Original Article

The prevalence of cognitive frailty and pre-frailty among older people in Bangkok metropolitan area: a multicenter study of hospital-based outpatient clinics

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Abstract

Objectives: To identify the prevalence of, and factors associated with, cognitive frailty and prefrailty, and to investigate correlation between frailty tools. **Methods**: One hundred and ninety five older adults were recruited from the medical outpatient clinics of 3 tertiary hospitals in Bangkok metropolitan region. The data collected were demographic information, lifestyle factors, functional status, mood assessment, and cognitive and frailty assessments. The frailty tools used were Frailty Phenotype and FRAIL scale. **Results**: The prevalence of pre-frailty, frailty, mild cognitive impairment (MCI), cognitive pre-frailty and cognitive frailty was 57.4%, 15.9%, 26.2%, 14.4% and 6.7%, respectively. A multivariate analysis showed that age ≥70 years (OR 5.34; 95% CI 2.06-12.63), and education at primary school or under (OR 4.18; 95% CI 1.61-10.82) were associated with cognitive frailty and cognitive pre-frailty. The correlation between physical frailty rated by the Modified Fried Frailty Phenotype and the FRAIL scale was good (Kappa coefficient = 0.741). **Conclusions**: The prevalence of cognitive frailty is not uncommon which requires screening and interventions. Age and a low educational level were related to cognitive frailty/prefrailty. The FRAIL scale yielded a high correlation with Frailty phenotypes, implying its benefit in routine clinical use in primary care practice, where there is limited time and resources.

Keywords: Cognitive frailty, Dementia, Frailty, Mild cognitive impairment, Pre-frailty

Introduction

With the rapid transition to an aging society worldwide, the higher proportions of older people are leading to an increase in age-related diseases through multiple pathophysiological mechanisms. The aging process can be defined as a decline in reserve and deterioration of function across multiple systems, including the physical, cognitive, and psychosocial functions[1]. A loss of homeostasis properties and decreased adaptability to stress concede increased vulnerability to disease, disability, and mortality in older people[2,3]. The term referring to this condition is frailty.

The definition of physical frailty was proposed by Fried et al. The criteria for diagnosis are composed of exhaustion, unintentional weight loss, low physical activity, reduced grip strength, and slow gait speed[4]. Physical frailty has been suggested as an earlier predictor of health status than the presence of disease[5]. While frailty in the physical domain has been acknowledged, the cognitive domain has not been given

Characteristics	Normal cognition (n = 137)	MCI (N = 51)	Dementia (N = 7)	Total (N = 195)	P-value
Age, years (mean ± SD)	66.5 ± 6[a]	72.4 ± 6.3[b]	74.3 ± 6.3[b]	68.3 ± 6.7	< 0.001*
Female (n, %)	93 (67.9)	35 (68.6)	5 (71.4)	133 (68.2)	0.978
BMI, kg/m² (mean ± SD)	25.1 ± 4.6	23.9 ± 4.3	22.0 ± 4.3	24.7 ± 4.6	0.097
Education level (n, %)					
No education	3 (2.2)	6 (11.8)	1 (14.3)	10 (5.1)	0.003*
Primary school	70 (51.1)	38 (74.5)	6 (85.7)	114 (58.5)	
Secondary school	13 (9.5)	2 (3.9)	0 (0.0)	15 (7.7)	
High school	29 (21.2)	4 (7.8)	0 (0.0)	33 (16.9)	
Vocational college	6 (4.4)	0 (0.0)	0 (0.0)	6 (3.1)	
University	16 (11.7)	1 (2.0)	0 (0.0)	17 (8.7)	
Marital status (n, %)					
Single	17 (12.4)	4 (7.8)	0 (0.0)	21 (10.8)	0.595
Married	91 (66.4)	33 (64.7)	6 (85.7)	130 (66.7)	
Widowed/divorced/separated	29 (21.2)	14 (27.5)	1 (14.3)	44 (22.6)	
Self-reported income insufficiency (n, %)					
Sufficient	120 (87.6)	40 (78.4)	7 (100.0)	167 (85.6)	0.146
Insufficient	11 (8.0)	10 (19.6)	0 (0.0)	21 (10.8)	
Savings	6 (4.4)	1 (2.0)	0 (0.0)	7 (3.6)	
Underlying disease (n, %)					
Hypertension	93 (67.9)	40 (78.4)	5 (71.4)	138 (70.8)	0.368
Diabetes	44 (32.1)	15 (29.4)	3 (42.9)	62 (31.8)	0.765
Dyslipidemia	81 (59.1)	27 (52.9)	4 (57.1)	112 (57.4)	0.748
Cancer	4 (2.9)	3 (5.9)	1 (14.3)	8 (4.1)	0.254
Stroke	7 (5.1)	0 (0.0)	0 (0.0)	7 (3.6)	0.215
Current alcohol drinker (n, %)	14 (10.2)	2 (3.9)	1 (14.3)	17 (8.7)	0.344
Current smoker (n, %)	13 (9.5)	4 (7.8)	0 (0.0)	17 (8.7)	0.664
Hospital visit during preceding year (n, %)	22 (16.1)	12 (23.5)	2 (28.6)	36 (18.5)	0.392
Falling during preceding year (n, %)	25 (18.2)	6 (11.8)	1 (14.3)	32 (16.4)	0.559
Self-perceived health (n, %)					
Good	61 (44.5)	15 (29.4)	2 (28.6)	78 (40.0)	0.167
Moderate	70 (51.1)	30 (58.8)	4 (57.1)	104 (53.3)	
Poor	6 (4.4)	6 (11.8)	1 (14.3)	13 (6.7)	
Poor self-perceived memory (n, %)	82 (59.9)	34 (66.7)	3 (42.9)	119 (61.0)	0.420
Poor self-perceived memory compared to other people of the same age (n, %)	84 (61.3)	28 (54.9)	2 (28.6)	114 (58.5)	0.192

MCI = mild cognitive impairment; BMI = body mass index.

Table 1. Baseline characteristics. Characteristics of participants, according to their cognitive impairment category.

much attention. This is despite evidence demonstrating a link between frailty and cognitive performance that has been established through both cross-sectional and prospective cohort studies[6,7]. Physical frailty can predict the occurrence of cognitive impairment or mild cognitive impairment (MCI). A recent meta-analysis found that the co-occurrence of physical frailty and cognitive impairment was associated with a higher hazard ratio of incident dementia than each

condition separately[8]. Therefore, early identification of this syndrome could lead to the secondary prevention of dementia and disability[9,10].

The International Academy on Nutrition and Aging (IANA) and the International Association of Gerontology and Geriatrics (IAGG) proposed the identification of cognitive frailty through a combination of physical frailty (Fried et al.) and cognitive impairment (CDR=0.5)[11]. Despite the consensus group having clear definitions, most studies have alternative, and possibly conflicting, definitions. The prevalence of cognitive frailty in previous reports has ranged between 1.0% and 39.7%[10-13]. This wide range might be related to differences in the participants' characteristics, study settings (e.g., community, primary care, and academic hospital), and assessment tools[14]. More than 27 frailty measures that aim to diagnose this syndrome have been published[15]. The Fried frailty phenotype is the most frequently used methodology for frailty diagnosis (69% of published research)[16]. However, it is difficult to integrate into routine clinical practice in outpatient clinic settings, where there is typically limited time and human resources available.

A simpler frailty assessment method which is quick, easy, reliable, and accurate is needed for implementation in routine clinical service. Among the simple tools that have been used, the FRAIL scale is short, consisting of only 5 items[17]. It does not require measurements nor administration by trained professionals. Its validity has also been examined by comparing it with the Fried phenotype[18], and it has recently been used as a frailty screening tool by several studies[18,19]. Nevertheless, it has not been utilized in an older outpatient population to test its convergent validity against the other standard tools.

This study aimed to examine the prevalence of cognitive frailty, the associated factors, and the correlation of the FRAIL scale with the Fried phenotype. It is imperative to estimate the magnitude of the problems and to help medical professionals endorse a strategy of screening older people who visit outpatient clinics in the Bangkok metropolitan region.

Methods

Data collection

Ethics approval was obtained from the Institutional Review Board and the Hospital Human Research Ethics Committee of the three studied hospitals. The physician who is a specialist in geriatric medicine (PW) was trained to use the instruments. The sample was taken by convenience sampling. The investigator screened participants according to the specified inclusion/exclusion criteria and introduced the study protocol. Informed consent was obtained from all participants.

Participants

Participants were required to be aged ≥60 years and to have visited the medical outpatient service at one of 3 tertiary hospitals. Two hospitals are located in Bangkok: Siriraj (a university hospital) and Lerdsin (a public hospital); the third hospital, Khrathum Baen, is in a neighboring province, Prathumtani.

Participants had to have good decision-making capacity and to be able to communicate in Thai. Participants were excluded if they could not complete frailty assessment via handgrip strength measurement, were unable to walk with or without gait aids independently, or had an unstable medical condition. The participants' baseline characteristics were summarized in Table 1.

Measurements

The researchers collected the subjects' characteristics, reviewed their medical histories, assessed their frailty and cognitive functions, determined their functional status, and explored the risk factors associated with cognitive frailty, as described below.

Frailty

The Fried frailty phenotype

In the context of local norms, the present study modified the 5 criteria of the Fried frailty phenotype[4] to define frailty as follows:

1. **Exhaustion.** Evaluation of self-perception was assessed by a subject's answer to the question, "During the last week, how often have you felt any tension or fatigue?", using the Center of Epidemiologic Studies Depression scale (CES-D), Thai version[20]. If the answer was "tension or fatigue for at least 3 days/week", the subject was grouped into "presence of exhaustion".

2. **Unintentional weight loss.** This was defined as a decrease of 4.5 kg, or a loss of more than 5% of the baseline body weight, during the preceding year.

3. **Low physical activity.** The measurement was performed by requesting the participants to give a rating in response to the question, "How do you rate your physical activity level?" The possible responses were low, moderate, or high. A participant answer of "low" was interpreted as low physical activity. A previous investigation of this method among older Thais revealed a high correlation with the Global Physical Activity Questionnaire (kappa 0.721)[21].

4. **Weakness.** This was measured by a handgrip dynamometer. The dominant hand was evaluated 3 times, and the average result was calculated[22]. The cut-off point was defined by gender and BMI, as follows[23].

	BMI (kg/m²)	Grip strength (kg)
Men	≤ 24	≤ 29
	24.1-26	≤ 30
	26.1-28	≤ 30
	> 28	≤ 32
Women	≤ 23	≤ 17
	24.1-26	≤ 17.3
	26.1-29	≤ 18
	> 29	≤ 21

5. **Slowness.** The assessment was done by asking the participants to walk a horizontal distance of 15 feet at their usual gait speed. The cut-off point was defined by gender and height, as follows[4].

	Height (cm)	Gait speed (sec)
Men	≤ 173	≥ 7
	> 173	≥ 6
Women	≤ 159	≥ 7
	> 159	≥ 6

Participants who had at least 3 of the 5 symptoms were classified as "frail". If they had 1-2 symptoms, they were categorized as "pre-frail".

FRAIL scale (Thai Version)

The FRAIL scale consists of 5 questions; each requires a "yes" or "no" answer, with 1 point given to each affirmative response[17]. The scale is entirely based on self-report. The total score was used to categorize each subject as frail (≥3 points), pre-frail (1 or 2 points), and robust (0 point). The FRAIL scale assesses the presence of fatigue, resistance, ambulation, illness, and loss of weight. The Thai version used in the current study was translated by Limpawattana et al[24]. The parameters are explained as follows.

1. **Fatigue.** This was evaluated by asking participants if they felt tired most of the time.
2. **Resistance.** This was measured by asking the participants about their capacity to climb a flight of stairs.
3. **Ambulation.** The parameter was evaluated by asking the participants to assess their capacity to walk a block independently.
4. **Illness.** This factor was defined by the presence of five or more of a total of 11 diseases (hypertension, diabetes mellitus, cancer [excluding basal cell carcinoma of the skin or equivalent], chronic obstructive pulmonary disease, coronary artery disease or myocardial infarction, congestive heart failure, asthma, arthritis, stroke, and chronic renal failure).
5. **Loss of weight.** This was defined as a decline of 5% or more during the preceding 6 months.

Cognitive function

The assessment of cognitive function was performed using the Thai Mental State Examination (TMSE)[25] and Montreal Cognitive Assessment-Basic (MoCA-B), the latter of which was determined to be suitable for use with lower-educated older people[26]. Participants who had a TMSE ≥24 out of 30 and an MoCA-B <25 out of 30 with no functional limitation were classified as "MCI". If they had a TMSE <23 and an MoCA-B <25 with functional decline, they were categorized as "dementia".

Cognitive frailty/pre-frailty

The definition of cognitive frailty was based on the presence of (1) a physical frailty of at least three or more points of the modified Fried frailty phenotype; and (2) MCI, which was defined by a TMSE ≥24 and an MoCA-B <25 without functional limitation. As there have been recent studies demonstrating an association between cognitive impairment and the pre-frail status (positive for 1-2 items of the Fried criteria), this study also investigated the combination of physical pre-frail status and MCI[27,28].

Potential associated risk factors

Reviews of patients' medical records and face-to-face interviews were used to collect information on the baseline characteristics, socioeconomic factors, underlying diseases, body mass index (BMI), self-perceived health status, self-perceived memory impairment and decline, hospitalization and history of falling during the preceding year, alcohol/smoking consumption, and medication usage.

Statistical analysis

The baseline characteristics were analyzed using descriptive statistics. Quantitative data were compared using the t-test and Chi-square test, depending on the type of variable. Fisher's exact test was used if the expected value was <5 in more than 20% of all cells. We compared the clinical characteristics, cognitive impairment, frailty, and cognitive frailty. To compare their characteristics, the participants were classified into 2 groups, according to the presence or absence of cognitive impairment and frailty syndrome. The two groups were Group 1: robust older persons with no evidence of physical frailty (0 point on the Fried criteria) and an absence of cognitive impairment (TMSE ≥24, MoCA-B ≥25); and Group 2: cognitive frailty/prefrailty individuals with at least one Fried criteria and with MCI (TMSE ≥24 and MoCA-B <25)[27]. Analytic statistics was used to investigate the factors associated with cognitive impairment and frailty. All statistically significant variables revealed by the univariate analysis were subjected to a multivariate analysis to analyze the predictors of cognitive frailty. The Kappa coefficient was estimated by comparing the physical frailty and the FRAIL scale. All data were performed using PASW Statistics for Windows (version 18.0; SPSS Inc., Chicago, IL, USA).

Results

A total of 195 older patients were recruited from Siriraj Hospital (n=65), Lerdsin Hospital (n=65), and Krathum Baen Hospital (n=65). The participants' mean age was 68.3 years, and 68.2% were women. The prevalence of pre-frailty, frailty, MCI, and cognitive frailty was 57.4%, 15.9%, 26.2%, and 6.7%, respectively.

Table 1 details the baseline characteristics of the participants and comparisons among the groups of different cognitive functions. The 3 cognitive conditions (normal, MCI, and dementia) displayed differences in mean age and educational level, as tabulated in Table 1.

We compared the baseline characteristics among groups

Characteristics	Robust (n = 52)	Pre-frailty (n = 112)	Frailty (n = 31)	Total	P-value
Age, years (mean ± SD)	66.7 ± 5.7	68.8 ± 6.9	69.0 ± 7.5	68.3 ± 6.7	0.139
Female (n, %)	38 (73.1)	74 (66.1)	21 (67.7)	133 (68.2)	0.668
BMI, kg/m² (mean ± SD)	24.5 ± 3.6	24.5 ± 4.2	25.6 ± 6.9	24.7 ± 4.6	0.483
Education level (n, %)					
No education	1 (1.9)	7 (6.3)	2 (6.5)	10 (5.1)	0.063
Primary school	24 (46.2)	65 (58.0)	25 (80.6)	114 (58.5)	
Secondary school	4 (7.7)	10 (8.9)	1 (3.2)	15 (7.7)	
High school	16 (30.8)	15 (13.4)	2 (6.5)	33 (16.9)	
Vocational college	2 (3.8)	4 (3.6)	0 (0.0)	6 (3.1)	
University	5 (9.6)	11 (9.8)	1 (3.2)	17 (8.7)	
Marital status (n, %)					
Single	3 (5.8)	15 (13.4)	3 (9.7)	21 (10.8)	0.310
Married	40 (76.9)	68 (60.7)	22 (71.0)	130 (66.7)	
Widowed/divorced/separated	9 (17.3)	29 (25.9)	6 (19.4)	44 (22.6)	
Self-reported income insufficiency (n, %)					
Sufficient	48 (92.3)	91 (81.3)	28 (90.3)	167 (85.6)	0.282
Insufficient	3 (5.8)	15 (3.4)	3 (9.7)	21 (10.8)	
Savings	1 (1.9)	6 (5.4)	0 (0.0)	7 (3.6)	
Underlying disease (n, %)					
Hypertension	30 (57.7)	84 (75.0)	24 (77.4)	138 (70.8)	0.052
Diabetes	10 (19.2)	41 (36.6)	11 (35.5)	62 (31.8)	0.075
Dyslipidemia	24 (46.2)	70 (62.5)	18 (58.1)	112 (57.4)	0.143
Cancer	0 (0.0)	4 (3.6)	4 (12.9)	8 (4.1)	0.015*
Stroke	1 (1.9)	6 (5.4)	0 (0.0)	7 (3.6)	0.275
Current alcohol drinker (n, %)	5 (9.6)	10 (8.9)	2 (6.5)	17 (8.7)	0.879
Current smoker (n, %)	6 (11.5)	8 (7.1)	3 (9.7)	17 (8.7)	0.636
Hospital visit during preceding year (n, %)	10 (19.2)	18 (16.1)	8 (25.8)	36 (18.5)	0.459
Fall during preceding year (n, %)	5 (6.9)	18 (16.1)	9 (29.0)	32 (16.4)	0.069
Self-perceived health (n, %)					
Good	25 (48.1)	46 (41.1)	7 (22.6)	78 (40.0)	0.212
Moderate	25 (48.1)	58 (51.8)	21 (67.7)	104 (53.3)	
Poor	2 (3.8)	8 (7.1)	3 (9.7)	13 (6.7)	
Poor self-perceived memory (n, %)	29 (55.8)	68 (60.7)	22 (71.0)	119 (61.0)	0.387
Poor self-perceived memory compared to other people of the same age (n, %)	30 (57.7)	64 (57.1)	20 (64.5)	114 (58.5)	0.755

MCI = mild cognitive impairment; BMI = body mass index

Table 2. Characteristics of participants, according to their frailty category.

of physical frailty conditions in Table 2. A significantly larger proportion of frail participants had cancer than the prefrail and robust participants (p=0.015).

The demographic and health characteristics of the participants according to their physical frailty, combined with their cognitive impairments, are displayed in Table 3. There was a larger proportion of cognitive frailty/pre-frailty among the participants with an older age, income insufficiency,

Characteristics	Normal cognition + robust (n = 41)	Frail/pre-frailty + MCI (n = 41)	P-value
Age, years (mean ± SD)	65.9 ± 5.5	72.9 ± 6.4	< 0.001*
Female (n, %)	30 (73.2)	28 (68.3)	0.627
BMI, kg/m² (mean ± SD)	24.5 ± 3.4	23.9 ± 4.3	0.433
Education level (n, %)			
No education	0 (0.0)	6 (14.6)	< 0.001*
Primary school	14 (34.1)	28 (68.3)	
Secondary school	4 (9.8)	2 (4.9)	
High school	16 (39.0)	4 (9.8)	
Vocational college	2 (4.9)	0 (0.0)	
University	5 (12.2)	1 (2.4)	
Marital status (n, %)			
Single	2 (4.9)	3 (7.3)	0.362
Married	31 (75.6)	25 (61.0)	
Widowed/Divorced/Separated	8 (19.5)	13 (31.7)	
Self-reported income insufficiency (n, %)			
Sufficient	40 (97.6)	33 (80.5)	0.022*
Insufficient	0 (0.0)	7 (17.1)	
Savings	1 (2.4)	1 (2.4)	
Underlying disease (n, %)			
Hypertension	22 (53.7)	32 (78.0)	0.020*
Diabetes	7 (17.1)	12 (29.3)	0.191
Dyslipidemia	17 (41.5)	21 (51.2)	0.376
Cancer	0 (0.0)	3 (7.3)	0.241
Stroke	1 (2.4)	0 (0.0)	1.000
Current alcohol drinker (n, %)	4 (9.8)	3 (7.3)	1.000
Current smoker (n, %)	5 (12.2)	1 (2.4)	0.201
Hospital visit during preceding year (n, %)	4 (9.8)	6 (14.6)	0.500
Fall during preceding year (n, %)	4 (9.8)	5 (12.2)	1.000
Self-perceived health (n, %)			
Good	22 (53.7)	12 (29.3)	0.028*
Moderate	18 (43.9)	23 (56.1)	
Poor	1 (2.4)	6 (14.6)	
Poor self-perceived memory (n, %)	25 (61.0)	30 (73.2)	0.240
Poor self-perceived memory compared to other people of the same age (n, %)	25 (61.0)	23 (56.1)	0.654

MCI = mild cognitive impairment; BMI = body mass index

Table 3. Characteristics of participants, according to their cognitive frailty category.

hypertension, and poor self-perceived health status than for the healthy population with normal cognitive function. Logistic regression analyses were performed to evaluate all of the potential risk factors except income insufficiency; that parameter could not be compared between the groups as there was no participant with income insufficiency in the robust group with normal cognition.

Three risk factors were found to be associated with MCI

Characteristics	MCI and frailty/pre-frailty (n = 41)			
	Crude OR (95% CI)	P-value	Adjusted OR (95% CI)	P-value
Age ≥ 70 years	5.15 (2.46-10.74)	< 0.001*	5.34 (2.06-12.63)	< 0.001*
Education level				
Primary school or lower	3.45 (1.44-8.28)	< 0.001*	4.18 (1.61-10.82)	0.003*
Secondary school or higher	Ref.		Ref.	
Underlying disease				
Hypertension	1.51 (0.67-3.43)	0.32	1.07 (0.44-2.63)	0.88
Self-perceived health				
Poor	4.71 (1.35-16.49)	0.015*	2.94 (0.74-11.73)	0.13
Moderate	1.56 (0.72-3.37)	0.26	1.13 (0.49-2.62)	0.78
Good	Ref.		Ref.	
MCI = mild cognitive impairment				

Table 4. The univariate and multivariate analyses for the associated factors and cognitive frailty.

Category	Overall (n = 195)		Kappa Coefficient	Interpretation
	Frailty phenotype	FRAIL scale		
Frailty	31 (15.9)	28 (14.4)	0.741	Substantial agreement
Pre-frailty	112 (57.4)	115 (59.0)	0.800	Substantial agreement
Robust	52 (26.7)	52 (26.7)	0.921	Near perfect agreement

Table 5. Correlation between Frailty Phenotype and FRAIL scale.

and prefrailty/frailty: age, educational level, and poor self-perceived health. The odds ratio (OR) of age was 5.15 (95% confidence interval [CI] 2.46-10.74), of educational level was 3.45 (95% CI 1.44-8.28), and of poor self-perceived health was 4.71 (95% CI 1.35-16.49). Factors that remained significant in the multivariate analyses were age (OR 5.34; 95% CI 2.06-12.63) and low educational level (OR 4.18; 95% CI 1.61-10.82). Table 4 has the detailed results.

The correlation between physical frailty rated by Modified Fried Frailty Phenotype and FRAIL scale questionnaire was good (Kappa coefficient=0.741). The correlation was highest for the robust group (Kappa 0.921). The FRAIL scale yielded a nearly similar prevalence among the pre-frailty (59% vs 57.4%) and frailty (14.4% vs 15.9%) subgroups, as summarized in Table 5.

Discussion

Our study demonstrated that the prevalence of frailty, MCI, and cognitive frailty was fairly high and associated with older age and low educational level. There was good correlation between physical frailty rated by Modified Fried

Frailty Phenotype and FRAIL scale questionnaire.

The prevalence of frailty, MCI, and cognitive frailty was higher than the corresponding rates reported in studies by Feng et al., Shimada et al., and Roppolo et al[12,32,33]. An explanation for this discrepancy may be that different diagnostic criteria were used to define cognitive impairment. In the current study, MoCA-B was applied; it has a higher sensitivity for the detection of cognitive impairment than the Mini Mental State Examination, which had been used by the other studies[34]. The MoCA-B is also more accurate in identifying MCI which might otherwise go under-detected. The prevalence of frailty in the work by Feng et al. was the lowest of the rates reported by the other studies. The research by Feng et al. was a three-year longitudinal study, which focused on a group of older community-dwelling adults. Their baseline characteristics indicated that they were healthier than the subjects investigated in the current study and the research by Shimada, Roppolo and colleagues.

The prevalence of frailty and cognitive frailty was lower than that reported by Delrieu et al., Fougère et al., and Jha et al[35,36]. Delrieu et al. showed that the prevalence of frailty,

MCI, and cognitive frailty was high, which might be a result of the older age of the participants in that study[35]. In addition, Delrieu et al. determined frailty to be present if the subjects were positive to at least one of the five Fried frailty phenotype criteria, whereas the other studies commonly used ≥ three out of the five. Moreover, the participants in the work by Delrieu et al. had to have at least 1 of the following 3 clinical criteria (memory complaint, limitation in one instrumental activity of daily living, and slow gait speed), which could lead to subjects being more likely to have cognitive frailty. By comparison, Fougère et al. found that the prevalence of frailty, MCI, and cognitive frailty was higher than in the present study. A possible reason for the discrepancy is that their study recruited older patients, which is noticeably different from the much younger participants in our study. Finally, Jha et al. determined that the prevalence of cognitive frailty was the highest among all of the studies. However, this result follows from the patient population having end-stage, decompensated heart failure considered eligible for heart transplantation, which would make them extremely vulnerable to developing frailty.

Increasing age was associated with cognitive frailty/pre-frailty. This finding was similar to the evidence of Rivan et al. and Brigola et al[37,38]. The mean age in the current study was very similar to those for the Rivan et al. study and the Brigola et al. study. The association between aging and cognitive frailty/pre-frailty is related to increased, multisystem, physiological impairments, and age-related changes may accelerate deterioration in multiple organ systems.

Our study found that a low educational level was associated with the cognitive frailty/pre-frailty participants. This result is comparable with that of the work by Brigola et al[38]. The strengths of the association in both our work and that of Brigola et al. were high. Both studies indicated that a low educational level is a substantial risk factor that can be reflected by a high odds ratios. The cognitive reserve theory may explain the association. According to the theory, participants with a greater cognitive reserve, which indicates a relatively high level of educational attainment, require a more severe neuropathologic burden to reach the threshold for clinical symptoms of cognitive impairment[39]. Conversely, participants with limited education require a lower burden before symptoms are displayed.

A significantly larger proportion of cognitive frailty/pre-frailty participants with income insufficiency was observed. If the number of participants had been sufficient, self-reported income insufficiency would have been compared by logistic regression. The impact of social problems - such as a poor quality of life and low social support - are important risk factors associated with cognitive frailty[12,37]. Income insufficiency is possibly one of those socially-related risk factors.

Previous studies have shown that cognitive frailty is significantly correlated with depressive mood, a low level of activities of daily living, and malnutrition[32,45]. In contrast, our study revealed no individuals with depression, functional dependence, or malnutrition. This negative finding might be explained by the recruitment method and assessment tools used by the present study.

Cognitive frailty was related to adverse outcomes with mortality, a greater risk of incident neurocognitive disorder, a higher risk for progression to dementia, and an increased incidence of functional disability[12,13,46,47]. This study was a cross-sectional study, which means that causality cannot be inferred from the results. Cognitive frailty/pre-frailty individuals should be considered as the target group for secondary prevention from disability and dementia. Doing so may change their aging trajectories from a pathological aging pattern to successful aging[40].

A considerable strength of the present study is that it is the first to report cognitive frailty in an outpatient hospital setting. Moreover, the advantages of utilizing a multicenter-study approach include different locations, a more extensive range of characteristics, and the quality of hospital care, which increases generalizability. Several variables were confirmed using patients' medical records to increase the accuracy of the study data.

This study has some limitations that should be mentioned. Firstly, as convenience sampling was applied, selection bias may be present, resulting in an overrepresentation of healthy people. However, participants with walking aids or wheelchairs were also included to reduce the gap, providing they met the selection criteria. Secondly, data was collected on several variables by questionnaire. The disadvantage of using a questionnaire is that the information is subject to recall and social desirability biases. For instance, participants with cognitive impairment might report inaccurate data. Nevertheless, several variables were confirmed through our review of the patients' medical records to improve reliability. Lastly, there is a need for prospective cohort studies that will give more information on the adverse outcomes of cognitive frailty. In addition, as this study was conducted with 195 participants, the estimate of prevalence might be less precise. For a more precise analysis, a greater number of participants would be required.

Cognitive frailty was found in 6.7% of the study population. This prevalence is fairly high, and appropriate assessments and health care planning are necessary to prevent the development of adverse health outcomes. The FRAIL scale yielded a nearly similar prevalence among the pre-frailty and frailty subgroups and showed good correlation with Modified Fried Frailty Phenotype; therefore, it could be used as a screening tool in an OPD setting. The use of screening strategies for the early diagnosis of cognitive frailty in an OPD setting should therefore be fully considered.

References

1. Khezrian M, Myint PK, McNeil C, Murray AD. A Review of Frailty Syndrome and Its Physical, Cognitive and Emotional Domains in the Elderly. Geriatr (Basel, Switzerland) 2017;2(4).

2. R. H, editor. Understanding ageing. New York: Cambridge University Press; 1995.

3. Chang S-F, Cheng C-L, Lin H-C. Frail Phenotype and Disability Prediction in Community-Dwelling Older People: A Systematic Review and Meta-Analysis of Prospective Cohort Studies. J Nurs Res 2019;27(3):e28.

4. 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.

5. Lahousse L, Maes B, Ziere G, Loth DW, Verlinden VJA, Zillikens MC, et al. Adverse outcomes of frailty in the elderly: the Rotterdam Study. Eur J Epidemiol 2014;29(6):419-27.

6. Halil M, Cemal Kizilarslanoglu M, Emin Kuyumcu M, Yesil Y, Cruz Jentoft AJ. Cognitive aspects of frailty: mechanisms behind the link between frailty and cognitive impairment. J Nutr Health Aging 2015;19(3):276-83.

7. Boyle PA, Buchman AS, Wilson RS, Leurgans SE, Bennett DA. Physical frailty is associated with incident mild cognitive impairment in community-based older persons. J Am Geriatr Soc 2010;58(2):248-55.

8. Grande G, Haaksma ML, Rizzuto D, Melis RJF, Marengoni A, Onder G, et al. Co-occurrence of cognitive impairment and physical frailty, and incidence of dementia: Systematic review and meta-analysis. Neurosci Biobehav Rev 2019;107:96-103.

9. Panza F, Lozupone M, Solfrizzi V, Stallone R, Bellomo A, Greco A, et al. Cognitive frailty: a potential target for secondary prevention of dementia. Vol. 13, Expert opinion on drug metabolism & toxicology. England; 2017. p. 1023-7.

10. Solfrizzi V, Scafato E, Lozupone M, Seripa D, Giannini M, Sardone R, et al. Additive Role of a Potentially Reversible Cognitive Frailty Model and Inflammatory State on the Risk of Disability: The Italian Longitudinal Study on Aging. Am J Geriatr psychiatry Off J Am Assoc Geriatr Psychiatry 2017;25(11):1236-48.

11. Kelaiditi E, Cesari M, Canevelli M, van Kan GA, Ousset P-J, Gillette-Guyonnet S, et al. Cognitive frailty: rational and definition from an (I.A.N.A./I.A.G.G.) international consensus group. J Nutr Health Aging 2013;17(9):726-34.

12. Feng L, Zin Nyunt MS, Gao Q, Feng L, Yap KB, Ng T-P. Cognitive Frailty and Adverse Health Outcomes: Findings From the Singapore Longitudinal Ageing Studies (SLAS). J Am Med Dir Assoc 2017;18(3):252-8.

13. Jha SR, Hannu MK, Gore K, Chang S, Newton P, Wilhelm K, et al. Cognitive impairment improves the predictive validity of physical frailty for mortality in patients with advanced heart failure referred for heart transplantation. J Hear lung Transplant Off Publ Int Soc Hear Transplant 2016;35(9):1092-100.

14. Sugimoto T, Sakurai T, Ono R, Kimura A, Saji N, Niida S, et al. Epidemiological and clinical significance of cognitive frailty: A mini review. Ageing Res Rev 2018;44:1-7.

15. Bouillon K, Kivimaki M, Hamer M, Sabia S, Fransson EI, Singh-Manoux A, et al. Measures of frailty in population-based studies: an overview. BMC Geriatr 2013;13:64.

16. Buta BJ, Walston JD, Godino JG, Park M, Kalyani RR, Xue Q-L, et al. Frailty assessment instruments: Systematic characterization of the uses and contexts of highly-cited instruments. Ageing Res Rev 2016;26:53-61.

17. Abellan van Kan G, Rolland Y, Bergman H, Morley JE, Kritchevsky SB, Vellas B. The I.A.N.A Task Force on frailty assessment of older people in clinical practice. J Nutr Health Aging 2008;12(1):29-37.

18. Woo J, Leung J, Morley JE. Comparison of frailty indicators based on clinical phenotype and the multiple deficit approach in predicting mortality and physical limitation. J Am Geriatr Soc 2012;60(8):1478-86.

19. Scarlett S, King-Kallimanis BL, Briody J. Exploring the relationship between frailty and disability across the north and south Ireland: A data harmonization study. JFrailty Aging 2014;3.

20. Mackinnon A, McCallum J, Andrews G, Anderson I. The Center for Epidemiological Studies Depression Scale in older community samples in Indonesia, North Korea, Myanmar, Sri Lanka, and Thailand. J Gerontol B Psychol Sci Soc Sci 1998;53(6):P343-52.

21. Wanaratna K, Muangpaisan W, Kuptniratsaikul V, Chalermsri C, Nuttamonwarakul A. Prevalence and Factors Associated with Frailty and Cognitive Frailty Among Community-Dwelling Elderly with Knee Osteoarthritis. J Community Health 2019;44(3):587-95.

22. Roberts HC, Denison HJ, Martin HJ, Patel HP, Syddall H, Cooper C, et al. A review of the measurement of grip strength in clinical and epidemiological studies: towards a standardised approach. Age Ageing 2011;40(4):423-9.

23. Samahito S, Bhatharobhas V, Ruangthai R, Sriyaphai A, Thearnthong A. Physical fitness norms for Thai people and Kasetsart University physical fitness analysis program version 1.O. Kasetsart Educ Rev 2004;2:27-40.

24. Limpawattana P, Putraveephong S, Inthasuwan P, Boonsawat W, Theerakulpisut D, Chindaprasirt J. Frailty syndrome in ambulatory patients with COPD. Int J Chron Obstruct Pulmon Dis 2017;12:1193-8.

25. Train the Brain Forum Committee. Thai mental state examination (TMSE). Siriraj Hosp Gaz 1993;45:661-74.

26. Julayanont P, Tangwongchai S, Hemrungrojn S, Tunvirachaisakul C, Phanthumchinda K, Hongsawat J, et al. The Montreal Cognitive Assessment-Basic: A Screening Tool for Mild Cognitive Impairment in Illiterate and Low-Educated Elderly Adults. J Am Geriatr Soc 2015;63(12):2550-4.

27. Ma L, Zhang L, Sun F, Li Y, Tang Z. Cognitive function in Prefrail and frail community-dwelling older adults in China. BMC Geriatr 2019;19(1):53.

28. Umegaki H, Makino T, Shimada H, Hayashi T, Wu Cheng X, Kuzuya M. Cognitive Dysfunction in Urban-Community Dwelling Prefrail Older Subjects. J Nutr Health Aging 2018;22(4):549-54.

29. Mahoney FI, Barthel DW. Functional evaluation: The Barthel Index: A simple index of independence useful in scoring improvement in the rehabilitation of the chronically ill. Md State Med J 1965;14:61-5.

30. Guigoz Y, Vellas B, Garry PJ. Assessing the nutritional status of the elderly: The Mini Nutritional Assessment as part of the geriatric evaluation. Nutr Rev 1996;54(1 Pt 2):S59-65.

31. Lotrakul M, Sumrithe S, Saipanish R. Reliability and validity of the Thai version of the PHQ-9. BMC Psychiatry 2008;8:46.

32. Shimada H, Makizako H, Doi T, Yoshida D, Tsutsumimoto K, Anan Y, et al. Combined prevalence of frailty and mild cognitive impairment in a population of elderly Japanese people. J Am Med Dir Assoc 2013;14(7):518-24.

33. Roppolo M, Mulasso A, Rabaglietti E. Cognitive Frailty in Italian Community-Dwelling Older Adults: Prevalence Rate and Its Association with Disability. J Nutr Health Aging 2017; 21(6):631-6.

34. Markwick A, Zamboni G, de Jager CA. Profiles of cognitive subtest impairment in the Montreal Cognitive Assessment (MoCA) in a research cohort with normal Mini-Mental State Examination (MMSE) scores. J Clin Exp Neuropsychol 2012;34(7):750-7.

35. Delrieu J, Andrieu S, Pahor M, Cantet C, Cesari M, Ousset PJ, et al. Neuropsychological Profile of "Cognitive Frailty" Subjects in MAPT Study. J Prev Alzheimer's Dis 2016;3(3):151-9.

36. Fougère B, Daumas M, Lilamand M, Sourdet S, Delrieu J, Vellas B, et al. Association Between Frailty and Cognitive Impairment: Cross-

Sectional Data From Toulouse Frailty Day Hospital. J Am Med Dir Assoc 2017;18(11):990.e1-990.e5.

37. Malek Rivan NF, Shahar S, Rajab NF, Singh DKA, Din NC, Hazlina M, et al. Cognitive frailty among Malaysian older adults: baseline findings from the LRGS TUA cohort study. Clin Interv Aging 2019;14:1343-52.

38. Brigola AG, Alexandre T da S, Inouye K, Yassuda MS, Pavarini SCI, Mioshi E. Limited formal education is strongly associated with lower cognitive status, functional disability and frailty status in older adults. Dement Neuropsychol 2019;13(2):216-24.

39. Schmitt FA, Davis DG, Wekstein DR, Smith CD, Ashford JW, Markesbery WR. "Preclinical" AD revisited: neuropathology of cognitively normal older adults. Neurology 2000;55(3):370-6.

40. Cesari M, Vellas B, Gambassi G. The stress of aging. Exp Gerontol 2013;48(4):451-6.

41. Dedeyne L, Deschodt M, Verschueren S, Tournoy J, Gielen E. Effects of multi-domain interventions in (pre)frail elderly on frailty, functional, and cognitive status: a systematic review. Clin Interv Aging 2017;12:873-96.

42. Tarazona-Santabalbina FJ, Gómez-Cabrera MC, Pérez-Ros P, Martínez-Arnau FM, Cabo H, Tsaparas K, et al. A Multicomponent Exercise Intervention that Reverses Frailty and Improves Cognition, Emotion, and Social Networking in the Community-Dwelling Frail Elderly: A Randomized Clinical Trial. J Am Med Dir Assoc 2016;17(5):426-33.

43. Liu Z, Hsu F-C, Trombetti A, King AC, Liu CK, Manini TM, et al. Effect of 24-month physical activity on cognitive frailty and the role of inflammation: the LIFE randomized clinical trial. BMC Med 2018;16(1):185.

44. Ng TP, Feng L, Nyunt MSZ, Feng L, Niti M, Tan BY, et al. Nutritional, Physical, Cognitive, and Combination Interventions and Frailty Reversal Among Older Adults: A Randomized Controlled Trial. Am J Med 2015;128(11):1225-1236.e1.

45. Langlois F, Vu TTM, Chassé K, Dupuis G, Kergoat M-J, Bherer L. Benefits of physical exercise training on cognition and quality of life in frail older adults. J Gerontol B Psychol Sci Soc Sci 2013; 68(3):400-4.

46. St John PD, Tyas SL, Griffith LE, Menec V. The cumulative effect of frailty and cognition on mortality - results of a prospective cohort study. Int psychogeriatrics 2017;29(4):535-43.

47. Montero-Odasso MM, Barnes B, Speechley M, Muir Hunter SW, Doherty TJ, Duque G, et al. Disentangling Cognitive-Frailty: Results From the Gait and Brain Study. J Gerontol A Biol Sci Med Sci 2016;71(11):1476-82.