

Prevalence and associated factors of pre-frailty and frailty among Thai community-dwelling older adults aged 65 years and above

Sukwida Manorangsarn^{1,2}, Pawan Chaiparinya¹, Sirima Mongkolsomlit³, Sujitra Boonyong^{1*}

¹Human Movement Performance Enhancement Research Unit, Department of Physical Therapy, Faculty of Allied Health Sciences, Chulalongkorn University, Bangkok, Thailand.

²Department of Physical Therapy, Faculty of Allied Health Sciences, Thammasat University, Pathum Thani Province, Thailand.

³Faculty of Public Health, Thammasat University, Pathum Thani Province, Thailand.

ARTICLE INFO

Article history:

Received 10 March 2025

Accepted as revised 30 July 2025

Available online 14 August 2025

Keywords:

Pre-frailty, physical frailty, Thai older adults, community-dwelling.

ABSTRACT

Background: As Thailand's aging population grows rapidly, frailty status may develop and have serious implications. Early detection or prevention can be encouraged, especially prior to the emergence of advanced frailty and functional deterioration. Pre-frailty and frailty should be identified and investigated.

Objectives: To explore the prevalence of frailty statuses and their associations with sociodemographic characteristics among Thai older adults.

Materials and methods: This study was a cross-sectional design. Two hundred sixty-eight Thai community-dwelling older adults aged ≥ 65 years were recruited. Their physical frailty status was determined using the Fried frailty phenotypic criteria, which comprise weakness, slowness, low physical activity, weight loss, and exhaustion. Multinomial (Polytomous) logistic regression was used to detect associations between frailty status and sociodemographics.

Results: Among participants, the prevalences of pre-frailty, frailty, and robustness were 38.4%, 42.5%, and 19.0%, respectively. In the multivariate-adjusted model, pre-frailty was significantly associated with age (relative risk ratio(RRR)=1.10; 95% confidence interval (CI)=1.01-1.18, $p=0.020$), occupation as governor or owner (RRR=0.37; 95%CI=0.15-0.92, $p=0.032$), and housewife (RRR=0.29; 95%CI=0.09-0.93, $p=0.037$). Likewise, frailty was associated with age (RRR=1.28; 95%CI=1.18-1.39, $p<0.001$), gender (RRR=0.34; 95%CI=0.14-0.85, $p=0.021$), BMI (RRR=0.88; 95%CI=0.79-0.98, $p=0.019$), and education (RRR=0.231; 95%CI=0.09-0.58, $p=0.002$). Additionally, comorbidity with ≥ 3 diseases was significantly associated with frailty (RRR=16.34; 95%CI=1.64-162.46, $p=0.017$).

Conclusion: Our findings reveal comparable prevalence rates of pre-frailty and frailty among Thai older adults. While age and occupation were associated with pre-frailty, a broader range of factors, including age, gender, BMI, comorbidities, and education, showed associations with frailty. These results underscore the importance of considering multiple factors collectively when screening or assessing an elderly individual's risk of developing pre-frailty or frailty.

Introduction

Pre-frailty describes a transitional health state beyond normal aging, characterized as a complex, multifactorial condition linked to gradual physiological decline.¹ Though often subclinical, it may present as fatigue or weakness and includes distinct bio-psychosocial domains. Pre-frailty increases the risk of frailty and adverse health outcomes.^{1,2} Previous studies have identified a high prevalence of pre-frailty in community-dwelling older adults, highlighting its role as a key transitional stage and target for early intervention.³⁻⁸

* Corresponding contributor.

Author's Address: Human Movement Performance Enhancement Research Unit, Department of Physical Therapy, Faculty of Allied Health Sciences, Chulalongkorn University, Bangkok, Thailand.

E-mail address: sujitra.b@chula.ac.th

doi: 10.12982/JAMS.2025.100

E-ISSN: 2539-6056

Although pre-frailty has received less research attention, its prevalence remains consistently higher than that of frailty, ranging from 43.1% to 49.5% globally³⁻⁶ and from 50.9% to 57.4% in Thailand,^{7,8} whereas frailty affects only 8% to 22% globally³⁻⁶ and 13.9% to 15.9% in Thailand.^{7,8} The higher prevalence of pre-frailty underscores the risk of progression without timely intervention. As a reversible stage between robustness and frailty, pre-frailty offers a crucial opportunity for preventive action.^{1,9-11}

Identifying factors linked to pre-frailty enables early detection and prevention. As a reversible stage, pre-frailty can be addressed before advanced decline.¹ However, research on its prevalence and associated factors in Thai community-dwelling older adults remains limited. Age, education, marital status, and comorbidities are key contributors to pre-frailty.^{4,10,11} A systematic review of studies conducted in Europe and China identified several risk factors associated with both frailty and pre-frailty, including advanced age, female sex, rural residence, low educational attainment, poor marital status, living alone, financial hardship, and limited access to medical reimbursement.^{4,10}

Understanding the prevalence of pre-frailty and frailty is essential for guiding health policy and planning effective responses to the challenges posed by an aging population. Accurate prevalence data can assist policymakers in evaluating the capacity of health and social service systems to manage the growing burden of geriatric pre-frailty, particularly in the context of Thailand's rapidly aging society. Furthermore, identifying factors associated with these conditions is critical to gaining deeper insight into the underlying causes of geriatric vulnerability within the Thai population. This knowledge is pivotal for developing timely, targeted interventions aimed at preventing or delaying the progression to frailty and reducing its adverse health outcomes. To support these objectives, it is necessary to update existing prevalence estimates and reassess contributing sociodemographic and health factors. The prevalence of frailty, as classified by the Fried physical frailty criteria, was explored in elderly individuals aged 65 years and older who were living in a community.⁹ Therefore, the purpose of this study was to investigate the prevalence of pre-frailty and frailty among community-dwelling individuals aged 65 years and older. It also aimed to examine the associations between frailty status and sociodemographic characteristics in this population.

Materials and methods

Study design

A cross-sectional study was conducted among older Thai adults living in communities in Pathum Thani Province, Thailand, from November 2021 to August 2022. The recruitment location was chosen based on potential participants' willingness to engage in the study and the cooperation of the health-promoting hospital, which provided space for the assessment station. The sample size was determined using population proportion estimates from the previous study.⁷ A sampling error

fixed at five percentage points, and a 95% confidence level ($\alpha=0.05$) were considered. Due to the potential for losses or refusals, the sample size was increased by 10%, resulting in a sampling plan of 268 older individuals. This study was approved by the Research Ethics Committee of Chulalongkorn University, Thailand (COA No. 089/2020) and conducted according to the Declaration of Helsinki. All participants provided written informed consent before starting data collection.

Participants

This study enrolled 268 participants using the convenience sampling method. Inclusion criteria were age 65 years or older, residence in the home for at least 1 year, ability to read and communicate in Thai, and no uncorrected hearing or visual impairments. Exclusion criteria included a medical history suggestive of Parkinson's or Alzheimer's disease, identified through a standard screening questionnaire administered by the main researcher.

Procedures

For each eligible participant, personal sociodemographic data were recorded, including age, sex, weight, height, body mass index (BMI), educational level, occupation, marital status, residential status, and health status, such as underlying diseases and other medical conditions. Participants were then evaluated for physical performance and frailty phenotypes based on the 2001 Fried physical frailty criteria.⁹ The assessment included five components; gait speed, muscle weakness, unintentional weight loss, low levels of physical activity (PA), and self-reported exhaustion; and was conducted by a physical therapist with 15 years of experience.

Gait speed was measured by timing participants as they walked at a comfortable speed along a 4.57-meter (15 feet) walkway.⁹ One to two practice trials were conducted to help participants acclimate. The assessor issued the following instruction to participants: "Ready, set, go. When I say go, walk at your comfortable speed until I say stop." To eliminate the effect of acceleration and deceleration, walking speed was timed in the middle of the walkway. Timing commenced when the participant's foot strike passed the first meter mark and stopped when the toe-off passed the last 1-meter mark. Data were recorded for three trials and then averaged. If the average walking speed was in the lowest 20% (by sex and height), a score of one point was recorded.⁹

Muscle weakness was measured by the grip strength (Takei Grip Strength Dynamometer, model T.K.K. 5401 GRIP-D, Japan) of the dominant hand in a standing position. Participants were allowed to practice once before data collection. The assessor instructed participants to "squeeze with as much force as you can." After two recorded trials, the data were averaged. If the average hand grip strength fell within the lowest 20% (by sex and BMI), a score of one point was assigned.⁹

Weight loss was identified by asking participants whether they had unintentionally lost more than 4.5 kg

during the past year. They were asked, “How much did you weigh last year, and how much do you weigh now?” The comparison between their weight on the day of data collection and their weight from the previous year determined the score. A weight loss exceeding 4.5 kg resulted in a score of one point.⁹

The Thai version of the International Physical Activity Questionnaire-Short Form (IPAQ-SF) was used to evaluate PA level, as it demonstrated strong test–retest reliability (intraclass correlation coefficient, ICC=0.69).¹² The IPAQ-SF consists of questions about the amount of time spent engaging in PA during the preceding 7 days. The assessor administered the questionnaire by reading each item aloud to each participant individually, thereby ensuring uniform comprehension and minimizing potential misinterpretation. Participants were then prompted to provide their responses. If the total kcal per week fell in the lowest 20% (<383 kcal/week for males or <270 kcal/week for females), a score of one point was given.⁹

Exhaustion was assessed by participant self-report using structured questions administered by the assessor. Participants were asked whether they had experienced extreme physical fatigue or exhaustion that prevented them from participating in activities. Specifically, they were asked, “Do you feel so exhausted or extremely physically fatigued that you could not perform something afterward?” and “Do you feel that all activities are done with difficulty?” Responses were rated based on the frequency of these feelings during the past week using a 4-point Likert scale: 0 = rarely or none of the time (<1 day), 1 = some or a little of the time (1-2 days), 2 = a moderate amount of the time (3-4 days), and 3 = most of the time (>5 days).¹³ Participants who responded with a score of 2 or 3 were classified as meeting the frailty criteria.⁹

Statistical analysis

All statistical analyses were conducted using STATA version 17. For continuous variables such as age, BMI, walking velocity, grip strength (kg), total PA, and frailty score, the mean and standard deviation (SD) were presented. Categorical variables, including sex, marital status, residential status, educational level, occupation

before retirement, comorbidities, PA level, and physical frailty characteristics (slowness, weakness, low PA, weight loss, and exhaustion), were reported as percentages.

Based on data normality, one-way analysis of variance (ANOVA) was used to compare continuous variables between the pre-frailty, frailty, and robust groups. Categorical variables were compared between groups using a chi-square or Fisher’s exact test. Univariate analyses were used to describe associations between frailty status and sociodemographic characteristics (age, gender, BMI, marital status, residential status, educational level, occupation, and comorbidity). Factors with $p < 0.25$ were retained and included as covariates in the multivariable analysis.¹⁴ Prior to performing multivariable logistic regression, age and occupation before retirement (labor, governor, owner, and housewife), with labor as the reference category, were identified as key variables for the pre-frailty model. For the frailty model, relevant factors included age, gender, BMI, education, and comorbidity (none = no disease, 1-2 diseases, and ≥ 3 diseases), with “none” as the reference category. Because the proportional odds assumption for the ordinal logistic regression model did not hold, a multinomial logistic regression analysis was conducted instead. This method, suitable for modeling categorical outcomes with more than two levels (robust, pre-frailty, and frailty), with the robust group as the reference category, allowed for the estimation of relative risk ratios (RRRs) with 95% confidence intervals (CI) for each outcome. The significance level was set at p -value < 0.05 .

Results

Prevalence of pre-frailty and frailty

The prevalence of each frailty status, along with participants’ demographic characteristics, is shown in Table 1. Of the participating Thai community-dwelling older adults, 19.0% were in the robust group, 38.4% were in the pre-frailty group, and 42.5% were in the frailty group. There were more females than males in all groups. The mean frailty score in the frailty group (3.69 ± 0.78) was significantly higher than pre-frailty (1.24 ± 0.43), as shown in Table 2.

Table 1. Participant demographics and characteristics.

Variables	Robust	Pre-frailty	Frailty	p value for difference
Number of participants (N, %)	51 (19.0%)	103 (38.4%)	114 (42.5%)	
Gender (N, %)				
Women	33 (64.7%)	61 (59.2%)	83 (72.8%)	
Men	18 (35.3%)	42 (40.8%)	31 (27.2%)	
Age (years), mean±SD	69.9±4.1	72.4±5.5	79.0±7.3	<0.001 ^{*a}
BMI (kg/m ²), mean±SD	25.5±3.8	24.5±3.8	23.9±3.9	0.040 ^{*a}
Marital status (N, %)				0.707 ^b
Single	4 (7.8%)	6 (5.8%)	10 (8.8%)	
Married/widow/divorce	47 (92.2%)	97 (94.2%)	104 (91.2%)	
Living status (N, %)				0.211 ^b
Alone	2 (3.9%)	13 (12.6%)	14 (12.3%)	
With relatives	49 (96.1%)	90 (87.4%)	100 (87.7%)	
Education level (N, %)				<0.001 ^{*b}
Elementary or no degree	30 (58.8%)	64 (62.1%)	94 (82.5%)	
Secondary or higher degree	21 (41.2%)	39 (37.9%)	20 (17.5%)	
Occupation before retirement (N, %)				0.009 ^{*b}
Labor	10 (19.6%)	44 (42.7%)	26 (22.8%)	
Governor/owner	32 (62.7%)	47 (45.6%)	71 (62.3%)	
Housewife	9 (17.7%)	12 (11.7%)	17 (14.9%)	
Comorbidity diseases (N, %)				0.017 ^{*b}
0 = None	6 (11.8%)	8 (7.8%)	1 (0.9%)	
1-2 diseases	28 (54.9%)	45 (43.7%)	56 (49.1%)	
≥3 diseases	17 (33.3%)	50 (48.5%)	57 (50.0%)	

Note: BMI: body mass index SD: standard deviation, ^{*}significant at $p \leq 0.05$, ^aANOVA, ^bChi-square test.

Table 2. Physical pre-frailty / frailty and percentage of positive item in each group.

Variables	Robust	Pre-frailty	Frailty	p-value for difference
Frailty score, mean±SD	0	1.24±0.43	3.69±0.78	<0.001 ^{*a}
Min-max	0	1-2	3-5	
Walking velocity, mean±SD	1.07±0.14	1.02±0.21	0.66±0.27	<0.001 ^{*a}
Slowness (N, %)	0	7 (6.8%)	78 (68.4%)	<0.001 ^{*b}
Hand grip strength, mean±SD	27.5±7.5	23.6±6.8	15.8±5.4	<0.001 ^{*a}
Weakness (N, %)	0	44 (42.7%)	104 (91.2%)	<0.001 ^{*b}
Total Physical activity, mean±SD	2187.4±2181.0	904.4±984.5	336.5±592.7	<0.001 ^{*a}
Low Physical activity (N, %)	0	46 (44.7%)	93 (81.6%)	<0.001 ^{*b}
Weight loss (N, %)	0	15 (14.6%)	53 (46.5%)	<0.001 ^{*b}
Exhaustion (N, %)	0	16 (15.5%)	93 (81.6%)	<0.001 ^{*b}

Note: SD: standard deviation, MET.min/week: Metabolic Equivalent of Task in minutes per week, ^{*}significant at $p \leq 0.05$; ^aANOVA; ^bChi-square test.

Sociodemographic characteristics among frailty statuses

Table 1 presents participant characteristics by frailty status. Frail individuals were the oldest group (mean age: 79.0 years), had the lowest BMI (23.9 kg/m²), and showed the highest proportions of low education (82.5%) and multiple comorbidities (≥ 3 diseases: 50.0%). Pre-frail individuals showed intermediate characteristics, with moderate age (72.4 years), BMI (24.5 kg/m²), and comorbidity burden, reflecting a transitional state. Robust individuals were younger (69.9 years), had a higher BMI (25.5 kg/m²), better education, fewer comorbidities, and were more likely to have held professional occupations.

Physical frailty characteristics

Table 2 presents physical frailty characteristics and the percentage of participants with positive items for each frailty status. Frail individuals had the highest frailty scores (mean=3.69), significantly slower walking speed (0.66 m/s), the weakest grip strength (15.8 kg), and the lowest PA level (336.5 MET.min/week), with most reporting slowness (68.4%), weakness (91.2%), exhaustion (81.6%), and weight loss (46.5%) ($p < 0.001$). Pre-frail individuals showed intermediate deficits across all measures, including moderate walking speed (1.02 m/s), grip strength (23.6 kg), and PA (904.4 MET.min/week), with 42.7% reporting weakness and 44.7% reporting low activity. In contrast, robust individuals had no frailty symptoms, demonstrating the highest physical performance and PA levels.

Factors associated with pre-frailty and frailty

Age and occupation prior to retirement were identified as significant predictors in the pre-frailty model, whereas

age, gender, BMI, educational attainment, and comorbidity were relevant factors in the frailty model. Multinomial logistic regression analysis revealed that each additional year of age was significantly associated with an increased risk of pre-frailty, with a RRR of 1.10 (95%CI [1.01, 1.18], $p = 0.020$), when compared to the robust reference group (Table 3). Furthermore, certain occupations—specifically governor, business owner, or housewife—were significantly associated with a reduced risk of pre-frailty, by approximately 63.0% and 71.0%, respectively, relative to the labor group (RRR=0.37; 95%CI [0.15, 0.92], $p = 0.032$, and RRR=0.29; 95%CI [0.09, 0.93], $p = 0.037$).

For the frailty outcome, multinomial logistic regression analysis demonstrated that each additional year of age was significantly associated with a 1.28-fold increase in the risk of frailty compared to the robust reference group (RRR=1.28; 95%CI [1.18, 1.39], $p < 0.001$). Males exhibited a significantly lower risk of frailty, with a 66.0% reduction compared to females (RRR=0.34; 95%CI [0.14, 0.85], $p = 0.021$). In terms of BMI, a higher BMI was associated with a significantly decreased risk of frailty, with an RRR of 0.88 (95%CI [0.79, 0.98], $p = 0.019$), indicating a 12.0% risk reduction relative to those with lower BMI. Similarly, participants with at least secondary education had a 77.0% lower risk of frailty compared to those with lower educational attainment (RRR=0.23; 95%CI [0.09, 0.58], $p = 0.002$). Finally, individuals with comorbidities involving three or more chronic conditions showed a markedly increased risk of frailty—approximately 16.34 times higher than those without any chronic conditions (RRR=16.34; 95%CI [1.64, 162.46], $p = 0.017$), as presented in Table 3.

Table 3. Associated factors related with pre-frailty and frailty by multinomial logistic regression.

Outcome	Variable	RRR	SE	z	p-value	95% CI	
Robust		(base outcome)					
Pre-frailty	Age	1.10	0.04	2.33	0.020*	1.01	1.18
	Gender						
	Female	Ref					
	Male	0.81	0.32	-0.53	0.594	0.37	1.76
	Body mass index	0.92	0.04	-1.64	0.101	0.84	1.02
	Education						
	Elementary or no degree	Ref					
	Secondary or higher degree	0.96	0.38	-0.1	0.922	0.44	2.09
	Occupation						
	Labor	Ref					
	Governor/owner	0.37	1.17	-2.14	0.032*	0.15	0.92
	Housewife	0.29	1.72	-2.09	0.037*	0.09	0.93
	Comorbidity						
	None	Ref					
	1-2 diseases	1.55	0.98	0.7	0.487	0.47	5.14
	≥3 diseases	2.50	1.68	1.36	0.173	0.67	9.30
	Constant	0.05	1.09	-1.08	0.279	0.00	94.98
Frailty	Age	1.28	0.54	5.92	0.000*	1.18	1.39
	Gender						
	Female	Ref					
	Male	0.34	1.58	-2.32	0.021*	0.14	0.85
	Body mass index	0.88	0.05	-2.35	0.019*	0.79	0.98
	Education						
	Elementary or no degree	Ref					
	Secondary or higher degree	0.23	1.08	-3.1	0.002*	0.09	0.58
	Occupation						
	Labor	Ref					
	Governor/owner	1.42	0.76	0.65	0.514	0.50	4.05
	Housewife	0.75	1.50	-0.43	0.668	0.21	2.76
	Comorbidity						
	None	Ref					
	1-2 diseases	9.02	10.32	1.92	0.055	0.96	84.99
	≥3 diseases	16.34	19.15	2.38	0.017*	1.64	162.46
	Constant	0.00	0.00	-4.35	0.000	0.00	0.00

Note: RRR: relative risk ratio, SE: standard errors, z: z-statistics, 95%CI: 95%confidence interval, *significant at $p<0.05$, Ref: reference.

Discussion

This study examined pre-frailty and frailty prevalence and their links to sociodemographic factors among community-dwelling older adults aged 65 years and above. Prevalence rates were 38.4% for pre-frailty and 42.5% for frailty. Pre-frailty was associated with age and preretirement occupation, while frailty correlated with age, gender, BMI, comorbidity, and education.

The pre-frailty prevalence in this study (38.4%) was lower than in prior Thai studies (50.9%-57.4%)^{7,8} and slightly below international findings (43.1%-49.5%).³⁻⁶ In contrast, frailty prevalence (42.5%) was significantly higher than reported in both Thai^{7,8} and global reports (6.3%-24.0%).³⁻⁶ These discrepancies may partly stem from differences

in participant age, as previous Thai studies included individuals aged ≥60 years^{7,8} while the referenced review included individuals aged 50 and higher.³ In contrast, this study included only adults aged ≥65 to align with the Fried frailty phenotype⁹ and prior research.^{3,6-8} This higher age threshold likely excluded younger pre-frail individuals under age 65, in whom pre-frailty is often first detected.¹⁵ Given that frailty increases with age,¹⁶ the higher minimum participant age in this study likely contributed to a greater proportion of older adults who had already developed frailty, leading to an increased overall prevalence.

This study found high rates of low PA (44.7%) and muscle weakness (42.7%) among pre-frail individuals. Frail participants exhibited nearly double these rates,

with 91.2% muscle weakness, 81.6% low PA, and 81.6% exhaustion. The current findings align with Shinohara et al., who identified muscle weakness as a precursor to frailty,¹⁷ and Xue et al.'s framework, which suggested that behavioral changes emerge as physiological reserves diminish and the ability to meet environmental demands declines prior to the onset of frailty.¹⁸ Physical inactivity accelerates the loss of type II muscle fibers, worsening weakness and musculoskeletal deterioration, which together drive frailty progression.¹⁸ Low PA and muscle weakness were the most common components of pre-frailty, making them key indicators. Promoting regular PA and strengthening exercises is essential to maintain independence and may slow down the progression from pre-frailty to frailty, emphasizing the need for timely preventive interventions.

The current study found that 14.6% of pre-frail individuals experienced weight loss, reflecting age-related changes observed in previous research.¹⁹ In addition, exhaustion was significantly less common in pre-frail individuals (15.5%) compared to frail individuals (81.6%). Age-related muscle loss and inactivity likely contribute to fatigue and slower gait speed, leading to reduced physical performance in everyday activities.¹⁸ These effects likely reflect more comorbidities, lower PA, and greater fatigue in the frail group. Age-related sarcopenia further impairs mobility, fueling a cycle of physical inactivity and muscular deterioration.⁹ The link between aging, muscle loss, and inactivity highlights the need for early detection and timely intervention to halt the progression from robustness to frailty.

In contrast, although slowness was more prevalent among the frailty group, it remained one of the less common frailty components. Previous studies have shown that slowness strongly predicts longevity²⁰ and future disability⁵ in older adults. However, as a cross-sectional study, this research identified factors associated with frailty but was unable to predict longevity or disability. Table 2 shows that slowness was the least common characteristic in pre-frailty and the second least common in frailty. Previous studies have reported that a gait speed less than 0.8 meters per second in those ≥ 75 increases frailty risk.²¹ Based on our findings, promoting PA and increasing walking speed should be prioritized for individuals with pre-frailty, as physical inactivity and slow gait accelerate the loss of fast-twitch muscle fibers and contribute to muscle weakness. Therefore, the primary focus for individuals with frailty should be active muscle contractions and strengthening exercises.

The multivariate-adjusted model showed age and preretirement occupation were significantly linked to pre-frailty. Consistent with prior studies, frailty increased with age.¹⁸ Occupations like governor, business owner, or housewife had a 63% to 71% lower pre-frailty risk compared to labor-intensive jobs. This risk disparity may stem from the physical demands of manual labor, including heavy lifting, prolonged standing, and repetitive tasks, which increase musculoskeletal disorders and pre-frailty risk.²² One study found those with musculoskeletal

complaints in three to five bodily regions were 3.77 times more likely to be pre-frail or frail.²² Laborers may also be more vulnerable due to limited access to preventive care and lower participation in health-promoting behaviors.²³ The cumulative physical demands of labor-intensive work may accelerate the decline of physiological reserves, reducing the body's ability to recover from illness or injury and contributing to the onset of pre-frailty. This evidence highlights that frail individuals face greater socioeconomic and occupational disadvantages. One study reported that frail individuals had higher rates of economic hardship, outdoor work, longer workweeks, and extended daily hours,²⁴ highlighting the need to consider occupational and socioeconomic factors when assessing frailty risk.

The multivariate-adjusted model identified comorbidity, age, BMI, gender, and education as key frailty factors. Individuals with ≥ 3 chronic conditions had a significantly higher frailty risk (RRR=16.34) than those without.²⁵ This aligns with evidence that age-related physiological decline and multiple comorbidities compound to accelerate frailty onset.²⁵ Furthermore, participants in this study with ≥ 3 comorbidities had a 16.34-fold higher frailty risk than those without, consistent with a higher comorbidity rate in the frailty group. Conditions like hypertension, diabetes, cardiovascular disease, and osteoarthritis impair mobility and increase fatigue, contributing to frailty symptoms. Multiple chronic conditions were linked to increased inactivity, exhaustion, and weakness, indicating that comorbidity reflects health burden and accelerates the progression from robustness to pre-frailty and frailty.^{6,26}

Frailty was more prevalent among women, partly due to the hormonal changes that occur after menopause. These hormonal shifts contribute to muscle degeneration, sarcopenia, and age-related muscle loss, leading to reduced physical function.²⁷ Estrogen decline associated with menopause exacerbates sarcopenia, which, when combined with low activity, fatigue, and weight loss, accelerates the development of frailty.^{28,29}

Educational level significantly affects frailty prevalence.^{4,7,8,30} Lower education is linked to physical, social, and environmental disadvantages, reduced health literacy, and difficulty managing medical care.³¹⁻³³ It also correlates with socioeconomic challenges, such as low income, poor housing, limited access to nutrition, physical inactivity, and delayed treatment, all of which increase the risk of chronic disease.²⁶

This study highlights the clinical importance of identifying key factors associated with pre-frailty, with an emphasis on age and preretirement occupation. While age is a well-known risk factor, the impact of occupational history represents a significant finding, emphasizing its role in screening and prevention measures. These insights support the integration of pre-frailty screening into geriatric care, particularly for community-dwelling and socioeconomically disadvantaged older adults. Assessing work history can guide targeted follow-up and educational interventions during the preretirement phase. The study also found that low PA was the most common frailty component among pre-frail participants, underscoring its

role as a key modifiable risk factor. Promoting regular PA is essential to preserve functional independence and reduce the risk of progression to frailty, emphasizing the need for early intervention. A key strength of this study is the use of the validated Fried frailty phenotype.⁹

Limitation

Several limitations should be acknowledged. First, the study's cross-sectional design limits causal inference, and the sample drawn from older adults in Pathum Thani may reduce generalizability. Future research involving a larger and more diverse cohort study is recommended to further clarify frailty determinants and guide targeted interventions.

Conclusion

Among community-dwelling adults aged ≥ 65 , pre-frailty and frailty prevalence were 38.4% and 42.5%, respectively. Pre-frailty was linked to age and labor-intensive work, while frailty was associated with age, gender, low BMI, low education, and comorbidity. These findings highlight the need for early detection and targeted interventions to prevent frailty progression.

Ethical approval

This study was approved by the Research Ethics Committee of Chulalongkorn University, Thailand (COA No. 089/2020) and conducted according to the Declaration of Helsinki. All the participants provided written informed consent before starting data collection.

Funding

This study was supported by the 90th Anniversary of Chulalongkorn University Fund (Ratchadaphiseksomphot Endowment Fund; Grant numbers GCUGR1125632113D-no113).

Conflict of interest

The authors reveal no actual or potential conflicts of interest relevant to the content of this article.

CRediT authorship contribution statement

Sukwida Manorangsan: conceptualization, methodology, formal analysis, investigation, writing-original draft preparation, writing-review and editing, funding acquisition; **Pawan Chaiparinya:** writing-original draft preparation, writing-review and editing; **Sirima Mongkolsomlit:** formal analysis, writing-review and editing; **Sujitra Boonyong:** conceptualization, methodology, investigation, writing-original draft preparation, writing-review and editing, funding acquisition.

Acknowledgements

We would like to thank all Thai community older adults who participated in this study.

References

- [1] Sezgin D, Liew A, O'Donovan MR, O'Caoimh R. Pre-frailty as a multi-dimensional construct: a systematic review of definitions in the scientific literature. *Geriatr Nurs*. 2020; 41(2): 139-46. doi: 10.1016/j.gerinurse.2019.08.004.
- [2] Fernández-Garrido J, Ruiz-Ros V, Buigues C, Navarro-Martinez R, Cauli O. Clinical features of prefrail older individuals and emerging peripheral biomarkers: a systematic review. *Arch Gerontol Geriatr*. 2014; 59(1): 7-17. doi: 10.1016/j.archger.2014.02.008.
- [3] O'Caoimh R, Sezgin D, O'Donovan MR, Molloy DW, Clegg A, Rockwood K, et al. Prevalence of frailty in 62 countries across the world: a systematic review and meta-analysis of population-level studies. *Age Ageing*. 2021; 50(1): 96-104. doi: 10.1093/ageing/afaa219.
- [4] Zeng XZ, Meng LB, Li YY, Jia N, Shi J, Zhang C, et al. Prevalence and factors associated with frailty and pre-frailty in the older adults in China: a national cross-sectional study. *Front Public Health*. 2023; 11: 1110648. Published 2023 Jul 24. doi: 10.3389/fpubh.2023.1110648.
- [5] Shimada H, Makizako H, Doi T, Tsutsumimoto K, Suzuki T. Incidence of disability in frail older persons with or without slow walking speed. *J Am Med Dir Assoc*. 2015; 16(8): 690-6. doi: 10.1016/j.jamda.2015.03.019.
- [6] Rodríguez-Laso Á, García-García FJ, Rodríguez-Mañás L. Transitions between frailty states and its predictors in a cohort of community-dwelling Spaniards. *J Am Med Dir Assoc*. 2022; 23(3): 524.e1-e11. doi: 10.1016/j.jamda.2021.07.008.
- [7] Wongtrakulruang P, Muangpaisan W, Panpradup B, Tawatwattananun A, Siribamrungwong M, Tomongkon S. The prevalence of cognitive frailty and pre-frailty among older people in Bangkok metropolitan area: a multicenter study of hospital-based outpatient clinics. *J Frailty Sarcopenia Falls*. 2020; 5(3): 62-71. doi: 10.22540/JFSF-05-062.
- [8] Thinuan P, Siviroj P, Lertrakarnnon P, Lorga T. Prevalence and potential predictors of frailty among community-dwelling older persons in Northern Thailand: a cross-sectional study. *Int J Environ Res Public Health*. 2020; 17(11): 4077. doi:10.3390/ijerph17114077.
- [9] Fried LP, Tangen CM, Walston J, Newman AB, Hirsch C, Gottdiener J, et al. Frailty in older adults: evidence for a phenotype. *J Gerontol A Biol Sci Med Sci*. 2001; 56(3): M146-56. doi: 10.1093/gerona/56.3.m146.
- [10] O'Caoimh R, Galluzzo L, Rodríguez-Laso Á, Van der Heyden J, Ranhoff AH, Carcaillon-Bentata L, et al. Transitions and trajectories in frailty states over time: a systematic review of the European Joint Action ADVANTAGE. *Ann Ist Super Sanita*. 2018; 54(3): 246-52. doi: 10.4415/ANN_18_03_12.
- [11] Sergi G, Veronese N, Fontana L, De Rui M, Bolzetta F, Zambon S, et al. Pre-frailty and risk of cardiovascular disease in elderly men and women: the Pro.V.A.

- study. *J Am Coll Cardiol*. 2015; 65(10): 976-83. doi: 10.1016/j.jacc.2014.12.040.
- [12] Rattanawiwatpong P, Khunphasee A, Pongurgsorn C, Intarakamhang P. Validity and reliability of the Thai version of short format international physical activity questionnaire (IPAQ). *J Thai Rehabil*. 2006; 16: 147-60.
- [13] Orme JG, Reis J, Herz EJ. Factorial and discriminant validity of the center for epidemiological studies depression (CES-D) scale. *J Clin Psychol*. 1986; 42: 28-33. doi: 10.1002/1097-4679(198601)42:1<28::aid-jclp2270420104>3.0.co;2-t.
- [14] Zhang Z. Model building strategy for logistic regression: purposeful selection. *Ann Transl Med*. 2016; 4(6): 111. doi: 10.21037/atm.2016.02.15.
- [15] Gordon SJ, Baker N, Kidd M, Maeder A, Grimmer KA. Pre-frailty factors in community-dwelling 40-75 year olds: opportunities for successful ageing. *BMC Geriatr*. 2020; 20(1): 96. doi: 10.1186/s12877-020-1490-7.
- [16] Collard RM, Boter H, Schoevers RA, Oude Voshaar RC. Prevalence of frailty in community-dwelling older persons: a systematic review. *J Am Geriatr Soc*. 2012; 60(8): 1487-92. doi: 10.1111/j.1532-5415.2012.04054.x.
- [17] Shinohara T, Saida K, Tanaka S, Murayama A, Higuchi D. Transition to frailty in older Japanese people during the coronavirus disease 2019 pandemic: a prospective cohort study. *Arch Gerontol Geriatr*. 2022; 98: 104562. doi: 10.1016/j.archger.2021.104562.
- [18] Xue QL. The frailty syndrome: definition and natural history. *Clin Geriatr Med*. 2011; 27(1): 1-15. doi: 10.1016/j.cger.2010.08.009.
- [19] Morley JE. Frailty and sarcopenia in elderly. *Wien Klin Wochenschr*. 2016; 128(Suppl 7): 439-45. doi: 10.1007/s00508-016-1087-5.
- [20] Studenski S, Perera S, Patel K, Rosano C, Faulkner K, Inzitari M, et al. Gait speed and survival in older adults. *JAMA*. 2011; 305(1): 50-8. doi: 10.1001/jama.2010.1923.
- [21] Castell MV, Sánchez M, Julián R, Queipo R, Martín S, Otero Á. Frailty prevalence and slow walking speed in persons age 65 and older: implications for primary care. *BMC Fam Pract*. 2013; 14: 86. doi: 10.1186/1471-2296-14-86.
- [22] Norheim KL, Bøggild H, Andersen JH, Omland Ø, Bønløkke JH, Madeleine P. Retirement status and frailty: a cross-sectional study of the phenotype of manual workers aged 50-70 years. *Eur J Public Health*. 2021; 31(1): 116-21. doi: 10.1093/eurpub/ckaa188.
- [23] Yoshizawa Y, Tanaka T, Takahashi K, Fujisaki-Sueda-Sakai M, Son BK, Iijima K. Impact of health literacy on the progression of frailty after 4 years among community-dwelling older adults. *Int J Environ Res Public Health*. 2021; 19(1): 394. doi: 10.3390/ijerph19010394.
- [24] Matsugaki R, Fujino Y, Zaitzu M, Saeki S, Matsuda S, Ogami A. Frailty is a risk factor for occupational falls among older workers: an internet-based prospective cohort study. *J Occup Health*. 2024; 66(1): uiae065. doi: 10.1093/jocuh/uiae065.
- [25] Ferrucci L, Walston JD. Frailty. In: Halter JB, Ouslander JG, Studenski S, High KP, Asthana S, Supiano MA, et al, Editors. *Hazzard's geriatric medicine and gerontology*. 8th Ed. New York: McGraw-Hill; 2022; Chapter 42.
- [26] Nejatnamini S, Campbell DJT, Godley J, Minaker LM, Sajobi TT, McCormack GR, et al. The contribution of modifiable risk factors to socioeconomic inequities in cardiovascular disease morbidity and mortality: a nationally representative population-based cohort study. *Prev Med*. 2023; 171: 107497. doi:10.1016/j.ypmed.2023.107497
- [27] Khadilkar SS. Musculoskeletal disorders and menopause. *J Obstet Gynaecol India*. 2019; 69(2): 99-103. doi: 10.1007/s13224-019-01213-7.
- [28] Greco EA, Pietschmann P, Migliaccio S. Osteoporosis and sarcopenia increase frailty syndrome in the elderly. *Front Endocrinol (Lausanne)*. 2019; 10: 255. doi: 10.3389/fendo.2019.00255.
- [29] Blumer J, Le B. Rethinking sarcopenia and frailty of the elderly. *Post Reprod Health*. 2025; 20533691251337173. doi: 10.1177/20533691251337173.
- [30] Singhal S, Singh S, Dewangan GC, Dey S, Banerjee J, Lee J, et al. The prevalence of frailty and its relationship with sociodemographic factors, regional healthcare disparities, and healthcare utilization in the aging population across India. *Aging Med (Milton)*. 2023; 6(3): 212-21. doi:10.1002/agm2.12263.
- [31] Eyigor S, Kutsal YG, Duran E, Huner B, Paker N, Durmus B, et al. Frailty prevalence and related factors in the older adult-FrailTURK Project. *Age (Dordr)*. 2015; 37(3): 9791. doi: 10.1007/s11357-015-9791-z.
- [32] Lee YS, Chen YM, Chou YY, Lin CS, Chen JP, Kuo FH, et al. Prefrailty subtypes differentially predict 5-year mortality in the functionally independent geriatric population. *Arch Gerontol Geriatr*. 2023; 106: 104897. doi: 10.1016/j.archger.2022.104897.
- [33] Berkman ND, Sheridan SL, Donahue KE, Halpern DJ, Crotty K. Low health literacy and health outcomes: an updated systematic review. *Ann Intern Med*. 2011; 155(2): 97-107. doi: 10.7326/0003-4819-155-2-201107190-00005.