JBMR Plus, 2024, **8**, 1–11
https://doi.org/10.1093/jbmrpl/ziad020
Advance access publication: January 4, 2024
Research Article

Prevalence of osteoporosis, sarcopenia, and high falls risk in healthy community-dwelling Thai older adults: a nationwide cross-sectional study

Apichat Asavamongkolkul, Nath Adulkasem, Pojchong Chotiyarnwong, Ekasame Vanitcharoenkul, Chandhanarat Chandhanayingyong, Panai Laohaprasitiporn, Krabkaew Soparat, Aasis Unnanuntana*

Department of Orthopaedic Surgery, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok 10700, Thailand

*Corresponding author: Aasis Unnanuntana, Department of Orthopaedic Surgery, Faculty of Medicine Siriraj Hospital, Mahidol University, 2 Prannok Road, Bangkoknoi, Bangkok 10700, Thailand. (uaasis@gmail.com).

Abstract

Thailand has transitioned from an aging society to an aged society, which implies that the prevalence of age-related disorders will increase; however, epidemiological data specific to the prevalence of age-related degenerative musculoskeletal disorders among Thai older adults remain limited. Accordingly, the aim of this study was to investigate the prevalence of age-related musculoskeletal diseases, including osteoporosis, sarcopenia, and high falls risk among healthy community-dwelling Thai older adults. This cross-sectional nationwide study enrolled Thai adults aged ≥60 yr from 2 randomly selected provinces from each of the 6 regions of Thailand via stratified multistage sampling during March 2021 to August 2022. All enrolled participants were evaluated for BMD, skeletal muscle mass, grip strength, and gait speed. Osteoporosis was diagnosed according to the World Health Organization definition, and sarcopenia was diagnosed according to the Asian Working Group for Sarcopenia (AWGS) 2019 criteria. Falls risk was determined using the self-rated Fall Risk Questionnaire. A total of 2991 eligible participants were recruited. The mean age of participants was 69.2 ± 6.5 yr (range: 60–107), and 63.1% were female. The prevalence of osteoporosis, sarcopenia, and high falls risk was 29.7%, 18.1%, and 38.5%, respectively. Approximately one-fifth of subjects (19.1%) had at least 2 of 3 risk factors (ie, osteoporosis, sarcopenia, and high falls risk) for sustaining a fragility fracture, and 3.4% had all 3 risk factors. In conclusion, the results of this study revealed a high and increasing prevalence of osteoporosis, sarcopenia, and high falls risk in healthy community-dwelling Thai older adults. Since these conditions are all major risk factors for fragility fracture, modification of Thailand's national health care policy is urgently needed to address the increasing prevalence of these conditions among healthy community-dwelling older adults living in Thailand.

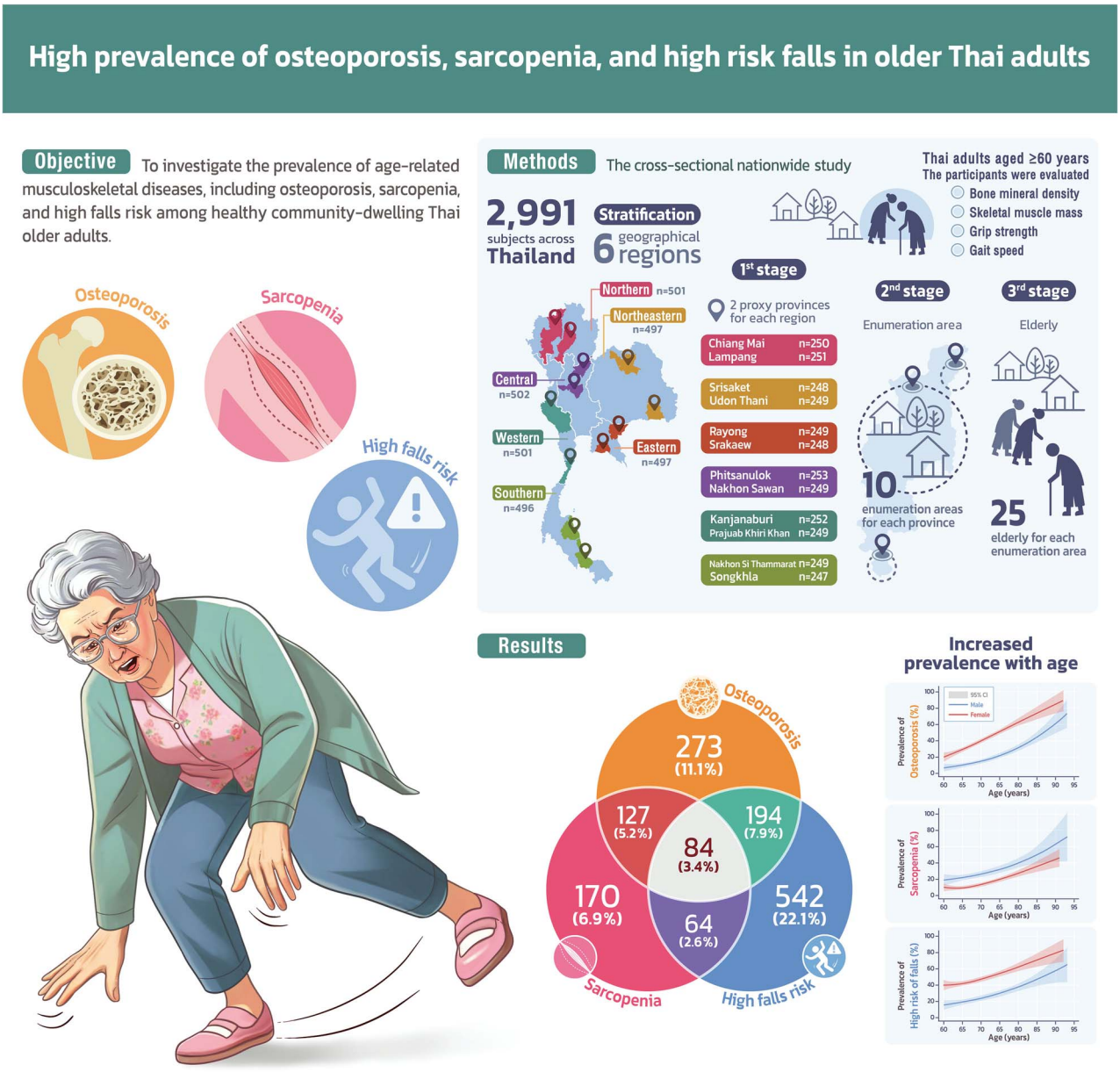
Keywords: prevalence, osteoporosis, sarcopenia, osteosarcopenia, nationwide cross-sectional study

Lay Summary

The prevalence of osteoporosis, sarcopenia, and high fall risk is increasing. Urgent modification of Thailand's health care policy is needed to address the rising prevalence of these conditions among Thai community-dwelling older adults.

Received: September 7, 2023. **Revised:** December 6, 2023. **Accepted:** December 22, 2023

Graphical Abstract



Introduction

In recent decades, the population aged 60 yr and older has increased substantially, and it is expected to continue to grow rapidly worldwide.[1] In 2015, the approximate percentage of older adults ranged from 12% to 16% of the total population in Europe, North America, and Oceania.[2] Although the proportion of older Asian adults was comparatively low at 8% in 2015, the speed of aging among Asians was reported to be fastest among all continents.[2-4] This aging phenomenon is driven by the increased life span of the world's population, and decreased fertility beginning in the middle of the 20th century.[2] Not surprisingly, increasing age negatively influences health status. The majority of older adults experience age-related noncommunicable diseases (NCDs), which results in more significant morbidity and reduced functional capacity.[5] Musculoskeletal degenerative disorders are among the most important age-related NCDs because they impair activities of daily living, which decreases overall quality of life.[6,7]

Among all of the degenerative musculoskeletal diseases, osteoporosis is the most common bone and joint disease, accounting for a global prevalence of approximately 18.3%.[8] This disease is characterized by altered skeletal microarchitecture and low bone mineral density (BMD).[9] Patients diagnosed with osteoporosis demonstrate an increased risk of fragility fracture resulting in high morbidity and mortality.[10] Sarcopenia is another common degenerative musculoskeletal disease, which is characterized by a progressive reduction in physical strength, performance, and appendicular skeletal muscle mass.[11] Previous studies demonstrated a strong relationship between osteoporosis and sarcopenia. Sarcopenic individuals were reported to be at higher risk for having or developing osteoporosis.[12] Similarly, osteoporotic older adults were shown to be at higher risk for having or developing sarcopenia.[13] Hirschfeld et al. found patients with both osteoporosis and sarcopenia, termed osteosarcopenia, to be associated with substantially more adverse consequences

compared to patients diagnosed with a single musculoskeletal degenerative disorder.[14] Osteosarcopenic patients showed a greater risk of impaired postural balance, reduced functional capacity, falls, fractures, and mortality.[15]

Asian countries have experienced a surge in the incidence of degenerative musculoskeletal diseases. The prevalence of osteoporosis is highest among Asian older adults (24.3%) compared to other continents.[16] However, the prevalence rates reported from previous studies are likely to be underestimated due to problems related to undiagnosed disease, substantial underreporting, and poor documentation.[17,18] Similarly, the prevalence of sarcopenia in older adult Asian population appears to be higher than in other regions. The prevalence of sarcopenia was reported to vary from 2.5% to 45.7% in Asian countries, whereas it was reported to range from 1% to 29% in Western countries.[19,20] Accordingly, Asian countries are confronting the unavoidable consequences of degenerative musculoskeletal diseases, including falls and fragility fractures.[21] The seriousness of this development is evidenced by the rapidly increasing osteoporotic fracture rate in Asia over recent decades, which has resulted in significantly increased individual and socioeconomic burden.[22,23] Therefore, preventing or minimizing these conditions is essential for improving the overall health status of older adult Asian populations.

Since Thailand has transitioned from an aging society to an aged society, it is estimated that the population of older Thai adults will reach approximately 23% by 2035.[3] Consequently, the prevalence of age-related degenerative musculoskeletal disorders among the Thai older adult population has and will continue to increase. Given the relative scarcity of epidemiological data specific to the prevalence of degenerative musculoskeletal diseases among Thai older adults, the aim of this study was to investigate the prevalence of osteoporosis, sarcopenia, and high falls risk in healthy community-dwelling Thai older adults. An improved and accurate understanding of the prevalence of age-related degenerative musculoskeletal disorders and their consequences is highly important for health care policymakers.[24] Modification to current national health care policies may be needed to prepare for and adjust to the changes that come with an aged society, and to help prevent or minimize the often catastrophic consequences of degenerative musculoskeletal disorders in Thailand.

Methods

A nationwide cross-sectional study of healthy community-dwelling Thai older adults was conducted during March 2021 to August 2022. Eligible participants were healthy Thai older adults aged ≥60 yr who had resided in the targeted study area for at least 6 mo. We excluded participants diagnosed with any underlying disease(s) that could potentially affect their performance on the physical tests, such as cardiopulmonary disease with Metabolic Equivalent of Tasks (METs) <4 and severe neuromuscular disease, those who were unable to ambulate independently, and who had relative contraindication(s) for undergoing a central DXA scan, such as recent administration of radiopaque contrast material, severe deformity, or having retained metallic implants at the hip and lower spine region. This study was conducted in accordance with the Declaration of Helsinki and followed the Strengthening the Reporting of Observational studies in Epidemiology guidelines. The Central Research Ethics Committee (CREC) of The National Research Council of Thailand (NRCT) approved the study protocol (COA-CREC 023/2021), and written informed consent was obtained from all study participants prior to data collection.

Sampling method

A stratified multistage sampling method was used. First, we stratified the sample into 6 strata according to Thailand's 6 geographical regions, and each stratum consisted of 500 participants. Second, 2 provinces were randomly selected from each region (Northern, Northeastern, Central, Eastern, Western, and Southern Regions). Third, 10 enumeration districts were randomly assigned across each selected province. Finally, 25 eligible participants were sampled and appointed for data collection in each enumeration district (Figure 1).

Diagnosis of osteoporosis

The BMD of each participant was measured using a mobile Dual energy X-ray Absorptiometry (DXA) scanner (Lunar Aria; GE Healthcare). Quality assurance procedures, including daily quality assurance block and regular spine phantoms testing, demonstrated an acceptable coefficient of variation of the mobile DXA scanner at 0.37%.[25] All BMD measurements were performed at the lumbar spine (L1–L4), femoral neck, and total femur according to the International Society for Clinical Densitometry recommendation by a certified densitometer technologist.[26] All BMD interpretations were performed by osteoporosis specialists. The diagnosis of osteoporosis and osteopenia was defined as a T-score of less than or equal to −2.5 SD and −2.4 to −1.0 SD, respectively.[27] We used an Asian BMD reference for T-score calculation according to the Thai Osteoporosis Foundation recommendation.[28]

Diagnosis of sarcopenia

Several assessments are needed to conclusively diagnose sarcopenia, including muscle strength examination, physical performance evaluation, and skeletal muscle mass quantification. All assessments were conducted by a team of trained investigators. Diagnosis of sarcopenia in this study was defined as decreased skeletal muscle mass and either physical strength or physical performance according to Asian Working Group for Sarcopenia (AWGS) 2019 recommendation (Supplementary Table S1).[29]

Skeletal muscle mass

We used a dual-frequency bioelectrical impedance analysis (DF-BIA) device (RD-545; Tanita Corporation) to measure study subject skeletal muscle mass. Although AWGS 2019 recommends the use of a multifrequency BIA device to evaluate lean muscle mass, the reliability and accuracy of lean muscle mass measurement by DF-BIA devices were validated with DXA results in Thai population.[30] In addition, DF-BIA devices are more accessible, practical, and easier to perform. The AWGS 2019 defines low muscle mass from BIA devices using a cutoff value of $<7.0\ kg\ m^{-2}$ for men and $<5.7\ kg\ m^{-2}$ for women.[29]

Hand grip strength

Participants were asked to perform a hand grip with maximal effort using a Smedley-type digital hand grip dynamometer (T.K.K. model 5401; Takei). This test was performed using each participant's dominant hand in a standing position with full elbow extension.[29] If a participant's dominant

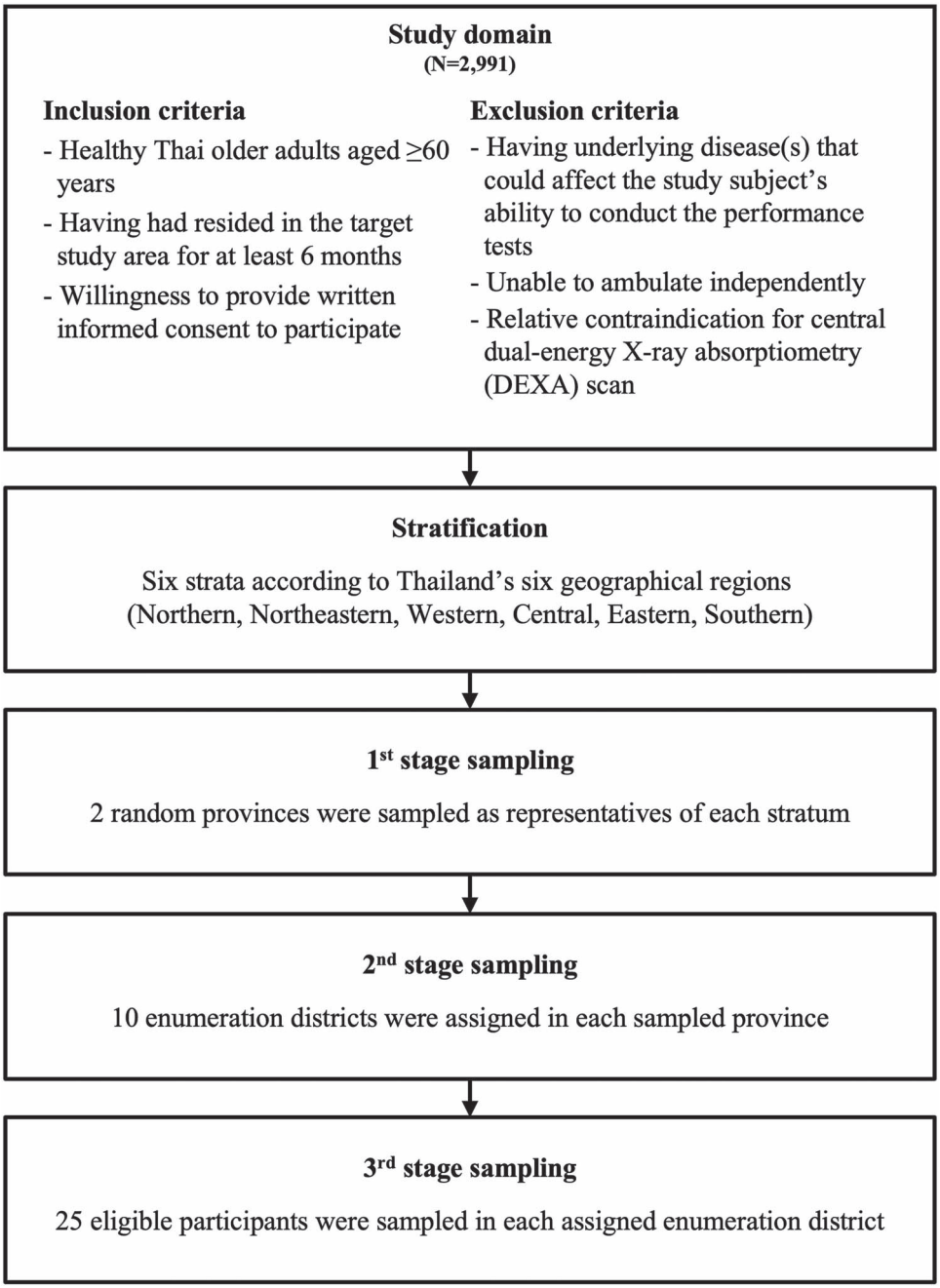


Figure 1. A flow diagram demonstrating the stratified multistage sampling method used in this study.

hand could not use a hand grip dynamometer (eg, sustained recent infection or injuries), the test was performed using the nondominant hand. Low muscle strength was defined as hand grip strength <28.0 kg for males and <18.0 kg for females. Participants who could not use either hand to perform the grip strength test were excluded from the sarcopenia analysis.

Physical performance

We determined the physical performance of each participant using gait speed and the five times sit-to-stand (FTSTS) test. Regarding gait speed, participants were instructed to walk from a standing position at a normal pace without deceleration for 6 m.[29] The test was performed at least twice with a 1-min pause between tests. The gait speed was calculated from the average of the 2 test times.

Concerning the FTSTS, each participant was asked to sit upright on an armless chair with their back against the backrest. The participant was then instructed to stand with his/her trunk upright, hips and knees fully extended, and arms crossed, after which the subject would sit and stand as quickly as possible 5 times.[29] The time participants used to complete the test was recorded. Participants were considered to have low physical performance if their gait speed was <1.0 m s^{-1} or the time needed to complete the FTSTS test was ≥12 s.[29]

Fall risk assessment

Participant's fall risk was assessed using the self-rated Thai Fall Risk Questionnaire (FRQ).[31] The self-rated FRQ is a 12-item questionnaire developed by the US Centers for Disease Control and Prevention (CDC) for fall risk screening. This

tool demonstrated good concurrent validity and has been widely used around the world.[31] Moreover, the Thai version of the FRQ showed good validity and reliability in Thai community-dwelling older adults.[31] Patients with a score of ≥4 are considered to be at high risk of sustaining falls.

Data collection

After written informed consent to participate was obtained, participants were appointed for data collection. We recorded demographic characteristics, including age, gender, body mass index (BMI), gait aid requirement, history of glucocorticoid intake, alcohol intake, and smoking status. Previous history of fragility fractures and falls was reviewed and recorded. Participant baseline health status was determined using the Charlson Comorbidity Index (CCI). Patient comorbidities, such as renal disease, diabetes mellitus, and rheumatoid arthritis, were reviewed and recorded. The prevalence of osteoporosis and sarcopenia was evaluated using the DXA results and the Appendicular Skeletal Muscle (ASM) Index, physical strength, and physical performance, respectively.

Sample size calculation and statistical analyses

The primary objective of this study was to determine the prevalence of osteoporosis in community-dwelling Thai older adults. As such, the sample size for this study was calculated using the sampling distributions of the sample proportion formula.[32] Previous study estimated the prevalence of osteoporosis in Asian population to range from 25.6% to 28.6% and fall rates to range from 22.1% to 30.6%.[33,34] Therefore, an estimated proportion of 25% was selected as a representative of both conditions for calculation of the sample size. Using the Thai older adult population of 12 million reported in 2019,[35] a margin of error of 2%, a confidence level of 95%, a design effect of 1.5, and a dropout rate of 5%, a sample size of 2837 was calculated for this study. The sample size was then rounded up to approximately 3000 subjects to facilitate easier sample stratification. The estimated proportion of Thai female and male older adults was 2:1. Hence, the calculated sample size was distributed across females and males according to that gender ratio. The secondary objective was to determine the prevalence of sarcopenia in community-dwelling Thai older adult population.

STATA 16 Statistics software (StataCorp LLC) was used to perform all statistical analyses. Descriptive statistics were used to summarize patient characteristics. Data are described as mean ± SD for continuous data with normal distribution and as median and interquartile range for nonnormally distributed continuous data. Categorical data are described as numbers and percentages. Comparisons of continuous data with normal distribution were made using Student's *t*-test and using Mann-Whitney U test for nonnormally distributed data. Categorical data were compared using chi-square test or Fisher's exact test depending on the size of the sample. A *P*-value <.05 was regarded as statistically significant for all tests.

Results

A total of 2991 eligible participants were enrolled from across the 6 regions of Thailand during the study period. The mean age of subjects was 69.2 ± 6.5 yr, the mean BMI was 24.0 ± 4.4 kg m^{-2}, and 1888 (63.1%) were female. Among all participants, 12.4% had a history of previous fragility fracture, and 12.9% required a gait aid for ambulation. The median CCI of included participants was 3, with an interquartile range between 2 and 4. The comorbidities of all participants are described in Table 1. Despite the presence of certain comorbidities, these subjects were still capable of independent ambulation, with or without the use of assisting devices. Consequently, we included them in the present study to accurately reflect the real-world conditions of aging subjects and enhance the generalizability of our research.

Table 1. Demographic and clinical characteristics of the study population (*N* = 2991).

Characteristics	Value
Age (years), mean ± SD	69.2 ± 6.5
Female gender, *n* (%)	1888 (63.1%)
Body mass index (kg m^{-2}), mean ± SD	24.0 ± 4.4
Gait aid, *n* (%)	382 (12.9%)
Previous fragility fracture, *n* (%)	367 (12.4%)
Current smoker, *n* (%)	392 (13.3%)
History of falls within 1 yr, *n* (%)	665 (22.5%)
History of glucocorticoid intake, *n* (%)	82 (2.8%)
History of alcohol intake, *n* (%)	192 (6.5%)
Charlson Comorbidity Index (CCI), median (p25, p75)	3 (2, 4)
CCI ≤ 4, *n* (%)	2149 (72.8%)
CCI > 4, *n* (%)	803 (27.2%)
Comorbidities, *n* (%)	
Myocardial infarction	108 (3.7%)
Congestive heart failure	24 (0.8%)
Peripheral vascular disease	91 (3.1%)
Cerebral vascular disease	70 (2.4%)
Alzheimer's disease/dementia	33 (1.1%)
Chronic pulmonary disease	67 (2.3%)
Connective tissue disease	32 (1.1%)
Gastric ulcer	291 (9.9%)
Chronic liver disease, *n* (%)	
Moderate to severe	7 (0.2%)
Mild	20 (0.7%)
Diabetes mellitus, *n* (%)	
With target organ damage	57 (1.9%)
Without target organ damage	465 (15.8%)
Hemiplegia/paralysis, *n* (%)	44 (1.5%)
End-stage renal disease, *n* (%)	62 (2.1%)
History of carcinoma, *n* (%)	
With metastasis	46 (1.6%)
Without metastasis	1 (<0.1%)
Human immunodeficiency virus, *n* (%)	4 (0.1%)
Rheumatoid arthritis, *n* (%)	23 (0.8%)

All participants received a BMD assessment. The average BMD was 0.948 ± 0.195, 0.764 ± 0.139, and 0.849 ± 0.160 g cm^{-2} for the lumbar spine, femoral neck, and total femur, respectively. The overall prevalence of osteopenia and osteoporosis was 44.2% and 29.7%, respectively. Unsurprisingly, the prevalence of osteopenia and osteoporosis was significantly higher in females than in males (Table 2). However, the prevalence of osteoporosis continued to increase after the age of 60 yr in both genders (Table 3 and Figure 2A).

There were 2543 participants who underwent appendicular muscle mass measurement and performance-based tests. However, 87 participants could not maintain a stable standing position for ASM evaluation using BIA. As a result, only 2456 participants were eligible for sarcopenia assessment. Of those, 445 (18.1%) were diagnosed with sarcopenia. Interestingly, the prevalence of sarcopenia was higher in males than in females aged 60 to 75 yr. (Table 3 and Figure 2B). Among individuals diagnosed with sarcopenia, 297 demonstrated a

Table 2. Prevalence of age-related musculoskeletal conditions among overall study subjects and compared between female and male healthy community-dwelling Thai older adults.

Conditions	Total	Female	Male	*P*-value [a]
Skeletal disorder ($n = 2991$)				
Normal	781 (26.1%)	306 (16.2%)	475 (43.1%)	
Osteopenia	1321 (44.2%)	872 (46.2%)	449 (40.7%)	
Osteoporosis	889 (29.7%)	710 (37.6%)	179 (16.2%)	***<.001***
Muscle disorder ($n = 2456$)				
Sarcopenia	445 (18.1%)	208 (13.3%)	237 (26.5%)	***<.001***
Falls risk ($n = 2952$)				
High falls risk (FRQ ≥ 4)	1137 (38.5%)	870 (46.6%)	267 (24.6%)	***<.001***

Bolded *P*-values indicate statistical significance. [a]The *P*-values reflect the comparisons between genders. FRQ, fall risk questionnaire.

Table 3. Prevalence of age-related musculoskeletal diseases compared between genders and stratified by age group.

Age-related musculoskeletal diseases	Total prevalence	Subgroup analysis by age (years)						
		60–65	66–70	71–75	76–80	81–85	86–90	>90
Skeletal disorder ($n = 2991$)								
Osteoporosis	889 (29.7%)	201 (19.6%)	228 (23.7%)	202 (35.4%)	147 (46.7%)	67 (51.2%)	32 (76.2%)	12 (75.0%)
Female	710 (37.6%)	176 (26.1%)	183 (31.8%)	162 (47.0%)	118 (61.1%)	42 (63.6%)	23 (85.2%)	6 (85.7%)
Male	179 (16.2%)	25 (7.1%)	45 (14.3%)	40 (17.8%)	29 (23.8%)	25 (38.5%)	9 (60.0%)	6 (66.7%)
P-value[a]	***<.001***	***<.001***	***<.001***	***<.001***	***<.001***	***.005***	.128	.585
Muscle disorder ($n = 2456$)								
Sarcopenia	445 (18.1%)	110 (13.2%)	116 (15.2%)	94 (20.0%)	71 (27.4%)	44 (44.4%)	7 (33.3%)	3 (50.0%)
Female	208 (13.3%)	50 (9.0%)	56 (11.4%)	41 (14.0%)	39 (24.7%)	16 (34.0%)	5 (33.3%)	1 (33.3%)
Male	237 (26.5%)	60 (21.4%)	60 (22.1%)	53 (29.3%)	32 (31.7%)	28 (53.9%)	2 (33.3%)	2 (66.7%)
P-value[a]	***<.001***	***<.001***	***<.001***	***<.001***	.254	.068	1.000	1.000
Falls risk ($n = 2952$)								
High falls risk (FRQ ≥ 4)	1137 (38.5%)	326 (32.0%)	322 (36.6%)	238 (42.4%)	149 (47.8%)	62 (48.8%)	29 (72.5%)	11 (73.3%)
Female	870 (46.6%)	268 (40.0%)	253 (44.4%)	178 (52.2%)	105 (55.0%)	40 (62.5%)	22 (84.6%)	4 (66.7%)
Male	267 (24.6%)	58 (16.7%)	69 (22.3%)	60 (27.3%)	44 (36.4%)	22 (34.9%)	7 (50.0%)	7 (77.8%)
P-value[a]	***<.001***	***<.001***	***<.001***	***<.001***	***.002***	***.003***	***.029***	1.000

Bolded *P*-valuesindicate statistical significance. [a]The *P*-values reflect the comparisons between genders. FRQ, fall risk questionnaire.

decline in all 3 assessments, meeting the criteria for severe sarcopenia. It is worth noting that the prevalence of severe sarcopenia was notably higher in males (18.6%) than in females (8.4%). Post hoc power analysis revealed a power of 82% for sarcopenia prevalence calculation in this study.

Fall risk assessment was available in 2952 participants. Almost one-quarter (22.5%) of participants had a history of falls within 1 yr before the survey. Women had a significantly higher mean fall rate than men (27.4% vs 14.1%, respectively, $P < .001$). The prevalence of a high risk of falls was 38.5%. Almost half of female participants demonstrated a high risk of falls, while approximately one-fourth of male participants had an FRQ score ≥4 (Table 2). Moreover, the prevalence of a high risk of falls proportionally increased with age between the 2 genders (Table 3 and Figure 2C).

A complete evaluation of osteoporosis, sarcopenia, and high falls risk was available in 2452 participants. Figure 3 shows a Venn diagram describing the percentages of participants with or more of the 3 conditions evaluated in this study. Approximately one-fifth of participants (19.1%) had at least 2 of the 3 conditions, and 8.6% of subjects were diagnosed with osteosarcopenia. A small percentage (3.4%) of subjects had both osteosarcopenia and a high risk of falls.

Discussion

The older adult population in Thailand continues to grow, and older adults are expected to account for approximately one-fourth of the Thai population within the next decade. Consequently, the prevalence of degenerative health conditions will inevitably rise, which means that the prevalence of falls and fragility fractures will also increase. The findings of this large-scale, nationwide, cross-sectional study emphasize this fact by demonstrating that up to one-third of healthy community-dwelling Thai older adults are affected by either osteoporosis or a high risk of falls and with females being more affected than males. In contrast, the prevalence of sarcopenia was greater in males.

The prevalence of osteoporosis in Thailand is also increasing. The proportion of Thai older adults with osteoporosis is higher than the Asian average.[16] The present study found an increase in the prevalence of osteoporosis in Thailand from 1998 to 2021 (Table 4).[36-40] In addition to the aging phenomenon, the observed increasing trend may be due to heterogeneity of population characteristics and age range. Nevertheless, the majority of previous studies conducted in Thailand were retrospective observational studies within a single region of the country, which may not accurately represent the actual prevalence of osteoporosis in Thailand. To our knowledge, this study is the only nationwide study focusing on the prevalence of osteoporosis in healthy community-dwelling Thai older adults to be conducted within the last 2 decades. Compared with the previous nationwide epidemiologic survey that was conducted in 2001, we observed an increase in the age-specific prevalence of osteoporosis in all age groups.[38] A similar trend was also observed in men. The prevalence of osteoporosis in Thai men increased from 12.6% in 2006 to 16.2% in 2023.[41] The higher prevalence of osteoporosis in

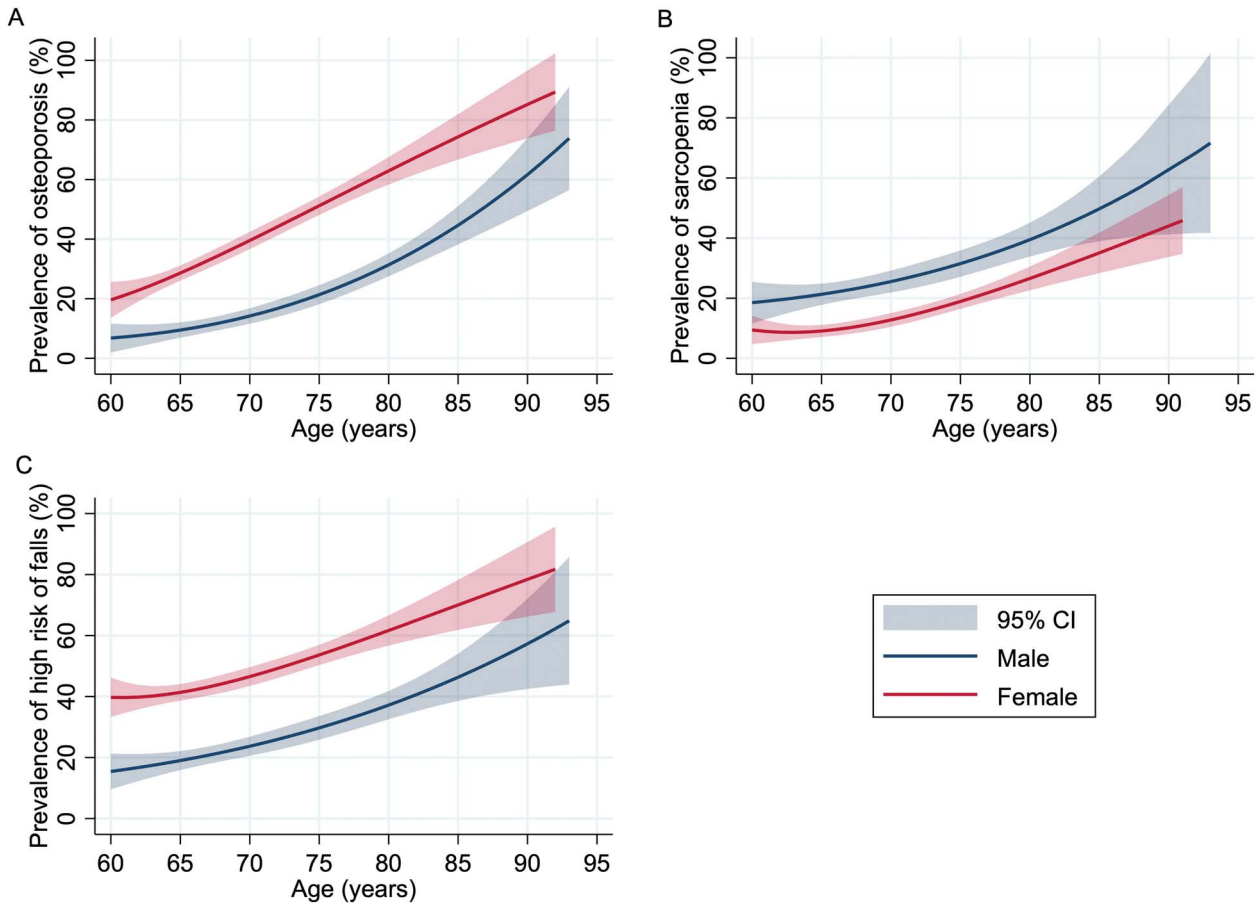


Figure 2. The prevalence of the age-related musculoskeletal conditions that were investigated in this study: (A) osteoporosis, (B) sarcopenia, and (C) high risk of falls were compared between genders and among different age groups of healthy community-dwelling Thai older adults.

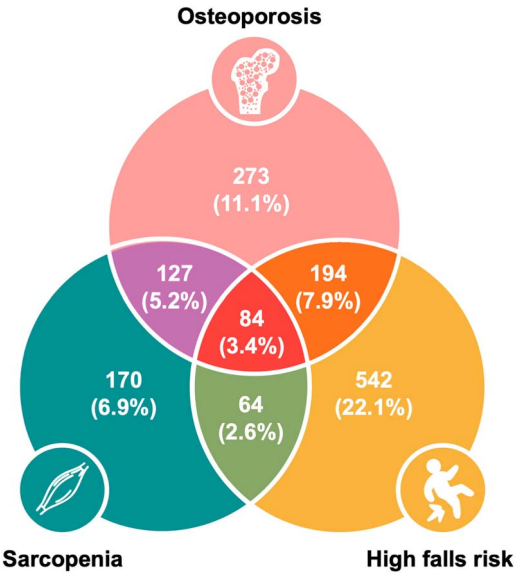


Figure 3. The proportions of study subjects with complete evaluations ($n = 2452$) who were affected by osteoporosis, sarcopenia, and/or a high risk of falls. The overlapping regions represent the coexistence of 2 or more of these conditions in the same person.

women compared to men is a well-documented phenomenon, primarily attributed to physiological skeletal changes resulting from hormonal fluctuations during the postmenopausal period.[42] Nevertheless, our study revealed that as many as 40% of Thai men exhibited osteoporosis after reaching the age of 80. This observation aligns with previous research, indicating that cortical volumetric BMD in men begins to decline after the seventh decade of life, driven by an imbalance between periosteal apposition and endocortical resorption.[43] Our findings highlight the fact that osteoporosis is currently affecting both male and female healthy community-dwelling older adults living in Thailand.

We found a slightly smaller prevalence of sarcopenia among Thai older adults compared to previous studies. However, the reported prevalence of sarcopenia in Thai older adults ranged widely from 19.7% to 35.3%.[44-47] The possible explanations for the wide range of sarcopenia prevalence include different populations, age ranges, years of data collection, and the diagnostic criteria used in each study. For example, it has been shown that the prevalence of sarcopenia as determined by the AWGS 2019 criteria tends to be lower than by the European Working Group on Sarcopenia in Older People criteria.[48,49] Nevertheless, we observed an increasing trend in the prevalence of sarcopenia in Thai older adults among studies with similar age groups and diagnostic criteria (from 19.7% in 2019 to 22.2% in 2021).[46,47] Consistent with previous studies, the present study found that older Thai men had a higher rate of sarcopenia than women.[44,46,47] One possible explanation for the prevalence of sarcopenia in aging men could be the decline in androgen levels, leading to decreased muscle mass.[50] However, it is important

Table 4. The previously reported prevalence of osteoporosis in Thai population.[36–40]

Author	Journal	Years of data collection	Sample size	Population	Age range (yr)	Study design	BMD	Prevalence
Taechakraichana N	*Journal of the Medical Association of Thailand*	1992–1995	1047	Thai women who attended the menopause clinic in a single medical center	50.5 ± 5.7[a]	Retrospective observational study	LS FN	15.7% 9.5%
Limpaphayom K	*Menopause*	1998–1999	1935	Community-dwelling Thai women across 6 geographical regions of Thailand	40–80	Cross-sectional study using stratified multistage random sampling	LS FN	19.8% 13.6%
Thangwijitra S	*Thai Journal of Obstetrics and Gynaecology*	2002–2008	245	Postmenopausal Thai women who attended the menopause clinic in a single medical center	42–72	Retrospective observational study	LS FN	10.6% 1.6%
Saengsuda S	*Journal of Health Science*	2011–2012	750	Thai women who had undergone BMD evaluation in a single tertiary medical center	50–92	Retrospective observational study	LS FN LS or FN	15.3% 12.6% 21.6%
Chanidkul P	*PLOS ONE*	2014–2019	3280	Postmenopausal Thai women who had been screened for osteoporosis in a single tertiary medical center	40–80	Retrospective observational study	LS FN LS or FN	18.6% 12.4% 23.0%
The current study	—	2021–2022	2991	Community-dwelling Thai older adults across six geographical regions of Thailand	60–107	Cross-sectional study using stratified multistage random sampling	LS FN LS or FN	25.6% 16.2% 29.7%

[a]Presented as mean ± SD due to the lack of age range information. FN, femoral neck; LS, lumbar spine (L1–L4).

to note that the majority of aging men do not experience overt hypogonadism, which suggests that androgen deficiency may not be the primary cause of sarcopenia in men.[51] Furthermore, some studies have reported a higher prevalence of sarcopenia in women.[52-54] Consequently, the relationship between sarcopenia and sex remains complex and not fully elucidated.

Approximately 20% of Thai older adults experienced one or more falls within 1 yr in recent years.[34,55] The number of falls has been slowly increasing since 1998, and women continue to fall more than men.[56] Consistent with previous reports, our study also observed a higher risk of falls in women than in men. The increased fall risk in women can be attributed to several factors, including osteoarthritis of the knee joints, cognitive function, and medication use.[57] Additionally, one study suggested that the heightened fall risk in women might be linked to greater variability in gait parameters during dual-task activities, such as walking while multitasking.[58] However, certain risk factors for falls exhibit sex-specific associations, such as incontinence and frailty in women, and poor balance and depression in men.[59] In 2021, a national survey reported a similar trend of accidental fall rates in Thai older adults.[60] Although the reported prevalence of falls was relatively small due to different definitions of falls, those researchers discovered a gradual increase in the prevalence of falls among community-dwelling seniors within the last decade. Compared with global trends, the fall rates in Thailand were slightly lower than the global prevalence of 26.5%. According to a 2022 systematic review, Oceania demonstrated the highest prevalence of falls among all continents (34.4%), followed by America (27.9%), Asia (25.8%), Africa (25.4%), and Europe (23.4%).[61] We hypothesize that different biological, environmental, and socioeconomic variations across world regions might influence the fall rate among older adults.[34] Nevertheless, the FRQ assessment conducted in this study demonstrated that up to 40% of Thai older adults are at high risk of subsequent falls. This number is concerning, as approximately 23% of falls in older adults cause serious injury.[62] Accordingly, a fall prevention strategy should be developed and implemented among community-dwelling seniors to prevent or minimize fragility fractures in this population.

It is apparent that osteoporosis, sarcopenia, and falls are important risk factors for fragility fractures.[63,64] Consequently, osteosarcopenic patients are at significantly higher risk for sustaining a fragility fracture compared to those with osteoporosis or sarcopenia alone. This study is the first to report the prevalence of osteosarcopenia among healthy community-dwelling Thai older adults. Despite the lack of clinical evidence, the prevalence of this condition is likely increasing since there is a significant increase in the prevalence of osteoporosis and sarcopenia in Thailand. Compared to the previously reported rates in other countries that ranged from 5% to 37%, our study found a comparable rate of osteosarcopenia in older Thai adults (8.6).[15,65] Awareness of this disease category should be urgently heightened in Thailand due to its profound impact on disability and mortality.[66] Moreover, the risk of fragility fracture is even higher in osteosarcopenic patients who were also found to be at high risk for falls. These study subjects accounted for 3.4% of our study cohort, and they should be considered at extremely high risk for sustaining a fragility fracture. This extremely vulnerable group requires special attention

to prevent fragility fractures and their potentially lethal complications.

Strengths and limitations

This study has several notable strengths. First, this is one of few nationwide studies that focuses on community-dwelling Thai older adults and how they are impacted by common age-related degenerative musculoskeletal diseases. Moreover, great care was taken to ensure that our study cohort would reflect the national population of Thailand. Participants were enrolled from both urban and rural areas and from across all 6 geographical regions of Thailand. As such, we believe that our study's findings accurately reflect the prevalence of osteoporosis, sarcopenia, and high falls risk in healthy community-dwelling Thai older adults. Second, this is the first study to investigate the rate of osteosarcopenia in Thailand.

Our study also has some mentionable limitations. First, the sample size calculated in this study didn't account for sarcopenia evaluation. However, our post hoc power analysis demonstrated adequate statistical power for the sarcopenia assessment. Second, the skeletal muscle mass evaluation in this study was performed using DF-BIA instead of DXA. However, previous study reported DF-BIA to be a valid and reliable tool for assessing skeletal mass in older adults.[30] Third, we enrolled only healthy community-dwelling Thai older adults, so the prevalence of these conditions in hospitalized or non-ambulatory subjects is not included in our results. Fourth and last, due to our study's cross-sectional design, the long-term outcomes of these common age-related degenerative musculoskeletal diseases cannot be demonstrated. Future study to investigate the real incidence of fragility fracture in this population group is warranted, and a study that assesses the effectiveness of any preventive strategies to prevent falls and future fractures, especially in the high-risk older adult group, should be conducted.

Conclusions

The results of this study revealed a high and increasing prevalence of osteoporosis, sarcopenia, and high falls risk in healthy community-dwelling Thai older adults. Importantly, this is the first study to reveal that up to one-fifth of this population had at least 2 out of 3 of these conditions, and 3.4% had all 3 conditions. Moreover, 8.6% of our study cohort had osteosarcopenia. Since these factors are considered major risk factors for fragility fractures, an increasing incidence of fragility fractures among healthy community-dwelling Thai older adults can be anticipated and should be planned for. To that end, modification of Thailand's national health care policy is urgently needed to address the increasing prevalence of these conditions among healthy community-dwelling Thai older adults.

Acknowledgments

The authors gratefully acknowledge the community-dwelling Thai older adults who generously agreed to participate in this study, the local village health volunteers who helped facilitate this study, and the staff of the Department of Orthopaedic Surgery for study coordination and journal submission.

Author contributions

Apichat Asavamongkolkul (Conceptualization, Funding acquisition, Project administration, Resources, Supervision, Methodology, Writing—review & editing [equal, co-first author]), Nath Adulkasem (Data curation, Conceptualization, Formal analysis, Investigation, Visualization, Writing—original draft preparation, Writing—review & editing [equal, co-first author]), Pojchong Chotiyarnwong (Conceptualization, Methodology, Investigation, Formal analysis, Writing—review & editing), Ekasame Vanitcharoenkul (Conceptualization, Methodology, Investigation, Formal analysis, Writing—review & editing), Chandhanarat Chandhanayingyong (Conceptualization, Methodology, Investigation, Formal analysis, Writing—review & editing), Panai Laohaprasitiporn (Conceptualization, Methodology, Investigation, Formal analysis, Writing—review & editing), Krabkaew Soparat (Methodology, Investigation, Data curation), and Aasis Unnanuntana (Conceptualization, Methodology, Investigation, Formal analysis, Writing—review & editing, Visualization, Validation, Supervision, Corresponding author)

Supplementary material

Supplementary material is available at *JBMR Plus* online.

Funding

This study was supported by a grant from the National Research Council of Thailand, Bangkok, Thailand. The funder had no influence on the study design or protocol, the interpretation of data, the final conclusions drawn, or the decision to publish.

Conflicts of interest

All authors declare no personal or professional conflicts of interest and no financial support from the companies that produce and/or distribute the drugs, devices, or materials described in this report.

Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request. The data are not publicly available due to privacy or ethical restrictions.

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