigate the association between specific sociodemographic traits of participants and their scale scores. The findings are summarized in Table 4. Theanalysis indicated a significant positive correlation between the overall SESE score and

**Table 3.** Analysis of Participants' Scale Scores Based on Selected Sociodemographic and Medical Characteristics

| Parameter (n=214) | | | | | | SESE Total | MMAS Subdimensions | | MMAS Total |
|---|---|---|---|---|---|---|---|---|---|
| | | Material Deprivation | Transportation-Financial | Environmental Exclusion | Informal Social Support | | Medication Adherence Motivation | Medication Adherence Knowledge Level | |
| | | Median (min-max) | | | | | | | |
| **Education status** | Not literate | 18 (10-34) | 18 (12-20) | 4 (4-16) | 11 (5-23) | 52 (38-88) | 1 (0-3) | 2 (0-3) 1.39± 0.110 | 3 (0-6) 2.52±0.189 |
| | Literate | 17 (9-29) | 18 (4-20) | 4 (4-14) | 10 (5-21) | 49 (24-74) | 2 (0-3) | 2 (0-3) 1.79± 0.086 | 3 (0-6) 3.32±0.153 |
| p* | | **0.006** | **0.001** | 0.269 | 0.294 | **<0.001** | **0.011** | **0.004** | **0.003** |
| **Co-habitant** | Alone or with a spouse | 16 (9-34) | 17 (4-20) | 4 (4-14) | 10 (5-23) | 48 (24-88) | 2 (0-3) | 2 (0-3) | 3 (0-6) |
| | Others | 19 (11-29) | 20 (12-20) | 4 (4-16) | 11 (5-16) | 53 (39-72) | 1 (0-3) | 2 (0-3) | 3 (0-6) |
| p* | | **<0.001** | **<0.001** | 0.944 | 0.196 | **<0.001** | **0.005** | 0.424 | 0.187 |
| **Presence of friends** | Yes | 17 (9-26) | 18 (5-20) | 4 (4-16) | 8 (5-13) | 46 (24-72) | 2 (0-3) | 2 (0-3) | 3 (0-6) 3.30±0.178 |
| | No | 18 (9-34) | 19 (4-20) | 4 (4-16) | 13 (8-23) | 54 (30-88) | 1 (0-3) | 2 (0-3) | 3 (0-6) 2.74 ±1.63 |
| p* | | **0.005** | **0.001** | 0.238 | **<0.001** | **<0.001** | **0.003** | 0.499 | **0.022** |
| **Level of physical dependence** | Totally-partially dependent | 18 (10-32) | 20 (5-20) | 4 (4-16) | 12 (5-22) | 53 32-84) | 1 (0-3) | 2 (0-3) | 3 (0-6) 2.65±0.160 |
| | Independent | 16 (9-34) | 16 (4-20) | 4 (4-14) | 10 (5-23 | 46 (24-88) | 2 (0-3) | 2 (0-3) | 3 (0-6) 3.39±0.177 |
| p* | | **0.001** | **<0.001** | 0.842 | **0.006** | **<0.001** | **<0.001** | 0.399 | **0.002** |
| **Medication administration method** | Yourself | 16 (9-34) | 17 (4-20) | 4 (4-16) | 10 (5-23) | 48 (24-88) | 2 (0-3) | 2 (0-3) | 3 (0-6) |
| | Assisted | 19 (10-32) | 20 (8-20) | 4 (4-16) | 12 (5-21) | 54 (29-84) | 0 (0-3) | 2 (0-3) | 2 (0-6) |
| p* | | **0.001** | **<0.001** | 0.691 | 0.087 | **<0.001** | **<0.001** | 0.162 | **<0.001** |

p*: Mann-Whıtney U test, SESE: Social Exclusion Scale for the Elderly, MMAS: Morisky Medication Adherence Scale , Min: minimum, Max: maximum

age, as well as a negative correlation with the total MMAS score.

The model derived from the regression analysis of the total SESE scores is shown in Table 5). The analysis indicates that the SESE score is independently associated with the presence of friends, educational level, physical dependency status, and total MMAS score in the multiple linear regression models (all p <0.05). Conversely, the total MMAS score is independently associated with the use of crutches, lung disease, medication

**Table 4.** Correlation Analysis of Selected Sociodemographic Characteristics and Scale Scores

| n=214 | | | Age | Number of drugs | SESE Subdimensions | | | | SESE Total | MMAS Subdimensions | | MMAS Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Material Deprivation | Transportation-Financial | Environmental Exclusion | Informal Social Support | | Medication Adherence Motivation | Medication Adherence Knowledge Level | |
| **Age** | | r | 1 | | | | | | | | | |
| | | p | . | | | | | | | | | |
| **Number of drugs** | | r | -0.081 | 1 | | | | | | | | |
| | | p | 0.239 | . | | | | | | | | |
| **SESE Subdimensions** | Material Deprivation | r | 0.182 | -0.011 | 1 | | | | | | | |
| | | p | **0.008** | 0.875 | . | | | | | | | |
| | Transportation-Financial | r | 0.210 | 0.091 | 0.251 | 1 | | | | | | |
| | | p | **0.002** | 0.187 | **<0.001** | . | | | | | | |
| | Environmental Exclusion | r | 0.110 | -0.203 | 0.119 | -0.088 | 1 | | | | | |
| | | p | 0.108 | **0.003** | 0.083 | 0.201 | . | | | | | |
| | Informal SocialSupport | r | 0.024 | 0.049 | 0.337 | 0.221 | 0.164 | 1 | | | | |
| | | p | 0.732 | 0.472 | **<0.001** | **0.001** | **0.016** | . | | | | |
| **SESE Total** | | r | 0.242 | 0.032 | 0.775 | 0.586 | 0.246 | 0.669 | 1 | | | |
| | | p | **<0.001** | 0.645 | **<0.001** | **<0.001** | **<0.001** | **<0.001** | . | | | |
| **MMAS Subdimensions** | Medication Adherence Motivation | r | -0.098 | -0.026 | -0.277 | -0.355 | 0.021 | -0.290 | -0.396 | 1 | | |
| | | p | 0.152 | 0.701 | **<0.001** | **<0.001** | 0.765 | **<0.001** | **<0.001** | . | | |
| | Medication Adherence Knowledge Level | r | -0.007 | -0.114 | -0.155 | -0.193 | 0.069 | -0.110 | -0.142 | 0.430 | 1 | |
| | | p | 0.915 | 0.097 | **0.023** | **0.005** | 0.313 | 0.109 | **0.038** | **<0.001** | . | |
| **MMAS Total** | | r | -0.060 | -0.073 | -0.243 | -0.317 | 0.045 | -0.245 | -0.318 | 0.866 | 0.815 | 1 |
| | | p | 0.382 | 0.287 | **<0.001** | **<0.001** | 0.514 | **<0.001** | **<0.001** | **<0.001** | **<0.001** | . |

p*:Spearman Correlation Test, r:Spearman Correlation rate

**Table 5.** Linear Regression Analysis of the Total Scores of the SESE and MMAS with Sociodemographic and Other Factors

| Parameter | β | (%95 CI) | | t | p |
|---|---|---|---|---|---|
| | | Lower Bound | Upper Bound | | |
| **SESE Total Score** | | | | | |
| **Age** | 0.230 | -0.028 | 0.488 | 1.763 | 0.080 |
| **Sex** | 2.051 | -0.179 | 4.281 | 1.816 | 0.071 |
| **Presence of friends** | 7.689 | 5.606 | 9.772 | 7.289 | **<0.001** |
| **Education status** | -3.301 | -4.730 | -1.872 | -4.561 | **<0.001** |
| **Level of physical dependence** | -3.364 | -5.151 | -1.577 | -3.717 | **<0.001** |
| **MMAS Total Score** | -0.744 | -1.318 | -0.170 | -2.560 | **0.011** |
| **MMAS Total Score** | | | | | |
| **Use of crutches** | 2.426 | 0.600 | 4.252 | 2.619 | **0.009** |
| **History of lung disease** | 0.574 | 0.017 | 1.132 | 2.030 | **0.044** |
| **Medication administration method** | -0.474 | -0.713 | -0.234 | -3.901 | **<0.001** |
| **SESE Total Score** | -0.049 | -0.074 | -0.024 | -3.886 | **<0.001** |

p:Linear regression analysis, β:Regression coefficient, CI: Confidence interval, t: Significance of regression coefficients,SESE: Social Exclusion Scale for the Elderly, MMAS: Morisky Medication Adherence Scale



administration method, and the total SESE score in multiple linear regression models (Table 5).

## DISCUSSION

Considering the outpatient clinic attended by individuals in the study, the scores from the SESE and MMAS scales were compared across sociodemographic characteristics.These included gender, education level, social relationships, medication assistance, physical dependency, and living arrangements. A literature review indicates limited research in our country on medication adherence and social exclusion in individuals aged 80 and older.

Our research revealed that increased social exclusion among older adults is associated with a decline in medication adherence. A 2024 study conducted in China showed that a lack of social support and feelings of loneliness negatively impacted medication adherence (11). Likewise, another study on older individuals with chronic diseases found that social exclusion reduced medication adherence (7). A Turkish study also observed that higher social support levels were linked to decreased feelings of loneliness and improved medication adherence (12).

The study revealed that as individuals aged, their level of social exclusion increased. Similar results have been reported in prior studies. A 2024 study conducted in Kazakhstan in 2024 demonstrated that the incidence of social exclusion among older adults has increased(13,14). This phenomenon can be attributed to factors like retirement, reduced economic resources, children attaining independence, physical constraints, chronic illnesses, and spousal loss.

Our study revealed that women were more prone to social exclusion compared to men. Similarly, studies conducted in Turkey and India also indicated a higher susceptibility of women to social exclusion (12,13,15). Conversely, Feng et al. found no significant differences between sexes in their study,which could be attributed to variations in age distribution among the studies (16).

The study was conducted on older individuals who reached the HAC and GOC. While the levels of social exclusion were comparable, patients from the GOC group exhibited greater medication adherence, possibly attributed to their enhanced health literacy and treatment awareness. To our knowledge, no similar study has been conducted focusing on this aspect.

By contrast, individuals lacking literacy skills experienced higher levels of social exclusion. Prior studies have also suggested that social exclusiondecreases with higher levels ofeducation (9, 11,12). This trend may be attributed to the increased social engagement of educated individuals compared to their less educated counterparts. Moreover, individuals who were fully or partially dependent exhibited greater social exclusion compared to fully independent individuals. Previous research has also shown that social exclusion increases as health deteriorates and physical mobility decreases (11, 13). This can be explained by dependent individuals' transportation and social participation challenges. In addition, individuals living alone or with a spouse had lower levels of social exclusion than those living with their children or relatives. However, previous research has indicated that social exclusion and depression are more prevalent among individuals living alone (11, 12). This difference can be explained by the individuals' need for social and economic support.

Our study revealed that individuals with friends experienced reduced levels of social exclusion. Other studies indicate that individuals with social communication skills have fewer depressive symptoms and experience less social isolation (17,18). This could be due to the social support and interaction offered by friendships.

Another crucial finding from our study is that individuals who took their medication independently

experienced lower levels of social exclusion than those who took their medication with assistance. To the best of our knowledge, this phenomenon may be attributed to physical dependency, as no comparable studies have been conducted.

There was no significant difference in medication adherence between women and men, as indicated by several studies (19,20,21). However, educational status plays a crucial role in medication adherence assessment. We demonstrated that medication adherence was lower among illiterates than among non-literates. Nonetheless, in 2024, Albadrani et al., in their study involving 421 patients, found no relationship between educational level and medication adherence (20). This discrepancy may be attributed to the fact that most participants in Albadrani's study were university graduates. It is expected that as education levels increase, health literacy also improves, leading individuals to pay more attention to their health.

One crucial discovery from our research was that medication adherence was greater among fully independent individuals compared to those who were entirely or partially dependent. Albadrani et al. in Saudi Arabia also observed a similar trend, suggesting that mobility issues could result in decreased medication adherence (20). However, other medical studies have shown no association with the previously mentioned parameters. Thesedifferencescould be attributed to the diverse degrees of dependence among the study participants. The decrease in medication adherence as physical dependence rises may be due to difficulties in obtaining medication and inconsistencies in caregiver assistance.

Additionally, we observed no differences in medication adherence based on cohabitation status. However, a 2024 study found that individuals living alone had lower medication adherence than those residing in nursing homes or under the supervision of others (20). Another study conducted in a hospital in Central Anatolia found that individuals living with their spouses and children exhibited higher medication adherence than those living alone (22). The discrepancy between our study and others may be attributed to the higher average age of the participants in our study.

Our study found that individuals with friends showed better medication adherence compared to those without friends. A 2012 study suggested that individuals with friends and social support networks have higher medication adherence (23). Medication adherence is closely associated with a support network that includes close friends providing emotional and practical assistance.

This study discovered no association between the number of medications utilized by individuals and their adherence levels. A similar outcomewas observed in a study conducted among individuals aged 65 years and older in Spain (24). Conversely, a study in Korea revealed that medication adherence declined with an increasing number of medications (25). While our data showed no correlation between the number of medications and medication adherence, it is expected that with regular use of more medications, adherence may decrease due to factors like medication fatigue and confusion among the medicines.

Our study had several limitations. First, it had a single-center design and was dependent on patient-reported data. Second, the causality between the study parameters could not be assessed because this was not a prospective design. Prospective cohort or interventional studies are needed to determine the direction of causality. Although the validity and reliability studies of the scales we used have been conducted, it should not be forgotten that self-report-based measurements may have recall bias and social desirability effects. In our study, participants' cognitive functions were not objectively and detailed evaluated. However, as stated in the "Materials and Methods" section, individuals with advanced cognitive impairment were not included in the study.Future studies

may yield more comprehensive results by using cognitive tests that also assess cognitive function.In addition to these noted limitations, focusing on an underrepresented population in geriatric research (aged 80 and over) can be viewed as a strength of our work. Another advantage of our study was that the researcher read and explained the survey questions aloud to avoid inaccurate and incomplete responses from older individuals. Furthermore, this study included geriatric clinic patients and older individuals who visited the hospital at home, allowing for a comparison of study parameters.

## CONCLUSION

This study showed that medication adherence may decrease and physical dependence may increase as social exclusion levels rise in older individuals. Social exclusion may be more pronounced among women; however, medication adherence is similar between the sexes. Individuals with friends are more likely to experience less social exclusion and demonstrate better medication adherence. Literate individuals may experience reduced social exclusion and exhibit strong medication adherence. No correlations were found between the number of medications administered and medication adherence. Individuals who lived alone or with a spouse experienced lower levels of social exclusion, with their medication adherence remainingunchanged. The level of social exclusion was consistent among patients who visited both the HAC and GOC; however, those visiting the GOC showed higher medication adherence.

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ORIGINAL ARTICLE

# GRIP STRENGTH IN GERIATRIC PATIENTS WITH LYMPHEDEMA FOLLOWING BREAST CANCER TREATMENT

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## Abstract

**Introduction:** Grip strength represents a critical, objective indicator of functional capacity in daily activities. This study sought to elucidate the impact of breast cancer-related lymphedema on grip strength and to explore the underlying factors contributing to its decline.

**Materials and method:** This is a retrospective study including patients over the age of 65 who presented to our outpatient clinic after developing lymphedema following breast cancer treatment. Hand grip strength was measured using a hand dynamometer in patients with lymphedema, and data on lymphedema stage and clinical parameters were collected.

**Results:** In older adults with lymphedema, grip strength was significantly reduced on the affected side (median: 8.0 kg [3–21]) compared to the non-affected side (median: 16.5 kg [10–29]; $p < 0.001$). Patients with more advanced stages of lymphedema were found to have lower grip strength on the affected side compared to those with earlier stages. In older adults with lymphedema, grip strength was also correlated with the subscales of quality of life and with fatigue, both considered important clinical outcomes.

**Conclusion:** Our findings highlight that lymphedema in older adults is associated with clear functional impairment, as evidenced by reduced grip strength on the affected side and a progressive decline across disease stages, underscoring the importance of early intervention to preserve hand function.

***Keywords:*** Lymphedema; Breast Neoplasms; Aged; Hand Strength.

## INTRODUCTION

Breast cancer is the second leading cause of death among women worldwide, and its incidence continues to rise globally (1, 2). Breast cancer management involves a range of therapeutic strategies, with surgical intervention remaining a cornerstone for both diagnostic clarification and treatment in the majority of cases. However, these interventions may disrupt axillary lymphatic flow, often leading to lymphedema as a common complication (3). Lymphedema is a swelling-related condition that usually affects individuals after mastectomy for breast cancer, leading to a reduced quality of life and creating a significant financial burden (4). In lymphedema, protein-rich fluid accumulates in the tissues, leading to persistent swelling and gradual structural changes (3).

Upper limb lymphedema following surgery can markedly reduce the mobility and functional capacity of the affected arm. As a result of lymphedema, patients may develop swelling, pain, and fibrosis, accompanied by restrictions in self-care, and in severe cases, long-term loss of upper limb function (5). Hand grip strength is a simple and cost-effective tool for evaluating muscular strength and has been shown to correlate with various measures of upper limb function (6). Among patients aged 40–60 with lymphedema, the difference in grip strength between their extremities was found to be greater compared to those without lymphedema (7). Considering the importance of grip strength measurements in a holistic assessment of geriatric patients, evaluating handgrip becomes particularly crucial when lymphedema—an upper extremity condition that can impair grip—is present. Grip strength is not only an indicator of upper limb function in older adults, but is also widely recognized as a reflection of overall physical strength. Furthermore, it provides valuable insights into how functional capacity may change over time (8).

Lymphedema related to breast cancer treatment may emerge shortly after surgery or even many years later, with reported cases occurring up to 11 years postoperatively (9). It remains unclear which factors contribute to the development of lymphedema in breast cancer patients following mastectomy. The primary aim of this study was to evaluate hand grip strength between the affected and non-affected upper extremities in older adults with breast cancer–related lymphedema, with consideration of the potential impact of clinical parameters such as diagnosis time, lymphedema stage, functional mobility, performance, quality of life, comorbidities, cancer stage, pain, and fatigue levels on grip strength in the affected side.

## MATERIALS AND METHOD

This retrospective study included 50 patients aged 65 years and older who visited the physical medicine and rehabilitation outpatient clinic between April 1, 2023, and April 30, 2025, and developed lymphedema during their breast cancer treatment. Demographic and clinical data, including age, disease stage, lymphedema stage, year of diagnosis, chemotherapy, radiotherapy, and hormone therapy treatments were recorded for all participants. Patients undergoing active chemotherapy or radiotherapy were not included in the study.

Hand grip strength was evaluated in kilograms using a Jamar dynamometer, with participants seated and elbows flexed at 90 degrees during the assessment. In this study, differences in hand grip strength between the affected and non-affected sides were examined, with further analysis addressing the potential impact of clinical parameters on grip strength in the affected side.

Lymphedema staging was determined according to standard clinical criteria: Stage 0 indicates normal limb appearance with impaired lymphatic transport (e.g., demonstrated by lymphoscintigraphy); Stage 1 represents early edema that subsides with limb elevation; Stage 2 is characterized by pitting edema



that does not resolve with elevation; and Stage 3 is marked by fibroadipose tissue accumulation and skin changes.

The assessment of quality of life was conducted using the culturally adapted and reliability-tested Turkish version of the EORTC QLQ-C30 (European Organisation for Research and Treatment of Cancer – Quality of Life Questionnaire Core 30), ensuring appropriateness for the target population (10). Performance status was determined using the validated Turkish versions of the Eastern Cooperative Oncology Group Performance Status (ECOG-PS) and the Karnofsky Performance Scale (KPS), which are widely applied in oncology settings (11, 12). Pain severity was measured on a 0–10 Visual Analog Scale (VAS), where higher scores indicate greater pain intensity.

Participants' comorbid conditions were evaluated using the Charlson Comorbidity Index (CCI), which is widely applied in clinical research (13). Fatigue was measured using the Checklist Individual Strength (CIS-20), which has been validated and shown to be reliable in Turkish populations as an effective tool to assess fatigue symptoms (14).

Ethical approval for this non-interventional study was granted by the Ethics Committee for Scientific Research of SBÜ Gülhane Training and Research Hospital, under decision number 2025/122, dated June 12, 2025. All procedures adhered to the ethical standards outlined in the Declaration of Helsinki and its subsequent revisions.

### Statistical analysis

Statistical analyses were conducted using IBM SPSS version 25.0 (SPSS Inc., Chicago, IL, USA). The assumption of normality was evaluated with the Shapiro-Wilk test, while homogeneity of variances was assessed with the Levene test. Descriptive statistics were presented as mean ± standard deviation and median (min–max) for continuous variables, and as frequency (%) for categorical variables. The Kruskal-Wallis test was used to compare grip strength across different lymphedema stages, with Dunn-Bonferroni post-hoc pairwise comparisons applied in cases of statistical significance. Additionally, median differences between right and left hand grip strength were evaluated using the Wilcoxon signed-rank test." And associations between variables were examined with Spearman's correlation test. A p-value of $<0.05$ was considered statistically significant.

## RESULTS

The demographic and clinical characteristics of geriatric lymphedema patients — including age, lymphedema and disease stages, and comorbid conditions — are summarized in Table 1. A history

**Table 1.** Descriptive Characteristics of Patients by Age, Lymphedema Stage, Disease Stage, and Comorbidity

| | n=50 |
|---|---|
| **Age (years) *** | 72.58 ± 9.53 |
| **Lymphedema stages** | |
| Stage 1 | 13 (26%) |
| Stage 2 | 28 (56%) |
| Stage 3 | 8 (16%) |
| **Breast Cancer Stage** | |
| Stage I | 0 (0%) |
| Stage IIA | 3 (6%) |
| Stage IIB | 4 (8%) |
| Stage IIIA | 15 (30%) |
| Stage IIIB | 11 (22%) |
| Stage IIIC | 12 (24%) |
| Stage IV | 5 (10%) |
| **Diagnosis year*** | 5.30 ± 3.95 |
| **Comorbidity** | |
| Low | 27 (54%) |
| Medium | 18 (36%) |
| High | 5 (10%) |

Descriptive statistics were shown as * mean ± SD

of radiotherapy was identified in 40 patients (80%), while 14 patients (28%) had previously received hormone therapy. Overall, 42 patients (84%) had a history of or were currently receiving hormone therapy, and in 54% of the cases, hormone therapy was ongoing at the time of evaluation. Lymphedema was observed on the left side in 26 patients (52%) and on the right side in 24 patients (48%), with all patients having right-hand dominance(15).

In older adults with lymphedema, grip strength was significantly lower on the affected side compared to the non-affected side. The median grip strength on the affected limb was 8.0 kg (range: 3–21), whereas it was 16.5 kg (range: 10–29) on the non-affected side ($p < 0.001$). This substantial difference highlights the functional impact of lymphedema on muscular performance, particularly in the upper extremities.

Quality of life was measured using the EORTC-QLQ-C30 questionnaire, which assesses functional domains such as Global Health Status (GHS/QoL), Physical Functioning (PF/QoL), Role Functioning (RF/QoL), Emotional Functioning (EF/QoL), Cognitive Functioning (CF/QoL), and Social Functioning (SF/QoL). The assessment of fatigue was conducted with the CIS-20 questionnaire, evaluating both the overall fatigue score and its distinct subscales, including subjective fatigue, concentration, motivation, and activity. Table 2 summarizes the mean and median scores for VAS, the functional domains of the EORTC-QLQ-C30, as well as the total and individual subscales of the CIS-20 questionnaire.

The correlations between the functioning subscales of the EORTC-QLQ-C30 and affected side grip strength, fatigue, functional status, and other clinical parameters are presented in Table 3. The analysis revealed a positive correlation between grip strength on the affected side and each of the functional subscales of quality of life.

Grip strength significantly differed across lymphedema stages, as shown by the Kruskal-Wallis test ($p < 0.001$). Patients in *Stage 1* demonstrated the highest grip strength, with a median of 13.0 kg (range: 10–21). In *Stage 2*, the median grip strength was 8.0 kg(range: 3–11), and it further decreased in *Stage 3* to 5.0 kg (range: 3–8). All pairwise comparisons were statistically significant,

**Table 2.** Descriptive Statistics of Clinical Assessment Parameters

| | **Functional and Symptom-Based Assessments** | | | | | | |
|---|---|---|---|---|---|---|---|
| | **VAS** | **GHS/QoL** | **PF/QoL** | **RF/QoL** | **EF/QoL** | **CF/QoL** | **SF/QoL** |
| **Mean (SD)** | 6.46 (1.69) | 63.17 (18.75) | 57.33 (17.56) | 57.33 (21.07) | 65.17 (17.87) | 70.00 (21.82) | 76.00 (16.55) |
| **Median** | 7.00 | 66.67 | 56.67 | 58.34 | 66.67 | 66.67 | 83.33 |
| **(Min-Max)** | 3.0-9.0 | 16.67-91.67 | 13.33-86.67 | 16.67-100.00 | 16.67-91.67 | 16.67-100.00 | (16.67-100.00) |
| **CIS-20** | | | | | | | |
| | **Total** | **Subjective Fatigue** | **Concentration** | **Motivation** | **Activity** | **Affected Size Grip Strength** | |
| **Mean (SD)** | 85.68 (21.39) | 33.80 (8.88) | 21.30 (5.41) | 17.06 (4.37) | 13.54 (3,64) | 8.80 (3.70) | |
| **Median** | 86.0 | 35.5 | 22.0 | 17.0 | 14.0 | 8.00 | |
| **(Min-Max)** | 39-129 | 13-51 | 10-32 | 7-26 | 6-21 | 3-21 | |

Abbreviations: VAS: Visual Analog Scale; GHS/QoL: Global Health Status / Quality of Life; PF/QoL: Physical Functioning / Quality of Life; RF/QoL: Role Functioning / Quality of Life; EF/QoL: Emotional Functioning / Quality of Life; CF/QoL: Cognitive Functioning / Quality of Life; SF/QoL: Social Functioning / Quality of Life; CIS-20: Checklist Individual Strength-20; SD: Standard Deviation.



**Table 3.** Correlations Between Functioning Subscales of the EORTC-QLQ-C30 and Affected Size Grip Strength, Fatigue, Functional Status, and Other Clinical Parameters

| Variables | Functioning Subscales EORTC-QLQ-C30 | | | | | |
|---|---|---|---|---|---|---|
| | **Global Health Status (r, p)** | **Physical Functioning (r, p)** | **Role Functioning (r, p)** | **Emotional Functioning (r, p)** | **Cognitive Functioning (r, p)** | **Social Functioning (r, p)** |
| **Age** | 0.07, 0.643 | 0.04, 0.787 | 0.11, 0.447 | 0.85, 0.559 | -0.01, 0.960 | 0.03, 0.821 |
| **Affected side grip strength** | **0.46, 0.001** | **0.30, 0.036** | **0.35, 0.014** | **0.40, 0.004** | **0.31, 0.027** | **0.48, < 0.001** |
| **Diagnosis Year** | 0.26, 0.067 | 0.12, 0.398 | 0.20, 0.172 | 0.19, 0.192 | -0.07, 0.652 | 0.12, 0.410 |
| **Lymphedema stage** | **-0.31, 0.028** | -0.16, 0.276 | -0.25, 0.084 | -0.26, 0.073 | -0.21, 0.144 | **-0.32, 0.028** |
| **CCI Result** | **-0.62, < 0.001** | **-0.45, < 0.001** | **-0.49, < 0.001** | **-0.63, < 0.001** | **-0.67, < 0.001** | **-0.62, < 0.001** |
| **ECOG-PS** | **-0.79, < 0.001** | **-0.67, < 0.001** | **-0.63 < 0.001** | **-0.71 < 0.001** | **-0.59, < 0.001** | **-0.64, < 0.001** |
| **KPS** | **0.82, < 0.001** | **0.76, < 0.001** | **0.76, < 0.001** | **0.79, < 0.001** | **0.69, < 0.001** | **0.69, < 0.001** |
| **Breast cancer stage** | **-0.73, < 0.001** | **-0.55, < 0.001** | **-0.56, < 0.001** | **-0.59, < 0.001** | **-0.50, < 0.001** | **-0.46, 0.001** |
| **VAS** | **-0.94, < 0.001** | **-0.85, < 0.001** | **-0.86, < 0.001** | **-0.85, < 0.001** | **-0.68, < 0.001** | **-0.71, < 0.001** |
| **CIS-20** | **-0.86, < 0.001** | **-0.79, < 0.001** | **-0.83, < 0.001** | **-0.78, < 0.001** | **-0.58, < 0.001** | **-0.63, < 0.001** |
| **Subjective Fatigue** | **-0,80, < 0.001** | **-0.79, < 0.001** | **-0.82, < 0.001** | **-0.81, < 0.001** | **-0.57, < 0.001** | **-0.67, < 0.001** |
| **Concentration** | **-0.72, < 0.001** | **-0.63, < 0.001** | **-0.71, < 0.001** | **-0.70, < 0.001** | **-0.55, < 0.001** | **-0.64, < 0.001** |
| **Motivation** | **-0.87, < 0.001** | **-0.73, < 0.001** | **-0.74, < 0.001** | **-0.76, < 0.001** | **-0.59, < 0.001** | **-0.64, < 0.001** |
| **Activity** | **-0.79, < 0.001** | **-0.78, < 0.001** | **-0.85, < 0.001** | **-0.71, < 0.001** | **-0.50, < 0.001** | **-0.47, < 0.001** |

Abbreviations:CCI: Charlson Comorbidity Index; ECOG-PS: Eastern Cooperative Oncology GroupPerformance Status; KPS: Karnofsky Performance Status; VAS: Visual Analog Scale; CIS-20: Checklist Individual Strength-20; EORTC-QLQ-C30: European Organisation for Research and Treatment of Cancer Quality of Life Questionnaire-C30.

Correlation coefficients (r) and p-values shown in bold represent statistically significant results ($p < 0.05$).

with $p < 0.001$ for stage 1 vs. stages 2 and 3, and $p < 0.01$ for stage 2 vs. stage 3. These findings indicate a progressive decline in handgrip strength with advancing lymphedema stage, underlining the growing impact of the condition on upper extremity function.

## DISCUSSION

Hand grip strength on the affected side was notably reduced in geriatric patients who developed lymphedema following breast cancer treatment. Research focusing on this issue in the elderly population is quite limited, highlighting the importance of these findings. Furthermore, an increase in lymphedema stage was significantly associated with a decline in grip strength, indicating a strong link between disease progression and functional deterioration.

Grip strength is considered an important indicator of overall health status in older adults. While it is often regarded as a proxy for general muscular strength, it is particularly relevant to upper extremity functions and activities (8). Grip strength not only reflects current functional capacity but also serves as a predictor of future functional status and its progression over time (8). In a study by Dodds et al., grip strength assessed during midlife in a British cohort was shown to be a significant predictor of mobility limitations and difficulties with personal care in early older age (16). In this context, our study highlights the difference in grip strength between the affected and unaffected limbs in older adults with lymphedema, offering valuable insight into potential clinical limitations that may arise as a result of this functional imbalance.

Previous research has indicated that breast cancer–related lymphedema can negatively impact not only daily functioning but also mental, emotional, social, and overall physical well-being, along with perceived quality of life (17). Building on this, our study primarily examined grip strength in lymphedema patients and found a significant reduction in the affected limbs. We also investigated the role of grip strength as a clinical indicator and its relationship to quality of life. Our findings revealed a, positive correlation between grip strength in the affected limb and all functional domains of quality of life.

Shinde et al. (18) demonstrated that grip strength progressively declined with increasing age, body mass index, and lymphedema stage in individuals aged 40 to 80 years. However, their study encompassed a broader age range and did not specifically target the geriatric population. In contrast, the present study focused specifically on individuals aged 65 and older, comparing grip strength between the affected and unaffected limbs in this geriatric population with lymphedema. It also examined how grip strength varies across different lymphedema stages, offering insight into the relationship between lymphedema progression and hand grip strength. The grip strength measurements were lowest in stage 3 and significantly differed across all pairwise comparisons of lymphedema stages. Notably, our findings provide valuable insight into the association between lymphedema stage and grip strength in the geriatric population, a topic that has received limited attention in the existing literature.

In our study, we identified correlations between affected-side grip strength and all functional subscales of quality of life. Grip strength is recognized as a useful biomarker for evaluating overall health status in older adults (8). Consequently, it stands out as a particularly valuable parameter for assessing quality of life and various health outcomes in the geriatric population.

Fatigue is a common and burdensome symptom among onco-geriatric patients, significantly compromising their quality of life (19). Around 34% of breast cancer survivors continued to experience notable fatigue even 5–10 years after their diagnosis, aligning with the prevalence rates observed within



the first 1–5 years following diagnosis (20). In elderly patients, the incidence of fatigue of any grade associated with letrozole has been reported to reach up to 45% (19). In addition to our primary objective, this study also explored the relationship between fatigue—a highly prevalent and clinically significant symptom among older adults—and quality of life through clinical parameter analyses. Notably, strong and very strong correlations were identified between fatigue scores and all functional subscales of quality of life, emphasizing the significant impact of fatigue on quality of life in this population. Assessing fatigue in patients and conducting comprehensive analyses to detect potential contributing factors at an earlier stage could help improve their quality of life.

The handheld dynamometer offers a simple, reliable, and non-invasive method for assessing grip strength, making it especially suitable for use in older adults. Its user-friendly design allows for quick application in clinical settings without causing discomfort or fatigue—an essential consideration in geriatric care. When applied in the context of lymphedema, this tool enables early detection of strength deficits that may otherwise go unnoticed. Identifying these changes in the early stages provides a critical opportunity for timely intervention, which may help prevent further functional decline and support better quality of life in aging individuals.

One of the main limitations of this study is its retrospective design, which precluded post-treatment assessments and follow-up. Additionally, the lack of standardized intervention protocols and longitudinal data limits drawing causal inferences. Future prospective observational studies incorporating both pre- and post-treatment assessments and long-term follow-up are warranted to better understand the dynamics between lymphedema, fatigue, and quality of life in geriatric patients. Such research would also help identify modifiable factors and guide more targeted, effective interventions tailored to this vulnerable population.

## CONCLUSION

This study highlights the impact of lymphedema on upper extremity function, fatigue, and quality of life in geriatric patients. The progressive decline in grip strength with advancing stage and its correlation with functional domains underscore the need for early recognition and targeted interventions. Comprehensive assessment of physical and clinical parameters may help guide more effective strategies to preserve independence and improve well-being in this vulnerable population.

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ORIGINAL ARTICLE

# ANALYSIS OF THE CORRELATION BETWEEN SLEEP QUALITY AND LONELINESS LEVELS IN GERIATRIC INDIVIDUALS

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## Abstract

**Introduction:** This study aims to investigate the correlation between sleep quality and loneliness levels in the geriatric population.

**Materials and Method:** A cross-sectional study was conducted with individuals aged 65 and older (N = 89) registered at a community health centre in Turkey. Participants completed a Descriptive Characteristics Form, the Loneliness Scale (UCLA-LS), the Standardized Mini Mental State Examination, and the Pittsburgh Sleep Quality Index (PSQI).

**Results:** The mean scores for loneliness and sleep quality were 46.09 ± 9.15 and 7.47 ± 3.12, respectively. A moderate positive correlation was found between loneliness scores and the components of Subjective Sleep Quality, Sleep Latency, Sleep Disturbance, Sleep Medication Use, and total PSQI ($p<0.05$).

**Conclusion:** The study revealed that geriatric individuals experienced moderate levels of loneliness and reported poor sleep quality. It was also found that the more loneliness they felt, the worse their sleep quality.

***Keywords:*** Aged; Sleep; Loneliness.

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## INTRODUCTION

With the advances in healthcare and technological developments, the increase in the average life expectancy in many countries around the world, has increased the proportion of people over the age of 65 in the population. As a natural result of this, the health and social problems of individuals in the geriatric age group are becoming more and more important (1). In geriatric individuals, the changes in sleep patterns and quality, along with the increase in the likelihood of many diseases and the use of medications as they age, lead to changes in their sleep structure. This causes geriatric individuals to face difficulties in performing activities of daily life (2). In a previous study performed by Aşiret and Çetinkayain which the sleep quality of elderly patients was evaluated, it was reported that these individuals had very poor sleep quality (3). In another study performed on geriatric individuals in Turkiye, it was found that elderly participants woke up very often at night and that this negatively affected their sleep quality (4). The results of many studies performed on the sleep quality of geriatric individuals in the world support the above results, and it has been determined that most geriatric individuals have sleep problems and their sleep quality levels are low (5-7).As aging progresses, older adults often shift from active roles to more passive ones and gradually withdraw from professional, social, and cultural environments. This transition can lead to increased isolation, reduced communication with others, and a heightened sense of loneliness(8,9).

One of the groups that has important roles in the care of geriatric individuals and is interested in the care of these individuals is nurses, who provide care to elderly participants in nursing homes, primary care centers, and psychiatric wards (10). Identifying the relationship between sleep quality and loneliness in the elderly is crucial, as addressing both issues together can support nursing care and medical interventions. Psychiatric nurses should be equipped to recognize and assess these problems, which can help enhance the quality of life and overall health of geriatric individuals. The researcher evaluated the correlation between sleep quality and loneliness levels of geriatric individuals.

### Research Question:

1. Is there a relationship between sleep quality and loneliness levels in older individuals?

## MATERIALS AND METHOD

### Design

The study used a descriptive cross-sectional fashion and looked at 89 people aged 65 and up who were registered at a Community Healthcare center in Elazığ between October 2024 and March 2025.

### Sample and Participants

To determine the sample size, the required sample size was calculated based on statistical techniques appropriate to the research question (Is there a relationship between sleep quality and loneliness levels in older individuals?). The required sample size for the study was calculated using correlation analysis using the G*Power 3.1.9.7 package program. The required sample size was found to be 84 (11), with a medium effect size (0.3), $\beta$=0.80, and $\alpha$=0.05. Thanks to the researcher's efforts, 89 elderly participants participated in the study. Computer-assisted simple random sampling was used to determine the participants.

### Inclusion Criteria

- A Standardized Mini Mental Test score of 24 and above
- Being open to communication and collaboration
- Volunteering to participate in the study



**Exclusion Criteria**

- Having a communication problem
- Having a psychiatric disease

**Data Collection Tools**

The Descriptive Characteristics Form, the Standardized Mini Mental Test, UCLA-LS, and PSQI were employed to collect the data.

**Descriptive Characteristics Form**

The form had 10 questions prepared by the researcher by scanning the literature, including age, sex, marital, educational and employment status, chronic disease, regular medication use, sleep quality, who you live with, and smoking habit.

***Standardized Mini-Mental Test***

Developed by Folstein et al. (1975), the original test, and the one developed by Molloy and Standish (1997) are easy to apply and provide data about the degree of cognitive impairment (12, 13). The validity-reliability of the SMMT was performed by Gülgen et al. in our country in 2002 .Gülgen et al.'s study reported that the threshold value of the scale was 23/24 with a sensitivity of 0.91, a specificity of 0.95, and high reliability between examiners (Pearson coefficient: 0.99, Kappa: 0.92) (14).

***UCLA-LS***

Russell, Peplau, and Ferguson (1978) developed the UCLA Loneliness Scale to measure the loneliness levels of individuals (15). The validity-reliability study of this scale in Turkish was performed by Demir (16), and it was reported that it was suitable for Turkiye. The internal consistency analyses were calculated on a total of 72 people, and the Cronbach $\alpha$ was calculated as .96in the study.

***PSQI***

A self-report measure called the PSQI is used to assess sleep disruption and quality over a one-month period. The PSQI was created by Buysse et al. in 1989 and has demonstrated sufficient validity, test-retest reliability, and internal consistency (17). Ağargün, Kara, and Anlar evaluated the validity-reliability of the index in our nation and concluded that it was appropriate for Turkish society. It was discovered that the Cronbach's $\alpha$ was 0.80. Each item is evaluated on a 0-3 scale, and the sum of the 7 component scores constitutes the total PSQI score. The total score has a value between 0-21 and higher scores indicate poor sleep quality (PSQI $\leq$5 = good sleep quality and PSQI >5 = poor sleep quality (18).

**Data Collection**

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

**Data Analysis**

Cronbach's $\alpha$ was employed to see the internal consistency. Normality distributions were examined by Skewness-Kurtosis values. The data were given with percentage frequency, mean scores, and standard deviation values. The Independent Groups T-Test was employed to compare the mean scores of two independent groups, and the One-Way Anova Test was employed to compare the mean scores of three or more independent groups. The Pearson Correlation Analysis was employed to determine relational inferences. Effect sizes were given with the Partial Eta Squared Value and the Cohen's d-Value. Analyses were made with IBM SPSS 25.

### Ethical Aspects of the Study

Health Sciences Non-Interventional Clinical Research Ethics Committee of Inonu University approved the study (22-10-2024,2024/6498).

## RESULTS

It was found that 61.8% of the elderly were between the ages of 65-68, 62.9% were women, 77.5% were married, 36% were primary school graduates, 71.9% were unemployed, 52.8% did not have any chronic disease, 75.3% did not smoke, 52.8% did not use regular medication, 44.9% had moderate sleep quality, and 52.8% lived with their spouses (Table 1).

No statistically significant differences were found between age, sex, marital, educational, employment, chronic disease, and smoking status, regular medication use, sleep quality level, and who they lived with and the average score of the PSQI (Table 2).

No statistically significant differences were found between the variables of age, gender, marital, educational, employment, chronic disease, and smoking status, regular medication use, sleep quality level, living with, and the UCLA-LS mean scores (Table 2).

Elderly individuals had the following mean component scores: Subjective Sleep Quality (1.29±0.76), Sleep Latency (2.01±0.67), Sleep Duration (0.30±0.71), Habitual Sleep Efficiency (0.28±0.75), Sleep Disturbance (1.75±0.73), Sleep Medication Use (0.58±0.86), and Daytime Dysfunction (1.25±0.87). The mean total PSQI score was 7.47±3.12, and the mean UCLA-LS score was 46.09±9.15 (Tablo 3).

A moderate positive correlation was found between loneliness scores and the components of Subjective Sleep Quality, Sleep Latency, Sleep Disturbance, Sleep Medication Use, and total PSQI ($p<0.05$). A weak positive correlation was observed with Daytime Dysfunction ($p<0.05$). No significant correlation was found with Sleep Duration or Habitual Sleep Efficiency ($p>0.05$) (Tablo 3).

**Table 1.** The Distribution of Elderly People Based on Sociodemographic Data (n=89)

| Characteristics | Variables | N | % |
|---|---|---|---|
| **Age** | 65-68 | 55 | 61.8 |
| | 69 and above | 34 | 38.2 |
| **Sex** | Female | 56 | 62.9 |
| | Male | 33 | 37.1 |
| **Marital status** | Married | 69 | 77.5 |
| | Single | 20 | 22.5 |
| **Education Status** | Primary education | 32 | 36.0 |
| | Secondary Education | 27 | 30.3 |
| | High school and above | 30 | 33.7 |
| **Working status** | Working | 25 | 28.1 |
| | Not working | 64 | 71.9 |
| **Chronic disease status** | Yes | 42 | 47.2 |
| | No | 47 | 52.8 |
| **Smoking status** | Yes | 22 | 24.7 |
| | No | 67 | 75.3 |
| **Regular medication use** | Yes | 42 | 47.2 |
| | No | 47 | 52.8 |
| **How does s/he evaluate sleep quality?** | Bad | 24 | 27.0 |
| | Middle | 40 | 44.9 |
| | Good | 25 | 28.1 |
| **Who does s/he live with?** | Spouse | 47 | 52.8 |
| | Children | 19 | 21.3 |
| | Other | 23 | 25.8 |



**Table 2.** The Comparison of the Scores Based on Sociodemographic Data (n=89)

| Characteristics | Variables | PSQI | | UCLA-LS | |
|---|---|---|---|---|---|
| | | Mean±SD | Test and p | Mean±SD | Test and p |
| **Age** | 65-68 | 7.20±2.82 | t=-1.045<br>p=0.299<br>d=0.228 | 46.60±9.08 | t=0.667<br>p=0.506<br>d=0.146 |
| | 69 and above | 7.91±3.56 | | 45.26±9.33 | |
| **Sex** | Female | 7.75±3.23 | t=1.096<br>p=0.276<br>d=0.240 | 45.54±7.60 | t=-0.743<br>p=0.460<br>d=0.163 |
| | Male | 7.00±2.93 | | 47.03±11.38 | |
| **Marital status** | Married | 7.59±3.13 | t=0.684<br>p=0.496<br>d=0.174 | 46.72±8.85 | t=1.219<br>p=0.226<br>d=0.310 |
| | Single | 7.05±3.14 | | 43.90±10.02 | |
| **Education Status** | Primary | 7.97±3.76 | F=0.679<br>p=0.510<br>η2=0.016 | 45.72±9.36 | F=0.091<br>p=0.913<br>η2=0.002 |
| | Secondary | 7.33±2.79 | | 45.89±9.96 | |
| | High school and above | 7.07±2.65 | | 46.67±8.41 | |
| **Working status** | Working | 6.80±2.83 | t=-1.273<br>p=0.206<br>d=0.300 | 44.40±7.31 | t=-1.091<br>p=0.278<br>d=0.267 |
| | Not working | 7.73±3.21 | | 46.75±9.74 | |
| **Chronic disease status** | Yes | 7.83±3.25 | t=1.033<br>p=0.305<br>d=0.219 | 46.36±8.72 | t=0.259<br>p=0.796<br>d=0.055 |
| | No | 7.15±3.01 | | 45.85±9.60 | |
| **Smoking status** | Yes | 7.14±2.83 | t=-0.579<br>p=0.564<br>d=0.142 | 48.14±8.17 | t=1.213<br>p=0.228<br>d=0.298 |
| | No | 7.58±3.22 | | 45.42±9.40 | |
| **Regular medication use** | Yes | 7.83±3.25 | t=1.033<br>p=0.305<br>d=0.219 | 46.36±8.72 | t=0.259<br>p=0.796<br>d=0.055 |
| | No | 7.15±3.01 | | 45.85±9.60 | |
| **How does s/he evaluate sleep quality?** | Bad | 8.25±3.49 | F=1.869<br>p=0.161<br>η2=0.042 | 46.92±9.86 | F=0.192<br>p=0.825<br>η2=0.004 |
| | Middle | 7.58±2.56 | | 46.10±9.18 | |
| | Good | 6.56±3.45 | | 45.28±8.68 | |
| **Who does s/he live with?** | Spouse | 8.04±2.99 | F=1.731<br>p=0.183<br>η2=0.039 | 46.70±8.82 | F=0.597<br>p=0.553<br>η2=0.014 |
| | Children | 6.68±3.25 | | 44.05±10.41 | |
| | Other | 6.96±3.18 | | 46.52±8.87 | |

UCLA-LS: Loneliness Scale, PSQI: Pittsburgh Sleep Quality Index

**Table 3.** The Mean Scale Scores of the Elderly and Results of Correlation Analysis Regarding Mean Scores (N=89)

| | X ±SD (Min-Max) | | UCLA-LS Loneliness Inventory |
|---|---|---|---|
| **Subjective Sleep Quality** | 1.29±0.76 (0-3) | R | **0.387**** |
| | | P | **0.001** |
| **Sleep Latency** | 2.01±0.67 (1-3) | R | **0.326**** |
| | | P | **0.002** |
| **Sleep Duration** | 0.30±0.71 (0-3) | R | 0.060 |
| | | P | 0.575 |
| **Habitual Sleep Activity** | 0.28±0.75 (0-3) | R | -0.149 |
| | | P | 0.164 |
| **Sleep Disorder** | 1.75±0.73 (0-3) | R | **0.436**** |
| | | P | **0.000** |
| **Sleeping Pills Use** | 0.58±0.86 (0-3) | R | **0.353**** |
| | | P | **0.001** |
| **Daytime Dysfunction** | 1.25±0.87 (0-3) | R | **0.241*** |
| | | P | **0.023** |
| **PSQI** | 7.47±3.12 (2-17) | R | **0.408**** |
| | | P | **0.000** |
| **UCLA-LS** | 46.09±9.15 (29.00-71.00) | R | 1 |
| | | P | |

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

UCLA-LS: Loneliness Scale, PSQI: Pittsburgh Sleep Quality Index

## DISCUSSION

In the study, it was found that the score geriatric individualsreceived on the loneliness scalewas 45.85±8.76. Therefore, it can be argued that the geriatric individuals participating in the study felt moderate loneliness as a result of the negative stimuli they encountered while continuing their lives. There are many studies in the literature supporting this result in geriatric individuals (9, 19, 20). It can be argued that the results are similar to the studies performed on the loneliness levels of geriatric individuals. A possible explanation for the moderate loneliness levels observed in geriatric individuals can be considered to be that the place where they live plays active roles in social activities and culture, and the time spent by elderly participants with their children and friends is not as much as expected. The reason for this might be that elderly participants came to the place where the study was performed alone during the data collection process and did not want to socialize. The fact that geriatric individuals feel moderate loneliness during the aging process has been shown in many studies, and that many variables affect this (8, 9, 19). In this study performed on geriatric individuals, unlike the literature data, there were no statistically significant differences between loneliness and age, sex, marital, educational, employment, chronic disease, and smoking status, regular medication use, sleep quality level and who they live with.

Many studies have shown that loneliness in the elderly is associated with sociodemographic factors such as sex, age, marital status, lifestyle, education, income, health behaviors, health status, and sleep quality (20,21). The differences between this study's findings and the literature may stem from factors such as the small sample size, participants' reluctance to express feelings during face-to-face interviews, the subjective nature of loneliness, and regional or cultural influences on its perception.

Based on the results obtained from this study, the mean score of sleep quality of geriatric individuals was 7.47±3.12. In this context, the fact that the total sleep quality score was greater than 5 indicates that the geriatric individuals in our study had poor sleep quality. In a previous study investigating the sleep quality of geriatric individuals in Portugal, it was observed that the majority of geriatric individuals had poor sleep quality (2). In a study evaluating sleep quality and its sub-dimensions among elderly nursing home residents in Turkiye,similar results were found with our study (10). In a cross-sectional study performed in China on the sleep quality of the elderly, it was reported that the sleep quality of the



participants was poor (22). It is seen that the results obtained from this study provide data consistent with other studies performed on the sleep quality of geriatric individuals. The possible reason for the poor sleep quality observed in geriatric individuals may be the physiological and hormonal changes observed in elderly participants because of aging, deterioration in body functions, chronic diseases and the use of various drugs related to this, lifestyle, loneliness, social isolation and environmental factors, which may be the effect of many factors.This study found no statistically significant relationship between sleep quality and sociodemographic factors such as age, sex, marital status, education, employment, chronic illness, smoking, regular medication use, sleep quality level, or cohabitation (6,7). While some studies in the literature support these findings, showing no association between sleep quality and most sociodemographic variables, others have reported significant correlations (1,5). The reason for this might be the insufficient sample size, the fact that stronger factors affecting sleep quality were not included in the analyses, the fact that PSQI is a subjective scale, the possibility of measurement errors, or the presence of uncontrolled variables.As can be seen, the literature provides different data on demographic characteristics and sleep quality levels. It can be argued that theresults contribute to the limited literature on sleep quality in elderly participants and the factors affecting it.

A moderate positive correlation was found between loneliness levels and subjective sleep quality, sleep latency, sleep disturbance, sleeping pill use, and overall PSQI scores, while a weak positive correlation was observed with daytime dysfunction ($p<0.05$). This relationship may stem from the psychological and physiological impacts of loneliness, which is linked to conditions such as depression and anxiety, contributing to delayed sleep onset and disrupted sleep patterns, thereby lowering overall sleep quality (8). In a population-based cohort study performed in the USA to investigate the correlation between social isolation and loneliness and the onset of insomnia symptoms among middle-aged and older adults, it was reported that social isolation might negatively affect the daily routines of older individuals, making it difficult for them to establish regular sleep habits (19).A cross-sectional study examining social isolation and sleep in the elderly found that reduced social interaction negatively impacts emotional well-being, leading to poorer sleep quality. Current research supports that loneliness affects sleep through both psychological and social pathways, showing a significant relationship between the two. The findings of this study align with existing literature on sleep quality in older adults (10).

The results obtained in the current study indicate that loneliness is associated with sleep quality in elderly individuals. This result, consistent with the existing literature data, supports the significant effect of loneliness on sleep quality.A study performed on the relationships between loneliness and social isolation and actigraph and self-reported sleep quality in a national sample of older adults found significant relationships between loneliness levels and sleep quality in these individuals (23).Recent studies also report a significant correlation between loneliness and sleep quality. For example, a systematic review and meta-analysis study that revealed a correlation between loneliness and sleep quality in older adults found that older individuals who were lonely were 1.75 times more likely to have poor sleep quality, and emphasized the strong correlation between these two variables (20). Similarly, a cross-sectional study in Shandong Province, China, reported significant correlations between loneliness and sleep quality, and an increase in loneliness negatively affected sleep quality (24). Another study performed on elderly participants with complex needs found that loneliness and social isolation were associated with sleep problems, and that this effect of loneliness on sleep contributed to inadequate sleep (25). These findings confirm that loneliness significantly impacts the sleep quality of older adults and

align with previous research. Studies indicate that the relationship between loneliness and sleep is complex and influenced by multiple factors. Both are key health concerns in the elderly, and reducing loneliness may help improve sleep. Physical health, social support, and psychological factors are central to this relationship, highlighting the need for holistic strategies to promote better sleep and overall well-being.

## CONCLUSION

The findings of this study indicate that exposure to negative environmental and psychosocial stimuli throughout life leads to moderate loneliness and poor sleep quality in geriatric individuals. Furthermore, a moderately positive and significant relationship was found between individuals' loneliness levels and their sleep quality. These results suggest that increased feelings of loneliness have a negative effect on sleep quality, and that sleep problems can intensify individuals' experiences of social isolation and emotional deprivation. To improve the quality of life of geriatric individuals, it is clear that social support mechanisms to address loneliness should be strengthened, as well as interventions to promote healthy sleep. In this context, the development of holistic approaches that are sensitive to the psycho-social needs of these individuals can contribute to both the reduction of feelings of loneliness and the improvement of sleep quality.

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ORIGINAL ARTICLE

# PROGNOSTIC EVALUATION OF GERIATRIC NUTRITIONAL RISK INDEX IN GERIATRIC PATIENTS WITH HEAD AND NECK CANCER

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## Abstract

**Introduction:** The aim of this study is to evaluate the prognostic effect of Geriatric Nutritional Index screening performed before oncological treatments in geriatric age group locally advanced head and neck cancer patients.

**Materials and Method:** Eighty-two patients diagnosed at geriatric age between January 2016 and November 2024 were included in the study. All patients had locally advanced disease (Stage 3 and Stage 4 disease). Age, tumor diameter, body mass index, Geriatric Nutritional Index, neutrophil-lymphocyte ratio , platelet-lymphocyte ratio , c-reactive protein, hemoglobin, lactate dehydrogenase, and primary tumor standardized uptake value maximum (pSUVmax) numerical variables were analyzed. Geriatric Nutritional Index was divided into four subgroups; patients with> 98 were considered as no risk for malnutrition, patients with≤ 98 and ≥ 92 were considered as mild risk, patients with< 92 and ≥ 82 considered as moderate risk and patients with< 82 considered as high risk.

**Results:** The median overall survival of the patients was 16.5 months. The median overall survival of patients with severe-risk Geriatric Nutritional Index was 5 months, while the median overall survival of patients with no-risk group was 44 months (p=0.067). In multivariate Coxregression analysis Geriatric Nutritional Index was identified as the single factor independently affecting survival (p: 0.032).

**Conclusion:** Geriatric Nutritional Index gave a comparable result with clinical and laboratory parameters known to have an effect on prognosis. Especially in geriatric patients, who are a group vulnerable to neglect in terms of treatment, a practical evaluation and Geriatric Nutritional Index calculation before oncological process planning may be guiding in terms of creating a survival prediction and deciding on the treatment process.

***Keywords:*** Geriatrics; Head and Neck Neoplasms; Nutrition Assessment; Mortality; Aged.

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## INTRODUCTION

Head and neck cancers account for approximately 3% of all cancer types but are associated with high mortality rates (1). Globally, an estimated 878,000 new cases are diagnosed each year, with annual fatalities reaching up to 444,000 (2). Despite advances in treatment modalities, the global 5-year survival rate remains around 50% (3). These cancers, which originate from the epithelium of the upper aerodigestive tract, are distributed across various anatomical sites, including the pharynx, larynx, nasal cavity, oral cavity, salivary glands, and paranasal sinuses. Due to both tumor localization and treatment-related complications following surgery or oncologic therapies, patients experience symptoms such as dysphagia, odynophagia, dysgeusia, and xerostomia, factors that contribute to a higher risk of malnutrition compared to other cancer types (4). Malnutrition-related mortality across all cancer types can reach up to 20% (1). This risk is particularly pronounced in the geriatric population, who are often frail and burdened with multiple comorbidities, making them more vulnerable to cachexia.

The European Society for Clinical Nutrition and Metabolism (ESPEN) recommends that nutritional screening be conducted for all cancer patients, including those diagnosed at early stages (1). Nutritional support initiated at the beginning of treatment and maintained throughout has been shown not only to improve quality of life but also to reduce treatment-related toxicity and lower the risk of mortality (5). While body mass index (BMI) is a commonly used and well-known parameter for nutritional screening, its standalone diagnostic utility is limited (6). Parameters that reflect both metabolic processes and body composition, rather than relying solely on height and weight, provide more accurate assessments. Accordingly, several nutritional screening tools have been developed, including the Nutritional Risk Index (NRI), Global Leadership Initiative on Malnutrition (GLIM) criteria, Geriatric Nutritional Risk Index (GNRI), and Prognostic Nutritional Index (PNI). This risk index, specifically defined for the geriatric age group, was first identified by Bouillanne O, et al. and colleagues as predictive of mortality and morbidity in a prospective study of elderly hospitalized patients(7).The GNRI, frequently used in geriatric populations, has been identified in several studies as a significant prognostic factor in patients with head and neck cancers, helping predict postoperative complications, survival outcomes, and treatment-related adverse effects (8–11). However, most of these studies involve heterogeneous patient populations with respect to age, and only a few have specifically targeted geriatric cohorts. One of these studies included preoperative evaluation in patients with oral squamous cell carcinoma and the other included pretreatment evaluation in patients with locally advanced head and neck cancer (LAHNC) treated with a tri-weekly cisplatin protocol(12,13). Demonstrating its prognostic impact in the elderly oncological patient group, those diagnosed with head and neck cancer, which can be considered the most nutritionally vulnerable, is invaluable for this fragile patient group, which is often confused about treatment approaches, as supported by these studies. By incorporating both serum albumin levels and the ratio of actual to ideal body weight, the GNRI offers a practical yet comprehensive method for assessing malnutrition.

In our study, we investigated the impact of GNRI assessment on survival before adjuvant or definitive oncological treatment in geriatric patients with LAHNC. We also compared it with clinical factors known to influence disease prognosis, including body mass index, neutrophil-lymphocyte ratio, platelet-lymphocyte ratio, c-reactive protein, hemoglobin, and lactate dehydrogenase.

## MATERIALS AND METHOD

### Research Protocol

91 patients aged 65 years and older who had been diagnosed with LAHNC at our institution between January 2016 and November 2024 were included

in the study. Patients were excluded if they lacked laboratory data, had no pathological diagnosis, were younger than 65, or had incomplete follow-up information. The study group comprised patients with squamous cell carcinoma located in the oral cavity, HPV-negative oropharynx, EBV-negative nasopharynx, hypopharynx, and larynx. Patients with EBV-positive nasopharyngeal carcinoma, HPV-positive oropharyngeal carcinoma, cervical esophageal carcinoma, stage I and stage II disease, and non-squamous cell carcinoma pathologies were excluded (Figure 1). Pre-treatment laboratory parameters were reviewed to calculate the GNRI, neutrophil-to-lymphocyte ratio (NLR), and platelet-to-lymphocyte ratio (PLR). Other laboratory values assessed included C-reactive protein (CRP), hemoglobin, lactate dehydrogenase (LDH), and albumin. Additional variables analyzed were age, sex, tumor size, T stage, N stage, TNM stage (AJCC 8$^{th}$ edition), number of metastatic lymph nodes, BMI, radiotherapy history, radiotherapy intent (definitive, adjuvant, palliative), and history of chemotherapy.

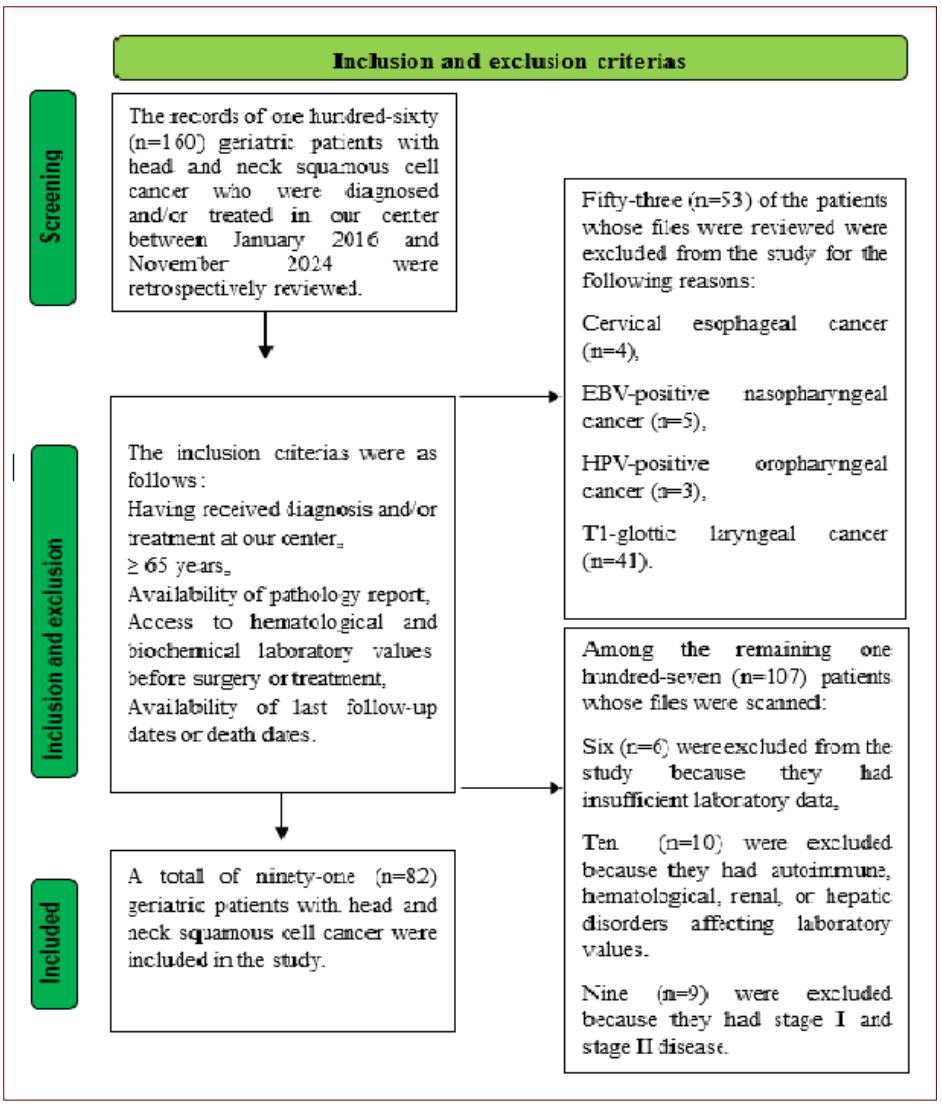



**Figure 1.** Inclusion and exclusion criterias

The steps of inclusion and exclusion from the study are shown in the flow diagram.



*The GNRI was calculated using the following formula:*

GNRI = (1.489 × albumin [g/dL]) + (41.7 × actual body weight / ideal body weight) (14). Ideal body weight (Wlo) was determined according to the Lorentz formula.

Geriatric Nutritional Index was divided into four subgroups;

patients with> 98 were considered as no risk for malnutrition,

patients with ≤ 98 and ≥ 92 were considered as mild risk,

patients with < 92 and ≥ 82 considered as moderate risk,

patients with < 82 considered as high risk.

### Ethics Committee Approval

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the local ethics committee (Kayseri City Education and Research Hospital-Date/Number:25.03.2025 / 379).

### Statistical Analysis

Power analysis was used to calculate the target sample size. Receiver operating characteristic (ROC) analysis was conducted to determine the cut-off values for numerical variables (age, tumor size, albumin, hemoglobin, LDH, CRP, NLR, PLR, BMI).

IBM SPSS version 21 (SPSS Inc., Chicago, IL, USA) was used for data analysis. Results are presented as frequencies, percentages, and medians (min–max). The Shapiro-Wilk test, along with histograms and Q-Q plots, was used to assess normality. Between-group comparisons were made using chi-square tests. Spearman's correlation test was used to analyze relationships between variables. Kaplan–Meier estimation and Cox regression methods were employed to assess and compare overall survival. Hazard ratios were calculated using Cox regression analysis with 95% confidence intervals. A p-value <0.05 was considered statistically significant.

## RESULTS

The distribution of diagnoses among the 82 patients aged 65 years and older was as follows: 11 nasopharyngeal (12.2%), 5 oropharyngeal (6.1%), 4 hypopharyngeal (4.9%), 51 laryngeal (56.1%), and 20 oral cavity (20.7%) cancers. The cohort included 75 male (91.5%) and 7 female (8.5%) patients. The median overall survival (mOS) was 16.5 months. The median age at diagnosis was 70 years (range: 65–87). Lymph node involvement was observed in 49 patients (59.8%)and most of them (29.3%) had more than 4 positive lymph nodes. The distribution of clinical stages was: stage III – 34 (41.5%), and stage IV – 48 (58.5%) (Table 1).

**Table 1.** Patient's clinical, tumoral, and laboratory characteristics

| Variables | Number (n=82) |
|---|---|
| **Gender** | |
| Female | 7 (8.5%) |
| Male | 75 (91.5%) |
| **Age (years), median (range)** | 70 (65-87) |
| <69.5 | 40 (48.8%) |
| ≥69.5 | 42 (51.2%) |
| **Anatomic location** | |
| Laryngeal | 46 (56.1%) |
| **Oral cavity** | 17 (20.7%) |
| **Nasopharyngeal** | 10 (12.2%) |
| **Oropharyngeal** | 5 (6.1%) |
| Hypopharyngeal | 4 (4.9%) |

| **Table 1.** Continued... | |
|---|---|
| **Tumor size (cm), median (range)** | 3 (0.2-10) |
| <2.95 | 40 (48.8%) |
| ≥2.95 | 42 (51.2%) |
| **T stage** | |
| T1 | 13 (15.9%) |
| T2 | 12 (15.9%) |
| T3 | 27 (32.9%) |
| T4 | 29 (35.4%) |
| **N stage** | |
| N0 | 29 (35.4%) |
| N1 | 25 (30.5%) |
| N2 | 17 (20.7%) |
| N3 | 11 (13.4%) |
| **TNM stage** | |
| Stage III | 34 (41.5%) |
| Stage IV | 48 (58.5%) |
| **Operation history** | |
| Yes | 52 (63.4%) |
| No | 30 (36.6%) |
| **Lymph nodal involvement** | |
| Yes | 33 (40.2%) |
| No | 49 (59.8%) |
| **Primary tumor SUVmax value, median (range)** | 13.59 (2.71-38.80) |
| <14.125 | 31 (37.8%) |
| ≥14.125 | 28 (34.1%) |
| No PET-CT scanning | 23 (28%) |
| **GNRI, median (range)** | 103 (72-118) |
| > 98, no risk | 51 (62.2%) |
| ≤ 98, ≥ 92, mild risk | 11 (13.4%) |
| < 92, ≥ 82, moderate risk | 15 (18.3%) |
| < 82, severe risk | 5 (6.1%) |
| **BMI (kg/m$^2$), median (range)** | 23.88 (14.04-47.74) |
| ≥ 24.04 | 38 (46.3%) |
| <24.04 | 44 (53.7%) |
| **LDH (U/L), median (range)** | 213 (93-478) |
| <211 | 40 (48.8%) |
| ≥211 | 42 (51.2%) |
| **CRP (mg/dL), median (range)** | 8.35 (0.2-198.2) |
| <8.05 | 40 (48.8%) |
| ≥8.05 | 42 (51.2%) |
| **NLR, median (range)** | 3.13 (0.87-22.23) |
| <3.13 | 41 (50%) |
| ≥3.13 | 41 (50%) |
| **PLR, median (range)** | 143.31(21.74-593.42) |
| <143.31 | 41 (50%) |
| ≥143.31 | 41 (50%) |



| **Table 1.** Continued... | |
|---|---|
| **Hemoglobin (g/dL), median (range)**<br>≥14.05<br><14.05 | 14 (8.8-17.7)<br>40 (48.8%)<br>42 (51.2%) |
| **Albumin (g/dL), median (range)**<br>≥4.15<br>< 4.15 | 4.15 (2.51-5.1)<br>38 (46.3%)<br>44 (53.7%) |
| **RT history**<br>Yes<br>No | <br>79 (96.3%)<br>3 (3.7%) |
| **RT intent**<br>Definitive<br>Adjuvant<br>Palliative<br>No RT | <br>28 (34.1%)<br>48 (58.5%)<br>3 (3.7%)<br>3 (3.7%) |
| **CT history**<br>Yes<br>No | <br>58 (70.7%)<br>24 (29.3%) |
| **PFS event**<br>Yes<br>No | <br>53 (64.6%)<br>29 (35.4%) |
| **Survival status**<br>Survi<br>Ex | <br>38 (46.3%)<br>44 (53.7%) |

Abbreviations: SUVmax; Standardized uptake value maximum, PET-CT; Positron emission tomography, GNRI;Geriatric nutritional risk index, BMI; Body mass index, LDH; Lactate dehydrogenase, CRP; C reactive protein, NLR; Neuthrophil to lymphocyteratio, PLR; Platelet to lymphocyte ratio, RT; Radiotherapy, CT; Chemotherapy, PFS; Progression-free survival

Based on ROC analysis, the determined cut-off values for numerical variables were as follows: age 69.5, tumor diameter 2.95 cm, albumin 41.5 g/L, BMI 24.04, LDH 211, CRP 8.05, NLR 3.13, PLR 143.31, primary tumor standardized uptake value maximum (pSUVmax) 14.125, and hemoglobin 14.05 g/dL. Patients were primarily categorized into four GNRI groups: no risk (>98, n=51), mild risk (92–98, n=11), moderate risk (82–92, n=15), and severe risk (<82, n=5).

In the survival analysis, the mOS for the GNRI-based groups was 44 months in the no-risk group and 5 months in the severe-risk group (Figure 2). For BMI, the mOS was 36 months in patients with BMI <24.04 and 33 months in those with BMI ≥24.04 (p = 0.917). For CRP, the mOS was 50 months in patients with CRP <8.05, compared to 25 months in those with CRP ≥8.05(p = 0.111). The mOS was 44 months for NLR <3.13 and 25 months for NLR ≥3.13(p = 0.232). For PLR, the mOS was 48 months for PLR <143.31 and 27 months for PLR ≥143.31 (p = 0.639). In patients with hemoglobin ≥14.05 g/dL and <14.05 g/dL, the mOS was 40 and 33 months, respectively (p = 0.539).In albumin evaluation, mOS was 48 months in those with >41.5 and 27 months in those with <41.5 (p=0.107). Regarding tumor diameter, patients with tumors <2.95 cm had an mOS of 42 months versus 27 months for those with tumors ≥2.95 cm (p = 0.386).

From a clinical standpoint, patients aged <69.5 had an mOS of 44 months, while those aged ≥69.5 had an mOS of 36 months (p = 0.454). Patients who received radiotherapy (RT) had a median overall survival of 40 months, compared to 1 months in

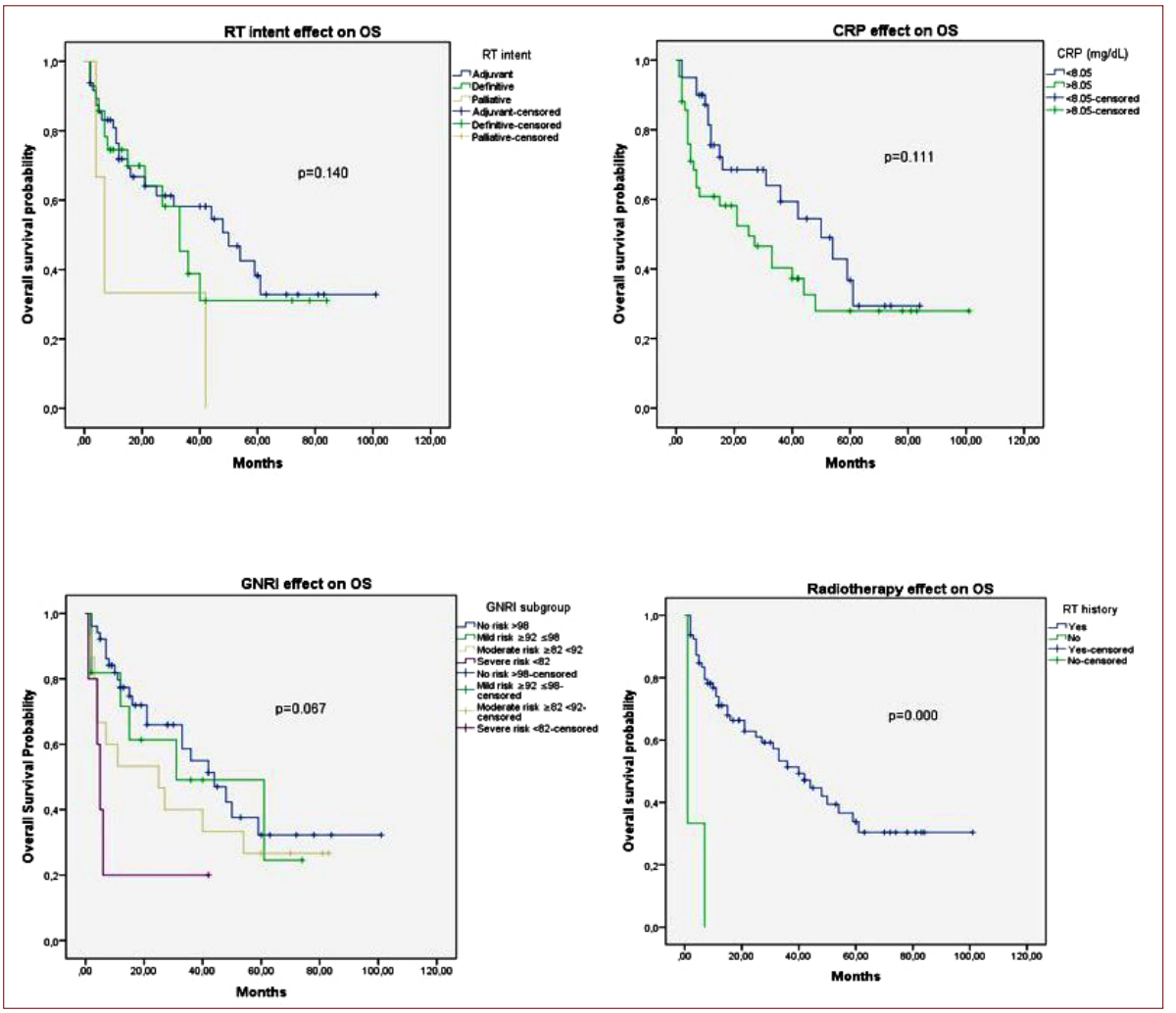



**Figure 2.**Kaplan-Meier Survival graphs

Survival graphs of laboratory parameters in terms of overall survival

those who did not receive RT (p = 0.000). However, the number of patients who did not receive RT was limited to only three, potentially introducing bias. Three of the patients who did not receive RT were stage 4, two with oropharyngeal malignant neoplasm, and one with hypopharyngeal malignant neoplasm. Two patients survived 1 month after diagnosis, while one survived 7 months. One of the patients who survived 1 month after diagnosis had stage 4 hypopharyngeal cancer and died due to respiratory distress and a fatal infectious event after diagnosis. The other patient had stage 4 oropharyngeal cancer and died due to persistent infection after diagnosis. The patient with stage 4 oropharyngeal cancer who survived 7 months refused treatment and died due to disease progression. Regarding RT intent, the mOS was 50 months for adjuvant RT, 33 months for definitive RT, and 7 months for palliative RT (p = 0.140), which is an expected result and supports the appropriateness of RT indications. In addition, stage 3 patients survived for 48 months, while stage 4 patients survived for 33 months (p=0.363).



In the univariate Cox regression analysis of factors affecting survival, GNRI was identified as the only prognostic factor that statistically significantly affected survival(Hazard Ratio(HR):3.735, %95CI: 1.273-10.964, p: 0.016) (Table 2). In the multivariate Cox regression analysis, GNRI was identified as the single significant prognostic factor (HR:1.376, %95CI: 1.027-1.843, p: 0.032) (Table 2).

**Table 2.** Evaluation of the effect of clinical and laboratory parameters on overall survival (Univariate and Multivariate Cox regression analyzes)

| **Univariate Cox regression analysis** | | | |
|---|---|---|---|
| **Variables** | **HR** | **95%CI** | ***p*** |
| **Age** | 1.252 | 0.689-2.275 | *0.460* |
| **Gender** | 1.235 | 0.382-3.991 | *0.725* |
| **TNM stage** | 1.319 | 0.720-2.416 | *0.369* |
| **Tumor size** | 1.297 | 0.715-2.351 | *0.392* |
| **Primary tumor SUVmax** | 0.844 | 0.413-1.726 | *0.642* |
| **BMI** | 1.032 | 0.570-1.867 | *0.917* |
| **Albumin** | 1.661 | 0.885-3.116 | *0.114* |
| **GNRI** | | | |
| No risk | Ref | Ref | *0.098* |
| Mild risk | 1.251 | 0.509-3.079 | *0.625* |
| Moderate risk | 1.568 | 0.759-3.239 | *0.224* |
| Severe risk | 3.735 | 1.273-10.964 | ***0.016*** |
| **LDH** | 0.936 | 0.516-1.697 | *0.827* |
| **CRP** | 1.618 | 0.885-2.957 | *0.118* |
| **NLR** | 1.384 | 0.788-2.591 | *0.239* |
| **PLR** | 1.151 | 0.635-2.087 | *0.643* |
| **Hemoglobin** | 1.202 | 0.664-2.177 | *0.544* |
| **RT history** | 11.597 | 3.337-40.302 | ***0.000*** |
| **RT intent** | | | |
| Adjuvant | Ref | Ref | *0.173* |
| Definitive | 1.243 | 0.638-2.419 | *0.523* |
| Palliative | 3.163 | 0.938-10.659 | ***0.063*** |
| **Multivarite Cox regression analysis** | | | |
| **Variables** | HR | 95%CI | *p* |
| **GNRI** | 1.376 | 1.027-1.843 | ***0.032*** |

Abbreviations: SUVmax; Standardizeduptakevaluemaximum, PET-CT; Positronemissiontomography, GNRI;Geriatricnutritional riskindex, BMI; Body massindex, LDH; Lactatedehydrogenase, CRP; C reactive protein, NLR; Neuthrophil to lymphocyteratio, PLR; Platelet to lymphocyteratio, RT; Radiotherapy.

$p < 0.05$ was accepted statistically significant and shown in bold.

## DISCUSSION

In geriatric patients with LAHNC, concerns regarding tumor location and treatment-related toxicity may limit the application of oncologic definitive approaches. In addition to patients' biological age, the presence of comorbidities often complicates clinical decision-making regarding definitive oncologic treatment. For this vulnerable age group, preliminary evaluations and prognostic scoring systems are particularly valuable in guiding oncological treatment planning (15). Several studies, regardless of age group, have demonstrated the prognostic importance of nutritional indices such as GNRI and PNI in patients with head and neck cancer (16,17). However, most of these studies have excluded geriatric patients. However, it is a well-known fact that the geriatric age group constitutes an increasing proportion of the world population and oncologic patient population (18). In elderly patients with head and neck cancer, whose treatment is inherently complex and associated with high risks, prognostic tools that are practical, time-efficient, and cost-effective are of substantial clinical value.

One of the studies conducted in this context is by Fujiwara Y et al., which evaluated the prognostic significance of GNRI in elderly patients with head and neck cancer receiving definitive chemoradiotherapy with a three-week cisplatin protocol (12). In this study, patients aged 65 and over, predominantly in stages T2-3 and N0-1-2, who were treated according to a specific regimen, were assessed. GNRI was categorized as >98 (high GNRI) and ≤98 (low GNRI). Among a total of 111 patients, 88 had high GNRI and 23 had low GNRI. Most patients had oropharyngeal, hypopharyngeal, or laryngeal cancer (HPV and EBV status were not differentiated in the cohort). In this specific cohort, factors affecting survival included stage 4 disease, N2 or higher disease, and high GNRI (p-values: 0.021, 0.026, and 0.048, respectively). In multivariate analysis, N2 or higher disease and high GNRI were identified as independent factors (HR: 4.37, 95% CI: 1.58–12.06, p=0.004; HR: 0.31, 95% CI: 0.64–4.17, p=0.029). In our study, 82 patients aged 65 and older, the all of whom were stage 3 or 4, were included. Unlike Fujiwara Y et al.'s study, our cohort predominantly consisted of patients with laryngeal cancer, and patients with HPV- and EBV-positive oropharyngeal and nasopharyngeal cancers, were excluded due to prognostic heterogeneity. Additionally, our cohort included the small number of patients who did not receive radiotherapy (3.7%). Regarding GNRI, the four-group classification was conducted. Of the total, 51 patients were in the no-risk group and 5 in the severe-risk group. While GNRI was also identified as an independent factor affecting overall survival in our study, similar to Fujiwara Y et al. Although GNRI maintained its role as an independent prognostic factor in both studies, its effect on survival was found to be stronger in our study (HR values: 0.31 vs. 1.376).

Another study was conducted by Yamahara K et al., which evaluated the predictive effects of pretherapeutic nutritional and inflammatory parameters in patients with early and advanced stage head and neck cancer (8). In this study, which included 164 patients of all ages, the primary tumor sites were larynx (46.3%), hypopharynx (24.4%), oropharynx (15.2%), oral cavity (8.5%), and nasal cavity (5.5%), with nasopharyngeal cancer excluded. In addition to GNRI, NLR, PLR, modified Glasgow Prognostic Score (mGPS), CRP/albumin ratio (CAR), hemoglobin, albumin, and BMI were analyzed. GNRI was divided into four categories: 92 patients <82 (high risk, 56.1%), 39 patients 82–92 (moderate risk, 68.3%), 25 patients 92–98 (low risk, 15.2%), and 8 patients >98 (normal, 4.9%). In univariate Cox regression analysis, factors affecting 3-year overall survival included T stage, TNM stage (early vs. advanced), hemoglobin, GNRI, PLR, NLR, mGPS, and CAR (p-values: <0.001, 0.036, <0.001, <0.001, 0.002, 0.03, 0.03, and 0.002, respectively). In multivariate Cox regression analysis, only GNRI was identified as an independent factor (normal vs. high:



HR: 0.06, 95% CI: 0.02–0.17, p<0.001; low vs. high: HR: 0.18, 95% CI: 0.06–0.52, p<0.001). The survival analyses also showed that GNRI value showed a statistically significant difference in survival in early and advanced stages, in tumor sites including larynx, oropharynx, and hypopharynx, and in treatment types involving both surgery and radiotherapy (p-values: <0.001, <0.001, <0.001, <0.05, <0.05, <0.001, and <0.001, respectively). Although our study also included a heterogeneous set of tumor sites, it exclusively focused on patients aged ≥65. In contrast to this study, only the advanced stage disease group was included in our study. Similar to this study, we also evaluated the GNRI subgroups by dividing them into four. In addition, similar to their study, we also evaluated NLR, PLR, hemoglobin and BMI values; however, none of these showed a significant impact on survival. This lack of effect may be attributed to the limited number of patients in our study and the limited age group and similar stage patients. Although mGPS and CAR were not assessed in our study, CRP, LDH, and albumin levels were analyzed. GNRI was also identified as the independent prognostic factor in our study, with a notably higher hazard ratio compared to theirs (HR values: 0.18 vs. 1.376), possibly due to the final analysis being conducted using a binary classification.

In the study by Yamagata G. et al., which investigated the predictive value of GNRI in patients with oral squamous cell carcinoma, data from a total of 155 patients were analyzed. The GNRI cut-off value was set at 98, and patients were divided into two groups: low GNRI (≤98) and high GNRI (>98) (19). In addition, PNI, BMI, and albumin values were also evaluated. As for treatment modalities, patients were grouped as surgery only, surgery + RT±CT, or RT only, and patients who did not undergo any intervention or treatment were excluded from the study. The OS rates in the high and low GNRI groups were 76.4% and 29.2%, respectively (p<0.001). In univariate Cox regression analysis, age (<70.4 vs. ≥70.4), T stage (T1–2 vs. T3–4), N stage (N0–1 vs. N2–3), TNM stage (I–II vs. III–IV), BMI (≥18.5 vs. <18.5), PNI (≥49.3 vs. <49.3), GNRI, and albumin (≥3.5 vs. <3.5) were identified as factors affecting survival (p-values: 0.023, 0.007, 0.018, 0.01, 0.004, 0.001, <0.001, and <0.001, respectively), while age, stage, and GNRI were identified as independent prognostic factors (HR: 2.184, 95% CI: 1.119–4.261, p=0.022; HR: 2.684, 95% CI: 1.457–5.367, p=0.011; HR: 4.559, 95% CI: 2.172–9.570, p<0.001). Although this study focused on a specific diagnostic cohort, the age group was heterogeneous. While the GNRI cut-off value was different from that in our study, GNRI continued to stand out as a prognostic factor with a high hazard ratio. This strong effect might be attributable to the homogeneity of the cohort in terms of diagnosis. Additionally, while numerical variables such as NLR, PLR, CRP, and LDH, which are available in our study, were not assessed in this study, the PNI, which we did not evaluate, was included. Although age is typically observed as a prognostic factor in studies including all age groups, as seen in this study, it had no effect on survival in our study. Also, categorizing the stage variable into two groups, which was not statistically significant in our study, might have contributed to the significance in theirs.

In another study conducted by Nakayama M. et al., which focused on a different outcome, the predictive role of pre-treatment GNRI values in anticipating side effects in patients with head and neck cancer receiving chemoradiotherapy was investigated (10). This study included a total of 82 patients from all age groups who received concurrent chemoradiotherapy, and patients were divided into two groups according to GNRI values: low GNRI (<98) and high GNRI (≥98). In addition, the mGPS was also analyzed. Total RT dose and cumulative CT dose were evaluated as guiding variables for side effect prediction. Striking findings regarding GNRI's effects on side effects were observed in the low GNRI group, which had significantly higher

rates of grade 3 or higher leukopenia, mucositis, and dermatitis (p-values: 0.001, 0.035, and 0.035, respectively). Regarding patient distribution, all patients in the high GNRI group had an mGPS score of zero ($p<0.001$). A statistically significant favorable distribution was also observed in favor of the high GNRI group in terms of BMI ($p<0.001$). Most N3 patients were in the low GNRI group, whereas most N0 and N1 patients were in the high GNRI group ($p=0.005$). In our study, the treatment group evaluated from a prognostic standpoint was more heterogeneous. Although our study was more homogeneous in terms of age, side effect evaluations could not be performed due to missing patient data. While our study included numerical values such as NLR, PLR, CRP, LDH, and albumin, which were not evaluated in this study, mGPS, a combined measure of CRP and albumin, was analyzed. The patient cohort consisted of laryngeal, nasopharyngeal, oropharyngeal, hypopharyngeal, oral cavity, and head and neck cancers of unknown primary origin. Except for the unknown primary group, it shows similarities with our cohort. While the dominant anatomical site in our study was the larynx, in this study, the oropharynx stood out (37%). This study, which assessed GNRI from a completely different perspective, demonstrated its predictive power not only for disease prognosis, as shown in both the literature and our study, but also for side effect predictability.

The limitations of our study include its single-center, retrospective nature; lack of side effect data, and the heterogeneity of diagnoses and treatment groups. In addition, another limitation is that the wide range in laboratory parameters such as CRP and LDH may have a negative effect on the albumin level and this may affect the results. Another potential shortcoming is the lack of consensus in the literature regarding GNRI cutoff values. Comparing our reference grouping with studies that do not use the same method may not be a sound approach. However, this is understandable given the limited number of studies available on patients diagnosed with geriatric head and neck cancer. Its original aspects are the inclusion of various numerical parameters(BMI, NLR, PLR, CRP, LDH) alongside GNRI in a specific age group, the analysis of variables such as the history of RT, and RT intent.

## CONCLUSION

GNRI appears to be a strong prognostic predictor in geriatric patients with LAHNC. In this frail and difficult-to-treat patient population, a simple and cost-effective calculation in clinical practice may offer prognostic insights, enabling the planning of oncologic treatment and early enteral nutritional support.

**Ethics Approval:** This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of Kayseri City Education and Research Hospital (25.03.2025/ 379).

**Competing Interests:** The authors have no relevant financial or non-financial interests to disclose.

**Consent to Participate:** Not applicable.

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**Author Contributions:** All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by all authors. The first draft of the manuscript was written by the corresponding author and all authors commented on previous versions of the manuscript. All authors read and approved of the final manuscript.

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CORRIGENDUM

# CORRIGENDUM: ANALYSIS OF ORAL AND MAXILLOFACIAL PATHOLOGIES AMONG A SAMPLE OF THE ELDERLY PATIENTS FROM A SINGLE INSTITUTE IN TURKEY: A RETROSPECTIVE STUDY

We realized that we had inadvertently omitted the BAP project that supported our work in the acknowledgments section of our article, "ANALYSIS OF ORAL AND MAXILLOFACIAL PATHOLOGIES AMONG A SAMPLE OF THE ELDERLY PATIENTS FROM A SINGLE INSTITUTE IN TURKEY: A RETROSPECTIVE STUDY," published in the Turkish Journal of Geriatrics, issue 2025; 28(1):39-46, doi: 10.29400/tjgeri.2025.420.

We apologize for the correction.

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**FROM THE EDITOR IN CHIEF**
*Yeşim GÖKÇE KUTSAL*

## INVITED REVIEW ARTICLE

**BEYOND THE BONE: RETHINKING SPINE SURGERY THROUGH THE LENS OF SARCOPENIA**
*İsmail Semih KESKİL, Yeşim GÖKÇE KUTSAL*

## ORIGINAL ARTICLES

**EFFECTS OF PREOPERATIVE SUPRA-INGUINAL FASCIA ILIACA BLOCK APPLIED TO PATIENTS OVER 65 YEARS OLD WITH HIP FRACTURES**
*Oya KALE, Derya GÜZELKAYA, Fatma ÖZKAN SİPAHİOĞLU, Lütfiye Fulya ESER ÇELİK, Evginar SEZER, Gülsen KESKİN, Yalım ATEŞ*

**PULSED RADIOFREQUENCY WITH TRANSFORAMINAL EPIDURAL STEROID INJECTION FOR LUMBAR DORSAL ROOT GANGLION: A RETROSPECTIVE STUDY COMPARING GERIATRIC AND YOUNGER PATIENTS WITH RADICULAR PAIN**
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## CORRIGENDUM

**CORRIGENDUM: ANALYSIS OF ORAL AND MAXILLOFACIAL PATHOLOGIES AMONG A SAMPLE OF THE ELDERLY PATIENTS FROM A SINGLE INSTITUTE IN TURKEY: A RETROSPECTIVE STUDY**
*Meltem ÖZDEN YÜCE, Emine ADALI, Gözde IŞIK, Mehmet Cemal AKAY, Ali VERAL,Muharrem Ergün DUDAK*