Editorial
Annals of Geriatric Medicine and Research as a Space of for Developing Research Ideas into Better Clinical Practices for Older Adults in Emerging Countries

Special Issue: Diabetes and Aging

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Diabetes and Muscle Dysfunction in Older Adults
Frailty and Disability in Diabetes

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Diabetic Peripheral Neuropathy as a Risk Factor for Sarcopenia
Clinical Features of Geriatric Syndromes in Older Koreans with Diabetes Mellitus

Original Articles
Handgrip Strength in the Korean Population: Normative Data and Cutoff Values
Barriers and Solutions for Improving Pain Management Practices in Acute Hospital Settings: Perspectives of Healthcare Practitioners for a Pain-Free Hospital Initiative
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Aims and Scope

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

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Editorial

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Commentary

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Hypotheses in large-scale clinical trials with high levels of evidence that affect clinical care guidelines are rarely developed from scratch. Rather, hypotheses from numerous small studies that tinker with processes from clinical experience or from modest research ideas are developed, tested, and discarded at varying stages of research and evidence levels. During these processes, some ideas attract attention from academic societies, policymakers, or industries and survive for inclusion in larger trials.

As both clinicians and researchers in an emerging country, we sometimes feel frustrated at the difficulties in initiating research on our older population. Government-based funding sources commonly require existing clinical evidence on research topics, usually from high-profile journals; however, publication in these high-profile journals from developed countries is sometimes difficult in the case of small or idea-generating studies performed specifically in older adults in emerging countries. Therefore, researchers sometimes feel that acquiring research support for understudied clinical topics is a chicken-and-egg problem. Even worse, some Asian countries evaluate researchers’ performance on the basis of their record of publication in high-impact journals, giving minimal impetus to researchers submitting their articles to journals from emerging countries. Consequently, researchers are prone to conducting studies with ideas and designs that meet the interests of the readership of journals from Western countries. This focus may decrease the clinical relevance of the research findings in their own populations.

However, the research topographies of known, known-unknown, and unknown-unknown scientific knowledge differ by country because of varying socio-demographic and cultural characteristics and care delivery systems (Fig. 1). For example, the socio-economic importance of frailty and functional impairment might be more evident in countries with high aging population ratios, whereas these issues are less obvious in countries with populations of lower age groups. With these differences, emerging nations may have to repeatedly establish clinical evidence on varying topics related to population aging that are already well-established in developed countries. Consequently, journals with population-specific readership are needed in emerging countries experiencing unprecedented demographic aging, with distinct population characteristics from those in developed countries with more established care systems for their older population. Furthermore, we need journals with editorial perspectives that support the tinkering processes of research ideas that may eventually improve clinical practices for older populations.

To meet these unmet needs, our journal has been working with contributors and readers worldwide to become an easily accessible multidisciplinary journal for geriatrics and gerontology in emerging countries experiencing population aging at an unprecedented pace. In terms of advances in academic communication, we now celebrate that our journal is being indexed in Scopus, after our inclusion in the Emerging Scientific Citation Index in 2018. Furthermore, scholars from emerging countries, including Thailand, Malaysia, Singapore, and Hong Kong, with vast research experience in the field, have joined our journal as editors.

To bolster the development of research ideas for older populations in our region, our journal is eager to receive research on population- or region-specific issues, with varying levels of evidence, including qualitative research such as narrative studies, small-scale case series, or proof-of-concept pilot studies. For example, a study...
Research frontlines
- These frontlines can vary with demographic, cultural characteristics
- Journals and academic societies can guide these frontlines for researchers

Fig. 1. Research topography for scientific knowledge.

from Japan by Hattori et al. describing cases of successful removal of percutaneous endoscopic gastrostomy tubes in patients with advanced dementia reflects unique cultural characteristics in East Asian countries regarding the importance of providing oral or enteral nutrition even to terminally frail patients. Similarly, a study from Brunei by Akbar et al. reports the perspectives of healthcare providers, including the cultural characteristics of Asian countries in terms of hierarchies among professionals and mood or pain status in less-expressive patients. Regarding the population-specific research topography of geriatrics and gerontology, we will publish more reviews and opinions to provide research perspectives, serving as signposts for planning studies. We welcome active input from varying countries, in addition to current contributions from small interest groups within the Korean Geriatrics Society.

As most countries have insufficient geriatric care workforces to serve the substantial healthcare demands of their rapidly aging populations, expanding geriatric concepts will be essential, as already observed in developed countries. To expand the concept of geriatrics to non-geriatric specialists and students, we also call for research on strategies for interprofessional geriatric education and geriatric teaching programs for medical students. Sharing of country-specific experiences and current problems in developing geriatric education systems will allow dialectic evolution of each country’s system to improve efficiency. Moreover, societies are in the processes of developing and advancing optimal care delivery systems for older adults with varying functional capacities and multimorbidity that are currently lacking in most countries. In these processes, clinicians, researchers, and policymakers can learn and brainstorm by sharing their country’s history, current situation, and plans for geriatric care. In 2018 and 2019, we received input from diverse countries, including Australia, Taiwan, and Korea. We hope to soon offer more papers on care model development in older populations.

In the next decade, most emerging countries are expected to experience increasing demands for their aging populations, with shortages of geriatric workforces and ailing healthcare systems that were designed for the 20th century. Our journal will serve as an arena for brainstorming among emerging nations worldwide to bring research ideas into practice by providing evidence in these aging populations.

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Aging and diabetes are both risk factors for functional decline or disability in older adults with diabetes. Recent studies demonstrated that the presence of diabetes significantly increases the risk of sarcopenia, frailty, and geriatric syndrome including falls, hospitalization, disability, and mortality in older adults. They have also suggested that sarcopenia, frailty, and geriatric syndrome should be categorized as a third category of complications in addition to the traditional micro- and macro-vascular complications leading to disability in older adults with diabetes. Prevention of functional decline is a crucial strategy in geriatric management. Recovery of functional independence from dependence or disability is uncommon and lengthy. Assessments of functional status and geriatric syndrome including sarcopenia or frailty should be mandatory in older adults with diabetes to promote early interventions based on physical exercise and nutrition education. This brief review discussed age-associated and diabetes-associated muscle changes and their association with functional decline.

Key Words: Skeletal muscle, Dysfunction, Diabetes mellitus, Sarcopenia, Frailty
The definition and diagnosis of sarcopenia and frailty have been described in detail previously\(^{9,14}\) and were not covered in this review.

**AGE-ASSOCIATED CHANGES IN SKELETAL MUSCLE**

Skeletal muscle has several important functions in humans, including posture, locomotion, and breathing\(^{19}\) in addition to the regulation of glucose and protein metabolism and heat production. Skeletal muscle comprises 40%–50% of total body weight and contains 50%–75% of body proteins.\(^{15}\) From a metabolic point of view, muscle mass depends on the balance between protein synthesis and breakdown; these processes are regulated by the multiple factors including nutrition, hormone, physical activity, exercise, and diseases (e.g., inflammation).\(^{14,17}\)

One of the distinctive clinical features of aging is the presence of muscle atrophy and weakness. In general, muscle mass progressively decreases after 20–30 years of age. While men have a greater muscle mass than women, the age-associated decrease in muscle mass is more rapid.\(^{18}\) The reduction of muscle mass is usually associated with decreases in muscle strength and aerobic exercise capacity. The annual rate of muscle mass decline is approximately 1%–2%, accelerates to 2%–3% per year after 60 years of age, and further increases after 75 years of age.\(^{19}\) In contrast, fat mass, especially visceral and intermuscular fat, increases. Thus, the decrease in skeletal muscle mass and increase in ectopic fat in muscles are common elements in the age-related remodeling of body composition. Muscle is a major organ of glucose metabolism; therefore, the reduction of muscle mass may cause increased insulin resistance.\(^{22-30}\) Accumulation of ectopic fat and its related adipokine in addition to mitochondrial dysfunction are other important factors leading to increased insulin resistance.\(^{31}\)

The mechanisms leading to the age-associated sarcopenia remain unclear. The proposed hypotheses include changes in muscle fiber type, apoptosis, reduced protein synthesis, hormonal changes, physical inactivity, malnutrition, and comorbidity.\(^{14,17,20}\) The combination of these factors may be responsible for age-associated sarcopenia. Changes in sarcopenic muscle include reduced myofiber size and number, particularly those of type II fibers and decreased numbers of type II fiber satellite cells resulting in a net change from type II to type I fibers.\(^{21}\) Additionally, mitochondrial density and function in myocytes are altered. Ectopic fat infiltration (myosteatosis) and alterations of neuromuscular junction also play a crucial role in the development of sarcopenia.\(^{20,22}\)

Several molecular mechanisms have been suggested in sarcopenic muscle including insulin-like growth factor 1, mammalian target of rapamycin (mTOR), myostatin/activin, and nuclear factor-kB; these complex pathways are susceptible to hormonal changes and pro-inflammatory cytokines in addition to age-associated anabolic resistance.\(^{20,22,23}\)

**DIABETES-ASSOCIATED CHANGES IN SKELETAL MUSCLE**

Bianchi and Volpato\(^{24}\) recently summarized the diabetes-related changes of muscle mass and function in epidemiological studies of different populations with T2D. Cross-sectional studies showed inconsistent results in total or leg muscle mass assessed by the dual-energy X-ray absorptiometry (DXA) or computed tomography in people with diabetes (higher in two studies or lower in two studies) compared to that in non-diabetic participants. However, three prospective studies including the Health, Aging, and Body Composition study,\(^{25}\) community-dwelling Chinese cohort,\(^{26}\) and the Osteoporotic Fractures in Men Study\(^{27}\) found an accelerated loss of muscle mass in older adults with diabetes compared to their non-diabetic counterparts. Moreover, several cross-sectional studies reported lower handgrip strength and knee extension torque in older people with diabetes despite having similar muscle mass.\(^{25-30}\) Prospective cohort studies showed a steeper decline in knee extension torque.\(^{31,32}\) As a consequence, the muscle quality was consistently lower in the lower extremities in most of the diabetic subjects compared to that in their non-diabetic counterparts.

In Korean older adults, the appendicular skeletal muscle mass (ASM) assessed by DXA was lower in diabetic patients than that in their non-diabetic counterparts while muscle mass index (ASM/height\(^2\)) was lower only in older men with diabetes.\(^{33}\) Yoon et al.\(^{34}\) reported that muscle mass and strength in older diabetic patients did not differ compared to those in nondiabetic subjects; however, the muscle quality was poorer and physical performance was impaired in diabetic subjects with poor glycemic control. The Korean Frailty and Aging Cohort Study (KFACS) also showed that community-dwelling older men and women with diabetes had a decreased muscle mass index (ASM/body mass index) and handgrip strength but that only women with diabetes showed decreased physical performance compared to non-diabetic participants (unpublished data). The KFACS indicated a prevalence of sarcopenia of approximately 13% in Korean older adults with diabetes according to the definition from the Asian Working Group for Sarcopenia; however, there was no significant difference in the prevalence of sarcopenia compared to that in non-diabetic participants.

The presence of diabetes accelerated the decrease of muscle mass, strength, and quality because of the associated insulin resistance and diabetes complications;\(^{5,35}\) however, the underlying mechanisms of these associations remain unclear. Insulin resis-
tance inhibits the mTOR pathway that leads to protein synthesis and decreases protein degradation.\textsuperscript{36} Insulin resistance also increases activation of the ubiquitin-proteasome pathway, resulting in the degradation of muscle protein.\textsuperscript{37} Chronic hyperglycemia increases the production of advanced glycation end products (AGEs). AGEs may contribute to sarcopenia through increased inflammation and endothelial dysfunction in the microcirculation of skeletal muscle; they also accumulate in the skeletal muscle and cartilage and increase stiffness in patients with diabetes.\textsuperscript{38,39}

Diabetic peripheral neuropathy is a common complication of diabetes, especially in older adults, and leads to sarcopenia in people with diabetes. Patients with peripheral neuropathy had higher calf intermuscular adipose tissue, which was associated with poor muscle strength and function.\textsuperscript{40} Recently, Oh et al.\textsuperscript{41} demonstrated that the muscle strength, as measured by handgrip strength, was lower in Korean men with diabetic neuropathy than that in those without neuropathy. The presence of diabetes was also associated with an increase in inflammatory cytokine levels. Increased levels are likely to be associated with both frailty and sarcopenia.\textsuperscript{42} Moreover, systemic inflammatory cytokines, such as tumor necrosis factor and interleukin-6, have detrimental effects on muscle mass, strength, and physical performance in older adults.\textsuperscript{43}

**SARCOPENIA, FRAILTY, AND GERIATRIC SYNDROME IN DIABETES**

Sarcopenia is a syndrome characterized by a progressive and generalized loss of skeletal muscle mass with either muscle weakness or poor physical performance.\textsuperscript{44} Frailty is a state of increased vulnerability to minor stressors because of decreased physiological reserve in multiple organ systems, which increases the risk of poor health outcomes including fall, hospitalization, disability, and death.\textsuperscript{45} The KFACS demonstrated a prevalence of frailty in Korean older men and women with diabetes of 5.5% and 9.5%, respectively, based on the Cardiovascular Health Study frailty phenotype criteria (unpublished data). The prevalence of frailty in women with diabetes was 2-fold higher than that in those without diabetes but the difference in the prevalence of frailty between older men with diabetes and those without diabetes was not statistically significant.

Sarcopenia and frailty have a commonality and may share similar pathways for functional decline or disability in older adults.\textsuperscript{46,47} Sarcopenia may be an intermediate step in the development of frailty in patients with diabetes because sarcopenia is one component of the frailty phenotype.\textsuperscript{48} Thus, sarcopenia may progress to physical frailty, then deteriorate to physical disability, and finally cause death in older adults (Fig. 1). The presence of diabetes increased the risk of sarcopenia and frailty by 2-fold and 1.5–4-fold, respectively.\textsuperscript{49} A meta-analysis showed that diabetes was associated with an increased odds of difficulties with activities of daily living (ADL) and instrumental activities of daily living (IADL) compared to those without diabetes (odds ratio = 1.82, 95% confidence interval 1.63–2.04 and odds ratio = 1.65, 95% confidence interval 1.55–1.74, respectively).\textsuperscript{7}

Fall is a major geriatric syndrome and is detrimental to quality of life; it is associated with activity avoidance, hospitalization, and even mortality.\textsuperscript{50} Fall is highly prevalent in older adults with diabetes, with annual incidence rates of 39% in those over 65 years of age and even higher in those with poor glycemic control and insulin treatment.\textsuperscript{47}

**CONCLUSION**

Diabetes, sarcopenia, and frailty are associated with functional decline, disability, and mortality. Diabetes accelerates the age-associated muscle loss and progression of muscle weakness that lead to the early pathophysiologic process of frailty. Thus, the management of frailty in patients with diabetes should initially focus on sarcopenia prevention.

Assessment of functional status and screening of sarcopenia and/or frailty in older adults with diabetes should be mandatory\textsuperscript{9} to promote early interventions based on physical exercise and nutrition education.

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**Fig. 1.** Additive effects of aging and diabetes on muscle dysfunction.

Sarcopenia is a major component of frailty. Diabetes accelerates the progression of sarcopenia to frailty, ultimately leading to disability, functional dependence, and death. Geriatric syndrome includes falls, incontinence, pressure ulcer, delirium, functional dependence.
CONFLICT OF INTEREST DISCLOSURES

The researcher claims no conflicts of interest.

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Diabetes is an important health problem with the population aging. Previously, it is well established that diabetes is associated with microvascular and macrovascular complications, but recently, several data suggest that diabetes is accompanied with frailty as well as disability among the older adults. Considering the clinical significance of frailty and disability, it is important to understand the pathway from diabetes to frailty and/or disability. Additionally, it is strongly recommended to find a new therapeutic intervention are required to meet the increasing demand of managing older diabetic patients with the population aging.

Key Words: Frail elderly, Diabetes mellitus, Disability

INTRODUCTION

Diabetes is a serious health condition for older adults that has an increasing clinical significance in aged societies. More than 25% of Korean adults over 60 years of age have diabetes mellitus, and approximately 50% of older adults have impaired fasting glucose levels. Diabetes is associated with complications including cardiovascular disease, retinopathy, renal failure, and peripheral vascular disease. The occurrence of microvascular or macrovascular diabetic complications increases significantly after 10 years of disease duration. These complications are related to functional decline, disability, and loss of quality of life. Among older adults with diabetes, geriatric syndrome, especially frailty, is emerging as a third category of complications in addition to the traditional microvascular or macrovascular diseases leading to considerable disability. Understanding the pathway from diabetes to frailty and/or disability is important for establishing early intervention and prevention strategies. This review discusses the relationship between frailty, disability, and diabetes among older adults.

FRAILTY AND DISABILITY IN OLDER DIABETIC PATIENTS

In recent years, frailty has emerged as an independent predictor associated with increased risks of adverse outcomes among older adults, irrespective of their associated comorbidities. Frailty is a state of decreased reserve and resistance to stressors resulting from cumulative declines across multiple physiologic systems with aging, which leads to vulnerability to adverse outcomes such as death, hospital admission, permanent institutionalization, falls, and additional disability. While disability is hard to reverse, frailty is a dynamic process with a wide range of interventions to reduce vulnerability. Fried et al. established a framework of the frailty phenotype in which three or more of the following criteria were present: unintentional weight loss, self-reported exhaustion, muscle weakness, slow walking speed, and low physical disability. The presence of one or two phenotype criteria describes a pre-frail state while the absence of any positive criteria describes a robust state. Another definition of frailty is the frailty index proposed by Rockwood and colleagues. In this concept, Frailty is recognized as an accumulation of deficit during aging (symptoms, diseases, condi-
tions, and disabilities). Studies have shown that frailty is a dynamic process and also potentially reversible through interventions in carefully chosen, evidence-based circumstances.

Several studies have shown that diabetic patients are more likely to be frail than non-diabetic older adults. From the German ESTHER cohort study and Whitehall II Prospective Study, the prevalence of frailty in adults older than 65 years was 3- to 5-fold higher in patients with diabetes than that in the general population. Data from the National Health and Nutrition Examination Survey (NHANES) and Cardiovascular Heart Study (CHS) indicate that frailty and pre-frailty are present in 25% and 18.2% of individuals with diabetes, respectively, compared to an overall prevalence of 6.9% among those aged ≥65 years. The Beijing Longitudinal Study of Aging II, demonstrated the highest prevalence of frailty among individuals with diabetes (19.3%), compared to 11.4% and 11.9% in pre-diabetic and non-diabetic individuals, respectively.

The pathophysiology of diabetes is closely associated with frailty. Long-duration diabetes increases the loss of skeletal muscle mass and function, which lead to reduced mobility and gait speed. Insulin resistance can aggravate lower limb dysfunction, further worsening the increase in intramyocellular fatty-acid metabolites caused by reduced mitochondrial activity that accompanies muscle aging. This is likely due to the increased risk of sarcopenia, which is linked to frailty. Hyperglycemia is associated with increased insulin resistance, chronic inflammation, oxidative stress, and mitochondrial dysfunction, all of which have deleterious effects on skeletal muscle mass and function, leading to sarcopenia.

Because frailty might be caused by the accumulation of subclinical damage in multiple organ systems, diabetic complications may also lead to frailty. A Japanese cross-sectional study of 9,695 participants showed a significantly increased risk of frailty among individuals with a history of diabetes and lower kidney function (odds ratio = 2.76, 95% confidence interval [CI], 1.21–8.24).

Among diabetic complications, autonomic neuropathy can cause orthostatic hypotension, arrhythmia, syncope, diarrhea, and bladder dysfunction. It may also result in the absence of typical hypoglycemic symptoms (palpitation, sweating, anxiety, and nausea) associated with hypoglycemia among older adults as the autonomic symptoms (dizziness or visual disturbance) rather than autonomic symptoms (palpitation, sweating, anxiety, and nausea) associated with hypoglycemia among older adults as the autonomic symptoms are decreased and counter-regulatory responses to hypoglycemia are reduced in older people. Severe hypoglycemia often leads to hospitalization in older adults, which could lead to the deterioration of a patient’s general condition and, eventually, frailty and disability. Repeated hypoglycemia is likely to result in frailty, disability, and poor health outcomes.

Hypoglycemia
Older adults with frailty have an increased risk of hypoglycemia as most of these individuals have problems with loss of appetite and weight loss. Recurrent hypoglycemia is common in older patients with diabetes but is less likely to be recognized and, thus, is under-reported by patients and healthcare professionals. The lack of recognition is mainly due to the predominance of neurological symptoms (dizziness or visual disturbance) rather than autonomic symptoms (palpitation, sweating, anxiety, and nausea) associated with hypoglycemia among older adults as the autonomic symptoms are decreased and counter-regulatory responses to hypoglycemia are reduced in older people. Severe hypoglycemia often leads to hospitalization in older adults, which could lead to the deterioration of a patient’s general condition and, eventually, frailty and disability. Repeated hypoglycemia is likely to result in frailty, disability, and poor health outcomes.

Falls
Falls are a common problem in older adults with frailty. A Japanese study showed that lower walking speed, one of the manifestations of frailty, was associated with falls in patients with type 2 diabetes. The risk factors for falls among patients with diabetes include polypharmacy, muscle weakness, previous stroke, motor and sensory neuropathy, poor glycemic control, hypoglycemia, insulin use,
cognitive dysfunction, orthostatic hypotension, and visual impairment.\textsuperscript{26,27} Fall prevention in patients with diabetes and frailty requires a multifactorial approach and there is strong evidence of a benefit in older adults. Gait, balance, and strength training might reduce the risk of falls in people with diabetes.

Cognitive Dysfunction

Frailty, and cognitive impairment, are prevalent among patients with cardiometabolic disease.\textsuperscript{28} Moreover, diabetes is a risk factor for the development of vascular as well as neurodegenerative dementia.\textsuperscript{29} Cognitive dysfunction significantly impacts the risk of both hypoglycemia and hyperglycemia in patients with diabetes. In particular, there is a bidirectional relationship between dementia and hypoglycemia; in other words, cognitive dysfunction is a risk factor for the development of hypoglycemia and hypoglycemia increases the risk of cognitive impairment in patients with diabetes.\textsuperscript{30} Therefore, the prevention of hypoglycemia should always be considered a priority in the treatment of older patients with diabetes and frailty.

Sarcopenia

Patients who have diabetes mellitus, particularly when associated with renal failure, show an accelerated loss of muscle function.\textsuperscript{31,32} Sarcopenia is an age-related decline in muscle function and mass.\textsuperscript{33} Sarcopenia is associated with increased disability and mortality\textsuperscript{34} and most likely forms the basis of frailty in patients with type 2 diabetes.

PREVENTION AND MANAGEMENT OF FRAILTY AMONG DIABETIC PATIENTS

Diabetes management may require assessments in the medical, psychological, functional, and social domains. In addition to the classic cardiovascular and microvascular disease, older adults with diabetes and frailty should be assessed for a group of conditions termed geriatric syndrome, which includes cognitive dysfunction, functional impairment, falls/fractures, polypharmacy, depression, vision and hearing impairment, urinary incontinence, and nutritional problems. This comprehensive medical evaluation may provide a framework to determine targets and therapeutic approaches and to identify individuals with significantly impaired functional status such as visual and lower-extremity complications or cognitive impairment, which may impact their ability to self-manage their diabetes.\textsuperscript{35}

Diabetes management strategies for robust older adults with diabetes are similar to those for younger adults. However, older adults with frailty should be provided individualized risk-minimization care plans according to the functional status and life expectancy. The American Geriatric Society suggests a glycosylated hemoglobin (HbA1c) target of 7.5%–8.0% for older adults. However, glycemic control targets may vary depending on the patient’s frailty status. An HbA1c target of 7.0%–7.5% is suitable for functionally independent older adults with a reasonable life expectancy, while a target of 8%–9% is appropriate for older adults with frailty and those with dementia and a life expectancy of fewer than 10 years.\textsuperscript{36}

Sulfonylurea or insulin, which can increase the incidence of hypoglycemia, should be used with care in dependent patients with frailty and cognitive impairment. Glimepiride has a long half-life and can result in severe and prolonged hypoglycemia. If sulfonylureas are used, short-acting agents such as glipizide or gliclazide are preferred.

Metformin can be a first-line choice of treatment in older patients with diabetes and frailty. Patients with frailty should be monitored carefully for weight loss and gastrointestinal side effects. Thiazolidinedione should be used with care in patients with congestive heart failure and those at risk for falls or fractures. Dipeptidyl peptidase 4 (DPP-4) inhibitors are effective and reasonably safe in older adults. Because glucagon-like peptide 1-receptor agonists may be associated with gastrointestinal side effects and weight loss, they may not be desirable in underweight individuals with frailty. As only injectable forms are available, they should also be considered only when caregiver support is available. While sodium-glucose cotransporter 2 inhibitors appear to be well-tolerated by older adults, long-term data are scarce.\textsuperscript{37,38} In addition, sodium-glucose transport protein 2 (SGLT2) inhibitors act as osmotic diuretics and are associated with weight loss as well as reduced blood pressure. Accordingly, these agents should be used with caution in older patients treated with antihypertensive agents, especially diuretics.

Diabetes nutritional therapy may have a protective effect against the development of frailty. Many older people lack adequate nutritional intake particularly that of protein, while also requiring increased dietary protein intake to compensate for age-related anabolic resistance. Older adults are recommended to consume 1.0–1.2 g protein per kg of body weight per day to maintain and regain lean body mass and function.\textsuperscript{39} Optimal nutrition with adequate protein intake combined with exercise programs, including aerobic and resistance training, could reduce the risks of sarcopenia and frailty.\textsuperscript{40-42} Treatment of diabetic autonomic neuropathy in older adults is complex because of their poor tolerability to many pharmacologic treatment options. It is essential to search for the secondary causes and decrease the intake of medications that may contribute to the patient’s symptoms. Lifestyle interventions such as diet alteration may help to reduce the need for pharmacologic treatments and their associated risks of adverse effects.\textsuperscript{41}
CONCLUSION

Diabetes is frequently accompanied by frailty and they share pathways leading to disability, morbidity, and mortality in older adults. Early recognition of frailty in older diabetic patients allows comprehensive multi-component interventions including physical exercise, nutritional support, and medication adjustment. Moreover, better strategies can be established for diabetes management, including setting glycemic goals, selecting anti-diabetic agents, and implementing other preventative interventions. Identification of the common mechanisms and the development of new therapeutic interventions are needed to meet the increasing demand for the management of older diabetic patients due to population aging.

CONFLICT OF INTEREST DISCLOSURES

The researchers claim no conflicts of interest.

REFERENCES


Diabetic Peripheral Neuropathy as a Risk Factor for Sarcopenia

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Background: Diabetic peripheral neuropathy (DPN) is prevalent in patients with type 2 diabetes, and its prevalence increases with age. A previous study demonstrated the association between DPN and muscle dysfunction; however, there are limited data on the association between DPN and sarcopenia.

Methods: We enrolled patients with type 2 diabetes and measured hand grip strength (HGS), lean body mass using a bio-impedance analysis, and gait speed using a 4-m walking test. Sarcopenia was diagnosed according to the criteria from the Asian Working Group for Sarcopenia. We also performed various examinations of neuropathy, including both small- and large-fiber neuropathy.

Results: Among 170 participants (mean age, 61.5±6.6 years), 24 (14.1%) were diagnosed with sarcopenia. The Michigan Neuropathy Screening Instrument Questionnaire (MNSI-Q) scores were higher in patients with sarcopenia than in those without sarcopenia (2.7±1.3 vs. 2.4±1.3; p=0.008). However, other neuropathy examination results were not significantly associated with sarcopenia. The MNSI-Q score was negatively associated with HGS, with an odds ratio (OR) of 1.367 (95% confidence interval [CI], 1.122–1.667) in predicting the presence of sarcopenia. After adjusting for sex, body mass index, and diabetes duration, the MNSI-Q score was associated with the presence of sarcopenia (adjusted OR=1.310; 95% CI, 1.041–1.647).

Conclusion: In this population with type 2 diabetes, patients with sarcopenia had higher neuropathy questionnaire scores than those without sarcopenia. Therefore, active screening for sarcopenia should be performed in subjects with DPN.

Key Words: Sarcopenia, Diabetic neuropathy, Skeletal muscle, Muscle strength

INTRODUCTION

Sarcopenia is prevalent in patients with type 2 diabetes, and the prevalence of both conditions increases with age. Various risk factors for sarcopenia in patients with type 2 diabetes have been reported. For example, poor glycemic control was related to decreased muscle quality and performance in a Korean population with type 2 diabetes who were aged 65 years or older. In addition, longer diabetes duration and dyslipidemia were associated with reduced skeletal muscle mass in a Japanese observational study. Recently, higher levels of advanced glycated end-products (AGEs) were reported in patients with sarcopenia, and the accumulation of AGEs was related to decreased muscle mass and strength. Because AGEs play a pathological role in diabetic vascular complications, there might be a close association between sarcopenia and chronic diabetes complications.

Diabetic peripheral neuropathy (DPN) is a microvascular complication, and hyperglycemia and other metabolic conditions are highly related to DPN. Compared with other diabetic microvascular complications, DPN may be directly associated with muscle dysfunction because muscles are directly innervated by peripheral nerves and their functions are controlled by nerve activity. A previous observational study of 39 patients aged 70–79 years showed decreased muscle performance in subjects with DPN compared with that in non-diabetic people. Another observational study confirmed this finding in 10 subjects with diabetes with a mean
age of 57.2 years. However, there are limited data on the association between sarcopenia and DPN in large populations; therefore, larger-scale studies are needed to evaluate the association between DPN and sarcopenia.

This study aimed to evaluate muscle mass, strength, and physical performance in subjects with type 2 diabetes and assess whether DPN was a significant risk factor for sarcopenia.

**MATERIALS AND METHODS**

**Participants**

We analyzed data from patients with type 2 diabetes who were enrolled in an ongoing prospective observational study. The procedure and inclusion and exclusion criteria of the study have been described previously. Briefly, the study participants were enrolled from an outpatient clinic of a tertiary academic hospital. We used a new screening tool for DPN in which the examination required the participants to stand by themselves for more than 2 minutes. We excluded participants with neuropathy owing to other causes such as thyroid disease, history of chemotherapy, and heavy alcohol consumption. The current analysis included data from a subgroup of participants aged 50 years and older. The study was approved by the Institutional Review Board of Seoul National University Bundang Hospital (No. B-1911/577-104). Written informed consents were obtained.

**Medical History and Anthropometric and Biochemical Analyses**

Medical history such as diabetes duration and medication was collected using a structured questionnaire. Anthropometric analysis, including body weight and height measurements and bio-impedance analysis (InBody 770; InBody, Seoul, Korea), was performed with the participants wearing light clothes. Body mass index (BMI) was calculated as body weight/height (kg/m²). Systolic and diastolic blood pressures were measured using an electronic blood pressure meter after 10-minute rest. Blood was drawn after an overnight fast. Renal function and glucose, glycated hemoglobin (HbA1c), total cholesterol, triglyceride, high-density lipoprotein (HDL) and low-density lipoprotein (LDL)-cholesterol levels were assessed using the protocol of the central laboratory.

**Neuropathy Evaluation**

Trained research nurses performed neuropathy evaluations, the results of which were confirmed by endocrinology specialists. Annual screening for neuropathy in subjects with type 2 diabetes start at diagnosis. Neuropathy was evaluated using the Michigan Neuropathy Screening Instrument Questionnaire (MNSI-Q), MNSI physical examination (MNSI-PE), a 10-g monofilament test, and SUDOSCAN (Impeto Medical, Paris, France). SUDOSCAN noninvasively measures electrochemical skin conductance; we included this measurement to complement the other methods of evaluating neuropathy.

**Sarcopenia Assessment**

Trained research nurses measured hand grip strength (HGS) using a digital grip strength dynamometer (GRIP-D; Takei Scientific Instruments, Tokyo, Japan) by following a standard protocol after requesting that the subjects not perform vigorous exercise before the measurement. The nurses measured HGS twice for each hand, and we used the mean value of the dominant hand in our analysis. The parameter of muscle mass index was the appendicular skeletal muscle mass (ASM) divided by the height squared (m²) (ASM/ht²). Low muscle strength and muscle mass were defined as values below the cutoffs of 26 kg and 7.0 kg/m², respectively, for men and 18 kg and 5.7 kg/m², respectively, for women. We assessed walking speed using a 4-m walking test, with the mean values of two trials used in our analysis. Sarcopenia was diagnosed according to the Asian Working Group for Sarcopenia (AWGS) criteria.

**Statistical Analysis**

We presented the data as mean ± standard deviation or as numbers and percentage. The differences between patients without and with sarcopenia were tested using parametric or non-parametric t-test and chi-square test. Simple correlations between parameters were evaluated by Spearman correlation analysis. Logistic regression analysis was used to identify risk factors associated with sarcopenia. We chose covariates from among the variables that differed significantly between patients with and without sarcopenia considering their clinical importance and multicollinearity. All variables, except sex, were continuous variables in logistic regression analysis. Statistical analysis was conducted using IBM SPSS Statistics version 22 for Windows (IBM SPSS, Armonk, NY, USA). Two-sided p-values < 0.05 were considered statistically significant.

**RESULTS**

Among 170 participants, 24 (14.1%) had sarcopenia. The participant characteristics are shown in Table 1. More women than men had sarcopenia. Body weight and BMI were lower in patients with sarcopenia than in those without sarcopenia. Furthermore, diabetes duration was longer in subjects with sarcopenia than in those without sarcopenia (14.6 ± 8.3 vs. 10.1 ± 7.3 years; p = 0.009). The MNSI-Q scores were higher in patients with sarcopenia than in those without sarcopenia (2.7 ± 1.3 vs. 2.4 ± 1.3; p = 0.008). However, the results of other neuropathy examinations, including MN-
SI-PE, 10-g monofilament test, and electrochemical skin conductance of feet obtained using SUDOSCAN, did not differ between the groups. More patients with sarcopenia were treated with insulin than patients without sarcopenia.

Table 2 shows the results of the evaluation of sarcopenia parameters. We observed large differences in ASM, ASM/ht², and HGS between the groups; however, walking speed showed only a decreasing trend in the sarcopenia group. To determine the association between muscle measurements and DPN, we conducted a correlation analysis for each sex (Table 3). In men, HGS was significantly associated with the MNSI-Q score and the results of MNSI-PE, 10-g monofilament test, and electrochemical skin conductance of the feet. However, no parameters were significantly associated with ASM/ht². In women, only the MNSI-Q score showed a negative association with HGS.

Table 4 shows the results of logistic regression analysis. Subjects with sarcopenia had substantially higher odds ratio (OR) for diabetes duration (OR = 1.075; 95% confidence interval [CI], 1.018–1.134) and the MNSI-Q score (OR = 1.367; 95% CI, 1.122–1.667). After adjusting for sex, BMI, and diabetes duration, the MNSI-Q score was significantly associated with the presence of sarcopenia (adjusted OR = 1.310; 95% CI, 1.041–1.647).

DISCUSSION

We observed a sarcopenia prevalence of 14.1% among patients with type 2 diabetes from a single tertiary academic hospital. Patients with sarcopenia had lower BMI, longer diabetes duration, and higher rates of insulin therapy. Therefore, more severe diabetes might be related to sarcopenia. Patients with sarcopenia also had higher MNSI-Q scores than those without sarcopenia. After adjusting for sex, BMI, and diabetes duration, the MNSI-Q score was significantly associated with the presence of sarcopenia.

While we adopted the AWGS criteria for sarcopenia, other diagnostic criteria exist for sarcopenia. Therefore, care is required when comparing our findings with those of other studies. More...
over, various evaluation tools are used for diagnosing DPN. In our study, we used a structured questionnaire that is widely applied in epidemiology studies and also performed key physical examinations. In addition, we performed a new technique, SUDOS-CAN, to evaluate sudomotor dysfunction by detecting abnormalities in small-fiber nerve function. In the present study, only the neuropathy (MNSI-Q) scores were associated with the presence of sarcopenia. In contrast, the physical examination and small-fiber nerve function abnormality findings did not discriminate the presence of sarcopenia. Further validation studies using the same definitions and diagnostic tests are needed to confirm our findings.

We previously reported the association between abdominal obesity and DPN in middle-aged patients with type 2 diabetes. In that study, we did not observe a significant association between neuropathy examination results and lean body mass. Moreover, in the present study, we did not observe a significant association between muscle mass index and neuropathy evaluation findings in older patients. In contrast, HGS was significantly associated with neuropathy evaluation results, although correlation coefficients were small (–0.318 in men and –0.361 in women). Both skeletal muscle index and HGS are likely to be preserved until middle age in the Korean general population. This trend suggests the presence of factors related to the preservation of muscle homeostasis in young and middle-aged adults. Between muscle mass and muscle strength, the latter might be more vulnerable to metabolic deterioration and aging. Researches showed that muscle strength can predict poor health outcomes, including cardiovascular diseases, cancer, and lung diseases. Our identification of DPN as a risk factor for sarcopenia, especially for the deterioration of HGS, suggests that physicians should employ prevention strategies in older individuals with DPN to prevent sarcopenia.

The association between DPN and muscle function has been assessed in other populations. Resnick et al. reported that compared with non-diabetic controls, older patients with DPN (mean age, 74.5 years) showed decreased walking speed. Our study revealed that the presence of sarcopenia was more likely associated with MNSI-Q (score) and MNSI-PE (score) in women. However, further validation studies using the same definitions and diagnostic tests are needed to confirm our findings.

**Table 3. Correlation coefficients between muscle mass index or HGS and neuropathy examination**

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ASM/ht² rho p-value</td>
<td>HGS rho p-value</td>
</tr>
<tr>
<td>MNSI-Q (score)</td>
<td>-0.083 0.418 0.001</td>
<td>-0.073 0.544 0.002</td>
</tr>
<tr>
<td>MNSI-PE (score)</td>
<td>0.098 0.339 0.016</td>
<td>0.153 0.201 0.110</td>
</tr>
<tr>
<td>10-g monofilament (score)</td>
<td>-0.004 0.967 0.001</td>
<td>-0.049 0.686 0.034</td>
</tr>
<tr>
<td>Foot ESC (µS)</td>
<td>0.124 0.223 0.001</td>
<td>0.166 0.164 0.556</td>
</tr>
</tbody>
</table>

HGS, hand grip strength; ASM, appendicular skeletal muscle mass; ht, height; MNSI-Q, Michigan Neuropathy Screening Instrument Questionnaire; MSNI-PE, MNSI physical examination; ESC, electrochemical skin conductance. p-values are derived from Spearman correlation analysis.

**Table 4. Logistic regression analysis of the risk factors for sarcopenia**

<table>
<thead>
<tr>
<th></th>
<th>Unadjusted</th>
<th>Adjusted</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR 95% CI</td>
<td>p-value</td>
</tr>
<tr>
<td>Female (reference, male)</td>
<td>6.668 2.354–18.889</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>0.786 0.672–0.918</td>
<td>0.002</td>
</tr>
<tr>
<td>Diabetes duration (y)</td>
<td>1.075 1.018–1.134</td>
<td>0.009</td>
</tr>
<tr>
<td>MNSI-Q (score)</td>
<td>1.367 1.122–1.667</td>
<td>0.002</td>
</tr>
<tr>
<td>MNSI-PE (score)</td>
<td>1.171 0.831–1.651</td>
<td>0.368</td>
</tr>
<tr>
<td>10-g monofilament (score)</td>
<td>0.841 0.676–1.046</td>
<td>0.121</td>
</tr>
<tr>
<td>Foot ESC (µS)</td>
<td>0.987 0.962–1.013</td>
<td>0.327</td>
</tr>
</tbody>
</table>

OR, odds ratio; CI, confidence interval; BMI, body mass index; MNSI-Q, Michigan Neuropathy Screening Instrument Questionnaire; MSNI-PE, MNSI physical examination; ESC, electrochemical skin conductance. p-values are derived from logistic regression analysis; adjusted for sex, BMI, and diabetes duration.
sults was in accordance with this association between DPN and muscle function in a relatively younger population. In another small observational study by Scarton et al., compared with non-diabetic controls, patients with DPN had increased ankle rigidity. However, this study did not include data on the general function of the lower extremities such as walking speed. In summary, the results of the current study demonstrated the association between DPN and decreased muscle function based on the results of simple physical examinations in a wider range of participant characteristics and larger population size.

Our study had several limitations. First, we did not perform dual-energy X-ray absorptiometry. Bio-impedance analysis requires further validation with gold standard methods to improve its accuracy. Second, we did not evaluate the association between sarcopenia and DPN in age subgroups. Because DPN prevalence increases with age, a more significant association between sarcopenia and DPN is possible in older subjects. Third, we did not include nerve conduction data to estimate large-fiber nerve function. Fourth, we enrolled subjects from a single tertiary academic hospital. Thus, the findings of our study cannot be generalized.

In summary, the results of this study demonstrated a significant association between higher DPN questionnaire score and the presence of sarcopenia. Therefore, clinical screening for sarcopenia is necessary for patients with DPN.

CONFLICT OF INTEREST DISCLOSURES

The researchers claim no conflicts of interest.

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Clinical Features of Geriatric Syndromes in Older Koreans with Diabetes Mellitus

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Geriatric Syndromes Study Group of Korea Geriatrics Society

INTRODUCTION

The life expectancy is increasing worldwide, and Korea has one of the fastest aging populations. According to national statistics, the proportions of the population aged 65 years or older were 3.8% in 1990, 7.2% in 2000, and 14.2% in 2017. This proportion is projected to reach 25% in 2030, marking the beginning of a super-aged society. With the rapid increase in the number of older adults, the incidence of diabetes mellitus (DM) is also increasing steeply. According to the International Diabetes Federation, 10 million patients were newly diagnosed with diabetes between 2015 and 2017, 8 million of whom were aged 65 years or older. 

Background: This study explored the prevalence and clinical characteristics of geriatric syndromes among Korean older adults with diabetes mellitus (DM). Methods: We used data from the 2017 National Survey of Older Koreans to analyze the classic geriatric syndromes of polypharmacy, urinary incontinence, falls, cognitive impairment, and functional impairment according to the presence of DM. Results: Among 10,299 participants aged 65 years or older, 2,395 had DM. The prevalence of polypharmacy was 64.1% in the DM group and 31.6% in the non-DM group (p<0.001). One or more falls per year occurred in 18.7% of participants with DM compared with 14.9% of those without DM (p<0.001). The prevalence of urinary incontinence was significantly higher in the DM group (3.8%) than in the non-DM group (2.5%) (p=0.001). The prevalence of cognitive impairment was 17.7% in the DM group versus 14.9% in the non-DM group (p=0.001). Functional impairment occurred in 32.2% of participants in the DM group compared with 26.8% of participants in the non-DM group (p<0.001). Finally, the number of geriatric syndromes was significantly associated with cardiovascular disease (CVD) and chronic kidney disease (CKD) in patients with DM. Conclusion: The results of this study showed a higher prevalence of geriatric syndromes among older Korean adults with DM. In addition, the coexistence of multiple geriatric syndromes was associated with CVD and CKD among patients with DM. These findings support the current guidelines for older adults with DM that recommend assessment for geriatric syndromes.

Key Words: Diabetes mellitus, Geriatric syndrome, Geriatric assessment
In Korea, the prevalence of DM in people aged ≥ 65 years was 30% in 2016. The treatment of DM in older adults is often difficult because of their impaired physical, psychological, and cognitive functions. Moreover, older adults with DM have an increased risk of premature death and comorbid diseases such as hypertension, coronary heart disease, and stroke compared with individuals without diabetes. Also, atypical symptoms occur in older adults with DM because of multi-morbidity and polypharmacy. Therefore, a comprehensive approach to various symptoms is necessary for the treatment of older adults with DM, for which comprehensive assessment of geriatric syndromes is needed. Geriatric syndromes refer to multi-factorial conditions among older adults that render them vulnerable to situational changes. Geriatric syndromes are highly prevalent and are associated with a high morbidity and poor quality of life. Considering the variability in symptoms among older adults with DM due to multiple comorbidities and disabilities, the American Diabetes Association recommends screening for geriatric syndromes such as polypharmacy, cognitive impairment, urinary incontinence, falls, and persistent pain in addition to diabetes self-management and health-related quality of life among older adults with DM. The Korean Diabetes Association also recommends individual assessment of geriatric syndromes such as polypharmacy, cognitive impairment, and functional impairment among older adults with DM and that the outcomes of such assessments be reflected in the diabetes treatment plan.

Therefore, the assessment of geriatric syndromes in older adults with DM is important. However, little is known regarding the demographic and clinical characteristics of geriatric syndromes among older adults with DM in Korea. Thus, the present study explores the prevalence and clinical characteristics of geriatric syndromes among older adults with DM on the basis of data from the 2017 National Survey of Older Koreans (NSOK).

MATERIALS AND METHODS

Study Population
The NSOK is a cross-sectional, nationwide mandatory survey performed every 3 years since 2008. The purpose of the NSOK is to provide baseline information to formulate policies related to older adults on the basis of a legal provision (Welfare of Older Persons Act). The NSOK investigates the socioeconomic status, health condition, and needs and desires of older Koreans via in-person interviews conducted by specialized surveyors. This study used data from the fourth NSOK survey, conducted in 2017 by the Korea Institute for Health and Social Affairs, which included 10,299 older adults aged ≥ 65 years in 934 survey areas from June 12 to August 28, 2017.

Assessment of Geriatric Syndromes
This study analyzed the classic geriatric syndromes of polypharmacy, urinary incontinence, falls, cognitive impairment, and functional impairment. Polypharmacy was defined as the prescription of 5 or more drugs for 3 months or longer. Urinary incontinence was defined as the presence of diagnosed incontinence for 3 months or longer. Falls were defined as the occurrence of one or more falls over 1 year, whereas recurrent falls were defined as the occurrence of two or more falls per year. Cognitive function was assessed using the Korean version of the Mini-Mental Status Examination for dementia screening (MMSE-DS), with cognitive impairment determined on the basis of a cutoff score adjusted for sex, age, and educational level. Physician-diagnosed Alzheimer disease was also categorized as cognitive impairment. Functional status in the older adults was assessed on the basis of 7 categories of activities of daily living (ADLs) and 10 categories of instrumental activities of daily living (IADLs), with functional impairment defined as the presence of one or more difficulties in ADL and IADL. Visual and hearing status was assessed via a structured questionnaire, with impairment defined as any inconvenience in daily life such as watching TV, reading the newspaper, talking on the phone, and talking with a person or the need for assistance due to visual and hearing impairment. Participants with limitations in sitting and rising from a chair or bed 5 times with both hands in front (without using both hands to assist in the task) were considered to have lower limb limitations. Depression was assessed using the Korean version of the Geriatric Depression Scale-Short Form which comprised 15 questions, with depression defined as a score ≥ 8 or a prior diagnosis of depression.

Definition of Diabetes and Diabetic Complications
DM was defined as the presence of diagnosed diabetes for 3 months or longer. Cardiovascular diseases (CVDs), including angina, myocardial infarction, and stroke and chronic kidney disease (CKD), were analyzed as diabetic complications. The presence of a definite diagnosis was assessed using a structured questionnaire.

Statistical Analysis
The data are presented as means with standard deviations or as frequencies with percentages according to the distribution of DM. Statistical analyses were performed using the t-test and Pearson chi-squared test. The odds ratios (ORs) of geriatric syndromes for diabetic complications were assessed via multivariate logistic regression analysis. Statistical analyses were performed using IBM.
SPSS Statistics for Windows version 24.0 (IBM Corp., Armonk, NY, USA). Analysis items with $p < 0.05$ were considered statistically significant.

**Ethical Considerations**
The study was conducted in accordance with the tenets of the Declaration of Helsinki. All NSOK protocols were approved by the Institutional Review Board of the Korea Institute for Health and Social Affairs (No. 2017-11). All participants volunteered and provided written informed consent before their enrollment. All participants’ records were anonymized before accession by the authors and all procedures were performed according to approved guidelines and regulations.

**RESULTS**

**Baseline Characteristics**
This study included 10,299 participants (4,120 men and 6,179 women) aged 65–106 years, 2,395 (928 men and 1,467 women) of whom had DM. Table 1 shows the baseline characteristics of participants in this study according to diabetic status. No significant differences in age, sex, and smoking status were observed. However, participants with DM had a higher body mass index and prevalence of hypertension, dyslipidemia, CKD, and CVD than did participants without DM. The DM group had more comorbidities than did the non-DM group ($p < 0.001$).

**Geriatric Syndromes among Older Adults according to DM Status**
Patients with DM were prescribed an average of 6.2 medications, which was significantly higher than that in the non-DM group (3.4 medications) ($p < 0.001$) (Table 2). The prevalence of polypharmacy ($\geq 5$ prescribed medications during $\geq 3$ months) was 64.1% in the DM group and 31.6% in the non-DM group ($p < 0.001$). One or more falls per year observed in 18.7% of participants in the DM group compared with 14.9% of participants in the non-DM group and the incidence of recurrent falls ($\geq 2$ falls per year) was also significantly higher in the DM group ($p < 0.001$). The prevalence of urinary incontinence was significantly higher in the DM group (3.8%) than in the non-DM group (2.5%) ($p = 0.001$). The prevalence of cognitive impairment was 17.7% in the DM group and 14.9% in the non-DM group ($p = 0.001$). Visual and hearing impairment observed in 46.6% of participants in the DM group compared with 42.7% of participants in the non-DM group ($p = 0.001$). Lower limb limitations were observed in 27.2% of participants in the DM group compared with 21.2% of participants in the non-DM group ($p < 0.001$). Depression existed in 14.8% of participants in the DM group compared with 10.8% of participants in the non-DM group ($p < 0.001$).

**Table 1. Clinical characteristics of participants from the 2017 National Survey of Older Koreans**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Without DM ($n = 7,904$)</th>
<th>With DM ($n = 2,395$)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>74.6 ± 6.5</td>
<td>74.6 ± 5.9</td>
<td>0.872</td>
</tr>
<tr>
<td>Sex, male</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3,192 (40.5)</td>
<td>928 (39.0)</td>
<td>0.198</td>
</tr>
<tr>
<td>Years of education</td>
<td>6.8 ± 4.6</td>
<td>6.5 ± 4.6</td>
<td>0.008</td>
</tr>
<tr>
<td>Current smoking</td>
<td>754 (9.5)</td>
<td>204 (8.5)</td>
<td>0.142</td>
</tr>
<tr>
<td>Alcohol consumption</td>
<td>2,029 (25.7)</td>
<td>497 (20.8)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>23.3 ± 3.0</td>
<td>24.1 ± 3.1</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Physical activity ≥ 150 min/wk</td>
<td>3,627 (45.9)</td>
<td>1,085 (45.3)</td>
<td>0.631</td>
</tr>
<tr>
<td>Hypertension</td>
<td>4,322 (54.7)</td>
<td>1,804 (73.3)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Dyslipidemia</td>
<td>1,937 (24.5)</td>
<td>944 (39.4)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Cancer</td>
<td>276 (3.5)</td>
<td>95 (4.0)</td>
<td>0.303</td>
</tr>
<tr>
<td>Cardiovascular disease</td>
<td>1,041 (13.2)</td>
<td>428 (17.9)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Chronic kidney disease</td>
<td>90 (1.1)</td>
<td>101 (4.2)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Comorbidity</td>
<td>2.5 ± 1.7</td>
<td>4.0 ± 1.7</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

Values are presented as mean ± standard deviation or number (%). DM, diabetes mellitus.

**Association between Diabetic Complications and Geriatric Syndromes in Older Adults with DM**
A significant association was observed between CVD and polypharmacy (OR = 7.01; 95% confidence interval [CI], 5.03–10.03) (Table 3). Participants with CVD had significantly higher ORs for falls (OR = 1.44; 95% CI, 1.11–1.87), cognitive impairment (OR = 1.34; 95% CI, 1.03–1.75), and functional impairment...
However, CVD was not associated with urinary incontinence. Furthermore, participants with CKD had significantly higher ORs for polypharmacy (OR = 3.85; 95% CI, 2.11–7.00), urinary incontinence (OR = 5.07; 95% CI, 2.49–10.33), and functional impairment (OR = 2.47; 95% CI, 1.60–3.82) (Table 3). Finally, the number of geriatric syndromes was significantly associated with CVD and CKD in patients with DM (Table 4).

**DISCUSSION**

This study evaluated the prevalence of geriatric syndromes among older Korean adults with DM. Patients with DM had a significantly higher prevalence of geriatric syndromes than did participants without DM. In addition, diabetic complications such as CVD and CKD were associated with geriatric syndromes.

Despite its importance in clinical practice, a universal definition of polypharmacy has yet to be established. Many studies, including the present study, defined polypharmacy as the daily use of 5 or more medicines. Although the prevalence of polypharmacy among older adults with DM varied from 6.25% to 93.4%, DM is a considerable cause of polypharmacy due to the requirement of glycemic control and treatment of diabetic complications. Growing evidence suggests that polypharmacy in patients with DM patients increases the number of adverse drug events such as severe hypoglycemia, drug-drug interactions, and interactions with coexisting comorbidities. Particularly, older adults with DM are at a high risk for polypharmacy because of multi-morbidity, age-related pharmacokinetic changes in liver or kidney diseases, and non-adherence to treatment regimens. The results of the present study also show a significantly higher rate of polypharmacy among older patients with DM than among non-DM participants. Notably, polypharmacy in patients with DM was associated with high

| Table 2. Characteristics of patients with geriatric syndromes according to DM status |
|----------------------------------|-------------------|-------------------|------------------|
| Characteristic                  | Without DM (n = 7,904) | With DM (n = 2,395) | p-value          |
| Number of medications          | 3.5 ± 3.9          | 6.2 ± 4.3          | < 0.001          |
| Polypharmacy, ≥ 5 medications   | 2,496 (31.6)       | 1,534 (64.1)       | < 0.001          |
| Urinary incontinence            | 201 (2.5)          | 91 (3.8)           | 0.001            |
| Falls, ≥ 1 per year             | 1,173 (14.9)       | 446 (18.7)         | < 0.001          |
| Recurrent falls, ≥ 2 per year   | 397 (5.1)          | 166 (7.0)          | < 0.001          |
| MMSE-DS score                   | 25.1 ± 3.9         | 24.7 ± 3.9         | < 0.001          |
| Cognitive impairment            | 1,155 (14.9)       | 415 (17.7)         | 0.001            |
| Functional impairment           | 2,120 (26.8)       | 771 (32.2)         | < 0.001          |
| SGDS score                      | 5.1 ± 1.9          | 5.3 ± 2.0          | < 0.001          |
| Depression                      | 838 (10.8)         | 347 (14.8)         | < 0.001          |
| Number of coexisting geriatric syndromes* | 2,496 (32.2) | 921 (39.3) | < 0.001 |
| 1                               | 1,245 (16.1)       | 593 (25.3)         |                  |
| ≥ 3                             | 604 (7.8)          | 325 (13.9)         |                  |

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

DM, diabetes mellitus.

*Geriatric syndromes included polypharmacy, urinary incontinence, falls, cognitive impairment, and functional impairment.

| Table 3. Association of geriatric syndromes with cardiovascular disease and chronic kidney disease |
|----------------------------------|-------------------|-------------------|------------------|
|                                 | Cardiovascular disease | Chronic kidney disease |
| Polypharmacy                    | 7.10 (5.03–10.03)  | 3.85 (2.11–7.00)  |
| Falls                           | 1.44 (1.11–1.87)   | 1.33 (0.81–2.18)  |
| Urinary incontinence            | 1.25 (0.70–2.23)   | 5.07 (2.49–10.33) |
| Cognitive impairment            | 1.34 (1.03–1.76)   | 0.93 (0.54–1.60)  |
| Functional impairment           | 1.78 (1.40–2.26)   | 2.47 (1.60–3.82)  |

Values are presented as odds ratio (95% confidence interval). The data were adjusted for age, sex, smoking status, alcohol consumption, body mass index, hypertension, and dyslipidemia.

| Table 4. Association of the numbers of coexisting geriatric syndromes with cardiovascular disease and chronic kidney disease |
|----------------------------------|-------------------|-------------------|------------------|
| Numbers of geriatric syndromes   | Cardiovascular disease | Chronic kidney disease |
| 0                                | Reference          | Reference          |
| 1                                | 6.05 (3.70–9.90)   | 5.02 (1.77–14.25)  |
| 2                                | 8.29 (4.98–13.81)  | 7.72 (2.67–22.35)  |
| ≥ 3                              | 12.28 (7.18–21.00) | 11.272 (3.80–33.40)|

Values are presented as odds ratio (95% confidence interval). The data were adjusted for age, sex, smoking status, alcohol consumption, body mass index, hypertension, and dyslipidemia.
prevalence of CVD and CKD. This result supports the guidelines of the American Diabetes Association and Korean Diabetes Association that recommend screening for polypharmacy in older patients with DM. Although the harms of polypharmacy are uniformly reported, the balance of benefits and harms has not been evaluated in randomized controlled trials. Therefore, a reduction in the number of medications should be determined on the basis of individual benefits and harms.

Falls are a major geriatric syndrome that can lead to fractures, aggravation of glycemic control, and reduction in the quality of life of older persons with DM. Several studies have shown that DM is a major risk factor for falls. The Study of Osteoporotic Fractures, which included 9,247 older women, demonstrated that women with DM had an increased risk of falling compared with non-DM women. The Women’s Health and Aging Study also showed that DM was associated with an increased risk of falls. The present study also observed a significantly higher incidence of falls among patients with DM. The increased risk of falls may be partially explained by gait impairment in patients with DM. Moreover, our study showed higher prevalence of visual and hearing impairment, lower limb limitations, and functional impairment in older adults with DM, which might contribute to gait impairment and an increased incidence of falls.

Previous studies have reported an association between diabetes and urinary incontinence. In a prospective study of 81,854 women, the prevalence of urinary incontinence was 24.4% among women with DM and 17.1% among those without DM. A 1.21-fold increased risk for any urinary incontinence (95% CI, 1.02–1.43) and 1.40-fold increased risk of severe incontinence in patients with DM were also reported (95% CI, 1.15–1.71). The present study also showed the association between urinary incontinence and DM. While the prevalence of urinary incontinence identified in this study was lower than that reported previously, it was similar to those reported in previous Korean studies. Urinary incontinence was also significantly correlated with CKD in the present. However, because of the cross-sectional nature, a prospective study is needed to assess the causal relationship between urinary incontinence and CKD.

Various studies have reported an association between diabetes and cognitive impairment. Epidemiological studies have observed a 1.6- to 3.0-fold increased risk of dementia among patients with DM. Hyperglycemia, advanced glycation end products, and hyperinsulinemia or insulin resistance are associated with the pathophysiological mechanisms underlying cognitive impairment. We also observed a higher prevalence of cognitive impairment among patients with DM. Moreover, cognitive impairment was associated with CVD among the patients with DM in the present study. This finding is similar to that of the Memory in Diabetes sub-study of the Action to Control Cardiovascular Risk in Diabetes study, which reported that cognitive impairment is associated with an increased risk of CVD.

Functional impairment is one of the most serious geriatric symptoms. A cross-sectional study of 6,588 community-dwelling individuals aged ≥ 60 years demonstrated a 2- to 3-fold higher risk of functional disability in patients with DM. In the Women’s Health and Aging Study, DM was associated with a 1.6-fold increased risk of functional disability in domains such as bathing, transfer from bed to chair, using the toilet, dressing, and eating. The Study of Osteoporosis Fractures reported that women aged ≥ 65 years with DM had a 2- to 2.5-fold increased incidence of functional disability. The results of the present study are similar to those of previous studies. In this study, functional impairment was associated with an increased prevalence of CVD and CKD. However, since CVD and CKD are important contributors to functional disabilities in patients with DM, a prospective study is necessary to assess the causal relationship.

Notably, the present study showed that the number of geriatric syndromes was associated with CVD and CKD in patients with DM, a finding that indicates the cumulative effects of multiple geriatric syndromes and that forms the basis of the current guideline that recommends screening for geriatric syndrome in older adults with DM.

To our knowledge, the present study is the first to use a large representative sample to assess geriatric syndromes in Korean patients with DM. However, this study has several limitations. First, because of the cross-sectional nature, further prospective studies are needed to assess the causal relationship between geriatric syndromes and diabetic complications. Second, considering the lack of laboratory data and diagnoses made on the basis of responses to structured questionnaires, the prevalence of underlying diseases might be underestimated.

In conclusion, the results of this study demonstrate a higher prevalence of geriatric syndromes among older adults with DM and also confirm the association of CVD and CKD and multiple geriatric syndromes in these patients. This result is meaningful, as it forms the basis of the current DM guidelines that recommend the assessment of geriatric syndromes in older patients with DM. However, further prospective studies are needed to assess the correlation between geriatric syndromes and prognosis in patients with DM.

CONFlicT OF INTEREST DISCLOSURES

The researchers claim no conflicts of interest.
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42. Langan SJ, Deary IJ, Hepburn DA, Frier BM. Cumulative cognitive impairment following recurrent severe hypoglycaemia in adult patients with insulin-treated diabetes mellitus. Diabetologia 1991;34:337-44.


Handgrip Strength in the Korean Population: Normative Data and Cutoff Values

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Background: We aimed to report the age- and sex-specific normative data of Korean handgrip strength (HGS) and to establish the cutoff values of low HGS in Korean populations. Methods: We analyzed the HGS data of 23,716 Koreans (10,793 men and 12,923 women) from the Korea National Health and Nutrition Examination Survey from 2014 to 2017. The means with standard deviations (SDs) of HGS were calculated for each 5-year interval starting from 10 years of age. To determine the relationship between HGS and body mass index (BMI), correlation analysis was also performed. The sex-specific cutoff values for low HGS were presented by deriving the –2 SD values of healthy young adults. Results: The mean HGS was 39.5±9.3 kg in men and 24.4±5.3 kg in women. The mean HGS increased from 10 to 39 years and peaked at 35–39 years in both men (46.0±7.2 kg) and women (27.2±4.6 kg). Men showed a higher correlation between HGS and BMI (r=0.378) than did women (r=0.134). The cutoff values for low HGS were 29.6 kg for men and 16.8 kg for women for –2 SD below the reference for healthy young adults. Conclusion: In Koreans, the mean HGS peaked at 35–39 years in both men and women, and the aging curve of HGS was steeper in men than in women. The cutoff values for low HGS were 29.6 kg and 16.8 kg for men and women, respectively.

Key Words: Hand strength, Muscle strength, Sarcopenia, Aging, Nutrition surveys

INTRODUCTION

Handgrip strength (HGS) is a simple, fast, and inexpensive measurement of maximum voluntary muscle strength. It is an important tool used for the diagnosis sarcopenia and is widely used as a single indicator of overall muscle strength.¹⁻⁴ HGS predicts not only overall muscle mass and mobility⁵ but also the incidence of chronic diseases or cardiovascular disease, nutritional state, quality of life, independence of daily life, length of hospital stay, and mortality.⁶⁻⁸ The European Working Group on Sarcopenia in Older People (EWGSOP) and the Asian Working Group for Sarcopenia (AWGS) recommend HGS as one of the axes for sarcopenia diagnosis.¹⁰⁻¹²

As HGS varies by age, sex, and race, the cutoff values for low HGS remain controversial.⁹ Furthermore, HGS can also vary depending on the calculation method for the cutoff and the protocol for HGS measurement.¹⁰ Although sarcopenia working groups such as the EWGSOP and AWGS have suggested cutoff values for low HGS, research in the Korean population is limited. Yoo et al.¹¹ suggested the use of HGS cutoff values based on the lower 20th percentile among 4,553 Koreans. One cross-sectional study of 7,969 Koreans proposed cutoff values derived from two standard deviations below the HGS values for healthy young adults, on the basis of data.¹² Different cutoff values among Asians have been studied in countries of the same race.⁹ Even within the same Asia, several countries have showed different cutoffs of HGS, so it is not reasonable to unify Asians as one HGS cutoff. It is very meaningful to have normative HGS data in each country. Therefore, further studies with a larger Korean population are needed to provide normative data on HGS in Koreans according to sex and age.
This study reports age- and sex-specific normative data on HGS and establishes cutoff values for low HGS in the Korean population using data from the Korea National Health and Nutrition Examination Survey (KNHANES) from 2014 to 2017.

MATERIALS AND METHODS

Data Source and Study Population
The data for this study were obtained from the KNHANES conducted from 2014 to 2017 by the Korea Centers for Disease Control and Prevention. The KNHANES is a population-based cross-sectional survey designed to assess health-related behaviors, health conditions, and the nutritional state of Koreans (http://knhanes.cdc.go.kr/). The study used a stratified, multistage, probability sampling method to select the study participants. From this pool of data (n = 31,207), we included participants aged ≥ 10 years (n = 27,809) who had completed the HGS test (n = 24,784). Persons who had a medical history of cerebrovascular accidents (n = 360), rheumatic arthritis (n = 276), and any malignancy (n = 432) were excluded. We finally included 23,716 participants (10,793 men and 12,923 women) in this study (Fig. 1). All of them provided written informed consent, and the Korea Centers for Disease Control and Prevention Institutional Review Board (ethical review committee for health survey data) approved the study protocol (No. 2015-01-02-6C).

Health Survey
A health questionnaire was used to obtain information on age, sex, socioeconomic status (house income), and educational status. Body weight and height were measured in light clothing without shoes. We calculated body mass index (BMI, kg/m²) as weight divided by the square of height. Information on comorbidities including cerebrovascular accidents, rheumatoid arthritis, and any type of malignancy was examined through health interview surveys.

HGS Measurement
HGS was measured using a digital hand dynamometer (T.K.K 5401; Takei, Tokyo, Japan) that measured between 5.0 and 100.0 kg of force in 0.1 kg increments and had an adjustable grip span. During the assessment, the participants were asked to stand upright with their feet hip-width apart and to look forward with the elbow fully extended. The dynamometer was held using the testing hand in a neutral, comfortable position (not flexed or extended) with 90° of flexion at the index finger. The participants performed three trials for each hand alternately, always starting with the dominant hand. The participants were instructed to squeeze the grip continuously with full force for at least 3 seconds and were asked not to swing the grip dynamometer during the test and not to hold their breath. A resting interval of at least 30 seconds was allowed between each measurement. HGS was defined as the maximally measured grip strength among the six measurements.

HGS Cutoff Values
First, using normative data from healthy young adults (20–39 years) as the reference, we calculated the cutoff value as 2 standard deviations (SD) below the mean reference value, as recommended by the EWGSOP. Second, a healthy population of older adults was selected as the reference group, and their sex-specific quintiles (lowest 20%) were also used as cutoff values.

Statistical Analysis
The participants’ characteristics were presented as means (SD) or percentages. The mean and SD of HGS and 95% confidence intervals (CIs) were calculated for each 5-year interval starting from 10 years of age. We compared the participants’ characteristics according to sex using t-test and χ² test for continuous and categorical variables, respectively. Pearson’s correlation coefficients were used to analyze the correlations between HGS and BMI. We used PASW Statistics version 18.0 (SPSS Inc., Chicago, IL, USA) for all analyses with statistical significance set at p < 0.05.

RESULTS
The mean age and BMI of the 23,716 participants were 46.3 ± 19.7 years and 23.5 ± 3.7 kg/m², respectively. The men were younger than the women (45.7 ± 20.0 vs. 46.9 ± 13.9 years; p < 0.001). Education level, household income, and their differences according to sex are shown in Table 1.
The mean HGS was 39.5 ± 9.3 kg in men and 24.4 ± 5.3 kg in women. The mean HGS increased from 10 to 39 years, peaking at 35–39 years in both men (46.0 ± 7.2 kg) and women (27.2 ± 4.6 kg) (Table 2). After this age, the HGS decreased. The aging curve was steeper in men than in women (Fig. 2). A 10% loss of mean HGS from the peak value was observed at 55–59 years in men and 60–64 years in women.

A positive correlation between BMI and HGS was observed in both men and women. However, men showed a higher correlation ($\beta = 0.976$ and $r = 0.378$) than did women ($\beta = 0.190$ and $r = 0.134$) (Fig. 3). The cutoff values for low HGS (~2 SD below the reference of healthy young adults) were 29.6 kg for men and 16.8 kg for women (Table 3).

### Table 1. Demographic characteristics of the study participants

<table>
<thead>
<tr>
<th></th>
<th>Total (n = 23,716)</th>
<th>Men (n = 10,793)</th>
<th>Women (n = 12,923)</th>
<th>p-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>46.3 ± 19.7</td>
<td>45.7 ± 20.0</td>
<td>46.9 ± 13.9</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>162.6 ± 9.6</td>
<td>169.3 ± 8.1</td>
<td>157.1 ± 6.8</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>62.6 ± 12.9</td>
<td>69.0 ± 13.2</td>
<td>57.2 ± 9.9</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Waist circumference (cm)</td>
<td>80.8 ± 10.9</td>
<td>84.2 ± 10.4</td>
<td>78.0 ± 10.4</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>23.5 ± 3.7</td>
<td>23.9 ± 3.6</td>
<td>23.2 ± 3.7</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Education level</td>
<td></td>
<td></td>
<td></td>
<td>&gt;0.05†</td>
</tr>
<tr>
<td>≤ Elementary school</td>
<td>5,712</td>
<td>2,186</td>
<td>3,526</td>
<td></td>
</tr>
<tr>
<td>Middle school</td>
<td>2,788</td>
<td>1,319</td>
<td>1,469</td>
<td></td>
</tr>
<tr>
<td>High school</td>
<td>6,552</td>
<td>3,070</td>
<td>3,482</td>
<td></td>
</tr>
<tr>
<td>≥ College</td>
<td>7,098</td>
<td>3,421</td>
<td>3,677</td>
<td></td>
</tr>
<tr>
<td>Household income</td>
<td></td>
<td></td>
<td></td>
<td>&gt;0.05†</td>
</tr>
<tr>
<td>Q1 (lowest)</td>
<td>4,103</td>
<td>1,673</td>
<td>2,430</td>
<td></td>
</tr>
<tr>
<td>Q2</td>
<td>5,720</td>
<td>2,597</td>
<td>3,123</td>
<td></td>
</tr>
<tr>
<td>Q3</td>
<td>6,679</td>
<td>3,172</td>
<td>3,607</td>
<td></td>
</tr>
<tr>
<td>Q4 (highest)</td>
<td>7,002</td>
<td>3,300</td>
<td>3,702</td>
<td></td>
</tr>
</tbody>
</table>

*Calculated using t-test.
†Calculated using Pearson's chi-squared test.

### Table 2. Normative data of handgrip strength by age category

<table>
<thead>
<tr>
<th>Age (y)</th>
<th>Handgrip strength (kg)</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Mean ± SD</td>
<td>Min–Max</td>
</tr>
<tr>
<td>10–14</td>
<td>849</td>
<td>24.2 ± 8.7</td>
<td>7.0–58.2</td>
</tr>
<tr>
<td>15–19</td>
<td>717</td>
<td>38.4 ± 7.2</td>
<td>14.0–65.0</td>
</tr>
<tr>
<td>20–24</td>
<td>548</td>
<td>42.2 ± 7.3</td>
<td>13.4–68.0</td>
</tr>
<tr>
<td>25–29</td>
<td>536</td>
<td>43.7 ± 7.4</td>
<td>19.0–72.0</td>
</tr>
<tr>
<td>30–34</td>
<td>681</td>
<td>45.6 ± 7.7</td>
<td>18.9–72.0</td>
</tr>
<tr>
<td>35–39</td>
<td>854</td>
<td>46.0 ± 7.2</td>
<td>7.0–69.0</td>
</tr>
<tr>
<td>40–44</td>
<td>891</td>
<td>44.8 ± 6.9</td>
<td>10.1–66.7</td>
</tr>
<tr>
<td>45–49</td>
<td>829</td>
<td>44.0 ± 6.7</td>
<td>15.3–79.9</td>
</tr>
<tr>
<td>50–54</td>
<td>822</td>
<td>42.5 ± 6.4</td>
<td>18.5–70.4</td>
</tr>
<tr>
<td>55–59</td>
<td>985</td>
<td>41.5 ± 6.4</td>
<td>11.8–79.5</td>
</tr>
<tr>
<td>60–64</td>
<td>789</td>
<td>39.7 ± 6.3</td>
<td>11.0–59.6</td>
</tr>
<tr>
<td>65–69</td>
<td>823</td>
<td>37.3 ± 6.0</td>
<td>16.9–59.4</td>
</tr>
<tr>
<td>70–74</td>
<td>625</td>
<td>34.7 ± 5.9</td>
<td>13.5–52.6</td>
</tr>
<tr>
<td>75–79</td>
<td>526</td>
<td>31.9 ± 6.5</td>
<td>8.0–52.0</td>
</tr>
<tr>
<td>≥ 80</td>
<td>318</td>
<td>27.6 ± 6.4</td>
<td>8.0–46.6</td>
</tr>
<tr>
<td>Total</td>
<td>10,793</td>
<td>39.5 ± 9.3</td>
<td>7.0–79.9</td>
</tr>
</tbody>
</table>
DISCUSSION

The most important finding of this study was that the mean HGS peaked at 35–39 years of age in both men and women. The aging curve of HGS was steeper in men than in women. Men showed a higher correlation between HGS and BMI than that in women. In this Korean population, the cutoff values for low HGS were 29.6 and 16.8 kg for men and women, respectively. To our knowledge, this is the largest (n = 23,716) cross-sectional study to report normative HGS data.

Several studies have suggested cutoff values for low HGS. The revised EWGSOP2 guidelines defined low HGS as < 27 kg for men and < 16 kg for women on the basis of cutoff values –2.5 SD below the mean reference for young adults. The Foundation for the National Institutes of Health (FNIH) Biomarkers Consortium Sarcopenia Project recommended cutoff points for low HGS of < 26 kg for men and < 16 kg for women. In Asian populations, the AWGS first proposed a low HGS cutoff value of < 26 kg for men and < 18 kg for women or the lower 20th percentile of the HGS of the study population without outcome-based data. An update from the AWGS in 2016 suggested that the previous consensus cutoff points might require further modifications, and Auyeung et al. recently defined low HGS as < 28.0 kg for men and < 17.7 kg for women on the basis of a pooled dataset from various Asian countries (Table 3).

Although, even in Asia, different cutoff values have been reported in studies of Koreans. Yoo et al. analyzed HGS data of 4,553 Koreans in the 2015 KNHANES and suggested cutoff values of 28.6 and 16.4 kg for men and women, respectively, on the basis of the lower 20th percentile of the HGS of the study population. Another study analyzed HGS data of 7,969 Koreans from the 2014–2015 KNHANES and proposed cutoff values of 28.9 kg for men and 16.8 kg for women, derived from 2 SD below the values for healthy young adults. In the current study, the cutoff values for

Table 3. Cutoff values for low handgrip strength proposed by this study and other references

<table>
<thead>
<tr>
<th>Age group (y)</th>
<th>Low handgrip strength (kg)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Men</td>
<td>Women</td>
</tr>
<tr>
<td>-2 SD of young adults (20–39 years)</td>
<td>29.6</td>
<td>16.8</td>
</tr>
<tr>
<td>Lowest quintile of older populations</td>
<td>28.6</td>
<td>16.4</td>
</tr>
<tr>
<td>EWGSOP</td>
<td>30</td>
<td>20</td>
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<tr>
<td>EWGSOP2</td>
<td>27</td>
<td>16</td>
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<tr>
<td>AWGS</td>
<td>26</td>
<td>18</td>
</tr>
<tr>
<td>FNIH sarcopenia project</td>
<td>26</td>
<td>16</td>
</tr>
<tr>
<td>KNHANES 2015 (n = 4,553)</td>
<td>28.6</td>
<td>16.4</td>
</tr>
<tr>
<td>KNHANES 2014–2015 (n = 7,969)</td>
<td>28.9</td>
<td>16.8</td>
</tr>
</tbody>
</table>

EWGSOP, European Working Group on Sarcopenia in Older People; AWGS, Asian Working Group for Sarcopenia; FNIH, Foundation for the National Institutes of Health; KNHANES, Korea National Health and Nutrition Examination Survey.
low HGS were 29.6 and 16.8 kg for men and women, respectively. Attention should be paid to the interpretation of the HGS test results as HGS values may vary depending on the measuring instrument and protocol. Amaral et al. compared the accuracy and reliability of three types of hand-held dynamometers (Jamar dynamometer, Takei dynamometer, and EMG System Manual Transducer with modified handle), reporting that the shape of the dynamometer handle influenced the measurement of HGS and that the HGS may show different results depending on the measuring instruments. Balogun et al. studied the effects of testing posture and elbow position on HGS measurements, reporting significant differences between HGS measured in a sitting position with the elbow in 90° flexion and that measured in a standing position with the elbow fully extended. One study assessed the effect of handedness on HGS, reporting that the definition of handedness varied considerably and that a non-dominant hand could have a higher HGS than a dominant hand. Therefore, HGS measurements using only the dominant hand are not recommended. Furthermore, previous studies on HGS did not standardize the number of grips per test and the use of the average or maximum values after repeated measurements. Thus, a standardized test protocol for HGS measurement is required as HGS varies according to the measuring instrument, testing posture, frequency of measurements, use of average or maximum values of repeated measurements, and use of the dominant or non-dominant hand.

Whereas HGS showed similar patterns with age, we observed a difference according to sex. The HGS of men increased markedly until their 30s and then decreased steeply until 80 years of age. However, the changes in HGS with age occurred differently in women, increasing slowly until their 30s, remaining constant until their 40s to 50s, and then decreasing after 65 years of age (Fig. 2). Thus, a 10% loss of mean HGS from the peak value was observed in their 40s to 50s, and then decreasing after 65 years of age (Fig. 2). Whereas HGS showed similar patterns with age, we observed a difference according to sex. The HGS of men increased markedly until their 30s and then decreased steeply until 80 years of age. However, the changes in HGS with age occurred differently in women, increasing slowly until their 30s, remaining constant until their 40s to 50s, and then decreasing after 65 years of age (Fig. 2). Thus, a 10% loss of mean HGS from the peak value was observed in their 40s to 50s, and then decreasing after 65 years of age (Fig. 2).

The mechanisms leading to absolute sex differences in the reduction of muscle mass and strength with increasing age are unknown, although hormonal factors are most likely involved. reported that a few inflammation markers associated with sarcopenia were also correlated with sex hormones. Therefore, future research should examine the influence of menopause and andropause on sarcopenia.

The results of this study demonstrated the strong association between HGS and BMI, especially in men (Fig. 3). Several previous studies have supported the association between HGS and BMI. Pasdar et al. reported significantly increased HGS with increasing BMI in both men and women, with a more significant relationship in men than in women. Keevil et al. also reported this sex difference, suggesting that it might originate from differences in adipokine levels between men and women. One study with cross-sectional data from eight cohort studies (n = 16,444) also showed that increased HGS was associated with a higher BMI only in men, which the authors attributed to a lower proportion of lean mass in women than in men because of genetic, hormonal, and environmental differences.

Therefore, comparisons of HGS should be adjusted or stratified by BMI, especially in men. An update from the AWGS in 2016 recommended stratification of cutoff values for low HGS by BMI, proposing the corresponding cutoffs for low HGS with BMI < 22.1, 22.1–24.3, 24.4–26.3, and > 26.3 kg/m² of 25.0, 26.5, 26.4, and 27.2 kg, respectively, for men and with BMI < 22.3, 22.3–24.2, 24.3–26.8, and > 26.8 kg/m² of 14.6, 16.1, 16.5, and 16.4, respectively, for women. Wu et al. also proposed corresponding cutoffs of low HGS for different BMI groups using data from community-dwelling Taiwanese. The FNIH sarcopenia project also showed alternative HGS values adjusted for BMI.

Our study has several limitations. First, other diagnostic criteria for sarcopenia, such as skeletal muscle mass or gait speed, were not included in the analysis. Therefore, is hard to determine how well our cutoff values relate to low muscle mass or gait speed. Second, as this study was based on a cross-sectional design, we only reported the mean HGS values for each age group. Additional prospective cohort studies are needed to analyze individual changes in HGS over time. Third, although our study identified the close relationship between BMI and HGS, we did not suggest different HGS cutoffs for stratified BMIs. Further research is needed to propose how to adjust HGS for BMI for a more accurate criterion for the diagnosis of sarcopenia. Finally, although HGS measurement is relatively simple, the measurement methods are not uniform worldwide, making comparisons between studies difficult.

In conclusion, we proposed the cutoffs values for low HGS as 29.6 kg for men and 16.8 kg for women on the basis of national data from 23,716 Koreans. Our data may be useful for future research on sarcopenia in the Korean or other Asian populations.

CONFLICT OF INTEREST DISCLOSURES

The researchers claim no conflicts of interest.

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Background: Effective pain management is a fundamental human right. However, global disparities in pain management practices exist across health settings. This study explored healthcare practitioners' views on pain management in the acute care hospital setting. Methods: The focus groups included clinical specialties most likely to encounter patients with 'difficult to manage pain', namely those in the Geriatrics and Palliative Care Unit (2 doctors and 3 nurses), Critical Care Unit (7 doctors), and the Pain Management Team (3 doctors and 2 nurses). The transcripts were analyzed using a qualitative thematic analysis. Results: The data analysis revealed four themes. Theme 1, 'Being too safe' described the presence of apprehensive attitudes among patients and healthcare practitioners that limits the appropriate use of diverse and tailored pain medications in acute care hospital settings. Theme 2, 'Working as a team' described the need for collaborative approaches to achieve hospital-wide evidence-based pain management. Theme 3, 'Adaptation for local and cultural preferences' explored how pain was perceived through cultural lenses and suggested strategies to tailor pain management to local and cultural preferences. Finally, Theme 4, 'Driving acute pain management forward' listed clinician solutions for improving pain management in acute care hospital settings toward a pain-free hospital initiative. Conclusion: Despite advances in pain medicine and pain teaching strategies, effective pain management is proportionate to both clinical and cultural preferences. Future studies should investigate the standardization of global pain management tools and guidelines to fit the local culture and context.

Key Words: Acute pain, Pain clinics, Pain management, Symptom assessment, Hospitals

INTRODUCTION

Pain is a common condition encountered by healthcare professionals, especially those providing care for older patients. Pain is associated with significant disability, reduced mobility, falls, anxiety, depression, and social isolation. In addition, pain is a frequent complication of patients admitted to hospitals and negatively impacts multiple aspects of health, including the development of chronic pain. Pain is poorly managed for reasons ranging from clinicians’ attitudes of focusing on pathophysiology rather than the quality of life to cultural, societal, and organizational reasons. However, pain management is a fundamental human right; thus, strategies and efforts are required to improve pain.

A review of quality monitoring data from 8 large hospitals in the United States identified the following 6 quality indicators for optimal pain management in a hospital setting: documented pain in-
tensity using a numeric or descriptive rating scale; documented pain intensity at frequent intervals; treatment of pain other than by the intramuscular route; treatment with regular analgesia; and if possible, a multimodal approach of pain prevention and control to facilitate function and quality of life; and the education and knowledge of patients regarding pain management. However, diverse factors such as fears related to opioid side effects, communication issues, cultural beliefs, and lack of knowledge limit effective pain management.

Pain-free hospital initiatives that integrate pain treatment into routine hospital care have been implemented internationally to achieve pain management quality indicators. For example, in Poland, hospitals that maintain high standards of postoperative analgesia in terms of preoperative patient information, assessment and documentation, and monitoring of medication side effects and complications are certified as ‘pain-free hospitals’. These hospitals provide positive outcomes for both patients and the hospitals, with improved recovery, reduced complications, shorter hospital stays, and improved patient satisfaction.

Raja Isteri Pengiran Anak Saleha (RIPAS) Hospital, the main tertiary hospital in Brunei Darussalam with 880 beds, strives to improve hospital pain management. Currently, the hospital’s Pain Management Team focuses on postoperative management, while other teams are responsible for managing pain in their respective patients. To implement measures to ensure consistent pain assessment and management throughout the hospital, it is crucial to understand the current pain assessment and management practices. Therefore, the present study explored the views of clinicians regarding acute pain management in the hospital setting to move toward a pain-free hospital.

MATERIALS AND METHODS

Health professionals from three clinical specialties most likely to encounter patients with ‘difficult to manage pain’, namely the Geriatrics and Palliative Care Unit, the Critical Care Unit, and the Pain Management Team, were invited to participate in the study. The different views and perspectives of these specialties were expected to contribute toward a better understanding of barriers within the hospital. The inclusion criteria for the participants were health professionals who worked in the hospital for at least 1 year, who were involved in pain management within their scope of practice, and who were able to speak good English. The participants were informed about the study by the heads of each department. Potential participants who required more details regarding the study or who agreed to participate were contacted by the researchers.

A qualitative approach was utilized to gain insight into the problems experienced by the participants regarding acute pain management in hospital settings. Focus groups were used to determine the participants’ views on issues related to acute pain management, as this approach allowed researchers to elicit a large amount of rich data from different perspectives over a set time. The semi-structured, in-depth focus groups lasted between 30 and 60 minutes and were both audio-recorded and transcribed verbatim. The transcripts were analyzed using qualitative thematic analysis. An open coding process was performed independently by the researchers (NA, MV, and AH). The generated codes were discussed, and after a series of inductive analyses with the team members, the codes that conveyed similar meanings were thematically clustered into categories.

Written informed consent was obtained from the participants before inclusion in each focus group. This study was approved by the joint Pengiran Anak Puteri Rashidah Sa’adatul Bolkiah (PA-PRSB) Institute of Health Sciences Research Committee and the Medical and Health Research and Ethics Committee, Ministry of Health, Brunei Darussalam (No. UBD/IHS/B3/8).

RESULTS

Three separate focus groups were formed with 17 participants in total: the Geriatrics and Palliative Care Unit (2 doctors and 3 nurses), the Critical Care Unit (7 doctors), and the Pain Management Team (3 doctors and 2 nurses). The analysis revealed four themes: being too safe, working as a team, adaptation for local and cultural preferences, and driving acute pain management forward.

Theme 1: Being Too Safe

This theme described the presence of apprehensive attitudes among patients and healthcare practitioners due to complex pain scenarios, which prevent the appropriate use of diverse and tailored pain medications across acute hospital settings. The participants understood pain as a complex phenomenon requiring in-depth knowledge and understanding. Optimal management required an ability to consider the patient’s condition and health circumstances. Participant #7 described the multifaceted considerations faced by clinicians before prescribing analgesia as follows:

“When you prescribe any pain medication, you have to look at the health of the patient… if the patient has systemic disease, then it will be different. If the patient is elderly… Does the patient have renal disease? Does the patient have lung disease? Does the patient have allergies?” (P7)

To take the patients’ health care needs into account, clinicians...
need to constantly update their knowledge regarding pain management. Inadequate experience or training may lead to apprehension regarding medications and side effects. Apprehension regarding the potential side effects of pain medications may lead clinicians to prescribe lower doses of drugs or less efficacious medications as safer practice, which may impact adequate patient pain relief:

“They are afraid of the side effects; they don’t know how to treat the side effects. So they usually give the same stuff… Paracetamol, Tramadol, maybe pethidine, but they won’t give the strongest stuff. They don’t know much about diverse drugs; therefore it is safer for them not to give.” (P5)

Issues regarding patients’ understanding of pain management, particularly their expectations of the benefits and side effects of treatment were also identified. Clinicians’ perceptions of their patients’ understanding of their pain management plan could influence their approach:

“Some patients don’t like Norgesic, because they say it makes them ‘pening’ (dizzy). But they don’t realize that pethidine will make them more ‘pening’.” (P10)

Participants also expressed concerns regarding the risks of harm due to patients misunderstanding their pain management plan. These patient care experiences resulted in extra care when providing advanced pain management techniques, particularly those requiring self-management by patients:

“I just worry about the lack of knowledge of patients because I know if they have a syringe driver, and if they are a bit anxious, they’ll probably ramp it up. Just like we had patients with pneumonia, they bought an oxygen machine. And you ask … ‘Don’t you think about checking what’s the problem.’” (P2)

These common uncertainties faced by participants led them to express the urgent need for a strategy to raise awareness of safe pain management within patients and the local community to achieve a standard approach, with mutual understanding and expectations from both clinicians and patients. One participant stated that some wards had no educational activities to promote patients’ understanding of their pain awareness:

“We hope that they (patients) are given the information because we do have information leaflets regarding that (postoperative pain). Some wards are better than others, some zilch, totally nothing.” (P9)

In contrast, the participants suggested a standard operating procedure (SOP) outlining ways to manage patients’ safety concerns:

“We need to have a policy or SOP. How do we make sure there is no abuse? How to make sure the law governs the giver and receiver…” (P1)

**Theme 2: Working as a Team**

This theme described the importance of leadership and teamwork in pain management in hospitals, which can be influenced by the willingness of senior practitioners to apply evidence-based pain management and the sense of leadership in managing patients’ pain as a team.

The participants described ‘hierarchical challenges’ in the hospital that impeded evidence-based pain management practices in acute hospital settings. Although pain knowledge and understanding have improved over time, clinicians may be unwilling to change their pain management strategies:

“Every year, I give them tutorial(s) on acute pain management… but when you go back to your ward, you follow what your seniors do. They learn, but when they see senior doctors, the boss says so, you follow.” (P10)

**Communicating patient’s pain between staff**

Good communication is vital to ensure clinical assessment and treatment of patients complaining of pain. Handover between staff regarding pain and communicating patients’ needs require further improvement to ensure continuity of care. The participants reported that staff compensate for limited handovers by duplicating pain history-taking and assessment:

“Doctors are not there all the time, nurses are. And the message has to reach the doctor from the nurses. Even epidural analgesia, they (patients) tell the midwife, the midwife (should) tell the anesthetist.” (P10)

“First of all, the pain nurse will talk to them, and then when the anesthetist goes to see them, they will ask again.” (P4)

**Collaborative approach within a multidisciplinary team**

The participants agreed that health professionals should work together toward improving pain management. As this is a shared responsibility among clinicians, a collaborative approach within a multidisciplinary team is required within the hospital:

“It’s not just us who has to assess, our nurses will give feedback. Our physio(therapist)s and OTs (Occupational Therapists) will also give
feedback. Physio would say ‘When they put weight on that side, we think the knee is sore. Can you look at that?’ And we may not have assessed that well when they are lying in bed in the morning. Same with occupational therapy, when dressing or transferring, they will mention (pain) to us.” (P2)

The participants also included family members as part of the “team” involved in pain assessment and management:

“Health professionals know how to assess pain. We can involve family to assess the pain. So there is no specific… which we call pain nurse, pain team.” (P3)

Theme 3: Adaptation for Local and Cultural Preferences
This theme explored how pain was perceived through cultural lenses and proposed strategies to tailor pain management to local preferences.

Cultural barriers in assessment
The participants felt that cultural variations should be considered during pain assessment and management. The language used in standard pain assessment tools to assess pain severity may not apply well in local settings:

“We tend to use more descriptive (terms) and the thing I use is how it affects their daily activities in life. Does it affect their sleep, does it affect their eating, does it affect their moving? If it affects them, it’s quite severe pain. Cause for them, they don’t understand what the tools mean.” (P1)

The participants also felt that patients were not as forthcoming when asking for analgesia, possibly due to cultural reasons. Patient requests for pain relief were considered an indication of high-intensity or severe pain:

“Bruneians have got a very high pain threshold. So we don’t need much pain relief. They are polite people. So if they are in pain, they endure. So they don’t even ask the nurse.” (P10)

Incorporating cultural preferences in pain management
The participants also considered cultural preferences when providing pain management. The majority of the population are Muslim and religion seemed to influence the effectiveness of the pain management strategy. The participants appeared to embrace this culture but were less confident in suggesting that their patients incorporate their religious values into pain management:

“Use the zikir (prayers) to recite in silence. It depends on their beliefs but it actually helps. But I don’t know how to reinforce this non-pharmacological (approach) from the Islamic perspective.” (P5)

Family involvement is also a cultural norm that influences the success of pain management:

“We ask family members to sit by their side to calm them. Some patients want family members; people they are familiar with to comfort them.” (P1)

Theme 4: Driving Acute Pain Management Forward
Clinician buy-in
‘Clinician buy-in’ and support is required from all relevant stakeholders to drive pain management forward. The barriers and different perspectives that may hinder pain-free hospital initiatives should be considered and discussed with stakeholders before initiating changes. This belief was illustrated in the following statements:

“If you want to introduce something, it means more work for the nurses. It means more work for the recovery (staff) and then, of course, they are resistant to do it. And we can’t blame them because they are overloaded as well.” (P7)

“I was flagged up so many impossibilities. ‘Patient is going to be nil by mouth’, I said ‘Give suppository’, ‘They don’t have any suppositories available’. ‘Get some from OT (operating theatre)’. ‘Oh, sometimes OT won’t give it’. The patient is in pain, you know.” (P9)

The participants indicated that improving pain management would be challenging without teamwork and agreement from all relevant parties.

Guidelines and mentorship
The participants also felt that localized guidelines would be useful to ensure a consistent clinical approach. Informally, staff have adapted or referred to those available overseas:

“In terms of a localized guideline, whether adapted or informal, I can simply say no such guideline. In terms of practice, we refer to management (guidelines) from the United Kingdom. If we look at all these guidelines, there are some differences. We will just agree and adapt to the local (situation).” (P1)

They also felt that mentorship is required to guide and train staff in the improvement in pain management:

“When I first started, it’s just Panadol (Paracetamol), nothing or Panadol. ‘What about tramadol? or ‘Maybe we’ll just try a little bit of
Morphine. Now our junior team is more confident with use of opioids. And pharmacological treatment is a bit more optimal.” (P2)

Another participant suggested the need for mentors or champions throughout the hospital to achieve the goal of a pain-free hospital:

“There should be someone in each ward, who is perhaps a pain lead. They don’t have to (be) specialized in it but they should be the one trying to motivate the rest of the staff to actually do it.” (P9)

DISCUSSION

Pain assessment and management in older adults have inherent challenges, with significant implications for functional outcomes. These challenges may be further complicated by other factors related to hospital-specific settings. This study explored the views of clinicians in a tertiary hospital on the barriers and solutions for effective pain assessment and management. A pain-free hospital project in Germany reported that more than half of the surgical and non-surgical patients were dissatisfied with pain management, with peak pain usually occurring outside normal working hours. Therefore, it is important to integrate effective pain management into routine practice across ward settings, moving away from pain specialty teams toward a pain-free hospital.

Healthcare practitioners reported that a key barrier to effective pain management was a feeling of apprehension toward the appropriate use of diverse pain medications in acute hospital settings. The doctors and nurses who participated in this study may have had significant knowledge deficits and false beliefs that could impede their treatment of patients in pain. A study assessing the knowledge and attitudes of doctors and nurses found that only 61% of the questions were answered correctly, necessitating hospital-wide educational programs to improve clinicians’ understanding of pain. Reassessment of the impact of educational interventions in terms of pain assessment, patient satisfaction, and improvement in knowledge, as well as the provision of access to evidence-based resources to maintain updated knowledge on pain assessment and management, is also recommended.

Participants also shared concerns regarding under-treatment of pain due to inadequate knowledge of medications and the management of side effects or adverse reactions. A study implementing a pain treatment algorithm based on numerical pain ratings found that the rate of opioid adverse drug reactions doubled, especially over-sedation and decreased patient level of consciousness. Dose adjustments and careful monitoring should be considered specifically for certain populations with higher risks, such as older patients, those with dementia, or those with previous cerebrovascular injuries. These practical challenges recognized by the participants in the present study should be addressed in educational sessions to avoid complications from pain management.

Our study also raised issues regarding patients’ understanding of pain relief, which may impede effective pain management. A study from the United States reported that, despite improvements in pain treatment, the rate of moderate to severe postoperative pain remained 80%, with more than half of patients expressing fear about pain after surgery. Patient participation in decision-making regarding pain management is associated with less time in severe pain, better pain relief, lower pain severity, and improved quality of care. These findings reinforce the need for increased professional and public awareness, including the establishment of pain management programs incorporating public and patient education.

The results of our study also highlighted the need for a consistent clinical approach with collaboration and effective communication between staff. While pain management varies between hospitals and wards, the participants expressed a desire for a hospital culture conducive to optimizing pain control. A large Canadian teaching hospital reported worse pain management in non-surgical patients compared with that in surgical patients, with longer waiting times for medications, increased likelihood of prescribing ineffective medications, and the prescription of breakthrough pain relief when required in only half the medical patients. Achieving a pain-free hospital requires the involvement of all health care teams to play important roles in acute pain medicine. These teams include physicians, nurses, pharmacists, psychologists, physiotherapists, occupational therapists, and patients.

There is also a narrative of hierarchy in hospitals, particularly where trainees are expected to not challenge or question the judgment or decisions of their seniors. This may be due to fears of appearing inadequate when facing uncertainty with complex patients or a desire to be viewed favorably due to their dependence on their seniors for career progression. The power differentials between healthcare providers need to be acknowledged to develop models for shared responsibility between professions, particularly as a collaborative approach for pain management is necessary to improve patient outcomes.

Educational activities and quality improvement initiatives should involve all medical providers to ensure a consistent clinical approach with a unified goal of providing safe, timely, and effective management of all acute pain scenarios. The Toronto General Hospital Transitional Pain Service developed a multidisciplinary program to reduce the risk of postoperative pain, illustrating the benefits of a team approach and effective interprofessional communication. The comprehensive pain intervention addressed pain pre-operatively, postoperatively, and at outpatient follow-up 6 months after surgery. Patients at high risk of pain complications were identi-
fied early and their care coordinated by a team of pain physicians, advanced practice nurses, psychologists, and physiotherapists who used patient encounters as opportunities to impact pain trajectories. A clinical algorithm was used to provide clinical services through the different stages of surgical recovery, including preventative behavioral interventions to reduce the likelihood of pain.22) Our study also identified cultural factors impacting pain assessment, including patients not requesting pain relief or with a high pain threshold in local settings. Pain assessment in older adults is challenging for multiple reasons, including multiple medical problems contributing to pain, an inability to self-report due to cognitive impairment, and the need to recognize atypical presentations or behavioral changes that may indicate pain.23) In this setting, these challenges may also be exacerbated by pre-existing cultural beliefs, such as pain as an inevitable part of the human condition, societal attitudes toward pain relief during surgery and childbirth, pain seen as necessary or unavoidable, or associating chronic pain with psychological problems, resulting in a reluctance to request analgesia or medical attention.4) The cultural validity of self-reported pain assessment tools should also be considered, and adjustments should be made to incorporate cultural views and tailor the language to suit the local population.24) For example, words may have different meanings, confounding patients’ understanding of their pain experience. Further work is required to establish shared meanings and pain descriptors due to the variety of languages spoken locally.25) The participants also identified patients’ preferences for non-pharmacological treatments. While this may be appropriate for initial treatment, an evidence-based approach is required. Clinicians must remain up-to-date on complementary and alternative approaches to provide patients information on these options for pain management.26) Further study may be required to assess how culture impacts patient and clinician understanding of pain and to tailor pain assessment and management strategies to suit the target population.

The final theme discussed how to drive acute pain management forward through clinician buy-in and providing guidelines and mentorship. Guidelines developed by multidisciplinary panels of experts and based on the best available evidence are essential for promoting the effective and safe use of opioid therapy.27) The development of pain practices may be promoted through nurse-to-nurse mentoring and ongoing interactive case-based learning in pain management.28) The Milan Cancer Institute, with extensive experience in pain assessment through validated tools, pain management, and educational efforts, also emphasized the importance of the long-term sustainability of these initiatives, with a need to persevere with continuing educational and informative programs to reduce pain frequency and severity and thus improve in-patient quality of life.29) The strengths of this study include its use of focus groups to gain insight into aspects of pain management from the main specialties dealing with clinical pain. However, the views of team members outside these specialties and allied health professionals may not have been fully represented. To move toward a pain-free setting, hospitals should focus on increased knowledge among clinicians and patients and a team approach to implement consistent pain management strategies that considers cultural factors to tailor plans to the local population. Future research should assess pain knowledge among clinicians and patients, the effectiveness of multidisciplinary pain management interventions, and the effects of culture on pain assessment and management.

In conclusion, the results of this study revealed clinicians’ views of pain assessment and management in a tertiary hospital setting, including the strengths and limitations of the provision of acute pain service. Despite advances in pain medicine, effective pain management is proportionate to both clinical and cultural factors. These issues should be identified and resolved, as optimal pain management is required to avoid complications including dependence and loss of function in older adults. Future studies should investigate the standardization of global pain management tools and guidelines to fit the local culture and context.

CONFLICT OF INTEREST DISCLOSURES

The researchers claim no conflicts of interest.

REFERENCES


INTRODUCTION

The activities of daily living (ADL) and instrumental activities of daily living (IADL) scales represent fundamental measurements of functional status and are important tools not only for planning and predicting the need for long-term care but also for assessing the effectiveness of various policies and services for older populations. Several studies have confirmed the accuracy, validity, and reliability of these functional scales. However, their accuracy as a measure of functioning may be limited by latent biases stemming from cultural differences in who performs different activities.

Gender differences in the ADL and IADL tasks have long been postulated. When asked about items related to performing light housework, doing laundry, and preparing meals, men often report that they do not perform these functions due to gender roles. Lawton recognized traditional gender roles as possible confounders of accurate functional assessment in the development of the IADL scale and consequently excluded cooking and housekeeping when assessing functional disability in men. However, LaPlante suggested that the successful performance of home management chores, such as cooking and cleaning, is necessary to maintain a reasonable standard of living. In another study investigating gender bias in the reported impairment of daily activities in cancer patients, approximately half of the help received by married men was attributable to gender role responsibilities (tasks seen as women’s work) rather than functional disability. Role-related help with household tasks was less prevalent among married women.

The perceived gender roles of older adults may further differ between countries and cultures. In East Asian countries such as Korea, where gender segregation has traditionally been more pronounced than in other countries, gender-specific patterns of item response bias for ADL/IADL questionnaires may be particularly...
sallent. Moreover, because of gender- and age-based differences in educational attainment, gender may have significant latent effects on the ADL/IADL item responses of older generations. Based on studies performed for the development of the Korean versions of ADL and IADL, Won et al. observed that older Korean men reported being unable to do laundry, prepare meals, and perform household chores because they had not previously performed these activities. Likewise, older women were likely to have difficulties managing money, using the telephone, and using transportation because they lacked prior experience with such tasks.

Women in Korea have only recently attained any degree of economic power. Social activities such as managing money, banking, using the subway, and driving were previously considered specific male tasks rather than basic functional activities. With dramatically improved and modernized education after World War II and the Korean War, older women of more recent generations and baby boomers may be less subject to gender bias in ADL/IADL responses. However, although they are physically capable of doing these things, many older Korean women are still dependent on their husbands, children, and other family members for tasks such as using cell phones, taking public transport, and using a bank. Thus, women are likely to report needing help with ‘cognitive activities’ while being independent in their ability to perform household activities, while older men show an opposite tendency.

Item response theory (IRT) is used in comparison tests and similar instruments to measure unobservable respondent characteristics. IRT models are used extensively in the study of health outcomes and the development of item banks and computerized adaptive testing. Eight previous IRT-based studies have revealed multidimensionality, comparability, and group differences in ADL/IADL responses. Cabrero-Garcia et al. suggested a modified aggregated ADL/IADL measure that would account for gender bias in determining the severity of impairment. Items on the IADL list can be divided into household, outdoor, and cognitive activities; based on traditional gender roles, gender bias is particularly strong in household activities. However, unidimensional analyses of ADL appear to be sufficient in women, while in men, ADL is bidimensional and divided into self-care and mobility.

To more accurately measure and monitor functional status, the use and interpretation of ADL/IADL measurements should consider the characteristics of tasks and cultural backgrounds of the respondents. Therefore, we investigated the gender-, educational level-, and age-specific IRTs of ADL/IADL items in older Korean adults and the latent bias in the measurement tool when determining functional status.

MATERIALS AND METHODS

Data and Sample

The analyses were based on the baseline wave of the Korean Longitudinal Study of Ageing (KLoSA), a population-based survey of a nationally representative sample of older adults conducted from July to September 2006. All participants aged 65 years or older were included if they responded to ADL/IADL items and reported their educational level. A total of 4,164 subjects were included in the final analyses. The study design and protocol were reviewed and approved by the Chung-Ang University Institutional Review Board (No. 1041078-201708-HRSB-163-01).

Functional Disability

Functional disability was measured using the 7-item Korean ADL scale and the 10-item Korean IADL scale. The ADL scale includes items on getting dressed, washing one’s face and hands, bathing, eating meals, leaving a room, using the toilet, and urinating and/or defecating; the IADL scale includes items related to personal grooming, going out for short walks, using transportation, making/receiving phone calls, managing money, doing household chores, preparing meals and cooking, shopping, taking medications, and doing laundry. If the respondents were partly or totally dependent for a given activity, they were categorized as dependent (dependent = 1, independent = 0). The sum of their ADL and IADL deficit scores were representative of their functional status. Some controversy remains whether ADL and IADL are unidimensional or multidimensional measures. As proposed previously, we divided ADLs and IADLs into two and three dimensions, respectively. The ADL tasks that included changing clothes, washing, showering, eating, using the toilet, and defecation and urination were categorized as ‘self-care’. Items related to getting up and leaving the room were conceptualized as ‘mobility’. We considered IADL tasks such as grooming and going out to rely on physical health or strength and, therefore, classified them as ‘physical IADLs’. Likewise, we considered tasks involving using transportation, managing money, using the telephone, and taking medication to require complex cognitive resources, and, thus, classified them as ‘cognitive IADLs’. We categorized other tasks, such as performing light housework, cooking, doing laundry, and shopping, as ‘household activities’.

Statistical Analyses

Gender, age, and educational level were exogenous variables. Age and education level were dichotomized (< 75 vs. ≥ 75 years and any vs. no education). The total combined ADL/IADL scores were log-transformed to correct for skewness before being used in
the analyses. We used Mantel–Haenszel (MH) adjustment methods. The MH odds ratio (OR) conditioned on the total scale score is test a commonly used for differential item functioning (DIF) analysis in which both response items and exogenous variables are binary. According to IRT, the responses to a survey item are expected to be the same across the level of the exogenous variables once conditioned on the latent variable. An independent association between any item and any exogenous variable (i.e., if the total scale-adjusted OR is not equal to 1.0) provides evidence that the response to that item is biased with respect to the exogenous variable.

DIF is used when the items intended to measure a latent trait are unfair, favoring one group of individuals over another. DIF is investigated in conjunction with fitting IRT models. DIF includes an assessment that the item behaves differently across respondents with the same value of the latent trait. An item ‘functions differently’ across individuals with the same latent trait level if these individuals have different probabilities of selecting a given response.

We explored the odds assumption for p-values from the odds score test < 0.05. As the p-value confounds sample size with effect size, we also followed a previous study on IRT by retaining all items with relatively large practically meaningful biases, which we defined as an OR > 2.0 or < 0.5. An OR of 2.0 means that those in the test group were twice as likely to provide a higher response (i.e., to report disability) to an individual item than those in the control group after matching for overall functional disability score. To test for item discrimination bias, we included an interaction term between the exogenous variable and the total ADL/IADL score for those items with practically meaningful item difficulty bias. We tested for differential factor functioning or factor bias by associating the factor score with each exogenous variable, while conditioning the overall ADL and IADL scores. The ADL and IADL items were grouped into 5 categories (self-care, mobility, physical activities, cognitive activities, and household activities) based on the results of previous studies. Finally, we calculated the disability rates using the full versions of ADL and IADL as well as shortened revised versions of the ADL and IADL from which we removed items that functioned significantly differently from the exogenous variables (gender, age, and educational level). We calculated the disability rates as the percentage of older adults categorized as dependent in one or more ADL/IADL items.

RESULTS

The mean participant age was 72.9 ± 6.3 years. About 35.5% were aged 75 years or older, 41.8% were men, and 44.5% had completed any level of formal education. All item responses were skewed towards the ‘do not need help’ category. The average total functional disability (ADL and IADL) score was 1.5 ± 3.7 (range, 0–17). The average log-transformed functional disability score was 0.33 ± 0.75 (range, 0–2.83). The percentages of dependent responses for the ADL/IADL items are shown in Table 1. Functional status was generally better for younger (<75 years) and educated (vs. non-educated) respondents, while gender differences in functional status varied by item. Women reported being better at household activities such as cooking and doing laundry, while men reported needing less help with other IADL items including going out, using transportation, shopping, managing money, and using the telephone. No gender differences were seen in responses to ADL items, aside from defecation (Table 1).

Two IADL items and all seven ADL items were relatively free of item bias according to gender, age group, and educational level (Table 2). Eight IADL items appeared to have practically meaningful item-level biases, with ORs > 2.0. Men were 7.69 times more likely to report needing help with preparing meals (95% confidence interval [CI], 5.14–11.50) and 2.55 times more likely to report needing help doing laundry (95% CI, 1.86–3.49) than women matched for overall functional disability. In contrast, men were less likely to report needing help going outside to a nearby location (OR = 0.43; 95% CI, 0.28–0.67), using transportation (OR = 0.21; 95% CI, 0.14–0.31), shopping (OR = 0.40; 95% CI, 0.25–0.63), managing money (OR = 0.36; 95% CI, 0.26–0.51), and using the telephone (OR = 0.48; 95% CI, 0.34–0.68). Adults aged 75 years or older were more likely to report dependence in managing money (OR = 2.04; 95% CI, 1.51–2.74) and using the telephone (OR = 3.37; 95% CI, 2.36–4.81) than younger elderly people matched for overall functional status.

Seven IADL items presented meaningful item-level bias according to educational level. The item bias was similar to the results by gender in terms of preparing meals, doing laundry, using transportation, shopping, managing money, and using the telephone. However, going outside nearby was not biased according to educational level. In addition, the odds of educated people reporting that they needed help doing household chores was 2.14 times greater than that of older adults with no education (95% CI, 1.31–3.48) (Table 2).

Men matched for functional ability reported being more disabled than women in performing household chores, preparing meals, and doing laundry, three items that comprised the household activities dimension of the IADL. Thus, this item-level bias carried over as a positive factor-level bias. As seen in Table 3, the OR of men reporting higher levels of disability in the household activities dimension subscale was 4.27 (95% CI, 3.25–5.60) times that in women matched for overall functional disability. Regarding the cognitive activities dimension, the OR for men was 0.37 (95%
CI, 0.29–0.46) times that of women matched for overall functional disability. The cognitive and household activities dimensions were positive factor-level biases for both age group and educational level (Table 2).

The internal consistency reliability of the full version of ADL/IADL was 0.96, as measured using Cronbach’s alpha. The reduced 9-item ADL/IADL that excluded the 8 IADL items with item-level bias retained an internal consistency reliability of 0.95. The 9-item version of the ADL/IADL showed a correlation of 0.68 with the full 17-item version. The disability rate from the reduced 9-item ADL and IADL was 10.6%, which was lower than that for the full version (25.3%). Gender differences in disability rates were apparent in the reduced version in that women were significantly more disabled (11.4%) than men (9.4%). No gender differences in disability rates were detected using the full version. Older and less educated individuals were more likely to have some disability; this tendency was the same regardless of full or short version of the ADL/IADL (Table 3).

**DISCUSSION**

In our study, eight out of ten IADL items functioned differently among subgroups defined by gender, age, and educational level. Four of these items related to household activities, three were cognitive activities, and one item was related to physical activity. The items comprising household activities were biased in the direction of higher endorsement by men (i.e., men were more likely to rate themselves as dependent in these areas), while items comprising cognitive activities were biased toward higher endorsement among women after matching for overall functional disability. Measurement with the DIF-adjusted versions of ADL and IADL revealed statistically robust gender-based differences in disability rates even though the absolute gap in disability rate by gender was similar between original and DIF-adjusted versions of ADL and IADL.

In previous studies examining gender-based item response bias, DIF was detected in items related to bathing, shopping, performing household chores, using the telephone, and taking medication. However recent studies applying DIF analysis to ADL and IADL were exclusively performed in Western settings, where the gendered division of household labor is not as skewed as in the Asian context. In this study, we found item-level bias in all of those items as well as in items related to managing money and using transportation, which are cognitive activities. In addition, we found item-level bias in the

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Table 1. Dependent rates (percentages) for each ADL and IADL task by sex, age, and educational level among older Korean adults, KLoSA baseline

<table>
<thead>
<tr>
<th></th>
<th>Total (n = 4,164)</th>
<th>Male (n = 1,741)</th>
<th>Female (n = 2,423)</th>
<th>65–74 (n = 2,683)</th>
<th>≥ 75 (n = 1,481)</th>
<th>None (n = 3,026)</th>
<th>Any (n = 1,135)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ADL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dressing</td>
<td>6.03</td>
<td>6.26</td>
<td>5.86</td>
<td>2.87</td>
<td>11.75**</td>
<td>6.74</td>
<td>4.14*</td>
</tr>
<tr>
<td>Washing</td>
<td>5.16</td>
<td>5.68</td>
<td>4.83</td>
<td>2.50</td>
<td>9.99**</td>
<td>5.58</td>
<td>4.05*</td>
</tr>
<tr>
<td>Showering</td>
<td>7.68</td>
<td>7.01</td>
<td>8.17</td>
<td>3.62</td>
<td>15.06**</td>
<td>8.59</td>
<td>5.29**</td>
</tr>
<tr>
<td>Eating</td>
<td>4.37</td>
<td>4.88</td>
<td>4.00</td>
<td>2.16</td>
<td>8.37**</td>
<td>4.79</td>
<td>3.26*</td>
</tr>
<tr>
<td>Rising and exiting a room</td>
<td>5.12</td>
<td>5.51</td>
<td>4.83</td>
<td>2.42</td>
<td>9.99**</td>
<td>5.65</td>
<td>3.70*</td>
</tr>
<tr>
<td>Using the toilet</td>
<td>3.77</td>
<td>4.31</td>
<td>3.38</td>
<td>2.01</td>
<td>6.95**</td>
<td>4.06</td>
<td>3.00</td>
</tr>
<tr>
<td>Defecating</td>
<td>3.53</td>
<td>4.19</td>
<td>3.05*</td>
<td>1.71</td>
<td>6.82**</td>
<td>3.93</td>
<td>2.47*</td>
</tr>
<tr>
<td><strong>IADL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grooming</td>
<td>5.88</td>
<td>5.92</td>
<td>5.86</td>
<td>2.65</td>
<td>11.75**</td>
<td>6.54</td>
<td>4.14*</td>
</tr>
<tr>
<td>Performing household chores</td>
<td>10.88</td>
<td>10.68</td>
<td>11.02</td>
<td>6.04</td>
<td>19.65**</td>
<td>11.96</td>
<td>8.02**</td>
</tr>
<tr>
<td>Cooking</td>
<td>14.07</td>
<td>17.98</td>
<td>11.27**</td>
<td>8.95</td>
<td>23.36**</td>
<td>14.34</td>
<td>13.39</td>
</tr>
<tr>
<td>Doing laundry</td>
<td>16.53</td>
<td>18.10</td>
<td>15.39*</td>
<td>10.85</td>
<td>26.82**</td>
<td>17.22</td>
<td>14.71</td>
</tr>
<tr>
<td>Going out</td>
<td>11.12</td>
<td>8.79</td>
<td>12.79**</td>
<td>5.48</td>
<td>21.34**</td>
<td>12.82</td>
<td>6.52**</td>
</tr>
<tr>
<td>Using transportation</td>
<td>15.27</td>
<td>10.97</td>
<td>18.37**</td>
<td>7.86</td>
<td>28.70**</td>
<td>18.11</td>
<td>7.67**</td>
</tr>
<tr>
<td>Shopping</td>
<td>10.71</td>
<td>8.39</td>
<td>12.38**</td>
<td>4.62</td>
<td>21.74**</td>
<td>12.62</td>
<td>5.55**</td>
</tr>
<tr>
<td>Managing money</td>
<td>13.52</td>
<td>10.28</td>
<td>15.85**</td>
<td>6.63</td>
<td>26.00**</td>
<td>16.13</td>
<td>6.52**</td>
</tr>
<tr>
<td>Using the telephone</td>
<td>9.03</td>
<td>7.24</td>
<td>10.32**</td>
<td>3.39</td>
<td>19.24**</td>
<td>10.84</td>
<td>4.23**</td>
</tr>
<tr>
<td>Taking medication</td>
<td>5.50</td>
<td>5.57</td>
<td>5.45</td>
<td>2.24</td>
<td>11.41**</td>
<td>6.18</td>
<td>3.70*</td>
</tr>
</tbody>
</table>

ADL, activities of daily living; IADL, instrumental activities of daily living; KLoSA, Korean Longitudinal Study of Aging.

*p<0.05, **p<0.001 by chi-square test according to sex, age, and educational level separately.
Direction of endorsement of further disability in women for the physical activity of getting around outside. Comparison of our results with those of previous studies (Supplementary Table S1) showed that more IADL items in the Korean older adults showed gender-specific response biases than those in other populations. To our knowledge, this is the first such report among East Asian countries. The differential item responses to household activities were more pronounced in this study than the gendered DIF reported in Singapore.

We also observed item response bias according to age group (< 75 vs. ≥ 75 years) for doing laundry and using the telephone. The older age group was less likely to endorse disability in doing laundry and more likely to do so in using the telephone. This finding is similar to the gender item response differences for these items. This similarity might be due to the high correlation between age and gender: 64.2% of the adults aged 75 years or older were women, indicating that women were more likely to be older than men. In previous studies, the items that differed in item response according to age included preparing meals and performing household chores. Fleishman et al. compared DIF according to combined gender and age groups, observing item-level bias in

### Table 2. DIF by gender, educational level, and age

<table>
<thead>
<tr>
<th></th>
<th>Men</th>
<th>Age ≥ 75 y</th>
<th>Education</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dressing</td>
<td>1.15</td>
<td>0.98</td>
<td>0.87</td>
</tr>
<tr>
<td>Washing hands and face</td>
<td>1.20</td>
<td>0.56</td>
<td>1.86</td>
</tr>
<tr>
<td>Bathing</td>
<td>0.64</td>
<td>0.92</td>
<td>1.30</td>
</tr>
<tr>
<td>Feeding self</td>
<td>1.40</td>
<td>0.67</td>
<td>1.08</td>
</tr>
<tr>
<td>Walking across room</td>
<td>1.44</td>
<td>0.74</td>
<td>1.24</td>
</tr>
<tr>
<td>Using toilet</td>
<td>1.15</td>
<td>0.54</td>
<td>1.38</td>
</tr>
<tr>
<td>Defecating &amp; urinating</td>
<td>1.83</td>
<td>0.56</td>
<td>0.54</td>
</tr>
<tr>
<td>IADL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grooming</td>
<td>0.99</td>
<td>0.90</td>
<td>1.16</td>
</tr>
<tr>
<td>Doing light housework</td>
<td>1.55</td>
<td>0.58</td>
<td>2.20</td>
</tr>
<tr>
<td>Preparing meals</td>
<td>7.83</td>
<td>0.51</td>
<td>4.90</td>
</tr>
<tr>
<td>Laundry</td>
<td>3.05</td>
<td>0.44</td>
<td>4.25</td>
</tr>
<tr>
<td>Going outside nearby</td>
<td>0.43</td>
<td>0.93</td>
<td>0.66</td>
</tr>
<tr>
<td>Using transportation</td>
<td>0.20</td>
<td>1.57</td>
<td>0.21</td>
</tr>
<tr>
<td>Shopping</td>
<td>0.40</td>
<td>1.97</td>
<td>0.37</td>
</tr>
<tr>
<td>Managing finances</td>
<td>0.37</td>
<td>1.74</td>
<td>0.30</td>
</tr>
<tr>
<td>Using the telephone</td>
<td>0.49</td>
<td>3.03</td>
<td>0.29</td>
</tr>
<tr>
<td>Taking medication</td>
<td>1.03</td>
<td>1.87</td>
<td>0.83</td>
</tr>
</tbody>
</table>

**ADL dimension**

Self-care dimension | 1.27 | 0.61 | 1.22
Mobility dimension  | 1.26 | 0.83 | 1.03

**IADL dimension**

Physical activities dimension | 0.66 | 1.13 | 0.70
Cognitive activities dimension | 0.35 | 2.80 | 0.22
Household activities dimension | 4.01 | 0.68 | 2.51

Bold text represent a significant difference (OR>2.0 or OR<0.5).

DIF, differential item functioning; ADL, activities of daily living; IADL, instrumental activities of daily living.

*Self-care include dressing, washing, showering, eating, using toilet, defecating and urinating; and Mobility include getting up and exiting a room.

*Physical activities include grooming, going out nearby; Cognitive activities, using transportation, managing money, using the telephone, taking medication; and Household activities, performing household chores, preparing meals, doing laundry, shopping.

### Table 3. Comparisons of disability rates from the full ADL/IADL and DIF-adjusted reduced scales

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Disability rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Full scale</td>
<td>DIF-adjusted short scale</td>
</tr>
<tr>
<td>Total</td>
<td>4,164</td>
<td>25.3</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>1,741</td>
<td>24.4</td>
</tr>
<tr>
<td>Female</td>
<td>2,423</td>
<td>26.0</td>
</tr>
<tr>
<td>Age (y)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>65–74</td>
<td>2,683</td>
<td>16.7**</td>
</tr>
<tr>
<td>75–84</td>
<td>1,250</td>
<td>35.4</td>
</tr>
<tr>
<td>≥ 85</td>
<td>231</td>
<td>71.0</td>
</tr>
<tr>
<td>Educational level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elementary or below</td>
<td>3,026</td>
<td>27.8**</td>
</tr>
<tr>
<td>Middle school</td>
<td>407</td>
<td>19.9</td>
</tr>
<tr>
<td>High school or over</td>
<td>728</td>
<td>18.0</td>
</tr>
<tr>
<td>Men</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (y)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>65–74</td>
<td>1,211</td>
<td>18.9**</td>
</tr>
<tr>
<td>75–84</td>
<td>463</td>
<td>32.4</td>
</tr>
<tr>
<td>≥ 85</td>
<td>67</td>
<td>67.2</td>
</tr>
<tr>
<td>Educational level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elementary or below</td>
<td>921</td>
<td>27.3**</td>
</tr>
<tr>
<td>Middle school</td>
<td>249</td>
<td>23.3</td>
</tr>
<tr>
<td>High school or over</td>
<td>570</td>
<td>20.2</td>
</tr>
<tr>
<td>Women</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (y)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>65–74</td>
<td>1,472</td>
<td>14.8**</td>
</tr>
<tr>
<td>75–84</td>
<td>787</td>
<td>37.2</td>
</tr>
<tr>
<td>≥ 85</td>
<td>164</td>
<td>72.6</td>
</tr>
<tr>
<td>Educational level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elementary school or below</td>
<td>2,105</td>
<td>28.0**</td>
</tr>
<tr>
<td>Middle school</td>
<td>158</td>
<td>14.6</td>
</tr>
<tr>
<td>High school or over</td>
<td>158</td>
<td>10.1</td>
</tr>
</tbody>
</table>

Full scale include 17 items of ADL and IADL; and DIF-adjusted short scale include 9 items of ADL and IADL.

ADL, activities of daily living; IADL, instrumental activities of daily living; DIF, differential item functioning.

*p < 0.05, **p < 0.01 by chi-square test.
shopping, doing light housework, and managing money in young men and shopping and using the telephone in middle-aged men compared to those in older men. The results of these studies demonstrated the tendency for items showing DIF of age and gender to overlap.

Previous studies have not identified IRT according to educational level. However, as many of the IADL items include cognitive activities and education level is low among the current older generations in countries such as Korea that have experienced recent rapid growth, it is important to investigate IRT according to educational attainment. In Korea, the current older generations, who reached adulthood during the period of rapid modernization after prolonged war during their school-age years, have relatively little exposure to westernized formal educational systems. Older women are particularly likely to have lower levels of formal education due to unequal opportunities in the educational system, as reflected by the fact that 69.5% of older women the present study had not completed an elementary school education. The similarities between DIF according to educational level and according to gender reflect the strong correlation between gender and education level.

The current full versions of ADL and IADL do not accurately capture disability rates because of their acknowledged biases in item responses by gender, age, and education level. In addition, the current scales do not clearly show differences between groups. The higher disability rates in women’s cognitive activities are due to the latent gender construct reflected in these items; if this is not considered, measurements of disability in women would be exaggerated. Likewise, men report greater difficulties with household activities items because of the latent construct reflected in these items and, if not taken into consideration, the disability rates of men are also exaggerated. Aside from the 8 items with high DIF, the reliability of these scales was high and the gender differences in disability rates based on ADL/IADL responses to the other 9 items were more accurate than those reported by the previous full version. Women have higher rates of disability than men and are more likely to have daily disabilities than are men of the same age due to musculoskeletal disease morbidity and pain sensitivity. In this study, women were more likely to report limitations, use of assistance, and a greater degree of disability, particularly among IADL categories. However, these gender differences were largely explained by differences in disability-related health conditions. The comorbid conditions associated with disability in this cohort, which were predominantly musculoskeletal, neurodegenerative, and psychological in origin, were generally more prevalent among women than in men. One limitation of our study was the time gap since the KLoSA baseline survey was performed (2006), 13 years ago. Many older citizens now own and use smartphones since their invention in 2007. Thus, technology compliance should be also considered when interpreting our study results.

As culture and the degree of social infrastructure development differ across countries, responses to ADL and IADL are highly context-specific. Unless corrected for, cross-national variations in disability rates may, therefore, reflect item-response bias rather than real differences in disability levels. Older adults in Korea have experienced strong gender segregation from a young age and have grown up in a social structural environment with limited educational opportunities, particularly for older women. These cultural aspects are reflected in IRT-based research of older Korean populations. Further IRT research on the ability to perform everyday activities in societies with diverse cultural backgrounds is needed to allow more accurate measurement of disabilities across cultures. In particular, comparisons of disability rates by country should separately assess household and cognitive activities from the IADL scale, or should completely exclude these two dimensions when comparing ADL and IADL item measurements. If possible, a culture-neutral ADL and IADL measurement that does not require DIF analyses should be developed.

CONFLICT OF INTEREST DISCLOSURES

The researchers claim no conflicts of interest.

SUPPLEMENTARY MATERIALS

Supplementary materials can be found via https://doi.org/10.4235/agmr.19.0047.

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Differential Item Functioning of ADL and IADL

Comparative Analysis of Anesthetic Legal Disputes between Older and Younger Patients Referred to the Korean Society of Anesthesiologists in 2009–2018

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Background: Although the average age of patients undergoing surgical procedures or anesthesia is increasing, differences in anesthesia-related injuries among different age groups have not been reported. This study compared older and younger patients on the basis of disputes regarding anesthesia-related injuries referred to the Korean Society of Anesthesiologists (KSA). Methods: We retrospectively analyzed disputes regarding anesthesia-related injuries referred to the KSA between 2009 and 2018. After excluding duplicates, incomplete data, local anesthesia cases, and patients aged ≤18 or 55–64 years, the subjects were divided into older (≥65 years) and younger (19–54 years) age groups. The parameters included in the KSA database were compared between these two groups. Results: The 115 cases included in the study included 28 and 87 cases from the older and younger groups, respectively. The proportions of preventable cases of anesthesia-related adverse events differed significantly between the older (25%) and younger groups (48.3%). The most common medical disputes in the older group were related to general anesthesia, orthopedic surgery, local hospitals, and anesthesiologist, whereas those in the younger group were related to sedation, plastic surgery, local clinics, and non-anesthesiologists. Conclusion: In addition to understanding the differences in anesthesia characteristics according to age group, it is also necessary to develop means for reducing preventable anesthesia-related adverse events. Furthermore, we must continue to register anesthesia-related disputes, and a voluntary reporting system should be established to prevent anesthesia-related accidents.

Key Words: Anesthesia, Geriatric assessment, Dissent and disputes

INTRODUCTION

South Korea became an aged society in August 2017. With 14.3% of the population considered aged in July 2018, it will become a post-aged society by 2026 according to the Korean Statistical Information Service.¹ According to the Health Insurance Review and Assessment Service (HIRA), the rate of geriatric anesthesia (age ≥ 65 years) has been increasing, accounting for 26% of all cases of anesthesia in 2018 and exceeding the proportion of aged people in the population. Furthermore, age is a risk factor for anesthesia and surgery. Therefore, it is important to closely monitor geriatric anesthesia and related injuries.

Injuries require treatment and patients make claims when unexpected damage occurs. As injuries related to anesthesia can cause serious patient injury, opinions and feedback from various sources are needed to solve this problem. Since the American Society of Anesthesiologists (ASA) organized the Closed Claim Project in 1985, research on patient safety has been conducted continuously, and patient safety concerning anesthesia has improved. The Korean Society of Anesthesiologists (KSA) established a database in 2009 at the request of the courts, public prosecutor’s office, and police regarding medical disputes or claims for problems associat-
ed with anesthesia. The findings of several analytical studies based on the KSA database2–4 have led to changes in healthcare policies. However, to our knowledge, no comparative studies have used this database to assess anesthesia-related injuries according to age group. Therefore, the present study compared older and younger patients on the basis of medical disputes referred to the KSA between 2009 and 2018.

MATERIALS AND METHODS

Study Design and Population
The present study was approved by the Institutional Review Board of Konyang University Hospital (No. KYUH-2018-06-017). We retrospectively analyzed the database, which was developed by the KSA in 2009–2018. There was no requirement to obtain informed consent from the subjects because of the retrospective nature of the study.

The inclusion criteria were legal claims associated with anesthesia in cases referred to the KSA in 2009–2018. Of those, duplicate cases because of re-consultation, cases in which a connection between anesthesia and outcome could not be confirmed because of incomplete data, cases involving local anesthesia, and cases in which the patients were aged ≤ 18 or 55–64 years were excluded. The parameters registered in the KSA database were compared between the remaining subjects, who were divided into older (≥ 65 years) and younger (19–54 years) age groups.

Patients Characteristics
The patients’ characteristics included age, sex, ASA physical status classification, pre-anesthetic assessment, and surgical diagnosis. The characteristics of the surgery included its nature (cosmetic, disease treatment, or diagnosis), types (plastic surgery, orthopedic surgery, general surgery, obstetrics and gynecology, urology, otolaryngology, ophthalmology, neurosurgery, cardiovascular surgery, dental, or ‘non-surgery’—i.e., procedures performed by non-surgeons, such as general physicians, internal medicine physicians, family medicine physicians, dermatologists, and anesthesiologists), and the types of hospital in which the operation took place (university or general hospital, local hospital, or local clinic). The characteristics of anesthesia included the types of anesthesia (general, spinal, epidural, sedation—defined here as only procedural sedation—or peripheral nerve block), anesthesia provider (anesthesiologist, non-anesthesiologist, or nurse), and induction agent.

Outcome assessments
Adverse events, defined as the cause of the final outcome, were classified as respiratory system, cardiovascular system, nervous system, or other events (musculoskeletal-system, skin, hepatic or renal, endocrine, thermal, or infectious events; transfusion reactions; equipment problems; incorrect drug or dose; drug reactions; and others). The outcomes were defined by the final result of the adverse event and were classified as temporary, permanent, or death. Permanent injury was defined as cases requiring continuous treatment, such as brain damage, quadriplegia, or irreversible neurological damage. The appropriateness of anesthesia was assessed by a reviewer who provided an expert consultation about the assigned cases using a numeric rating scale (NRS) from 1 to 9, in which 1 was the least appropriate and 9 was most appropriate in the process of anesthesia. On the basis of appropriateness, we estimated the preventability of the adverse event or outcome,4 which was the possibility that a certain injury could have been prevented by appropriate treatment or precautions. NRS 1–3 included preventable events, that is, events that could easily have been prevented; NRS 4–6 included moderately preventable events, that is, events that might have been preventable; and NRS 7–9 included hardly preventable events, that is, events that were unlikely to have been prevented.4 The primary outcome was the percentage of preventable events. In addition, in the older patient group, we determined whether a preoperative frailty evaluation or comprehensive geriatric assessment had been carried out.

We performed comparisons between total cases and cases without sedation because sedation is used mainly in cosmetic or diagnostic procedures, which are expected to differ from other procedures in terms of patient age distribution. Moreover, the causes of accidents in sedated patients were different from those in other patients administered anesthesia.4–6

Statistical Analyses
Statistical analyses were carried out using PASW Statistics for Windows, version 18.0 (SPSS Inc., Chicago, IL, USA). The patients’ characteristics, surgical characteristics, anesthesia characteristics, adverse events, outcomes, and appropriateness were compared between the older and younger groups. Continuous data were analyzed using Student t-test or Mann–Whitney U-test depending on the variables and normality, whereas categorical data were analyzed using the chi-square test or Fisher exact test. p-values < 0.05 were considered statistically significant.

RESULTS
Anesthesia-related claims in 154 cases in the target age groups were referred to the KSA; of these, 115 cases were analyzed after excluding duplicate cases, cases of incomplete data, and local anesthesia cases. A flowchart is shown in Fig. 1.
Comparisons of the Older and Younger Groups: Analysis of Total Cases

The older and younger groups included 28 and 87 cases, respectively. The differences between the two groups are presented in Table 1. The percentages of preventable cases were 25% in the older group and 48.3% in the younger group (p = 0.047). The distributions of ASA physical status classification differed significantly between the two groups (p = 0.003), with 75% ASA class-I and -II cases in the older group and 90.8% in the younger group. The types of anesthesia also differed significantly between the two groups (p < 0.001), with general anesthesia most common in the older group and sedation most common in the younger group (50.0% and 52.9%, respectively). The nature of the surgery also differed significantly between the two groups (p < 0.001), although treatment was the most common reason for surgery in both (89.3% and 48.3%, respectively). The distribution of hospital type in which anesthesia differed significantly between the two groups (p < 0.001); with local hospitals most common in the older group and local clinics in the younger group (53.6% and 59.8%, respectively). The distributions of anesthesia providers also differed significantly between the two groups (p < 0.001), with anesthesiologists the most common provider in the older group and non-anesthesiologists most common in the younger group (82.1% and 52.9%, respectively). The presence of anesthesia records was significantly higher in the older group than in the younger group (82.1% and 42.5%, respectively; p < 0.001). The mortality rates

Table 1. Comparisons of the older and the younger groups: total cases

<table>
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<tr>
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<tr>
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<td>19 (21.8)</td>
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</tr>
<tr>
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<td>7 (25.0)</td>
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</tr>
<tr>
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<td>14 (50.0)</td>
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<td>Epidural</td>
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<td></td>
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<td>Sedation</td>
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<td>46 (52.9)</td>
<td></td>
</tr>
<tr>
<td>Peripheral nerve block</td>
<td>0 (0)</td>
<td>3 (3.4)</td>
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</tr>
<tr>
<td>Nature of surgery</td>
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<tr>
<td>Types of hospital</td>
<td></td>
<td></td>
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</tr>
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<tr>
<td>Local hospital</td>
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<td></td>
</tr>
<tr>
<td>Local clinic</td>
<td>2 (7.1)</td>
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<td></td>
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<td>&lt; 0.001</td>
</tr>
<tr>
<td>Anesthesiologist</td>
<td>23 (82.1)</td>
<td>38 (43.7)</td>
<td></td>
</tr>
<tr>
<td>Non-anesthesiologist</td>
<td>5 (17.9)</td>
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<td></td>
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<td>3 (3.4)</td>
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</tr>
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<td>Preventable case</td>
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<td>42 (48.3)</td>
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<tr>
<td>Permanent injury</td>
<td>3 (10.7)</td>
<td>24 (27.6)</td>
<td></td>
</tr>
<tr>
<td>Temporary injury</td>
<td>2 (7.1)</td>
<td>4 (4.6)</td>
<td></td>
</tr>
</tbody>
</table>

Values are expressed as the median (Q1–Q3) or number (%).
ASA, American Society of Anesthesiologists; NE, not evaluated.
were 82.1% in the older group and 67.8% in the younger group. Fig. 2A presents the types of surgery in the two groups. Orthopedic surgery was the most common type in the older group, whereas plastic surgery was the most common type in the younger group (57.1% and 31%, respectively).

Adverse events are presented in Fig. 3A. The most common adverse events were cardiovascular system events in the older group and respiratory system events in the younger group (57.1% and 50.6%, respectively; p = 0.009). No patients with the older group had received preoperative frailty evaluations or comprehensive geriatric assessments.

Comparisons of Older and Younger Groups without Sedation
The 65 patients who were not sedated included 24 and 41 patients in the older and younger groups, respectively. Table 2 shows the comparisons of the two age groups without sedation. The percentages of preventable cases were 16.7% in the older group and 29.3% in the younger group, which were lower than those observed in the total case analysis. The distribution of ASA physical status classifications differed significantly between the two groups (p < 0.001), with 75% and 92.7% of cases categorized as ASA class-I and -II in the older and younger groups, respectively. The distributions of hospital types differed significantly between the older and younger groups (p = 0.027), with local hospitals being the most common in both groups (54.2% and 48.8%, respectively). General anesthesia was the most common in both groups, at 58.3% and 73.2% among those without sedation, respectively. The most common anesthesia providers were anesthesiologists in both groups without sedation (95.8% and 82.9%, respectively). The mortality rates did not differ significantly between the older and younger groups, at 79.2% and 75.6%, respectively, after excluding patients with sedation.

Orthopedic surgery was most common in both the older and younger groups (76.2% and 34.1%, respectively) (Fig. 2B) regardless of sedation. Cardiovascular events were the most common adverse events in both groups (66.7% and 39%, respectively) among those without sedation (Fig. 3B).

DISCUSSION
We observed a difference in legal anesthesia-related disputes between older and younger groups and propose that an increased understanding of the factors leading to the differences between the two groups might help prevent anesthesia-related accidents.

Although cardiovascular and respiratory events were overall the most common adverse events in the older group younger groups, cardiovascular events were the most common in both groups without sedation. This difference may have been due to differences in the types of surgery and anesthesia between the older and younger groups. Only 3% of cases had monitored anesthesia care (MAC) in a study of closed claims in 2012, and MAC claims were associated with higher age, higher ASA, and similar percentages of death and brain damage compared with other anesthesia-related claims. Furthermore, as there were no sedation-related claims in an analysis of anesthesia-related medical disputes referred to the KSA in 2004, cosmetic procedures using propofol sedation appear to have begun to be performed mainly in younger patients. Except for sedation, although the ASA physical status was higher in older group than that in the younger group, there were no differences in the type of surgery, type of anesthesia, or preventable cases be-
tween the two groups. The percentages of patients with sedation and of younger age in this study were higher than those reported in a closed claims study in the United States (US); these factors may have contributed to the difference in preventable events between the two groups.

We expected that claims would be rare in older patients, as we assumed that death or injury would be more readily accepted in these patients, even in the context of critical events. As older adults often have multiple comorbidities, such as diabetes mellitus, hypertension, and cardiac hypertrophy, they are not only a high-risk group for anesthesia and surgery but also require management in terms of baseline diseases. In addition, anesthesia in geriatric patients must be administered carefully because of their decreased sympathetic response, venous compliance, and cardiac preload; propensity for injury in association with glucose tolerance; diastolic dysfunction; and decline in renal function and mass. Indeed, the rate of claims by older patients is about 5–10 times lower than that by younger patients. In addition, as our older patients received appropriate explanations and provided consent on the basis of their family’s understanding of their condition and the associated risks in the event of problems, we expected a low likelihood of medical disputes when negative results occurred. Contrary to our expectations, however, the percentage of claims referred to the KSA in the older group was 24.3% and increased to 36.9% after excluding cases with sedation. Although older adult patients comprised 14.3% of the population in 2018, 26.2% of cases of anesthesia involved older adults. Thus, the percentage of older patients undergoing anesthesia for surgery is higher than the percentage of older adults in the overall population.

Reducing the overall number of claims requires examination of the current problems associated with sedation. Our results regarding sedation-related problems are consistent with those of previous studies showing that respiratory system events were the most common adverse events. Several studies have warned of the risk of respiratory depression associated with propofol overdose. The risk of propofol overdose is emphasized because the metabolic ability varies 19-fold among individuals; thus, a lack of sufficient physician attention is related to a high risk of overdose. A previous study using the KSA database of 2009–2014 showed that most cases of sedation were managed by a non-anesthesiologist (92.3%) and were associated with the use of propofol (89.7%), similar to our observations. Our results show that propofol accounted for 92% of sedation-related claims, which is a comparably high percentage to that reported previously.

The European National Societies of Anesthesia concluded that non-anesthesiologists should not use propofol as a sedative agent for clinical procedures. Moreover, Korean studies have recommended that propofol be used only with close monitoring by authorized clinicians or anesthesiologists. Despite these concerns, the use of propofol and critical problems related to its use have increased in Korea. Furthermore, claims for sedation-related injuries continue to be made. Although sedation can be performed by any qualified specialist, simultaneous anesthesia and surgery is difficult. Recently, the European Society of Anesthesiology proposed a minimal requirement that those performing procedural sedation be able to assess and manage the level sedation. They also recom-

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**Fig. 3.** Comparison of adverse events between the older and younger groups: (a) total cases and (b) cases without sedation. ‘Others’ includes musculoskeletal-system, skin, hepatic or renal, endocrine, thermal, or infectious events; transfusion reactions; equipment problems; inappropriate drug or dose; drug reaction, etc.
mended that procedural sedation and analgesia be performed in an environment in which an anesthesiologist is readily available.20) Several methods have been proposed to resolve the problems associated with sedation, including strengthening the sedation monitoring standards, for example, via addition of end-tidal CO₂ (EtCO₂) monitoring, making the monitoring of operations by doctors mandatory (depending on the type or difficulty of surgery), or mandating anesthesiologist participation in sedation. Such measures could help prevent sedation-related accidents. In situations requiring the use of propofol, the ‘Practice Guidelines for Propofol Sedation by Non-anesthesiologists’23) should be followed.

On the basis of the numbers of cases of anesthesia investigated by the HIRA in 2018 (1,112,139 in university and general hospitals, 689,872 in local hospitals, and 124,779 in local clinics) as well as the poor condition of patients and the difficulty in performing surgery in university or general hospitals, the number of anesthesia accidents were predicted to be higher in university or general hospitals than in other hospitals. However, local hospitals and local clinics were most commonly associated with claims in the older group and younger groups, respectively. The low rate of cases proceeding to a dispute in university or general hospitals may be due to the provision of adequate explanations about anesthesia before surgery, as well as to the provision of informed consent, the difficulty of determining whether the accident was caused by anesthesia or surgery, and physician recognition of poor patients’ condition. In contrast, the increased numbers of disputes in local hospitals and local clinics may be due to the lower likelihood of adequate explanations regarding anesthesia before surgery, lower rate of informed consent, and deficiencies in physician education and ability to cope with medical disputes. Furthermore, as the behavior of physicians and their ability to communicate with patients affect the numbers of claims,22) disputes are more likely in local hospitals and local clinics characterized by a lack of communication between physicians and patients because of the absence of full-time anesthesiologists.23) In our study, the anesthesiologists were full-time in only 42.5% of hospitals in the younger group and written consent for anesthesia was obtained in only half of cases across both groups. Freelance anesthesiologists are relatively common in Korea, which may have been the cause of improper preanesthetic assessments23) and inadequate explanations about anesthesia before surgery.

However, there are other problems associated with anesthesia in Korea in addition to inadequate explanations and lack of informed consent. There were no claims involving intubation failure during the induction of general anesthesia at university or general hospitals in the KSA database, whereas four deaths related to intubation failure had occurred in local clinics and hospitals. Adequate equipment, such as videoscopes or bronchoscopes, as well as sufficient manpower to address airway problems is likely to be available in university or general hospitals. However, anesthesia providers at local hospitals or clinics are not usually available full time,23) and shortage of manpower and equipment is possible. Freelance anesthesiologists may not be sufficiently familiar with a hospital’s facilities to act appropriately in the event of an accident. As peripheral oxygen saturation (SpO₂) and EtCO₂ monitoring reduce the incidence rates of mortality and brain death associated with respiratory problems,10) a standard for anesthetic care including sedation is necessary to ensure adequate manpower and equipment essential for anesthesia.

### Table 2. Comparisons of the older and the younger groups after excluding cases with sedation

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<tr>
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<th>Older (n = 24)</th>
<th>Younger (n = 41)</th>
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<td>Sex, male</td>
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<tr>
<td>I</td>
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<tr>
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<tr>
<td>III</td>
<td>6 (25.0)</td>
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<td>NE</td>
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<td>Epidural</td>
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<tr>
<td>Temporary injury</td>
<td>2 (8.3)</td>
<td>2 (4.9)</td>
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</table>

Values are expressed as the median (Q1–Q3) or number (%). ASA, American Society of Anesthesiologists; NE, not evaluated.
It is important to collect detailed data on anesthesia-related injuries. The closed-claims database established by the ASA in 1985 has contributed to improved patient safety.\(^{(24)}\) A system has also been implemented in Korea since 2015 for voluntary reporting of medical accidents; however, it comprises mainly reports of minor accidents and reports of fatal accidents are very rare. The rates of serious adverse events, including death and permanent brain damage, in closed-claims analyses conducted in the US were 56% in 1975 and 27% in 2000.\(^{(23)}\) The death rates in the older and younger groups in the present study were 82.1% and 67.8%, respectively, higher than those reported in the US. This difference may be because of a greater tendency for cases involving minor problems to proceed to medical disputes in the US than in Korea. However, the percentage of cases resolved through settlement before proceeding to a medical dispute is high in Korea, and medical disputes regarding minor problems can be resolved by government organizations such as the Korea Consumer Agency or the Korea Medical Dispute Mediation and Arbitration Agency, which may also cause the percentage of cases of deaths to differ from that in the US. An increase in medical litigation associated with cases of death, permanent injury, temporary nerve injury, or backache that are not due to malpractice is expected; thus, suitable preparations are necessary to deal with such cases. Analysis of closed-claims studies and cases referred to the KSA could provide a basis for resolving common accidents. However, because of settlements, it is difficult to determine the true incidence of some accident types, even in fatal cases. In addition, if the numbers of accidents associated with a type of drug or anesthesia are increasing, early identification and prevention may be limited. Therefore, a system that allows voluntary reporting of accidents to the KSA is essential. However, even if the KSA were to create such a system, individuals making voluntary reports cannot be legally protected, and the system could be subject to the issue of warrants by the courts. A system that legally protects those reporting to the KSA and thus encourages voluntary reporting, as in other fields of geriatric medicine, is required to prevent medical accidents and improve patient safety.\(^{(21)}\)

Although the awareness of patients’ rights is increasing in Korea, an understanding of the difference between medical malpractice and medical maloccurrence (i.e., adverse outcomes that are unrelated to the quality of care provided) remains poor. A Korean court recently ruled that an automobile accident that caused only minor scalp abrasions was responsible for dementia. Legal disputes related to older patients may be more likely in cases of postoperative functional deterioration or dementia and may be affected by whether appropriate patient evaluation is judged to have been performed. Predicting the complications of anesthesia and surgery in older surgical patients requires expanding the implementation of preoperative comprehensive geriatric assessments; furthermore, informed consent and appropriate explanation of anesthesia are also important to improve patient safety and prevent legal disputes.

This study has some limitations. First, the data were extracted from datasheets stored at the KSA. As mentioned above, we could not accurately determine the incidence of anesthesia-related injuries because of the use of claims data. In addition, as this was a retrospective study, the results might have differed if other assessment criteria had been used, including the preventability and appropriateness of anesthesia as assessed by different anesthesiologists.

In conclusion, we identified differences in anesthesia-related disputes between older and younger patients. Preventable events were more likely in younger patients than in older patients. When sedation was not considered, no differences were seen between the older and younger groups. However, the analysis was based on the KSA database and it was not possible to determine causal relationships in the anesthesia-related injury data. Anesthesia-related disputes should be registered via a voluntary reporting system, which must be established by the KSA itself to help prevent accidents.

**CONFLICT OF INTEREST DISCLOSURES**

The researchers claim no conflicts of interest.

**REFERENCES**

6. Domino KB. Trends in anesthesia litigation in the 1990s: moni-
Air Pollutants and Frailty in Older Adults: A Geriatrician’s Perspective

Heayon Lee, Eunju Lee, Il-Young Jang
Division of Geriatrics, Department of Internal Medicine, Asan Medical Center, University of Ulsan College of Medicine, Seoul, Korea

Many studies have provided evidence that air pollutants are harmful to humans. Emerging data and literature from South Korea support the relationship between air pollutants and healthcare expenditure and the threat of even ambient air pollution to mortality, morbidity, and various adverse health outcomes and quality of life. Through monthly balanced data using fixed and random-effect models, this study demonstrated the contributions of 5 common air pollutants to healthcare expenditure in 16 cities and provinces over 8 years (January 2010 to September 2017). The study also showed how each air pollutant affected healthcare expenditures in a particular population. Led by economists and not physicians, these findings emphasized the association between air pollutants and healthcare expenditures, indicating the urgent need for policymakers to develop effective healthcare policies.

The authors not only presented a systematic analysis of healthcare expenditure but also categorized the healthcare costs by region, demographic structure, and specific diseases. One interesting aspect was their presentation of the regional minimum and maximum per-patient healthcare expenditures. The authors showed that a higher personal income level leads to higher healthcare expenditure and that per-patient healthcare expenditure increases with population age. As in other countries, older adults in South Korea are the population most vulnerable to air pollutants and environmental diseases. These reports will facilitate research on air pollutant exposure and health effects in the older population of South Korea. Moreover, life-course approaches investigating the adverse effects of air pollutants in older adults are needed. The results of these studies will highlight the urgent need for an emphasis on this topic in older populations.

However, older populations are heterogeneous, and individuals may have a wide variety of health conditions, which may result in differences in their resistance to the exposure and health effects of air pollutants. Researchers and policymakers discussing the impact of air pollutants should consider the following characteristics of older adults: (1) vague symptoms and atypical presentation even in known specific diseases that are easily misdiagnosed as a normal aging process and which delay the diagnosis of the worsening of chronic disease or newly-onset disease; (2) functional decline, including physical performance or cognition, as an early sign of health deterioration in older populations; (3) various aging specific symptoms and disorders known as geriatric syndromes, and their accumulation which facilitates the worsening vicious cycle in the health condition of older adults eventually leading to morbidity and mortality; and (4) multimorbidity and risk of polypharmacy, which increase the risk of adverse effects and obscure the judgment of exposure.

Air pollution exacerbates poor prognoses by increasing individuals’ susceptibility to diseases rather than causing direct harm to health or disease itself. For the reasons mentioned above, however, the effects of air pollutants on older populations cannot be judged simply by individual risk factors such as age, chronic disease, cardiovascular disease, and cognitive function. Unlike that in the general younger population, the health spectrum of the older population is varied. Even when exposed to chronic ambient air pollutants, vulnerable older individuals are more likely to have vague symptoms such as fatigue, dizziness, functional decline, and ultimately, a worsened quality of life owing to air pollutant exposure before physician diagnosis. In particular, it remains unclear if the conventional analytic method that assesses the impact of air pollutant exposure mainly based on several subtle cardiopulmonary or cognitive functions can distinguish between the effects of air pollutants and the aging phenomenon, which is eventually likely to understate its influence. Vulnerability in older adults can be described as a looped system formed by a linkage between vulnerable health factors; therefore, the conventional risk stratification system is unlikely to be effective in older adult populations. Similar to other several diseases, a unique evaluation and risk stratification system specialized for older populations are required.

With these concerns, our researchers believe that frailty, a valuable measure of the health status of older individuals, might be the...
most suitable marker for measuring the effects of air pollutants in older populations.17,18) This measure encompasses all age-related symptoms and disorders such as dementia, sarcopenia, insomnia, and falls, which can be used to estimate the possible effects. However, the timing and intensity of the effects on the domains are expected to vary greatly and should be given to respiratory influences, nonspecific symptoms, and pathophysiology. Therefore, rather than the conventional frailty index, a targeted concept and definition of frailty, namely an “air-pollutant frailty index” that reflects both the specificity of the aging physiology and the conventional known health effects of air pollutant exposure, should be developed. As with human immunodeficiency virus, myelodysplastic syndrome, and systemic lupus erythematosus, this concept of a disease-specific frailty index is also likely to be effective in vulnerable young populations. This frailty concept will serve as a compass for future fine dust studies in older adults.

CONFLICT OF INTEREST DISCLOSURES

The researchers claim no conflicts of interest.

REFERENCES

Courses and Conferences

The academic events in 2020 of the Korean Geriatrics Society are as follows.
We would like to invite members of the Korean Geriatric Society and anyone who are interested.

[The 66th Annual Meeting of the Korean Geriatrics Society]
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For more information please contact kgskorea1968@gmail.com

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- 우수한 성분 조합의 국내 최초의 Olmesartan/Amlodipine/Rosuvastatin 3제 복합제 1-3
  - 아미노 중 유일하게 촉진 감소 효과 입증, Statin 중 유일하게 축삭동맥경화 진행 시 대용량 보유
  - 국내 다기관 임상 3상 연구를 통해 우수한 효과와 안전성 입증
- 병절 조절이중으로 성분간 음물 상호 작용 없이 치료에서 흡수 최적화 4
- 1일 1회 복용, 적은 제형으로 환자의 복약 편의 & 순응도 개선 5

2. Rosuvastatin 제조분양서, 산약제 등기사항.  
5. 올로맥스 제조분양서, 산약제 등기사항.
초기부터 진행된 당뇨병까지

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