E-ISSN 2228-8082
Volume 77, Number 1, January 2025

PMAC PRINCE MAHIDOL AWARD CONFERENCE 2025

2025 Happy NEW Year

SMJ

Siriraj Medical Journal

The world-leading biomedical science of Thailand

Geriatric Medicine and Gerontology

MONTHLY

ORIGINAL ARTICLE REVIEW ARTICLE

Siriraj Academic Center of Geriatric Medicine
Faculty of Medicine Siriraj Hospital

Indexed by

Scopus® DOAJ

THAILAND SECTION 1954

https://he02.tci-thaijo.org/index.php/sirirajmedj/index
E-mail: sijournal92@gmail.com

SMJ
Siriraj Medical Journal
The world-leading biomedical science of Thailand
Volume 77 Number 1
January 2025

ORIGINAL ARTICLE

REVIEW ARTICLE

SIRIRAJ MEDICAL JOURNAL

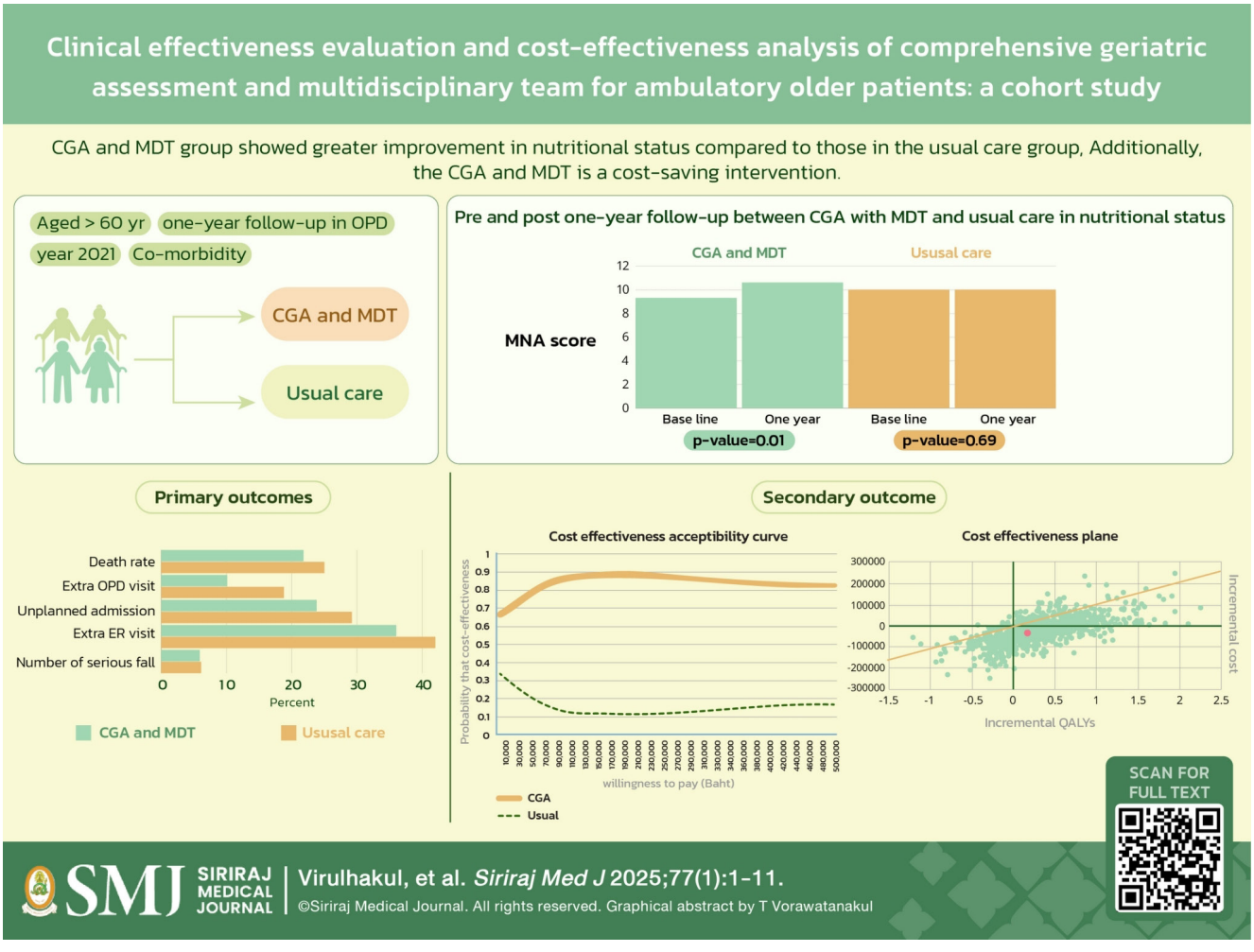
https://he02.tci-thaijo.org/index.php/sirirajmedj/index

Office: His Majesty the King's 80th Birthday Anniversary 5th December 2007 Building (SIMR), 2nd Fl., Room No.207
Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok 10700, Thailand
E-mail: sijournal92@gmail.com

Clinical Effectiveness Evaluation and Cost-effectiveness Analysis of Comprehensive Geriatric Assessment and Multidisciplinary Team for Ambulatory Older Patients: A Cohort Study

Prakasit Virulhakul, M.D.[1], Somboon Intalapaporn, M.D.[2], Sichon Luerithipong, M.D.[2], Narisa Tantai [3], Satanan Maneeon[3], Weerasak Muangpaisan, M.D.[2,*]

[1]Department of Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand, [2]Department of Preventive and Social Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand, [3]Pharmacy Department, Siriraj Hospital, Mahidol University, Bangkok, Thailand.



*Corresponding author: Weerasak Muangpaisan
E-mail: drweerasak@gmail.com
Received 13 October 2024 Revised 7 November 2024 Accepted 16 November 2024
ORCID ID:http://orcid.org/0000-0001-5863-3597
https://doi.org/10.33192/smj.v77i1.271623

ABSTRACT

Objective: The comprehensive geriatric assessment (CGA) and multidisciplinary team (MDT) services are essential components of clinics that promote holistic care for older patients. However, their clinical and cost-effectiveness have not been fully established.

Materials and Methods: This study was a 1-year cohort, two-arm observational study conducted in ambulatory older patients at the Geriatric and Internal Medicine OPD. The primary endpoint was clinical effectiveness: activity of daily living (ADL), Thai mental status examination (TMSE), Mini-nutritional assessment (MNA), extra-visit, hospitalization, length of stay, fall rate, and death rate. The secondary endpoint was a cost-utility analysis using a decision-tree and Markov model. Outcomes included the incremental cost-effectiveness ratio (ICER), and quality of life, assessed by the European Quality of Life Five Dimensions Five Levels (EQ-5D-5L). Sensitivity analysis was conducted through probabilistic methods.

Results: Older adults who received the CGA and MDT service in the geriatric OPD showed improved nutritional status, with the MNA-SF score increasing from 9.3 (± 3.3) to 10.9 (± 2.9) (p=0.01). There were no significant differences between groups in terms of extra-visits, hospitalizations, length of stay, fall rate, or death rate. After one year, the ICER for the CGA and MDT group was US$-3,073 per quality-adjusted life year (QALY) gained to usual care, indicating cost savings at a threshold of $4, 564.9 US dollar per QALY gained.

Conclusion: The CGA and MDT service in a geriatric clinic is clinically effective compared to usual care over a one-year follow-up, as demonstrated by the improvement in nutritional status. Additionally, the CGA and MDT is a cost-saving intervention.

Keywords: Clinical effectiveness evaluation; cost-effectiveness; incremental cost-effectiveness; comprehensive geriatric assessment; multidisciplinary team, geriatric clinic (Siriraj Med J 2025; 77: 1-11)

INTRODUCTION

Currently, the number of older adults is increasing significantly.[1] Older adults with comorbidity are considered a national healthcare challenge.[2,3] Evidence shows that patients who receive comprehensive geriatric assessment (CGA) and multidisciplinary team (MDT) services tend to live at home longer, have a reduced rate of institutionalization, receive more palliative care, and are prescribed safer, low-risk medications.[4-8] Studies in Europe and the US have found that CGA & MDT services improve clinical outcomes in over usual care in inpatient department (IPD) settings. However, these services in Western countries often incur high costs due to the extensive use of comprehensive service.[4,9-13] One study in Southeast Asia demonstrated that CGA and MDT services in an IPD setting can be both clinically effective and cost-saving for older adults.[14] It is necessary to evaluate clinical and cost-effectiveness[15] of CGA and MDT services in the Out-patient department (OPD) settings for older adults, as this has not yet been studied in Thailand or in tertiary hospitals worldwide.

MATERIALS AND METHODS

Study design

This study was a prospective cohort, 52-week trial with two parallel arms, conducted in the Geriatric OPD and Internal Medicine OPD at a tertiary hospital in Bangkok, Thailand. The study included both clinical and cost-effective analyses.

Cost-utility analysis was performed using a model-based approach (Decision Tree and Markov Model). The comparators were CGA and MDT versus usual care. The effectiveness was measured in life years (LY) and quality-adjusted life year (QALY). The study adopted a societal perspective, with a time horizon extending over length of life. Probabilistic sensitivity analysis was used as the analytic method.

Intervention and control

In the intervention group (CGA and MDT), older adults were patients who had previously received services in the Geriatric OPD. They underwent medical examinations and received treatment from a team of geriatricians and MDT, including a pharmacist, psychologist, geriatric nurse, dietitian, and rehabilitation team.

In the usual care group, older adults were patients who had previously received services in the Internal Medicine OPD. They received medical examinations and standard care from their doctors, who were either internists or specialist medicine physicians.

Participants and recruitment

The participants were older adults who met the following criteria: 1) aged 60 years or older with at least two comorbidities, 2) able to follow up at the hospital, and 3) had no communicable diseases. If participants were unable to provide personal history, a proxy or caregiver willing to participate in the study was asked to provide information instead. The exclusion criteria included older adults who: 1) had an unstable medical condition (ie sepsis, shock), 2) were expected to undergo surgery within 1 month, 3) had an accident which required immediate treatment within 24 hours, 4) were predicted to have a life expectancy < 6 months and 5) were not willing to participate in the research. All eligible older adults and their legal representatives were invited to participate in the study without undue influence and provided written informed consent.

Older adults visiting the Geriatric OPD and Internal Medicine OPD were randomly selected based on their OPD registration times: 8.00 AM, 9.00 AM, 10.00 AM, 11.00 AM, 1.00 PM, 2.00 PM, 3.00 PM. If a selected older adult did not meet the inclusion criteria, the next individual registered at that time was chose. The recruitment process was stratified by age and level of ADL. ADL evaluation included the Barthel Index, Lawton Scale, and ADL state.[16]

Procedures

The researcher conducted interviews with older adults. After obtaining informed consent, the researcher began by assessing their cognitive function using the Thai mental status examination (TMSE) test. The total score is 30 and the cut-off value for possible cognitive impairment is 23 or less. It includes assessment in orientation, memory, attention, calculation, language ability, picture copying, and abstract thinking. If the patients were diagnosed or showed symptoms of dementia and had a TMSE score ≤ 23 points, baseline characteristics, including age, gender, education level, Barthel ADL score, Lawton IADL score, Charlson comorbidity index, Utility (EQ5D5L), MNA short form, number of falls within 3 months, underlying diseases, and history of recent hip fracture were gathered from their caregiver or proxy.

The second and third interviews were conducted at the 6th month and 12th months, respectively. Phone interviews were used to collect cost-related information at the 3rd and 9th months. Onsite interviews at the 6th and 12th months were carried out to collect both clinical and cost data. Permission was requested from the hospital database department to access medical staff salaries for both the CGA and MDT and usual care groups to calculate direct medical costs.

At the beginning (day 0), and again at the 6th and 12th months, the researcher collected utility data by explaining the EQ-5D-5L scoring process to older adults or their caregivers before conducting the interview.

The analysis was performed at the 12-month mark to compare the clinical effectiveness and cost effectiveness between the two groups.

Outcomes

From the total of 138 older adults at the beginning of the study, the 55 older adults in CGA&MDT and 52 in usual care who remained at the one-year follow-up were analyzed (Fig 1).

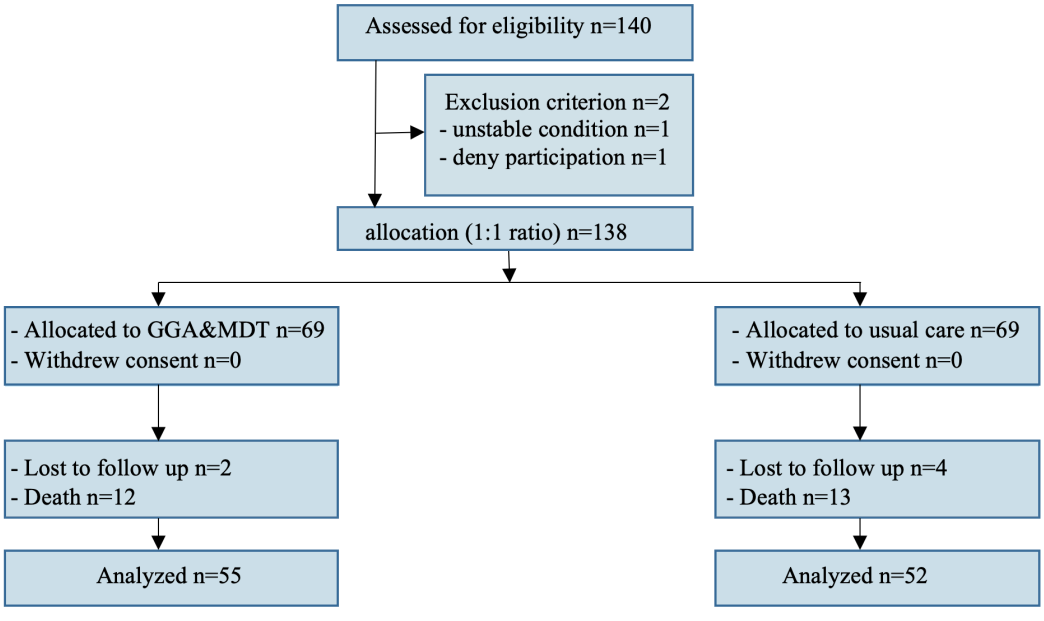


Fig 1. Study flowchart.
Abbreviations: CGA= comprehensive geriatric assessment, MDT=multidisciplinary team

Primary outcome

The primary outcome was the clinical effectiveness assessed across five aspects; 1. ADL consisting of the Barthel Index, Lawton Scale and ADL state[16], 2. Quality of life (QOL) and patient satisfaction, 3. Cognitive function assessed using TMSE, 4. Nutritional status evaluated using the MNA-SF, and 5. Unplanned hospitalizations, OPD visits, emergency department visits, length of hospital stays, fall events, and death rate.

The ADL was classified into five groups[17] as follows.

1. ADL 0: No ADL limitation
2. ADL 1: Mild ADL limitation
3. ADL 2: Moderate ADL limitation
4. ADL 3: Moderate ADL limitation
5. ADL 4: Complete ADL limitation

Given the study's one-year duration, the expected number of participant deaths was small. Therefore, the ADL state was used to predict the chance of death based on the study by Stineman MG.[15] The classification of ADL groups allowed for a one-year follow-up to match the ADL predictor with the possibility of death.[15] This information was then used to calculate, QALY, and incremental cost effectiveness ratio (ICER) in a decision tree diagram18 and Markov model.[19]

Secondary outcomes

The secondary outcomes included cost effectiveness in terms of the ICER. The intervention (CGA and MDT) cost and control (usual) cost were compared to assess both cost and QOL. ICER was evaluated to determine if adopting the new intervention is an efficient use of resources.

Costs were considered from a societal perspective, with a discount rate of 3%. Data were collected prospectively over a one-year period. The costs included direct medical costs, direct non-medical costs and indirect costs. Direct medical costs borne by patients were obtained from the hospital database, including medical services and personnel costs. The personnel cost was calculated by multiplying their hourly salary by the duration of service provided to each older adult. Direct non-medical costs included living expenses during the study, such as transportation, food and accommodation for healthcare visits. Costs covering expenses for drugs, transportation, food, accommodation, and medical devices for each older adult were collected and recorded in a logbook. Total costs for each older adult were computed by adding all medical costs listed in the parameter and utility table. The transitional ADL states and utility were obtained from evaluations at the 0^{th} and 12^{th} month evaluation for both groups. At the 0^{th} month, ADLs were classified into states 0 to IV; at the 12^{th} month, they were classified into states 0 to IV and death (within 12 months) (Supplementary Fig 1). The utility scores derived from the health-related quality of life measure (EQ-5D-5L) questionnaire were converted to a scale ranging from 0 to 1 (with lower scores indicating lower quality of life and higher scores indicating better quality of life). Though there are many QOL measures, we chose the EQ-5D-5L which is the generic, preference-based measure to generate QALYs for the cost-effective analysis. This questionnaire is completed with low burden to patients and readily applied in a various health setting. It covered five dimensions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. The EQ-5D-5L questionnaire has an associated utility which is derived from its preference-based score in the Thai population.[20]

Statistical analysis

Sample size calculation

The effect of the CGA and MDT intervention on ADL outcomes from a previous study showed that older adults who received CGA and MDT intervention in an IPD setting and were followed up for 3 months had a higher mean Barthel ADL score than those in the usual care group (17.15 vs 14.35).[14] To achieve a power of 90% and a two-sided significance level of 0.05, 126 older adults were required to detect a difference. Considering a potential loss to follow up rate of 10%, the total sample size needed was 138 older adults.

Data analysis

A per-protocol analysis was used for the clinical outcomes. A linear model was performed to analyze the change in clinical effectiveness (mean ADL scores using the (Barthel and Lawton indexes over 12 months. In the regression analysis, potential risk factors for the clinical outcomes with a P value of <0.2 from the univariate analysis were included. The categorical data, including extra visits, hospitalization, fall rate, death rate, and patient satisfaction, were compared between the 0^{th} month and 12^{th} months to assess the effects of the CGA and MDT intervention versus usual care. For the proportional effectiveness analysis of categorical outcomes, a chi-square test was used. For continuous variables, a Student's t-test was applied to normally distributed data, while the Mann-Whitney U test was used for non-normally distributed data. The estimated effect size was reported as a mean or median difference for relevant data, along with 95% confidence intervals. Statistical analyses were conducted using PASW Statistics 18 (SPSS Inc., Chicago, IL, USA). All tests were two-tailed, and a p-value of less

than 0.05 was considered statistically significant. The outcome of the economic analysis was based on the intention-to-treat analysis.

To estimate the costs and QALY, and assess the cost-effectiveness of the CGA and MDT service, a decision tree was applied to model the transitional states of older adults' ADL from the 0th to the 12th month, dividing participants into the intervention arm (CGA and MDT) and the control arm (usual care). Following this, a simple two-state Markov model ("Alive" and "Dead") was employed.[21,22] In the Markov model, all participants interviewed after the 1-year follow-up started in the "Alive" state. During each annual Markov cycle, they faced a risk dying and could transition to the absorbing "Dead" state[5] (Supplementary Fig 2). The annual risk of dying was based on the all-cause 1-, 5-, and 10-year mortality rates in older adults, as described in the study of activities of daily living stages by Stineman MG.[17] The model ran for 30 cycles to ensure that, by the end of the analysis, all participants had transitioned to the "Dead" state. For each Markov cycle in which participants remained in the "Alive" state, they incurred an annual cost and QALY estimate. No costs or QALY were associated with the "Dead" state. At the end of the analysis, the discounted costs and QALY were summed over all cycles to estimate the per-participant mean costs and QALY for both CGA and usual care, respectively. The model was implemented in Microsoft Excel, with the outcome presented as total cost and total QALY.

The ICER was used to measure cost-effectiveness by dividing the difference in costs between the intervention and control groups by the difference in QALY gained. This helped determine if the CGA and MDT services provided more benefit per cost compared to usual care.

A probabilistic sensitivity analysis was conducted to account for uncertainty. Cost-effectiveness acceptability curves and cost-effectiveness plane were used to explore uncertainties in costs and outcomes. A Monte Carlo stimulation[23] was employed, generating 1,000 rounds of simulation using a gamma distribution for cost uncertainties and a beta distribution for utility and probability of death in each ADL state parameter. The costs of CGA and MDT and usual care, as well as QALY data, were collected over one year from the hospital database and patient interviews.

RESULTS

Patient characteristics

At baseline, each group consisted of 69 older adults. The older adults in CGA and MDT and usual care groups were comparable in many aspects. For example, the mean age was 81.5 (± 8.6) years in the CGA and MDT group and 77.6 (± 8.3) years in usual care group, respectively (Table 1). However, the CGA and MDT group had lower TMSE scores compared to the usual care group. There was also a higher proportion of older adults with dementia, OA knee and recent hip fracture within 3 months in the CGA and MDT group. Cancer patients were present in both groups (Table 1).

Outcomes

Clinical effectiveness analysis

After one year of follow-up, the clinical outcomes were summarized in supplementary table 1. Older adults in the CGA and MDT group showed greater improvement in nutritional status compared to those in the usual care group. Specifically, the MNA-SF score for older adults who received CGA and MDT services from a Geriatric OPD improved significantly, increasing from 9.3 (± 3.3) to 10.9 (± 2.9), p=0.01 (Table 2). In contrast, the usual care group showed a non-significant change in their MNA-SF score over the same period (10.1 (± 2.8) vs 10.2 (± 2.6), p=0.69) (Table 2). Other clinical outcomes were similar between the two groups.

The CGA and MDT services in the OPD setting did not demonstrate a reduction in unplanned OPD visits, hospitalizations, ER visits, or occurrences of serious and non-serious falls. Additionally, there was no significant decrease in mortality rates after one year of r follow-up, with 12 deaths in the CGA and MDT group and 13 in the usual care group (21.8% vs 25.0% p=0.76) (Supplementary Table 2).

Quality-adjusted life year

At the one-year follow-up, the number of older adults in the CGA and MDT group was 55, while the usual care group had 52 participants. At baseline, the CGA and MDT group had a non-significant utility difference compared to the usual care group (0.68 (± 0.23) vs 0.60 (± 0.24)) (Supplementary Table 2). After one year, the CGA and MDT group showed an increase in utility, rising from 0.68 (± 0.23) at baseline to 0.76 (± 0.21) (p=0.01) (Table 3). Similarly, the usual care also experienced an increase in utility from 0.60 (± 0.24) at baseline to 0.72 (± 0.22) after one-year (p=0.01) as shown in Table 2. Both groups demonstrated significant improvement in utility.

Economic evaluation: cost-effectiveness analysis

The relevant costs for CGA and MDT and usual care were US$8,309 and $9,039, respectively. The QALYs for the CGA and MDT and usual care groups were

TABLE 1. Baseline characteristics and underlying diseases.

Categories	CGA & MDT N = 69	Usual care N = 69	p-value
Age (SD)	81.5 ± 8.6	77.6 ± 8.3	0.08
Female (%)	49 (71%)	45 (65%)	0.573
No income (%)	73%	65.7%	0.796
Barthel score (Max 20) (SD)	15.0 ± 4.8	15.4 ± 4.2	0.6
Lawton score (Max 8) (SD)	3.4 ± 2.3	3.8 ± 2.4	0.155
Charlson comorbidity index (SD)	5.2 ± 1.5	5.4 ± 1.9	0.469
TMSE score (SD)	19.9 ± 7.7	23.8 ± 8.3	0.004
Utility (EQ5D5L) (SD)	0.68 ± 0.23	0.60 ± 0.24	0.060
MNA SF score (SD)	9.1 ± 2.6	9.9 ± 2.7	0.066
Previous fall times within 3 months			
1 time	15	9	0.310
2 times	18	16	
Underlying disease			
HT	42 (61)	47 (68)	0.374
DM	15 (22)	27 (39)	0.26
DLP	25 (36)	29 (42)	0.49
Stroke (Ischemic and Hemorrhagic)	12 (17)	12 (17)	1
- recent stroke within 6 months	0 (0)	1 (1.4)	
Recent hip fracture			
- within 3 months	13 (19)	0 (0)	<0.001
Dementia	13 (19)	1 (1.4)	0.001
Coronary Artery Disease	3 (4)	8 (11.5)	0.116
Spondylopathy	4 (6)	3 (4)	0.698
Parkinson disease	3 (4)	4 (5.8)	0.698
CKD any stage	12 (17.4)	17 (25)	0.317
NPH	2 (3)	1 (1.4)	0.559
Liver cirrhosis	1 (1.4)	4 (6)	0.172
CA stage I to III	8 (12)	7 (10)	
ongoing radiotherapy	0 (0)	1 (1.4)	
ongoing chemotherapy	0 (0)	1 (1.4)	0.97
CA stage IV (metastasis)	0 (0)	2 (3)	
ongoing oral chemotherapy	0 (0)	1 (1.4)	0.154
OA knee	17 (25)	3 (4)	0.001
COPD	2 (1.4)	1 (1.4)	0.559

Abbreviations: CGA = comprehensive geriatric assessment, MDT = multidisciplinary team, TMSE = Thai mental state examination, MNA SF = mini-nutritional assessment short form, EQ5D5L = European quality of life five dimensions five levels, UC = universal coverage, SD = standard of deviation, HT = hypertension, DM = diabetic mellitus, DLP = dyslipidemia, CKD = chronic kidney disease, NPH = normal pressure hydrocephalus, CA = cancer, OA = osteoarthritis, COPD = chronic obstructive pulmonary disease

TABLE 2. Comparison of baseline and 1-year outcomes of the CGA and MDT group and usual care group.

Categories	baseline	12-month	p value
CGA & MDT group	**N = 55**	**N = 55**	
Barthel score (Max 20) (SD)	16 ± 5.1	15.52 ± 4.3	0.09
Lawton score (Max 8) (SD)	3.6 ± 2.3	3.9 ± 2.5	0.15
TMSE score (SD)	20.8 ± 7.4	20.9 ± 7.3	0.99
Utility (EQ5D5L) (SD)	0.66 ± 0.24	0.76 ± 0.21	0.01
MNA-SF score (SD)	9.3 ± 3.3	10.6 ± 2.9	0.01
Usual care	**N = 52**	**N = 52**	
Barthel score (Max 20) (SD)	15.5 ± 4.4	15.8 ± 4.1	0.45
Lawton score (Max 8) (SD)	3.94 ± 2.5	4.29 ± 2.4	0.13
TMSE score (SD)	23.54 ± 5.1	22.8 ± 4.8	0.07
Utility (EQ5D5L) (SD)	0.62 ± 0.25	0.72 ± 0.22	0.01
MNA-SF score (SD)	10.1 ± 2.8	10.2 ± 2.6	0.69

Abbreviations: TMSE = Thai mental state examination, MNA= mini-nutritional assessment, EQ5D5L= Euro quality of life group 5 dimensions 5 levels, MNA-SF= mini-nutritional assessment short form, SD= standard deviation

TABLE 3. Costs, health outcomes, and ICER of the CGA and MDT group compared to the usual care group.

options	Total cost (US dollar)	Life-years (years)	QALY (years)	ICER (US dollar/QALY)
Usual care	9039	2.3216	2.0840	
CGA&MDT	8309	2.9477	2.7688	
Incremental value	-730	0.1789	0.2376	-3073 (dominant)

Abbreviations: CGA&MDT= comprehensive geriatric assessment and Multidisciplinary team, Lys = life years, QALY = quality adjusted life year (currency rate in January 2022: 35.05 Baht = 1 US dollar)

2.321 and 2.084, respectively. The incremental cost was $-730, and the incremental QALYs were 0.237. The incremental life year gain at one year was 0.18 years. Based on probabilistic analysis, the incremental cost-effectiveness was cost-saving at $3,073 per QALY (Table 3).

Uncertainty analysis

The cost-effectiveness acceptability curve, based on the net benefit approach, was used to illustrate the relationship between the ceiling ratio (willingness to pay for a unit of QALY gained) and the probability of favoring each group. From a societal perspective, the results indicated that the CGA and MDT service, at a cost of $4,564 per QALY gained, had a 90% probability of being cost-effective, while the usual care service had only a 10% probability (Fig 2). Therefore, the CGA and MDT service was the preferred choice.

The results of the probabilistic analysis are shown on the cost-effectiveness plane (Supplementary Fig 3). The joint distribution of incremental costs and QALYs reveals that the CGA and MDT service is associated with a slightly decrease in cost in 99% of the simulations (at a cost-effectiveness threshold of $4,564) and a gain in QALYs in 92 % of the simulations.

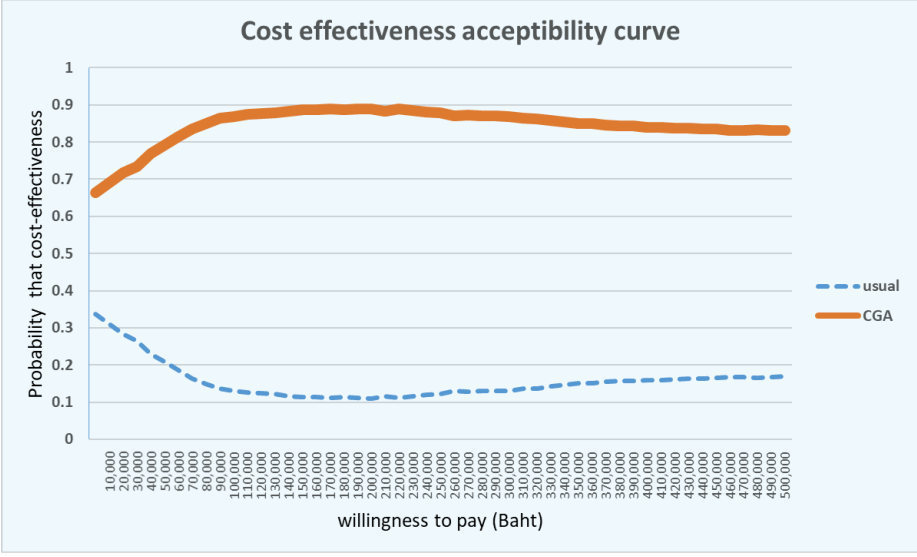


Fig 2. Cost-effectiveness acceptability curves for quality-adjusted life-year gained
Abbreviation: CGA= comprehensive geriatric assessment and multidisciplinary team

DISCUSSION

This was the first prospective study to assess the clinical effectiveness and cost-effectiveness of a geriatric service at a Geriatric OPD in a tertiary hospital within a medical school in Thailand. Previous studies on the cost-effectiveness and clinical effectiveness of OPD services were conducted in municipal ambulatory OPD settings in Sweden[5] and community clinics in England.[25] While these European studies demonstrated clinical effectiveness benefits, the cost analysis did not show cost-effectiveness due to the high intervention costs. In contrast, this study found that CGA and MDT was a cost-saving intervention in the OPD setting in Thailand.

Following these initial findings on cost-effectiveness, a closer look at baseline characteristics reveals further insights into the unique benefits observed in the CGA and MDT group. The baseline characteristics between two groups were similar, although the CGA and MDT group had a lower TMSE score compared to the usual care group at baseline. Despite this, the outcomes showed that MNA-SF score in the CGA and MDT improved more than in the usual care group, while both groups experienced an increase in quality of life along over the one-year study period. The improvement in nutritional status among older adults could be attributed to the CGA and MDT service, which maintained the physical, mental and functional health of patients with poor nutritional status. This was achieved by providing appropriate nutritional education and nutritional supplements to effectively enhance their nutritional health.

In addition to nutritional improvements, the study also considered the broader context of quality of life, especially considering pandemic-related challenges. The evaluation of quality of life (EQ-5D-5L score) appeared to be lower than the mean score for the Thai population.[20] Several factors may explain this finding. First, this study was conducted during the COVID-19 pandemic, which directly affected older adults' quality of life, particularly in terms of depressed mood and anxiety, as well as the well-being of caregivers.[26-28] Secondly, most older adults in this study were female, had multiple comorbidities, and experienced financial problems due to the lockdown, all of which are associated with lower quality of life scores.[29]

While these factors impacted quality of life, the study also assessed how CGA and MDT services affected healthcare utilization and mortality, providing a comprehensive view of their impact on older adults. The CGA and MDT services in the OPD setting did not demonstrate a benefit in reducing unplanned OPD visits, hospitalizations, ER visits, or the incidence of serious and non-serious falls. Additionally, the CGA and MDT services did not decrease the number of deaths during the one-year follow-up period. This may be because the CGA and MDT service did not directly address the primary causes of mortality in older adults, particularly those due to infectious diseases. Neither the death rate nor the occurrence of undesirable events (unplanned OPD visits, hospitalizations, ER visits, serious and non-serious falls) was found to be directly preventable through this intervention.

Although certain healthcare utilizations were not significantly reduced, comparing these findings with studies from different regions emphasizes the cost-effectiveness of CGA and MDT services in specific contexts. The

findings indicated that while CGA and MDT services were a more expensive option in terms of direct medical costs, they were likely to provide better outcomes in nutritional status and quality of life compared to usual care. Although the cost of medical personnel in the CGA and MDT group was three times higher than that of the usual care group, other societal costs associated with CGA and MDT were lower. This demonstrates both clinical and cost effectiveness, similar to the study by *Soejono CH*[14] in Southeast Asia. However, that study was non-randomized control trial and was conducted in an IPD setting. It showed that the CGA provided clinical and cost benefits over usual care in the 30 days follow-up after hospitalization. In our study, the cost savings in the CGA and MDT group were mainly due to a trend of fewer extra OPD visits and unplanned admissions. While these numbers were not statistically lower than those in in the usual care group, the total cost savings still suggested cost-effectiveness. Interestingly, the CGA and MDT service did not significantly reduce unexpected events but did contribute to overall cost-saving results. The number of extra OPD visits in the GCA and MDT group was not lower than in the usual care group, a finding that contrasts with the study by *Wei et al*.[30] The study by *Wei et al* reported reduced number of drugs prescribed, fewer healthcare utilization in terms of OPD visits, emergency department visit, and hospitalizations among older adults in the Geriatric OPD which provided the CGA and MDT services as compared to non-geriatric OPD clinic. The reduction in medical costs was shown in patients with more comorbidities and an older age (≥ 80 years).

Our study cannot be directly compared with others conducted in different countries due to variations in the cost of living.[31] In Europe and the US, the cost of living is 3-4 times higher than ASEAN countries, which corresponds to the higher costs of medical care, including medical personnel, as shown in many studies.[10,32] The CGA and MDT service improved the quality of care for older adults by detecting undiagnosed problems, such as cognitive impairment, depression, fall risk, inappropriate medication use and urinary incontinence.[33] This highlights the potential benefit of CGA and MDT services in low to middle-income countries, where lower medical care costs can significantly enhance the quality of clinical practice for older adults.

A probabilistic sensitivity analysis was conducted to assess uncertainty, confirming that the CGA and MDT service was more cost-effective than usual care in terms of QALY gained. The acceptability curves indicated that the cost per QALY, from a societal perspective was approximately $3,052 per QALY, which is lower than the national threshold of $4,564 per QALY.[24] Therefore, the CGA and MDT service not only results in societal cost savings but also improves the quality of life for older adults.

The study's strengths in design contribute to the reliability of these findings, despite certain limitations. The study lies in its prospective design with a follow-up period of up to one year, demonstrating significant clinical and cost outcomes in the Geriatric OPD. Other studies on cost-effectiveness analysis have been retrospective, which can introduce limitations such as recall bias and difficulties in accurately collecting cost data.[34] Moreover, previous studies did not find that CGA and MDT services in an OPD setting were cost-saving; they primarily demonstrated clinical effectiveness in providing more palliative care services.[5,35]

Nevertheless, acknowledging study limitations helps in understanding the scope and generalizability of these results, especially considering pandemic-era data and the unique baseline differences observed between groups. First, the COVID-19 pandemic during the study period affected the number of older adults receiving the MDT service. This could affect the service provision from the non-COVID period. Second, we did not identify the specific causes leading to extra admissions, ER visit and falls. Some causes might not be avoidable even with the CGA and MDT. Third, there were slight difference in baseline characteristics between the 2 groups which might affect the outcomes. The potential confounding variables such as age, income, ADL, illness severity (determined by Charlson Comorbidity Index: CCI) were not significantly different between group. However, some of the illness conditions were different such as dementia, OA knee and recent hip fracture within 3 months. Dementia and OA knee were more prevalent in the CGA & MDT group, while recent hip fracture was more prevalent in the usual care group. These could affect the service need and clinical outcomes. Lastly, as the study was conducted in a single medical school, which is a tertiary hospital in Bangkok Metropolitan with a large number of older adults and MDT experts, generalizing the results nationwide requires caution due to the lack of such expertise in other healthcare settings and different living expenses.

CONCLUSION

This study demonstrates the clinical and economic effectiveness of CGA and MDT services in an outpatient setting, affirming their role as essential components of elderly care for enhancing quality of life and managing

health-related costs. The broader implications of these findings suggest that CGA and MDT services could be beneficial beyond Thailand, serving as a model for aging populations worldwide. By focusing on cost-effectiveness and holistic care, these interventions can help healthcare systems meet the complex needs of older adults, providing sustainable and high-quality care on a global scale. Further research in diverse healthcare settings is needed to refine this model, ensuring that CGA and MDT remain adaptable to the unique challenges of different regions and healthcare infrastructures.

ACKNOWLEDGMENTS

The authors thank facilitators, nurses, computer programmers, research assistants, and all older adults who participated in the present study.

DECLARATION

Grants and Funding Information

This project is not funded by any external source.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Author Contributions

Conceptualization and methodology, P.V., S.I., N.T., S.M. and W.M. ; Investigation, P.V.; Formal analysis, P.V., N.T., S.M. and W.M. ;Visualization and writing – original draft, P.V., N.T. and S.M.; Writing – review and editing, W.M., N.T. and S.M; Supervision, W.M. All authors have read and agreed to the final version of the manuscript.

Use of artificial intelligence

The manuscript is not produced using artificial intelligence.

Human ethics approval declaration

This study was approved by the Institutional Review Board, Bangkok, Thailand (IRB No. 1057/2563). Written informed consent was obtained from each older adult or their legal representative.

REFERENCES

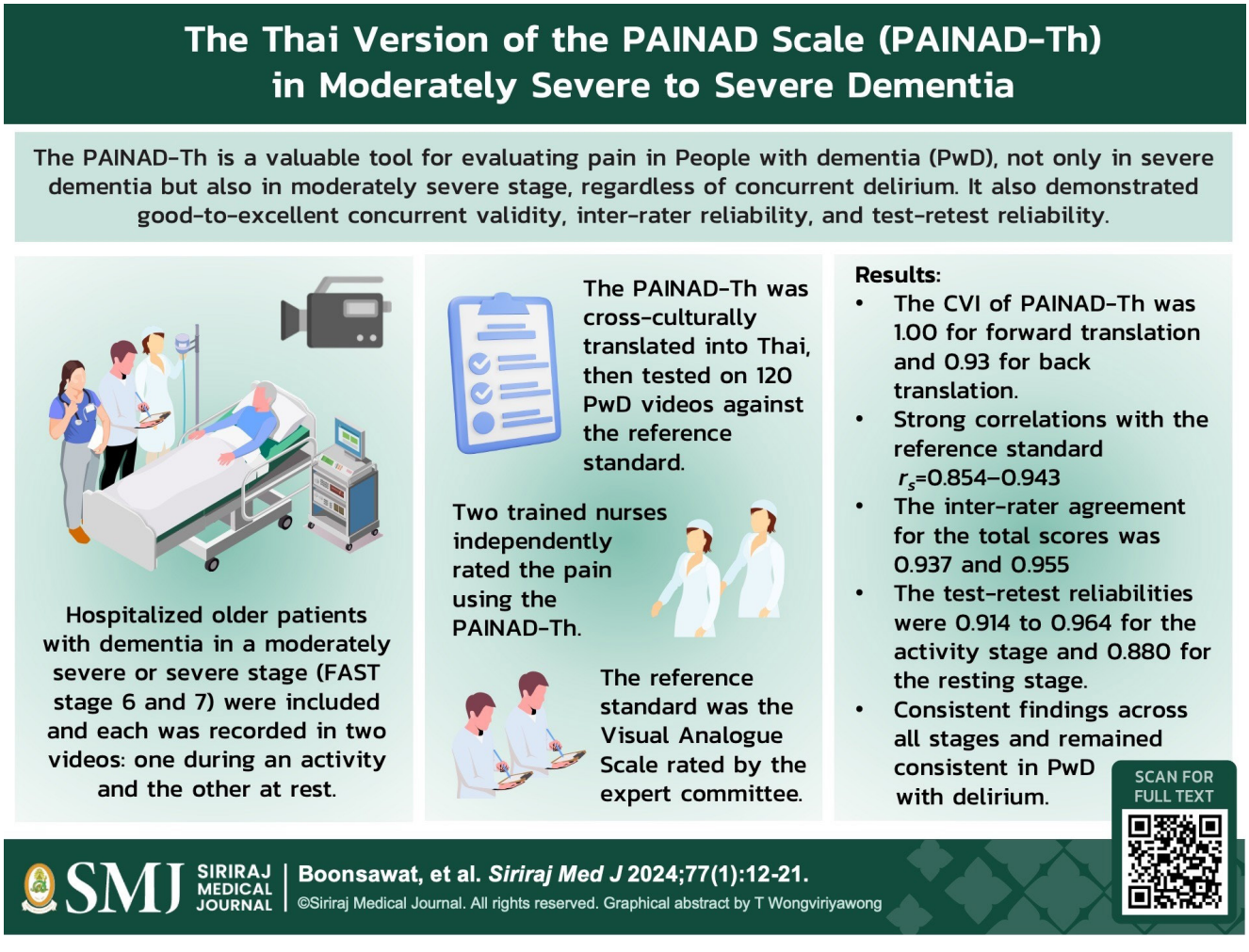
1. Carl H. Fact sheet: World population trends 2012. Population reference bureau. 2012.
2. Chewasopit W. AGING SOCIETY: THE CHANGED MARKETING FACTOR. Journal of MCU Nakhondhat. 2019;6:38-54.
3. Rakbumned C. Expenditure budget burden,The Secretariat of The House of Representatives. 2017.
4. Ellis G, Whitehead MA, Robinson D, O'Neill D, Langhorne P. Comprehensive geriatric assessment for older adults admitted to hospital: meta-analysis of randomised controlled trials. BMJ 2011;343:d6553.
5. Lundqvist M, Alwin J, Henriksson M, Husberg M, Carlsson P, Ekdahl AW. Cost-effectiveness of comprehensive geriatric assessment at an ambulatory geriatric unit based on the AGe-FIT trial. BMC geriatrics. 2018;18(1):32.
6. Boorsma M, Frijters DH, Knol DL, Ribbe ME, Nijpels G, van Hout HPJC. Effects of multidisciplinary integrated care on quality of care in residential care facilities for elderly people: a cluster randomized trial. CMAJ. 2011;183(11):E724-E32.
7. Amelie M. Outpatient comprehensive geriatric assessment: effects on frailty and mortality in old people with multimorbidity and high health care utilization. Aging Clin Exp Res. 2019;31(4): 519-25.
8. Poudel A, Peel NM, Mitchell CA, Gray LC, Nissen LM, Hubbard RE. Geriatrician interventions on medication prescribing for frail older people in residential aged care facilities. J Clinical interventions in aging. 2015;10:1043.
9. Ellis G, Langhorne P. Comprehensive geriatric assessment for older hospital patients. BMJ. 2005;71(1):45-59.
10. Ekdahl AW, Wirehn A-B, Alwin J, Jaarsma T, Unosson M, Husberg M, et al. Costs and effects of an ambulatory geriatric unit (the AGe-FIT study): a randomized controlled trial. J Am Med Dir Assoc. 2015;16(6):497-503.
11. Jeppesen SS, Matzen LE, Brink C, Bliucukiene R, Kasch S, Schytte T, et al. Impact of comprehensive geriatric assessment on quality of life, overall survival, and unplanned admission in patients with non-small cell lung cancer treated with stereotactic body radiotherapy. J Geriatr Oncol. 2018;9(6):575-82.
12. Morley JE, Arai H, Cao L, Dong B, Merchant RA, Vellas B, et al. Integrated care: enhancing the role of the primary health care professional in preventing functional decline: a systematic review. J Am Med Dir Assoc. 2017;18(6):489-94.
13. Ellis G, Whitehead MA, Robinson D, O'Neill D, Langhorne PJB. Comprehensive geriatric assessment for older adults admitted to hospital: meta-analysis of randomised controlled trials. BMJ. 2011;343:d6553.
14. Soejono CH. The impact of'comprehensive geriatric assessment (CGA)'implementation on the effectiveness and cost (CEA) of healthcare in an acute geriatric ward. Acta Med Indones. 2008; 40(1):3-10.
15. Sumonthip P, Boonkerd J, Phrayai N, Permkrietkajorn R. Program evaluation Comprehensive geriatric assessment clinic Satisfaction Older patients. Ramathibodi Nursing Journal. 2013;16(3): 443-55.
16. Stineman MG, Xie D, Pan Q, Kurichi JE, Zhang Z, Saliba D, et al. All-cause 1-, 5-, and 10-year mortality in elderly people according to activities of daily living stage. J Am Geriatr Soc. 2012;60(3): 485-92.
17. Stineman MG. All-cause 1-, 5-, and 10-year mortality in elderly people according to activities of daily living stage. J Am Geriatr Soc. 2012;60(3):485-92.
18. Podgorelec V. Decision trees: an overview and their use in medicine. J Med Syst. 2002;26(5):445-63.
19. Komorowski M. Markov models and cost effectiveness analysis: applications in medical research. J Secondary analysis of electronic health records. 2016:351-67.
20. Pattanaphesaj J. Health-related quality of life measure (EQ-5D-5L): measurement property testing and its preference-based

score in Thai population: Mahidol University Salaya, Thailand; 2014.
21. PATTANAPRATEEP DO. CLINICAL ECONOMICS. 2019.
22. Drummond MF, Sculpher MJ, Claxton K, Stoddart GL, Torrance GW. Methods for the economic evaluation of health care programmes: Oxford university press; 2015.
23. Barreto H, Howland F. Introductory econometrics: using Monte Carlo simulation with Microsoft excel: Cambridge University Press; 2006.
24. Nimdet K, Ngorsuraches S. Willingness-To-Pay For Life-Saving Treatments In Thailand: A Discrete Choice Experiment. Value Health. 2017;20(9):A682.
25. Tanajewski L, Franklin M, Gkountouras G, Berdunov V, Edmans J, Conroy S, et al. Cost-effectiveness of a specialist geriatric medical intervention for frail older people discharged from acute medical units: economic evaluation in a two-centre randomised controlled trial (AMIGOS). PLoS One. 2015;10(5): e0121340.
26. Hay JW, Gong CL, Jiao X, Zawadzki NK, Zawadzki RS, Pickard AS, et al. A US population health survey on the impact of COVID-19 using the EQ-5D-5L. 2021;36(5):1292-301.
27. Gray RS, Hahn L, Thapsuwan S, Thongcharoenchupong N. Strength and stress: Positive and negative impacts on caregivers for older adults in T hailand. Australas J Ageing. 2016;35(2): E7-E12.
28. Bergmann M, Wagner M. The Impact of COVID-19 on Informal Caregiving and Care Receiving Across Europe During the First Phase of the Pandemic. 2021;9.
29. Lim SL, Woo KL, Lim E, Ng F, Chan MY, Gandhi M. Impact of COVID-19 on health-related quality of life in patients with cardiovascular disease: a multi-ethnic Asian study. Health Qual Life Outcomes. 2020;18(1):1-7.
30. Wei Y-J, Hsieh C-F, Huang Y-T, Huang M-S, Fang T-J. The influence of integrated geriatric outpatient clinics on the health care utilization of older people. J BMC geriatrics. 2020;20(1): 1-12.
31. Ulmer MJ. Chapter III. The Theory of the Cost of Living Index. The Economic Theory of Cost of Living Index Numbers: Columbia University Press; 1949. p. 26-43.
32. Ranhoff AH. Out-patient geriatric assessment by a hospital-based general practitioner: Results and financial implications. Norsk Epidemiologic. 1998;8(2).
33. Salagre S, Kundawar A, Srivastava P, Saha T, Mantri A, Jain S, et al. Comprehensive Geriatric Assessment (CGA) Screening of Geriatric Patients in a Tertiary Care Hospital: a Cross-sectional Study in India. J Assoc Physicians India. 2022;70(1): 11-2.
34. Hosoi T, Yamana H, Tamiya H, Matsui H, Fushimi K, Akishita M, et al. Association between comprehensive geriatric assessment and short-term outcomes among older adult patients with stroke: A nationwide retrospective cohort study using propensity score and instrumental variable methods. E Clinical Medicine. 2020;23:100411.
35. Dahlqvist J, Ekdahl A, Friedrichsen M. Does comprehensive geriatric assessment (CGA) in an outpatient care setting affect the causes of death and the quality of palliative care? A subanalysis of the age-FIT study. Eur Geriatr Med. 2019;10(3):455-62.

Reliability and Validity of the Thai Version of the PAINAD Scale: An Extended Application of Pain Assessment in the Moderately Severe Stage of Dementia

Natthapapath Boonsawat, M.D.[1,2], Patumporn Suraarunsumrit, M.D.[2], Sutisa Pitiyarn, R.N., A.P.N.[2], Napaporn Pengsorn, R.N.[4], Varalak Srinonprasert, M.D.[2], Sahatsa Mandee, M.D.[3], Titima Wongviriyawong, M.D.[2,*]

[1]Division of Geriatric Medicine, Department of Medicine, Khon Kaen Hospital, Khon Kaen, Thailand, [2]Division of Geriatric Medicine, Department of Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand, [3]Department of Anesthesiology, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand, [4]Department of Preventive and Social Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand.



**Corresponding author: Titima Wongviriyawong*
E-mail: titima.won@mahidol.ac.th
Received 14 October 2024 Revised 1 November 2024 Accepted 14 November 2024
ORCID ID:http://orcid.org/0000-0003-0121-4003
https://doi.org/10.33192/smj.v77i1.271644

ABSTRACT

Objective: To evaluate the reliability and validity of the Thai version of the PAINAD (PAINAD-Th) scale for assessing pain in people with dementia (PwD).

Materials and methods: A cross-cultural translation of the PAINAD scale involving forward and back-translation to and from Thai was conducted, and then the content validity index (CVI) of semantic equivalence was evaluated. The PAINAD-Th was tested on 120 videos of PwD. Each participant was recorded in two videos: one during an activity and the other at rest. Subsequently, two trained nurses independently observed the videos and rated the PAINAD-Th to assess inter-rater reliability. The rating process was repeated in one week to investigate the test-retest reliability. The concurrent validity was assessed against the Visual Analogue Scale rated by the expert committee.

Results: The CVI of PAINAD-Th was 1.00 for forward translation and 0.93 for back translation. The PAINAD-Th showed strong correlations with the reference standard (r_s=0.854–0.943, p-value <0.001). The inter-rater agreement for the total scores was 0.937 and 0.955, and the test-retest reliabilities were 0.914 to 0.964 for the activity stage and 0.880 for the resting stage, respectively. The concurrent validity index did not vary significantly across different stages of dementia; the findings remained consistent in the delirium subgroup analysis.

Conclusions: The PAINAD-Th is a valuable tool for evaluating pain in PwD, not only in severe dementia but also in moderately severe stage, regardless of concurrent delirium. It also demonstrated good-to-excellent concurrent validity, inter-rater reliability, and test-retest reliability.

Keywords: Pain; dementia; reproducibility of results (Siriraj Med J 2025; 77: 12-21)

INTRODUCTION

Dementia is a complex syndrome characterised by impairment across multiple cognitive domains, resulting in a progressive decline in daily functioning.[1] In addition to cognitive decline, dementia affects behaviour, mood, mental state, and interpersonal relationships.[2] In the early stage, people with dementia (PwD) may not need assistance in basic daily activities and can communicate their needs well, but as the disease advances to the severe stage, they usually have limited expression of their needs and are unable to perform daily activities without assistance.[3]

Pain detection is one of the challenging problems in PwD. Despite the high prevalence of pain up to 50% of people with dementia in hospital settings,[4] it is often inadequately identified and managed due to the difficulties in expressing pain,[5] resulting in depression, further cognitive and physical decline, increased risk of falls, poor sleep quality, and a reduction in the quality of life of affected individuals.[6,7]

Pain self-reporting is considered the gold standard for evaluating pain in patients who can express the characteristics and severity of their pain. In people with mild to moderate cognitive impairment, it is suggested that pain can be evaluated by querying their pain using the Numerical Rating Scale or verbal expression.[8,9] However, pain assessment in people with severe cognitive impairment using self-report is challenging because of their decreased communication ability. Notwithstanding the difficulty in verbally expressing pain, PwD possibly manifest their pain in non-specific manifestations such as confusion, agitation, restlessness, irritability, or changes in appetite.[10-12]

This adversity has led to the development of various pain assessment tools in PwD, based on behavioural observation, including the "Discomfort Scale-Dementia of the Alzheimer's Type" (DS-DAT), "Checklist of Nonverbal Pain Indicators" (CNPI), "the ABBEY Pain Scale", "Mobilization-Observation-Behavior-Intensity-Dementia Pain Scale" (MOBID), "Pain Assessment Checklist for Seniors with Limited Ability to Communicate" (PACSLAC), "Pain Assessment in Advanced Dementia" (PAINAD) scale, and Doloplus-2 scale. Among the tools mentioned, the UK National guidelines recommend using the PAINAD and Doloplus-2 scales to assess pain in PwD.[9]

The PAINAD scale was developed by Warden, et al. to assess pain in PwD. It includes observing individuals in five features: breathing, negative vocalisation, facial expression, body language, and consolability. Each feature is scored on a scale ranging from 0 to 2 based on specifically described characteristics. The scale exhibited good construct validity, strong interrater reliability, and a good correlation with the DS-DAT scale and the Visual Analogue Scale (VAS).[13] The PAINAD has shown strong concurrent validity in clinical research, regardless of cognitive status in older adults undergoing hip fracture surgery.[14] Additionally, it has demonstrated a high sensitivity of 92% in identifying and detecting pain in older people with severe dementia.[15]

The PAINAD scale has been translated into multiple languages, including Italian, German, Portuguese, Dutch, Chinese, and Korean.[16-22] However, it has not been translated into Thai. Given the absence of an optimal pain assessment tool for individuals with moderate to severe dementia in Thailand, despite the increasing prevalence of dementia among older adults as a result of a rapid transition of the Thai population into a super-aged society within a decade,[23] this study aims to assess the reliability and validity of a Thai version of PAINAD (PAINAD-Th) for measuring pain in PwD. Moreover, this study aimed to explore the validity of the PAINAD-Th in delirium superimposed on dementia patients, given the high prevalence of delirium varying between 38–72% in a tertiary hospital setting.[24-26]

MATERIALS AND METHODS

This study comprised three phases of validity processes carried out at Siriraj Hospital, a large university hospital in Bangkok, Thailand. The study protocol was approved by the Siriraj Institutional Review Board before commencing (Si 560/2019). The process of cross-cultural translation and the evaluation of the validity and reliability of PAINAD-Th involved three distinct phases, as outlined below.[27,28] Video recordings were used for training and interrater reliability processes to minimise the disturbance of vulnerable subjects and ascertain that the assessments were based on the exact circumstances.

Phase 1: Translation of PAINAD to a Thai version

In the initial forward-translation step, the original English version of the PAINAD scale was translated into Thai after receiving permission from one of the PAINAD developers, Prof. Ladislav Volicer, by two bilingual geriatricians with Thai mother tongues. Subsequently, a complete translated version was created through consensus between the two translators. A back-translation was then independently undertaken by another translator, who is bilingual in traditional Thai and English and has a master's degree in linguistics. Subsequently, a team of three subject-matter experts (two geriatricians and one anesthesiologist) reviewed the back-translation and rated each feature from 1–4. Higher scores (3 or 4) indicated closer equivalence to the original version. The content validity index for semantic equivalence to the original version of the PAINAD was then assessed.[29] Any uncertainties about the translation were discussed with the back-translator. All features underwent a thorough review to ensure accuracy and grammatical correctness. Subsequently, the final version of the PAINAD-Th scale was attained.

Phase 2: Training process

The two nurses underwent a two-step training process facilitated by a geriatric fellow. Initially, they participated in a one-hour instructional session where they received detailed explanations of each component of the PAINAD-Th scale and were assessed to confirm their comprehension of the tool. Subsequently, each nurse independently practised using the scale while observing the same set of 10 videos. The objective was to sufficiently acquaint the nurses with the patient-observation procedures, enabling them to independently and consistently utilise the PAINAD-Th scale in the later evaluation.

Phase 3: The test of reliability and validity of PAINAD-Th

The reliability and validity of the PAINAD-Th scale were assessed through inter-rater reliability, test-retest reliability, and concurrent validity analyses.

Study design

From September 2019–March 2020, patients aged over 60 who had been admitted to Siriraj Hospital were enrolled in the study if any one of the following conditions were met:

1) they had a prior diagnosis of dementia in their medical records;

2) they had been diagnosed with dementia by a geriatrician on admission or

3) they had an abnormal cognitive assessment[30] (namely, a modified Informant Questionnaire on Cognitive Decline in the Elderly score (modified IQCODE)[31] ≥ 3.42, a Thai Mental State Examination score (TMSE)[32] < 24, or a Montreal Cognitive Assessment score(MoCA)[33] < 25).

After the dementia patients were identified, the geriatric fellow assessed the severity of dementia using the Functional Assessment Staging Test (FAST)[34] in order to enrol patients with a moderately severe or severe stage of dementia (FAST stage 6 and 7). The family members or guardians of patients were informed about the research aims and procedures, including video recordings, and then informed consent was obtained. Patients were excluded if they were comatose or quadriplegic, had severe sepsis or septic shock,[35] or had been admitted to an intensive care unit.

On the initial assessment, baseline characteristics were collected and assessed by the geriatric fellow. These included age, sex, comorbidities, the Barthel Index,[36] for assessing basic activities of daily living, FAST stage for dementia, and the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) classification for

delirium.[1] The delirium diagnosis made by the geriatric fellow had previously demonstrated a substantial agreement with an experienced geriatrician with Cohen's kappa coefficient of 0.783.

Pain diagnosis reference standard

A researcher recorded videos of each participant for two episodes, each for a 5-minute duration. The first record, labelled as "activity", was captured during an activity that could provoke pain, such as wound dressing, bed-bathing, or physical therapy session, while the second one, labelled as "rest", was recorded while the patient was at rest. Two geriatricians who were unaware of the scoring of the PAINAD-Th established a comprehensive pain assessment as a reference standard by reviewing the participants' medical histories from electronic medical records and inpatient documents, including potential sources of pain, and then used a Visual Analogue Scale (VAS)[37] to assess the participants' pain levels based on their behaviour in the activity and rest videos, given the participants were unable to communicate their pain accurately.

Determination of PAINAD-Th reliability

The primary outcomes included assessing the reliability and validity of PAINAD-Th for measuring pain in PwD in moderately severe to severe stages. To test inter-rater reliability, two trained nurses independently evaluated the participants' pain using PAINAD-Th by observing the same sets of video records. One week later, the rating process was reproduced to investigate the test-retest reliability of PAINAD-Th. Concurrent validity was investigated by evaluating it against the VAS assessment by the geriatricians.

Statistical analysis

The sample size calculation for exploring the concurrent validity of PAINAD-Th was based on the previous study reporting a moderate correlation (correlation coefficient; r=0.65) of translated PAINAD (Italian version) with the Visual Rating scale.[16] Our study expected the lowest value that still represents a moderate correlation (r=0.4–0.69),[38] thus, the correlation coefficient of 0.4 was used to estimate the sample size, given an acceptable significant level of 5% (p=0.05) with a power of 80% and a 20% dropout rate; the calculated sample size was 57.

Demographic data for categorical variables were reported as percentages. For continuous variables, data were presented as means with standard deviations for parametric data, and medians with interquartile ranges for non-parametric data. The content validity index was used to determine the semantic equivalence to the original PAINAD scale by summing the percentages of agreement of all items given a rating of 3 or 4 by the expert committee. Intraclass correlation coefficients (ICCs) were analyzed for inter-rater reliability using a two-way mixed-effects model with absolute agreement type and for test-retest reliability using a two-way mixed-effects model with consistency type.[39,40] The concurrent validity of PAINAD-Th compared to the reference standard was analyzed using Spearman's rank correlation coefficient, due to the non-parametric nature of the data. Analyses were conducted using PASW Statistics for Windows (version 18.0; SPSS Inc., Chicago, Ill., USA).

RESULTS

Baseline characteristics

A total of 60 participants were enrolled in the study, with a mean age of 84.7 ± 7.1 years. In total, 120 video recordings were obtained. Women comprised 66.7% of the sample, with the majority (60%) diagnosed with Alzheimer's disease. Approximately two-thirds of the participants were in the moderately severe stage of dementia. The most common diagnosis associated with painful conditions was fractures, accounting for 38.3% of cases. Delirium was present in 23.3% of participants, with hypoactive delirium being the most prevalent subtype. Characteristics of the included participants are outlined in Table 1.

Content validity index

The content validity indices for the semantic equivalence were 1.00 for the forward translation and 0.93 for the back translations.

Concurrent validity

The concurrent validity of the PAINAD-Th at rest demonstrated strong correlation coefficients (r_s), ranging from 0.854 to 0.943, with a p-value <0.001. During activity, the correlation coefficients (r_s) ranged from 0.897 to 0.904, also with a p-value <0.001 (Table 2). Subgroup analyses were conducted to assess concurrent validity across different dementia stages and based on the presence of delirium. The results indicated a slightly stronger correlation with the reference standard in the severe stage compared to the moderately severe stage. In participants without delirium, the PAINAD-Th exhibited a very strong correlation with the reference standard (Table 2).

Inter-rater reliability and test-retest reliability

Concerning inter-rater reliability, the ICCs for the

TABLE 1. Baseline characteristics.

Characteristics	Results (N=60)
Age, mean ± SD	84.7 ± 7.1
Male, n (%)	20 (33.3)
Education, median (P25, P75)	4.0 (4.0, 12.0)
Charlson comorbidity index[a], n (%)	
0	–
1–2	32 (53.3)
3–4	18 (30.0)
≥ 5	10 (16.7)
Admission ward, n (%)	
Medical	17 (28.3)
Surgical	17 (28.3)
Orthopedic	26 (43.3)
Diagnoses related to painful conditions, n (%)	
Fracture	23 (38.3)
Surgical procedure	16 (26.7)
Joint contracture/ arthritis	4 (6.7)
Limb ischemia	3 (5.0)
Headache	3 (5.0)
Abdominal pain	1 (1.7)
None	10 (16.7)
Diagnoses related to dementia, n (%)	
Alzheimer's disease	36 (60.0)
Vascular dementia	12 (20.0)
Other dementia types	9 (15.0)
Mixed-type dementia	3 (5.0)
Cognitive test, median (P25, P75)	
Thai Mental State Examination (TMSE)	14.5 (10.3, 17.5)
Caregiver, n (%)	
Spouse	9 (15.0)
Child	31 (51.7)
Relative	8 (13.3)
Formal caregiver	12 (12)
FAST stage, n (%)	
Stage 6, moderately severe	
6A	5 (8.4)
6B	7 (11.6)
6C	11 (18.3)
6D	4 (6.7)
6E	17 (28.3)
Stage 7, severe	
7A	7 (11.7)
7B	1 (1.7)
7C	1 (1.7)
7D	3 (5.0)
7E	3 (5.0)
7F	1 (1.7)

TABLE 1. Baseline characteristics. (continue)

Characteristics	Results (N=60)
Delirium, n (%)	
Total	14 (23.3)
Hypoactive	8 (13.3)
Hyperactive	4 (6.7)
Mixed	2 (3.3)
Barthel Index, n (%)	
Very severely disabled	19 (31.7)
Severely disabled	14 (23.3)
Moderately disabled	20 (33.3)
Mildly disabled	7 (11.7)

Note: [a] Age-unadjusted Charlson comorbidity index

TABLE 2. Concurrent validity: the correlation between the VAS (reference standard) and the PAINAD-Th.

	Spearman's Rank Correlation Coefficient (rs; 95% CI)			
	Rater 1		Rater 2	
	Activity	Rest	Activity	Rest
All cases	0.904	0.854	0.897	0.943
(N=60)	(0.807–0.960)	(0.756–0.940)	(0.801–0.951)	(0.879–0.990)
Stages of Dementia				
Moderately severe stage	0.883	0.878	0.884	0.949
(N=44)	(0.765–0.955)	(0.748–0.964)	(0.775–0.954)	(0.891–1.000)
Severe stage	0.995	0.834	0.965	0.964
(N=16)	(0.973–1.000)	(0.472–0.966)	(0.865–0.997)	(0.842–1.000)
Delirium Diagnosis				
Delirium	0.843	0.827	0.861	0.883
(N=14)	(0.530–0.976)	(0.560–1.000)	(0.495–0.993)	(0.667–1.000)
No delirium	0.952	0.878	0.922	0.966
(N=46)	(0.898–0.977)	(0.750–0.960)	(0.833–0.965)	(0.906–1.000)

Abbreviation: VAS, Visual Analogue Scale
Note: all p-value <0.001

total PAINAD-Th scores were 0.937 (activity stage) and 0.955 (rest stage). At rest, each item showed a moderate-to-good ICC, ranging between 0.691 and 0.818. The ICCs for the activity stage also showed moderate-to-good ICCs of 0.671 to 0.861 (Table 3). The test-retest reliabilities for the total scores were good to excellent (ICCs of 0.880 to 0.964). When examining each feature, the ICCs generally showed good reliabilities, except for a few features that displayed moderate reliabilities. These include the breathing feature assessed during the activity stage, and the body language feature assessed both in the rest stage and during the activity stage (Table 4).

TABLE 3. Inter-rater reliability for each feature and total score.

PAINAD-Th feature	Intraclass correlation coefficient (ICC; 95% CI)	
	Activity	Rest
Breathing	0.671 (0.566–0.789)	0.735 (0.594–0.833)
Negative vocalisation	0.861 (0.778–0.914)	0.818 (0.713–0.887)
Facial expression	0.701 (0.470–0.829)	0.773 (0.647–0.858)
Body language	0.780 (0.658–0.862)	0.766 (0.631–0.855)
Consolability	0.827 (0.726–0.893)	0.691 (0.531–0.803)
Total score	**0.937 (0.880–0.965)**	**0.955 (0.926–0.973)**

TABLE 4. Test-retest reliability for each feature and total score.

PAINAD-Th feature	Intraclass correlation coefficient (ICC; 95% CI)	
	Rater 1	Rater 2
Activity		
Breathing	0.676 (0.511–0.793)	0.606 (0.417–0.744)
Negative vocalisation	0.746 (0.609–0.840)	0.792 (0.674–0.870)
Facial expression	0.828 (0.727–0.893)	0.771 (0.643–0.856)
Body language	0.695 (0.538–0.806)	0.680 (0.517–0.796)
Consolability	0.767 (0.638–0.854)	0.861 (0.778–0.915)
Total score	**0.964 (0.941–0.978)**	**0.914 (0.861–0.948)**
Rest		
Breathing	0.764 (0.633–0.852)	0.857 (0.772–0.912)
Negative vocalisation	0.789 (0.670–0.868)	0.635 (0.455–0.764)
Facial expression	0.731 (0.586–0.830)	0.741 (0.601–0.837)
Body language	0.720 (0.572–0.823)	0.622 (0.439–0.756)
Consolability	0.884 (0.813–0.929)	0.846 (0.754–0.905)
Total score	**0.880 (0.807–0.926)**	**0.880 (0.807–0.927)**

DISCUSSION

This study demonstrated good validity and reliability of the PAINAD-Th scale for pain assessments among patients with moderately severe or severe dementia. The result was consistent with previous studies.[13,16-21] The content validity indices of the PAINAD-Th, as evaluated by experts, demonstrated high scores, signifying semantic equivalence to the original version and suitability for implementation in a Thai context. The concurrent validity of the PAINAD-Th, evaluated by comparing the results against the VAS determined by the two geriatricians, showed an excellent correlation. This result was similar to a study by Warden, *et al.*,[13] which was tested against the VAS and was slightly higher than that of D. Costardi, *et al.*[16] The strong correlation may be influenced by the comprehensive pain assessments by an expert committee across multiple domains. This includes observing the participant's body language, facial expressions, and pain-indicating vocalizations, all of which may partly resemble those of the PAINAD-Th features. Regarding pain-indicating vocalizations assessed by the expert committee, some of the PwD may be able to accurately report their pain verbally, even in moderate to severe stages,[41,42] which could correspond to an observational comprehensive assessment of pain recommended for individuals with severe dementia.[43]

In this study, the use of PAINAD-Th also effectively measured pain in patients with dementia in their moderately severe and severe stages, addressing the gap left by previous studies that focused only on patients in the severe stage.[13,16-21] Additionally, the PAINAD-Th scale accurately identified pain in both resting and active stages.

We also observed that the assessment of the breathing feature during activity demonstrated lower inter-rater reliability and test-retest reliability compared to other features, which is consistent with the previous study.[13] The findings may be attributed to the difficulty of accurately assessing breathing patterns through video recordings when PwD could have altered respiratory pathology, leading to apnea or breathing dysrhythmias.[44,45] Besides, Cheyne-Stokes respiration may not be a specific indicator of pain, as this pattern is commonly seen in patients with unstable central respiratory control, such as those with stroke and heart failure.[46] As a result, the variation of breathing patterns in PwD could perplex the rating of the breathing feature.

Despite the discrepancy in each feature score between the two raters, the decision to proceed with further management was based on the total score rather than each feature. It is important to note that the lower agreement on each feature may not diminish the overall rating result.

Our study demonstrated that the PAINAD-Th effectively evaluated pain in PwD who also experienced delirium. The data revealed a strong correlation between the PAINAD-Th scores and the established reference standards, suggesting that this tool is reliable in complex clinical situations, such as acute care settings where delirium is frequently encountered.[24,25] Although the correlation was slightly reduced in PwD with delirium compared to those without, this discrepancy likely stems from the inherent challenges of assessing pain in delirious patients. Delirium often manifests with various symptoms, such as disorganized thinking, perceptual disturbances, and inattention, that can obscure the accurate interpretation of pain-related behaviours. For example, negative vocalizations may not necessarily indicate pain but could reflect other unmet needs, making it difficult to differentiate. However, considering that pain is a well-documented precipitating factor for delirium[47], the availability of a tool like the PAINAD-Th, which can capture pain signals even in these complex cases, is crucial for ensuring timely and effective clinical interventions. The test's ability to operate reliably in such challenging contexts underscores its value in managing pain in PwD, particularly in settings where delirium is a common complicating factor.

This study presents both strengths and limitations that should be recognized. A key strength was the methodology employed to assess test-retest reliability, inter-rater reliability, and concurrent validity. Geriatricians and nurses observed the same set of video recordings, enabling direct comparison of the pain ratings provided by nurses against the reference standard values determined by geriatricians, without any interval between assessments. This approach ensured consistency and robustness in evaluating the tool's validity. Additionally, the study demonstrated that pain assessment using the PAINAD-Th could be effectively conducted after a one-hour training session. It is plausible that further competency could be achieved through more extensive training or supplementary self-learning resources, which may enhance understanding of the tool. This could serve as a framework for the tool's integration into daily clinical practice and support its feasibility for use by non-specialist personnel.

However, several limitations must be acknowledged. A primary limitation is that patient assessments were conducted via video recordings, while in clinical settings, pain assessments are typically performed in person, allowing for a more comprehensive and time-sensitive evaluation. Furthermore, the validity of the reference

standard could be strengthened by confirming the resolution of symptoms following pain relief, thereby providing additional verification of the tool's accuracy in identifying pain.

Another limitation is that we did not account for behavioural and psychological symptoms of dementia (BPSD) diagnoses prior to the reference-standard pain assessment. BPSD is highly prevalent, affecting up to 90% of PwD,[48,49] and includes a variety of manifestations, such as agitation, anxiety, irritability, and abnormal vocalization. These symptoms may contribute to the overdiagnosis of pain by the reference standard, as certain behavioural cues assessed by the PAINAD-Th scale can overlap with features of BPSD. This overlap could lead to a high correlation between the reference standard and the PAINAD-Th scale.

However, it is important to note that BPSD is often triggered by unmet needs such as pain, hunger, toileting, or communication difficulties. Thus, diagnosing and addressing potential pain may be more beneficial than overlooking it, given the significant impact untreated pain can have on the quality of life in PwD.

CONCLUSION

The PAINAD-Th is an effective tool for assessing pain in people with dementia, regardless of the presence of delirium. Compared to the standard reference, it has demonstrated good-to-excellent content validity, concurrent validity, inter-rater reliability, and test-retest reliability. Furthermore, its utility extends not only to severe dementia cases but also to moderately severe stages.

ACKNOWLEDGEMENTS

We extend our gratitude to Mrs. Nipaporn Sangarunakul for her invaluable administrative support.

DECLARATION

Grants and Funding Information

This research was supported by the Siriraj Research Fund (R 016231064), Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Conceptualisation and methodology, T.W., N.B., P.S., and V.S.; Investigation, N.B., S.P., N.P., S.M., P.S., T.W.; Formal analysis, N.B., T.W.; Visualization and writing – original draft, N.B.; Writing – review and editing, T.W., V.S.; Funding acquisition, N.B., T.W.; Supervision, T.W. All authors have read and agreed to the final version of the manuscript.

REFERENCES

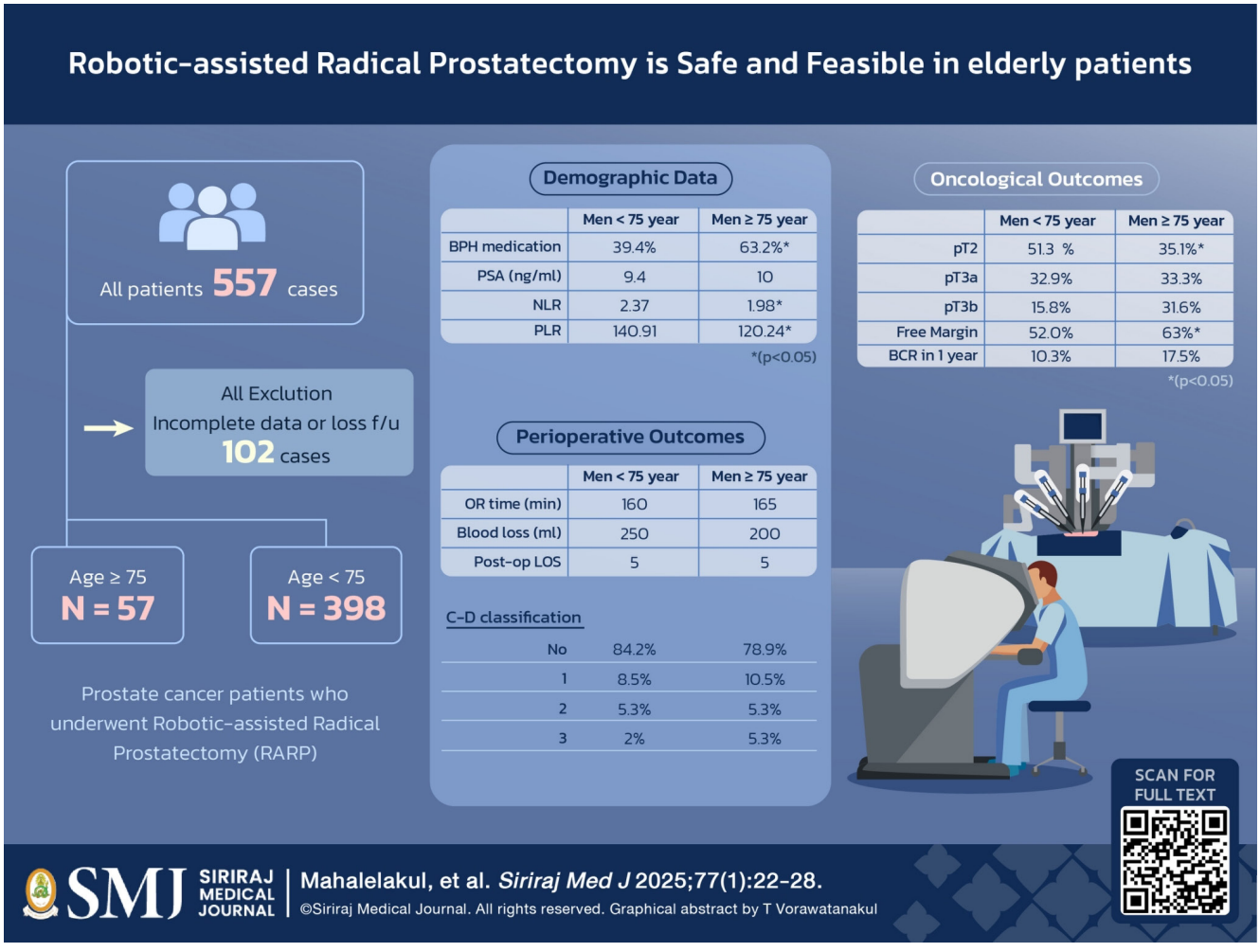
1. American Psychiatric Association. Diagnostic and statistical manual of mental disorders : DSM-5. Arlington, VA: American Psychiatric Association; 2013.
2. Taemeeyapradit U, Udomittipong D, Tepparak N. Characteristics of behavioral and psychological symptoms of dementia, severity and levels of distress on caregivers. J Med Assoc Thai. 2014;97(4):423-30.
3. Reisberg B, Ferris SH, de Leon MJ, Crook T. The Global Deterioration Scale for assessment of primary degenerative dementia. Am J Psychiatry. 1982;139(9):1136-9.
4. Lin PC, Li CH, Chou PL, Chen YM, Lin LC. Prevalence of pain-related diagnoses in patients with dementia: a nationwide study. J Pain Res. 2018;11:1589-98.
5. Tan EC, Jokanovic N, Koponen MP, Thomas D, Hilmer SN, Bell JS. Prevalence of Analgesic Use and Pain in People with and without Dementia or Cognitive Impairment in Aged Care Facilities: A Systematic Review and Meta-Analysis. Curr Clin Pharmacol. 2015;10(3):194-203.
6. Corbett A, Husebo BS, Achterberg WP, Aarsland D, Erdal A, Flo E. The importance of pain management in older people with dementia. British Medical Bulletin. 2014;111(1):139-48.
7. Miu DKY, Chan KC. Under-detection of pain in elderly nursing home residents with moderate to severe dementia. Journal of Clinical Gerontology and Geriatrics. 2014;5(1):23-7.
8. American Geriatric Society Panel on the Pharmacological Management of Persistent Pain in Older Persons. The management of persistent pain in older persons. J Am Geriatr Soc. 2002;50(6 Suppl):S205-24.
9. Schofield P. The Assessment of Pain in Older People: UK National Guidelines. Age Ageing. 2018;47(suppl_1):i1-i22.
10. Collett B, O'Mahoney S, Schofield P, Closs SJ, Potter J, Guideline Development G. The assessment of pain in older people. Clin Med (Lond). 2007;7(5):496-500.
11. van Dalen-Kok AH, Pieper MJ, de Waal MW, Lukas A, Husebo BS, Achterberg WP. Association between pain, neuropsychiatric symptoms, and physical function in dementia: a systematic review and meta-analysis. BMC Geriatr. 2015;15:49.
12. Sampson EL, White N, Lord K, Leurent B, Vickerstaff V, Scott S, et al. Pain, agitation, and behavioural problems in people with dementia admitted to general hospital wards: a longitudinal cohort study. Pain. 2015;156(4):675-83.
13. Warden V, Hurley AC, Volicer L. Development and psychometric evaluation of the Pain Assessment in Advanced Dementia (PAINAD) scale. J Am Med Dir Assoc. 2003;4(1):9-15.
14. DeWaters T, Faut-Callahan M, McCann JJ, Paice JA, Fogg L, Hollinger-Smith L, et al. Comparison of self-reported pain and the PAINAD scale in hospitalized cognitively impaired and intact older adults after hip fracture surgery. Orthop Nurs. 2008;27(1):21-8.
15. Jordan A, Hughes J, Pakresi M, Hepburn S, O'Brien JT. The utility of PAINAD in assessing pain in a UK population with severe dementia. Int J Geriatr Psychiatry. 2011;26(2):118-26.
16. Costardi D, Rozzini L, Costanzi C, Ghianda D, Franzoni S, Padovani A, et al. The Italian version of the pain assessment

in advanced dementia (PAINAD) scale. Arch Gerontol Geriatr. 2007;44(2):175-80.
17. Lukas A, Hagg-Grun U, Mayer B, Fischer T, Schuler M. Pain assessment in advanced dementia. Validity of the German PAINAD-a prospective double-blind randomised placebo-controlled trial. Pain. 2019;160(3):742-53.
18. Buyukturan O, Naharci MI, Buyukturan B, Kirdi N, Yetis A. The Turkish Version of Pain Assessment in Advanced Dementia (PAINAD) Scale. Noro Psikiyatr Ars. 2018;55(3):271-5.
19. Pinto MC, Minson FP, Lopes AC, Laselva CR. Cultural adaptation and reproducibility validation of the Brazilian Portuguese version of the Pain Assessment in Advanced Dementia (PAINAD-Brazil) scale in non-verbal adult patients. Einstein (Sao Paulo). 2015;13(1):14-9.
20. Lin PC, Lin LC, Shyu YI, Hua MS. Chinese version of the Pain Assessment in Advanced Dementia Scale: initial psychometric evaluation. J Adv Nurs. 2010;66(10):2360-8.
21. Zwakhalen SM, Hamers JP, Berger MP. The psychometric quality and clinical usefulness of three pain assessment tools for elderly people with dementia. Pain. 2006;126(1-3):210-20.
22. Kwon SH, Cho YS, Kim H. Reliability and Feasibility of the Pain Assessment in Advanced Dementia Scale-Korean Version (PAINAD-K). Pain Manag Nurs. 2021;22(5):660-7.
23. Department of Older Persons. Situation of The Thai Older Persons 2022. Bangkok, Thailand: Amarin Corporations Public Company Limited; 2023. Available from: https://thaitgri.org/?p=40218.
24. Iamaroon A, Wongviriyawong T, Sura-Arunsumrit P, Wiwatnodom N, Rewuri N, Chaiwat O. Incidence of and risk factors for postoperative delirium in older adult patients undergoing noncardiac surgery: a prospective study. BMC Geriatr. 2020;20(1):40.
25. Srinonprasert V, Pakdeewongse S, Assanasen J, Eiamjinnasuwat W, Sirisuwat A, Limmathuroskul D, et al. Risk factors for developing delirium in older patients admitted to general medical wards. J Med Assoc Thai. 2011;94 Suppl 1:S99-104.
26. Srinil T, Lao-amornphunkul S, Narksut A, Thikom N, Pansangar C, Thanakiattiwibun C, et al. Incidences, Characteristics, Management and Outcomes of Different Subtypes of Postoperative Delirium in Elderly Patients Admitted to the Surgical Intensive Care Unit: A Secondary Analysis of a Prospective Cohort Study. Siriraj Medical Journal. 2024;76(7):406-14.
27. Beaton DE, Bombardier C, Guillemin F, Ferraz MB. Guidelines for the process of cross-cultural adaptation of self-report measures. Spine (Phila Pa 1976). 2000;25(24):3186-91.
28. Tsang S, Royse CF, Terkawi AS. Guidelines for developing, translating, and validating a questionnaire in perioperative and pain medicine. Saudi J Anaesth. 2017;11(Suppl 1):S80-S9.
29. Yusoff MSB. ABC of content validation and content validity index calculation. Education in Medicine Journal. 2019;11(2):49-54.
30. Senanarong V, Poungvarin N, Sukhatunga K, Prayoonwiwat N, Chaisewikul R, Petchurai R, et al. Cognitive status in the community dwelling Thai elderly. J Med Assoc Thai. 2001;84(3):408-16.
31. Siri S, Okanurak K, Chansirikanjana S, Kitayaporn D, Jorm AF. Modified Informant Questionnaire on Cognitive Decline in the Elderly (IQCODE) as a screening test for dementia for Thai elderly. Southeast Asian J Trop Med Public Health. 2006;37(3):587-94.
32. Muangpaisan W, Assantachai P, Sitthichai K, Richardson K, Brayne C. The Distribution of Thai Mental State Examination Scores among Non-Demented Elderly in Suburban Bangkok Metropolitan and Associated Factors. J Med Assoc Thai. 2015;98(9):916-24.
33. Tangwongchai S, Phanasathit M, Charernboon T, Akkayagorn L, Hemrungrojn S, Phanthumchinda K, et al. The validity of thai version of the montreal cognitive assessment (MoCA-T). Dement Neuropsychol. 2009;3(2):172.
34. Sclan SG, Reisberg B. Functional assessment staging (FAST) in Alzheimer's disease: reliability, validity, and ordinality. International psychogeriatrics. 1992;4(3):55-69.
35. Angus DC, van der Poll T. Severe sepsis and septic shock. N Engl J Med. 2013;369(9):840-51.
36. Mahoney FI, Barthel DW. Functional Evaluation: The Barthel Index. Md State Med J. 1965;14:61-5.
37. Scherder EJ, Bouma A. Visual analogue scales for pain assessment in Alzheimer's disease. Gerontology. 2000;46(1):47-53.
38. Schober P, Boer C, Schwarte LA. Correlation Coefficients: Appropriate Use and Interpretation. Anesth Analg. 2018;126(5):1763-8.
39. Koo TK, Li MY. A Guideline of Selecting and Reporting Intraclass Correlation Coefficients for Reliability Research. J Chiropr Med. 2016;15(2):155-63.
40. Bobak CA, Barr PJ, O'Malley AJ. Estimation of an inter-rater intra-class correlation coefficient that overcomes common assumption violations in the assessment of health measurement scales. BMC Med Res Methodol. 2018;18(1):93.
41. Manz BD, Mosier R, Nusser-Gerlach MA, Bergstrom N, Agrawal S. Pain assessment in the cognitively impaired and unimpaired elderly. Pain Manag Nurs. 2000;1(4):106-15.
42. Pautex S, Michon A, Guedira M, Emond H, Le Lous P, Samaras D, et al. Pain in severe dementia: self-assessment or observational scales? J Am Geriatr Soc. 2006;54(7):1040-5.
43. Achterberg W, Lautenbacher S, Husebo B, Erdal A, Herr K. Pain in dementia. Pain Rep. 2020;5(1):e803.
44. Wrzesien A, Andrzejewski K, Jampolska M, Kaczynska K. Respiratory Dysfunction in Alzheimer's Disease-Consequence or Underlying Cause? Applying Animal Models to the Study of Respiratory Malfunctions. Int J Mol Sci. 2024;25(4).
45. Hibi S, Yamaguchi Y, Umeda-Kameyama Y, Iijima K, Takahashi M, Momose T, et al. Respiratory dysrhythmia in dementia with Lewy bodies: a cross-sectional study. BMJ Open. 2013;3(9):e002870.
46. Cherniack NS, Longobardo G, Evangelista CJ. Causes of cheyne-stokes respiration. Neurocritical Care. 2005;3(3):271-9.
47. White N, Bazo-Alvarez JC, Koopmans M, West E, Sampson EL. Understanding the association between pain and delirium in older hospital inpatients: systematic review and meta-analysis. Age Ageing. 2024;53(4).
48. Cerejeira J, Lagarto L, Mukaetova-Ladinska EB. Behavioral and psychological symptoms of dementia. Front Neurol. 2012;3:73.
49. Phannarus H, Muangpaisan W, Siritipakorn P, Pianchob S, Supapueng O. Development of a Thai tool for assessing behavioral and psychological symptoms of dementia: A confirmatory factor analysis. Brain Behav. 2020;10(11):e01816.

Outcomes of Robot-assisted Radical Prostatectomy in Men Aged 75 Years Old or Older: A Single-center Study in Thailand

Attapol Mahalelakul, M.D., Pubordee Assavavirojekul, M.D., Sunai Leewansangtong, M.D., Varat Woranisarakul, M.D., Thitipat Hansomwong, M.D., Sittiporn Srinualnad, M.D.*

Division of Urology, Department of Surgery, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand.



*Corresponding author: Sittiporn Srinualnad
E-mail: sitsrinualnad@gmail.com
Received 28 September 2024 Revised 24 October 2024 Accepted 1 November 2024
ORCID ID:http://orcid.org/0000-0002-5118-7675
https://doi.org/10.33192/smj.v77i1.271301

ABSTRACT

Objective: The aim of this study was to evaluate the surgical, oncological outcomes, and complications in men ≥75 years of age who have undergone robot-assisted radical prostatectomy (RARP).

Materials and Methods: A retrospective analysis was performed on data from patients who underwent RARP between July 2018 and December 2020. This analysis included the patients' characteristics, perioperative outcomes, postoperative outcomes, oncologic outcome and biochemical recurrence(BCR) comparing an elderly group (≥75 years old) with a younger group (<75 years old).

Results: In total, 455 patients were classified into two groups: 57 patients aged ≥75 and 398 patients aged <75 years old. No significant differences were observed in BCR at 12 months10.3% vs. 17.5% (p=0.1), perioperative and postoperative complications, pathological positive lymph node, or resection margins. The pathological T-staging and Gleason grade groups were more aggressive in the older group with pT3 64.9 vs. 48.7% ($p < 0.05$) and Gleason grade group 4 and 5 41.3% vs. 25.1%, ($p < 0.05$).

Conclusion: RARP is safe and feasible procedure in selected elderly patients, offering comparable perioperative and postoperative surgical outcomes to those seen in younger patients.

Keywords: Prostate cancer; robot-assisted radical prostatectomy; elderly; outcome; biochemical recurrence (Siriraj Med J 2025; 77: 22-28)

INTRODUCTION

Prostate cancer (PCa) is the second most frequent cancer and the fifth leading cause of cancer-related death among men in 2022.[1] In Thailand, it is the fourth most common cancer in men.[2] According to WHO data from 2020, the life expectancy of Thai males at birth is 74.4 years, with a life expectancy of 22.8 years at age 60[3], and these figures are increasing annually. For urologists, this growing trend of reduced mortality in the elderly population presents challenges in choosing appropriate treatment options, such as radical prostatectomy (RP), radiation, or androgen deprivation therapy (ADT).

Previous studies have shown that elderly patients with PCa often present with more aggressive and locally advanced tumors.[4] Therefore, it is crucial for urologists to offer active treatment to selected elderly patients, as some may experience local tumor invasion or systemic metastasis. Robot-assisted radical prostatectomy (RARP), first performed in 2000, has demonstrated better outcomes and safety profiles compared to open RP[5,6], especially when combined with some surgical techniques and preoperative MRI.[7,8] Additionally, this approach spares patients from the systemic effects associated with ADT, which is commonly administered alongside radiation therapy in patients with unfavorable or high-risk PCa. However, the upper age limit for RP as a curative treatment for localized PCa remains a topic of debate.

The aim of this study was to evaluate the surgical and oncological outcomes, as well as complications, in men aged 75 years old or older who have undergone RARP.

MATERIALS AND METHODS

This retrospective cohort study was conducted at the Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok. The study proposal was approved by the Siriraj Institutional Review Board of the Faculty of Medicine Siriraj Hospital, Mahidol University (272/2565(IRB4)).

From July 2018 to December 2020, the records of 557 patients with PCa who had underwent RARP were reviewed. Patients were divided into two groups: those younger than 75 years old and those aged 75 years or older. Both groups were analyzed for assessing their preoperative characteristics, which included body mass index (BMI), American Society of Anesthesiologists classification (ASA), prior prostatic surgery, BPH medication use, prostate specific antigen (PSA), neutrophil-to-lymphocyte ratio (NLR), and platelet-to-lymphocyte ratio (PLR). Perioperative characteristics included operative time, neurovascular bundle (NVB) sparing, blood loss, and prostatic weight. Postoperative characteristics included Gleason score, pathological stage, surgical margin status, complications (classified by Clavien–Dindo), length of postoperative hospital stay, and postoperative PSA level.

All the patients were followed up with serum PSA measurements every 3 months after the surgery. Biochemical recurrence (BCR) within one year was defined as a PSA level of 0.2 ng/ml or higher.

Sample size was calculated based on the research by Burkhard Ubrig (2018), we estimated that in the group of prostate cancer patients who underwent RARP at Siriraj Hospital, those aged 75 years and older, as well as those younger than 75 years, will have a biochemical recurrence

rate after one year of follow-up of approximately 25.0% and 10.0%, respectively. We established the ratio (n2/n1) of prostate cancer patients aged 75 years and older (n1) to those younger than 75 years (n2) as 7/1, or a ratio of 7. Given a two-sided Type I error (α) of 0.05 and a power of the test of 80%, the required sample size for prostate cancer patients aged 75 years and older (n1) is at least 57 cases, while for those younger than 75 years (n2) it is at least 398 cases, totaling 455 cases overall.

Statistical analysis was performed using SPSS statistics version 23 (IBM Corp, Armonk, NY, USA). Demographic data were presented according to the distribution of quantitative variables: the mean ± standard deviation for normally distributed variables and median with interquartile range for non-normally distributed variables. T-tests were used to compare continuous values between two groups. For binary variables, the chi-square test was used. Multivariate analyses were conducted to identify significant predictors of BCR. A p-value < 0.05 was considered statistically significant.

RESULTS

Patients were divided into two groups: those younger than 75 years old (n=398) and those aged 75 years or older (n=57) (Fig 1). RARP was performed using the Da Vinci Robotic 4-Arm system with a transperitoneal approach. Pelvic lymph node dissection was performed in the majority of cases, with the extent of dissection determined at the surgeon's discretion.

Preoperative characteristics of the two groups are shown in Table 1. The mean age in the group aged <75 was 67 years old (63–70), compared to 77 years old (75–79) in the group aged ≥75 years. The percentage of patients with ASA class 3 was higher in the older group (35% vs. 23.4%). BPH medication use was also significantly higher in the elderly group (63.2% vs. 39.4%). Both the neutrophil-to-lymphocyte ratio (NLR) and platelet-to-lymphocyte ratio (PLR) were significantly lower in the older group. The median PSA levels were not significantly different between the two groups.

The perioperative and postoperative characteristics are displayed in Table 2. The non-NVB sparing technique was more commonly performed in the older group, with a significantly higher rate compared to the younger group (89.5% vs. 51.5%, p < 0.05). Prostate size was significantly larger in the older group. Similarly, pathological T-staging was more advanced in the older group, with 64.9% classified as pT3 compared to 48.7% in the younger group. The proportion of patients with a high Gleason grade group (4 and 5) was also higher in the older group (41.3% vs. 25.1%). The operative time was not significantly different between the two groups (160 min vs. 165 min, p = 0.82), nor was blood loss (250 ml vs. 200 ml, p = 0.38). Despite the higher prevalence of aggressive pathological features in the older group, there were no significant differences in surgical margin, pelvic node involvement, or postoperative complications between the two groups. The majority of patients in both groups did not experience postoperative complications. However, 8 patients (2%) in the younger group and 3 patients (5.3%) in the older group experienced Clavien–Dindo grade 3 complications.

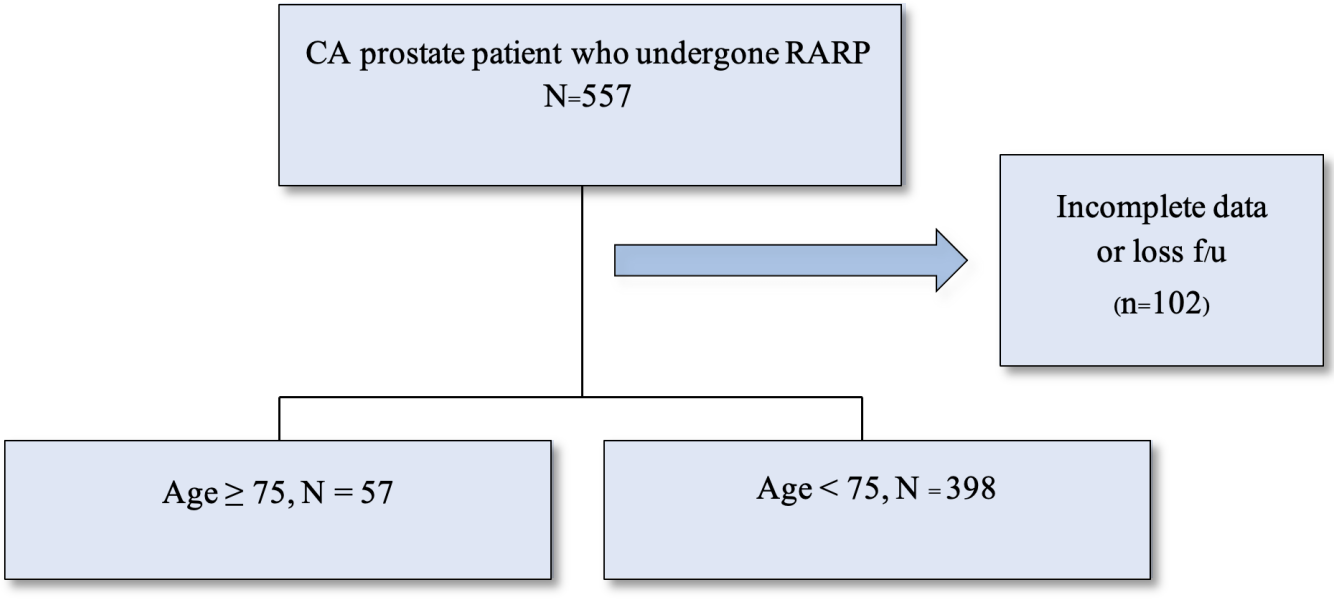


Fig 1. Patient selection.

TABLE 1. Patient characteristics.

	<75 years	≥ 75 years	*p* value
Number of patient	398	57	
Age (IQR)	67 (63-70)	77 (75-79)	
ASA			< 0.05
1	41 (10.3%)	0 (0%)	
2	264 (66.3%)	37 (64.9%)	
3	93 (23.4%)	20 (35.1%)	
BMI (kg/m^2)	24.22 (22.42-26.58)	23.82 (22.2-25.4)	0.2
BPH medication	157 (39.4)	36 (63.2)	<0.001
Previous prostate surgery	7 (1.85%)	3 (5.3%)	0.12
PSA (ng/ml)	9.4 (6.67-15)	10 (7.28-17.49)	0.5
NLR	2.37 (1.73-3.15)	1.98 (1.6-2.4)	< 0.05
PLR	140.91 (108.9-189.56)	120.24 (93.18-144.29)	< 0.05

Abbreviations: NLR = Neutrophil-Lymphocyte ratio, PLR = Platelet-Lymphocyte ratio

The duration of hospitalization was not significantly different between the two groups. BCR at one year was higher in the older group (10.3% vs. 17.5%), but this difference was not statistically significant (p = 0.1).

Multivariate analysis revealed that preoperative PSA of 15 or higher, higher Gleason grade group, and positive surgical margin were significantly associated with BCR (Table 3).

DISCUSSION

As life expectancy for men continues to increase, a larger proportion of elderly patients are being diagnosed with clinically significant PCa, with many potentially having a life expectancy extending beyond 10 years. Careful selection of candidates for surgical intervention for PCa among the elderly is therefore crucial. While a minimum life expectancy of 10 years is typically deemed necessary when considering potentially curative therapy, many urologists refrain from pursuing definitive treatment for localized PCa in elderly patients based solely on age, without considering their overall life expectancy. There is extensive literature on the oncological outcomes of RP in patients aged 65 years old or older, or 70 years old and older.[9,10] However, only a limited number of studies have specifically examined oncological outcomes for men aged 75 years old and above.[11,12]

Previous studies have shown that older patients undergoing RARP often present with higher pathological stages, Gleason scores, and PSM rates. Similarly, the older group in our study exhibited higher histological and staging characteristics compared to the younger cohort, with 64% of older patients having pT3 disease. Interestingly, while the PSM rate was lower in the older group, the difference was not statistically significant. Previous research has highlighted a strong correlation between PSM and recurrence of PCa. Yang et al.[13] identified an association of PSM, GG 4 to 5, pT3, and PSA levels greater than 10 ng/ml, reporting a 5-year BCR rate of 66.7%. Consistent with their findings, our multivariate analysis emphasized the importance of PSM in predicting BCR, while age did not predict BCR. This suggests that RARP is a viable option for selected older patients, offering comparable short-term oncological outcomes to younger adults, even when presenting with slightly more advanced disease.

Physical status and cognitive function are crucial predictors of postoperative outcomes. The Mini-Cog and G-8 screening tools[14] are recommended for comprehensive preoperative assessment in urological cancers, including RARP. In our study, the majority of older patients were classified as ASA class 2. Complications rates, as classified by the CDC, did not differ significantly between the groups,

TABLE 2. Perioperative and Postoperative outcomes.

	<75 years	≥ 75 years	*p* value
Operative time (min) (IQR)	160 (125-201.25)	165 (135-200)	0.82
NVB preservation			< 0.05
None	205 (51.5%)	51 (89.5%)	
Unilateral	51 (12.8%)	3 (5.3%)	
Bilateral	142 (35.7%)	3 (5.3%)	
Blood loss (ml)	250 (150-400)	200 (100-310)	0.38
Prostate weight (g)	38.7 (29.4-51)	45 (35.35-58.25)	< 0.05
Patho			< 0.05
pT2	204 (51.3%)	20 (35.1%)	
pT3a	131 (32.9%)	19 (33.3%)	
pT3b	63 (15.8%)	18 (31.6%)	
Gleason grade group			< 0.05
1	26 (6.5%)	1 (1.8%)	
2	164 (41.2%)	17 (29.8%)	
3	99 (24.9%)	12 (21.1%)	
4	33 (8.3%)	6 (4.5%)	
5	76 (19.1%)	21 (36.8%)	
pN1	24 (6%)	5 (8.8%)	0.56
Resection margin			0.12
Positive	191 (48%)	21 (36.8%)	
Negative	207 (52%)	36 (63.2%)	
C-D classification*			0.24
No	335 (84.2%)	45 (78.9%)	
1	34 (8.5%)	6 (10.5%)	
2	21 (5.3%)	3 (5.3%)	
3a	8 (2%)	3 (5.3%)	
Post-op LOS	5 (4-6)	5 (3-18)	0.46
BCR in 1 year	41 (10.3%)	10 (17.5%)	0.1

*Clavien-Dindo classification

TABLE 3. Multivariate analysis showing predictors of post-operative BCR in both groups.

	Adjusted OR (95%)	*p* value
PSA ≥15	2.73 (1.46-5.11)	0.002
Gleason grade group	1.41 (1.10-1.82)	0.007
Margin positive	2.96 (1.35-6.50)	0.007

with 21% of older patients experiencing postoperative complications (5.3% with grade 3 complications versus 2% in the younger group). These results align with a study by Ubrig et al.[15], which reported minor complications in 26.3% of patients over 75 years undergoing RARP, with major complications occurring in only 1.3% of cases. These findings underscore the importance of comprehensive preoperative evaluation and the integration of validated tools for patients undergoing RARP.

Frailty, a condition marked by reduced physiological reserves and impaired function across multiple systems, leads to a diminished capacity for the body to respond to stress. Systemic inflammation is a key contributor to physical decline and frailty in older adults. Meta-analyses have shown that frailty and pre-frailty are associated with elevated levels of serum inflammatory markers. The NLR and PLR are emerging biomarkers of inflammation. Previous studies have found that declines in physical function and frailty are associated with higher NLR and PLR in elderly patients.[16-19] Moreover, several studies have confirmed that these novel markers are linked to cancer progression and prognosis. In our study, both NLR and PLR were significantly lower in the older group, although their relevance to the 1-year BCR was not established. Additionally, a large population-based study in China by Meng et al.[20] reported variations in inflammatory biomarkers, including NLR and PLR, across different age groups, with higher values observed in men older than 65 years (NLR: 1.71 vs. 1.85, PLR: 106 vs.139). This suggests a potential selection bias, as healthier older adults may be more likely to undergo RARP. Research into the impact of NLR and PLR in the Thai population remains limited. However, a study by Veerakulwatana et al.[21] found no association between NLR or PLR levels and 30-day major complications following radical cystectomy, a more aggressive procedure than RARP.

PSA has been used for detection of recurrent disease. The American Urological Association (AUA) and the European Association of Urology (EAU) have recommended defining BCR as a serum PSA ≥0.2ng/mL followed by a second confirmatory level.[22,23] Approximately 20-40% of patients with clinically localized PCa will present BCR after RP.[24,25] Short time from RP to BCR has also been associated with poor clinical prognosis. Ten-year rate of systemic progression for PCa was 10% for patients who experienced BCR more than six years after RP, compared to 19% for those with BCR occurring less than 1.2 years after RP.[26] Therefore, we have chosen to conduct follow-up on BCR for one year and from our study BCR at one year was higher in the older group (10.3% vs. 17.5%), but this difference was not statistically significant ($p = 0.1$).

Recent studies have shown that elderly patients often exhibit more aggressive pathological findings, which align with the results of our own research. As such, there are potential benefits to performing RARP in selected patients aged 75 years and older, as they may achieve surgical and oncological outcomes comparable to those of younger patients. Therefore, age should not be considered a contraindication for surgical intervention.

However, there are several limitations of our study to note. First, this study involved a retrospective analysis, therefore it was restricted by the available evidence level. Second, our results might not be representative for all men over 75 years old because our cohort involved a highly selected group of patients. Third, our follow-up duration was too short to show biochemical, cancer-specific, and overall survival. Finally, there may be potential bias from the surgeons' experience.

ACKNOWLEDGEMENTS

The authors would like to thank Ms. Jitsiri Chaiyatho and all coordinators of the Siriraj Hospital for their important contributions to this study.

DECLARATION

Grants and Funding Information

There are no sources of funding to disclose.

Conflict of Interest

The authors declare that they have no conflicts of interest.

Author Contributions

Conceptualization and methodology, S.S, A.M. and T.H. ; Investigation, S.S., T.H., V.W., S.L. and P.A. ; Formal analysis, S.S. and A.M. ; Visualization and writing – original draft, A.M. ; Writing – review and editing, S.S., A.M. and T.H. ; Supervision, S.S. All authors have read and agreed to the final version of the manuscript.

REFERENCES

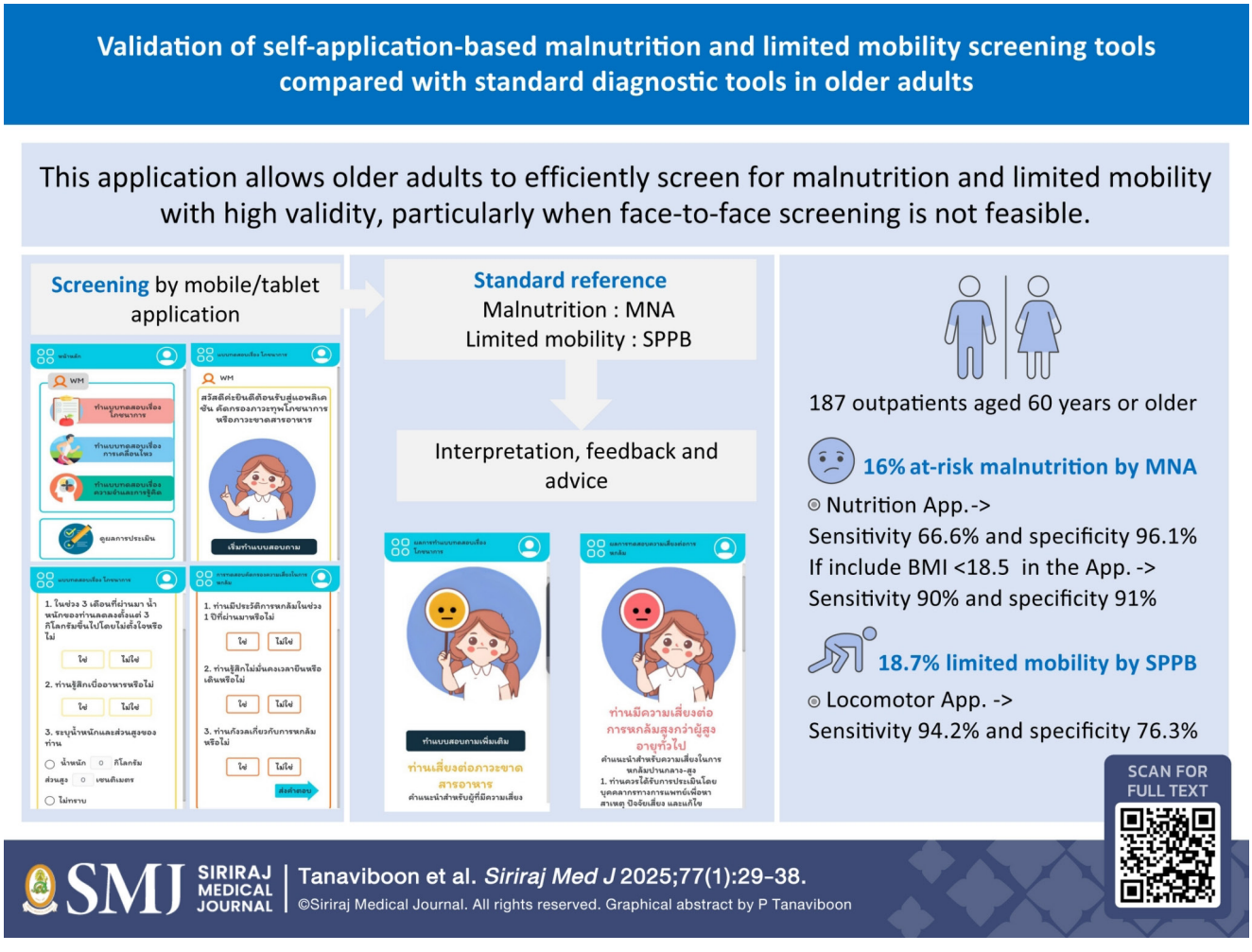
1. WHO. Incidence of cancer in male 2022.Available from: https://gco.iarc.fr/today/en/dataviz/pie?mode=cancer&group_populations=1&sexes=1.
2. WHO. Global cancer obsevatory. 2022.
3. WHO. Life expectancy at age 60 (years) 2020.Available from: https://www.who.int/data/gho/data/indicators/indicator-details/GHO/life-expectancy-at-age-60-(years).
4. Brassell SA, Rice KR, Parker PM, Chen Y, Farrell JS, Cullen J, et al. Prostate cancer in men 70 years old or older, indolent or aggressive: clinicopathological analysis and outcomes. J Urol. 2011;185(1):132-7.
5. Ilic D, Evans SM, Allan CA, Jung JH, Murphy D, Frydenberg M. Laparoscopic and robotic-assisted versus open radical prostatectomy for the treatment of localised prostate cancer. Cochrane Database

Syst Rev. 2017;9(9):CD009625.
6. Srinualnad S, Hansomwong T, Aussavavirojekul P, Saksirisampant P. Paradigm shift from open surgery to minimally invasive surgery in three approaches for radical prostatectomy: comparing outcomes and learning curves. Siriraj Med J. 2022;74(10): 618-26.
7. Hansomwong T, Saksirisampant P, Isharwal S, Aussavavirojekul P, Woranisarakul V, Jitpraphai S, et al. Role of preoperative magnetic resonance imaging on the surgical outcomes of radical prostatectomy: Does preoperative tumor recognition reduce the positive surgical margin in a specific location? Experience from a Thailand Prostate Cancer Specialized Center. Asian J Urol. 2023;10(4):494-501.
8. Mahamongkol K, Hajidae M, Aussavavirojekul P, Hansomwong T, Srinualnad S. The Impact of Retro-apical Urethral Dissection Approach Technique on Positive Surgical Margins in Robotic-assisted Laparoscopic Radical Prostatectomy: A Study in Thailand. Siriraj Med J. 2023;75(11):827-34.
9. Malaeb BS, Rashid HH, Lotan Y, Khoddami SM, Shariat SF, Sagalowsky AI, et al., editors. Prostate cancer disease-free survival after radical retropubic prostatectomy in patients older than 70 years compared to younger cohorts. Urologic Oncology: Seminars and Original Investigations; 2007: Elsevier.
10. Pfitzenmaier J, Pahernik S, Buse S, Haferkamp A, Djakovic N, Hohenfellner M. Survival in prostate cancer patients≥ 70 years after radical prostatectomy and comparison to younger patients. World J Urol. 2009;27:637-42.
11. Ryu JH, Kim YB, Jung TY, Kim SI, Byun S-S, Kwon DD, et al. Radical prostatectomy in Korean men aged 75-years or older: safety and efficacy in comparison with patients aged 65–69 years. J Urol. 2016;31(6):957-62.
12. Xylinas E, Ploussard G, Paul A, Gillion N, Vordos D, Hoznek A, et al. Laparoscopic radical prostatectomy in the elderly (> 75 years old): oncological and functional results. Prog Urol. 2009; 20(2):116-20.
13. Yang C-W, Wang H-H, Hassouna MF, Chand M, Huang WJ, Chung H-J. Prediction of a positive surgical margin and biochemical recurrence after robot-assisted radical prostatectomy. Sci Rep. 2021;11(1):14329.
14. Bouzan J, Willschrei P, Horstmann M. Additional value of Mini-Cog© in urogeriatric patients concurrently screened by G8 scores. Medicines. 2023;10(10):56.
15. Ubrig B, Boy A, Heiland M, Roosen A. Outcome of robotic radical prostatectomy in men over 74. J Endourol. 2018;32(2): 106-10.
16. Hou P, Xue H-P, Mao X-E, Li Y-N, Wu L-F, Liu Y-B. Inflammation markers are associated with frailty in elderly patients with coronary heart disease. Aging (Albany NY). 2018;10(10):2636.
17. Yoshida Y, Iwasa H, Kim H, Suzuki T. Association between neutrophil-to-lymphocyte ratio and physical function in older adults: A community-based cross-sectional study in Japan. Int J Environ Res Public Health. 2022;19(15):8996.
18. Wang J, Huang L, Xu M, Yang L, Deng X, Li B. Study on the clinical implications of NLR and PLR for diagnosing frailty in maintenance hemodialysis patients and their correlations with patient prognosis. J Healthc Eng. 2022; 2022(1):1267200.
19. Xu W, Liang Y, Lin Z. Association Between Neutrophil–Lymphocyte Ratio and Frailty: The Chinese Longitudinal Healthy Longevity Survey. Front Med (Lausanne). 2022;8:783077.
20. Meng X, Wei G, Chang Q, Peng R, Shi G, Zheng P, et al. The platelet-to-lymphocyte ratio, superior to the neutrophil-to-lymphocyte ratio, correlates with hepatitis C virus infection. Int J Infect Dis. 2016;45:72-7.
21. Veerakulwatana S, Suk-Ouichai C, Taweemonkongsap T, Chotikawanich E, Jitpraphai S, Woranisarakul V, et al. Perioperative factors and 30-day major complications following radical cystectomy: A single-center study in Thailand. Heliyon. 2024; 10(13).
22. Cookson MS, Aus G, Burnett AL, Canby-Hagino ED, D'Amico AV, Dmochowski RR, et al. Variation in the definition of biochemical recurrence in patients treated for localized prostate cancer: the American Urological Association Prostate Guidelines for Localized Prostate Cancer Update Panel report and recommendations for a standard in the reporting of surgical outcomes. J Urol. 2007;177(2):540-5.
23. Heidenreich A, Bastian PJ, Bellmunt J, Bolla M, Joniau S, van der Kwast T, et al. EAU guidelines on prostate cancer. Part II: Treatment of advanced, relapsing, and castration-resistant prostate cancer. Eur Urol. 2014;65(2):467-79.
24. Stephenson AJ, Scardino PT, Eastham JA, Bianco Jr FJ, Dotan ZA, Fearn PA, et al. Preoperative nomogram predicting the 10-year probability of prostate cancer recurrence after radical prostatectomy. J Natl Cancer Inst. 2006;98(10):715-7.
25. Hull GW, Rabbani F, Abbas F, Wheeler TM, Kattan MW, Scardino PT. Cancer control with radical prostatectomy alone in 1,000 consecutive patients. J Urol. 2002;167(2 Part 1): 528-34.
26. Boorjian SA, Thompson RH, Tollefson MK, Rangel LJ, Bergstralh EJ, Blute ML, et al. Long-term risk of clinical progression after biochemical recurrence following radical prostatectomy: the impact of time from surgery to recurrence. Eur Urol. 2011; 59(6):893-9.

Validation of Self-application-based Malnutrition and Limited Mobility Screening Tools Compared with Standard Diagnostic Tools in Older Adults

Panvadee Tanaviboon, M.D.[1], Weerasak Muangpaisan, M.D. [2,3], Angkana Jongsawadipatana, M.Sc.[2], Pitiporn Siritipakorn, M.N.S .[2], Somboon Intalapaporn, M.D.[2,*]

[1]Division of Geriatric Medicine, Department of Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand, [2]Division of Geriatrics, Department of Preventive and Social Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand, [3]Siriraj Academic Center of Geriatric Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand



*Corresponding author: Somboon Intalapaporn
E-mail: sintalapaporn@gmail.com
Received 21 October 2024 Revised 23 November 2024 Accepted 23 November 2024
ORCID ID:http://orcid.org/0009-0005-3714-0562
https://doi.org/10.33192/smj.v77i1.271719

ABSTRACT

Objective: To validate application screening tools against face-to-face standard tools (the Mini Nutritional Assessment (MNA) and Short Physical Performance Battery test (SPPB)) in older adults.

Materials and Methods: A mobile or tablet application was developed based on user interfaces and experiences. Outpatients aged 60 years and over were tested with this tool. We used 2 questions from the WHO-ICOPE algorithm and 3 questions from the STEADI algorithm to screen for at-risk malnutrition and limited mobility, respectively. The MNA and SPPB were used to detect malnutrition and limited mobility, respectively, to test their validity.

Results: The study involved 187 participants, 16% of whom were diagnosed with at-risk malnutrition by the MNA and 18.7% of whom had limited mobility according to the SPPB. The sensitivity and specificity of the malnutrition application tool were 66.6% and 96.1%, respectively. When BMI < 18.5 was combined in the application, the sensitivity and specificity were 90% and 91%, respectively. For limited mobility, the sensitivity and specificity of the application were 94.2% and 76.3%, respectively. The majority of participants rated the application for easy understanding as «excellent» (65%) and rated their confidence in their ability to use the application by themselves as "excellent" (70%).

Conclusion: The application is an age-friendly, time-saving tool that can be used when face-to-face screening is difficult with good validity.

Keywords: Screening; Application; Older adults; Malnutrition; Locomotor capacity; Intrinsic capacity; Limited mobility; WHO-ICOPE (Siriraj Med J 2025; 77: 29-38)

INTRODUCTION

Populations worldwide are transitioning toward an aging society, and the trend is rapidly increasing. In October 2017, the World Health Organization (WHO) released "Integrated care for older people: Guidelines on community-level interventions to manage declines in intrinsic capacity".[1] The guidelines include care for various aspects of intrinsic capacity, including vitality, locomotor, psychological, visual, hearing, and cognitive capacity.[1]

"Vitality" refers to the physiological factors related to locomotor capacity, encompassing balance and energy expenditure within the body. One significant factor contributing to reduced vitality among older adults is malnutrition,[1,3] a problem affecting up to 10% of the population aged 65 and above;[2] its impact on quality of life is substantial and affects disability rates, hospitalization duration, mortality rates, and healthcare costs.[3-4]

Locomotor capacity refers to an individual's physical ability to move from one place to another. Mobility is a crucial factor in healthy aging, developing disability, and preventing dependence on others.[1] Limited mobility is common among older adults, leading to difficulties in movement, cognitive decline, and social issues. Additionally, limited mobility can result in dependency, disabilities, physical injuries, hospitalization, and an increased length of stay.[11,12] Screening for limited mobility and providing care to improve flexibility are essential for achieving a good quality of life.[1]

As mentioned, assessing nutritional status and locomotor capacity is crucial. Early screening for malnutrition and limited mobility, followed by prompt assessment and treatment, can lead to positive outcomes.[1] Screening tools should be rapid, user-friendly, cost-effective, standardized, and valid.[5] Various types of screening tools have been developed to assess intrinsic capacity; however, they have limitations such as the need for face-to-face assessments, time-consuming procedures, and difficulty reaching individuals who are far away and cannot easily access healthcare facilities. Furthermore, many tests require long evaluation times. For example, the SPPB assessment takes an average of approximately 10–15 minutes.[11] In the present era of advanced medical technology, electronic applications are being increasingly used for screening to assess nutritional status more effectively. The benefits include remote access without the need to visit a hospital, which is particularly advantageous during the COVID-19 pandemic, as it helps reduce face-to-face contact. Researchers have aimed to develop electronic applications to screen for malnutrition and limited mobility among Thai older adults, thus increasing the chance of accessing diagnostic tests and interventions to improve their physical capabilities. Moreover, if malnutrition or decreased mobility is detected, basic self-care instructions and guidance on seeking medical attention at hospitals, especially for high-risk individuals, are provided. However, tool development requires validity evaluation and possibility of self-screening.

MATERIALS AND METHODS

This research was approved by the Ethics Committee for Research in Human Subjects, Faculty of Medicine, Siriraj Hospital, Mahidol University, Thailand. The approval number is 344/2566 (IRB3). The certificate of approval is Si 463/2023. This study was subsequently conducted from 2023–2024 and is classified as observational clinical research (diagnostic research). The older adults who came to Siriraj Hospital, the quaternary care medical center in Thailand, were randomly selected using the consecutive sampling method. Researchers conducted patient screening using the Eligibility Criteria Checklist before obtaining consent from participants or their relatives.

The inclusion criteria included outpatients aged 60 and older who could communicate, read Thai and answer questions on mobile or tablet applications. Exclusion criteria included those with visual or hearing impairments that impeded the application or standard tests, disabilities affecting the use of the application or SPPB, and dyspnea (functional classes III–IV). Individuals who requested not to be contacted or do not wish to disclose their medical records were excluded, as were those with prior evidence of severe neuropsychiatric diseases affecting communication, such as severe dementia with behavioral and psychological symptoms of dementia (BPSD) or schizophrenia. Inpatient older adults were also excluded. Participants or their legal representatives had the right to withdraw from the research at any time without consequences; this ensured that participation was voluntary and that participants could drop out at their discretion. Additionally, participants who did not cooperate in completing the questionnaire or testing via electronic tools or the standard test were excluded from the study.

All participants were provided with detailed explanations and asked for consent before they participated in the study. General patient information, including sex, age, occupation, level of education, primary caregiver, preexisting conditions, current medications, history of alcohol consumption, history of surgery, history of hearing and vision impairment, oral health status and denture usage, functional status, physical activity, history of falling, gait aid usage, and oral nutritional supplementation, was also collected from the electronic medical record system and self-reporting. Participants underwent screening for malnutrition and mobility impairment via application screening tools, with participants using the tools themselves; afterward, trained medical personnel evaluated them for the MNA and SPPB. The user satisfaction and experience were also investigated. Statistical analysis was conducted on all collected data. Appendix: Figure 1 illustrates the flow chart of the validation process.

Malnutrition

Standard tool: The current gold standard for diagnosing malnutrition is the GLIM criteria, which comprises screening and assessment of nutritional status.[9] According to the MaNuEL study, the MNA can be used as a standard reference tool for evaluating the validity of nutritional screening instruments;[6,8] these are considered 'semigold' reference standards and can be used as substitutes for the gold standard in certain cases, such as for measuring changes in body composition.[6] The full form of the Mini Nutritional Assessment (MNA)[10,19] comprises both screening and assessment components for nutritional status, including measurements via anthropometry;[5] notably, it bears similarities to the GLIM criteria used for diagnosing malnutrition.[10] Additionally, various studies have shown that the MNA performs well in community-dwelling older adults.[5,8,10] Consequently, researchers have chosen to utilize the MNA to assess the validity of electronic screening programs for at-risk malnutrition in elderly individuals. The cutoff point is below 24 points.

Screening tool: We use a tool that is simple and concise, making it easy for older adults to use. To screen for at-risk malnutrition, we used the WHO-ICOPE 2 questions (unintentional weight loss >3 kg over the last 3 months, OR appetite loss).[1] Appendix: Figure 2 illustrates the self-application-based malnutrition screening tool. In previous trials when we developed this tool, there were limited data of its validity, but now there is a study published. However, the study was not in application-based self-assessment and has never been conducted in Thailand. In a cross-sectional study of the ICOPE screening tool in China, the sensitivity was 51.3%. However, the specificity was 94.7%, which indicates a high validity. When included a BMI below 20 kg/m^2 provided better sensitivity.[6] Thus, we included BMI in the application and separated the calculation of the statistic of whether or not to include BMI. The screening was considered positive when the participant answered yes to one of the two questions.

Locomotor capacity impairment (Limited mobility)

Standard tool: Several tools have been used to evaluate senior people's mobility and balance.[11,20-22] However, there is currently no clear consensus on which tool should be the primary assessment method, depending on the aspect that we want to evaluate.[11] The SPPB is a tool used to assess gait, balance, and endurance in older adults,

both in research and clinical settings.[26] The SPPB can predict disability, falls, activities of daily living (ADL), limited mobility, and hospitalization rates.[10,25] Studies have consistently reported that the SPPB is accurate and reliable for assessing mobility capacity in older adults across various environments, with minimal environmental impact on measurement reliability.[13-14] Researchers use the SPPB as a standard assessment tool for evaluating the validity of electronic screening programs for limited mobility. A cutoff of less than 10 points is used to detect locomotor capacity impairment or limited mobility.

Screening tool: To screen for limited mobility or locomotor capacity impairment that causes an increase in fall risk, we used the first-step 3-key questions of the STEADI algorithm (feel unsteady when standing or walking, worry about falling, or have fallen in the past year).[35,36] In the prospective cohort study of older adults living in Nakhon Ratchasima, Thailand, the sensitivity of the first step 3-key questions by clinicians was 93.9%, and the specificity was 88%.[37] The screening was considered positive when the participant answered yes to one of the three questions. Appendix: Figure 3 illustrates the self-application-based limited mobility screening tool (limited mobility).

User acceptance testing

We conducted interviews with participants to rate the application in terms of two aspects: ease of understanding and confidence in the use of the application. For ease of understanding, the participants rated the application on a scale of 1- to 5, with 1 being poor, 2 being fair, 3 being average, 4 being good, and 5 being excellent. Similarly, for their confidence in using the application by themselves, the participants provided ratings on the same 1- to 5 scale, indicating their level of confidence from poor to excellent. These ratings provided valuable insights into the user experience and overall satisfaction with the application.

Sample size calculation

Tool: Self-application-based malnutrition screening tool.

The sample size for this study was calculated based on the sensitivity and specificity values obtained from previous studies. Screening for malnutrition has demonstrated a sensitivity of 73% and a specificity of 84%.[23] The pooled prevalence of at-risk malnutrition is reported to be 42.6%.[24] To estimate the required sample size for each group, the principle of estimating a single proportion with a margin of error (d=0.10) is applied. This method ensures that the sample size is sufficient to accurately reflect the sensitivity and specificity of the malnutrition screening tool within an acceptable margin of error. Therefore, the estimated total sample size required for at-risk malnutrition in this study was 178 participants.

Tool: Self-application-based limited mobility screening tool.

The sample size for locomotor capacity impairment was calculated based on the sensitivity and specificity of the ICOPE tool from previous studies. For individuals with limited mobility, the ICOPE tool has shown a sensitivity of 85% and a specificity of 92.8%, with a prevalence of limited mobility of 35%.[25] To calculate the required sample size for each group, the principle of estimating a single proportion with a margin of error (d=0.10) was applied. The estimated total sample size required for the study was 140 participants.

Thus, the total sample size was initially calculated as 178 participants. A possible 5% data loss rate must be taken into consideration when adjusting the sample size. Consequently, an adjusted total sample size of 187 participants was needed for the investigation.

Statistical analysis

We analyzed the outcome measurements for this study to confirm the validity of the application screening tools in detecting malnutrition and locomotor capacity impairment, comparing them with the standard tools MNA and SPPB. We present descriptive data in terms of percentages, means, and standard deviations to provide participant demographic data. The validity of the self-application-based malnutrition and limited mobility screening tools was evaluated by sensitivity, specificity, positive and negative predictive values, and likelihood ratios. The accuracy was also investigated. User satisfaction and experience were assessed by analyzing participants' ratings of easy understanding of and confidence in their use of the application. We reported these ratings as percentages. The data were analyzed using SPSS version 18.0 (SPSS Inc., PASW Statistics for Windows, Chicago, IL, USA).

RESULTS

A total of 187 people participated in the study (mean age, 69.8±7 years). Appendix: Figure 4 illustrates the age distribution of the participants. Thirty (16%) patients were diagnosed with at-risk malnutrition by the MNA, and 35 (18.7%) were diagnosed with limited mobility by the SPPB. The baseline characteristics are described in the Table 1 & 2. The validity of the application for

TABLE 1. Demographic data: Nutritional status.

Parameter	Normal nutritional status (n=157)	At risk malnutrition/ Malnutrition (n=30)	Total (n=187)
Age (mean±SD)	70±6.9	69±7.5	70±7
Female, n (%)	101 (64.3)	24 (80)	125 (66.8)
Education, years (mean±SD)	12±4.7	11±5	12±4.7
Living alone, n (%)	22 (14)	7 (23.3)	29 (15.5)
Financial problem, n (%)	9 (5.7)	2 (6.7)	11 (5.9)
Oral problem, n (%)	119 (75.8)	26 (86.7)	145 (77.5)
Denture use, n (%)	64 (41)	15 (50)	79 (42.2)
Cognitive impairment, n (%)	15 (9.5)	2 (6.7)	17 (9.1)
Malignancy, n (%)	12 (8)	5 (14.7)	17 (9.2)
Stroke, n (%)	6 (3.8)	1 (3.3)	7 (3.7)
CAD, n (%)	8 (5.1)	1 (3.3)	9 (4.8)
DM, n (%)	39 (25)	5 (16.7)	44 (23.7)
Osteoporosis, n (%)	7 (4.5)	5 (16.7)	12 (6.4)
Polypharmacy ≥ 5 drugs, n (%)	43 (27.4)	6 (20)	49 (26.2)
History of fall in past 1 yr, n (%)	20 (12.7)	4 (13.3)	24 (12.8)
Oral nutritional supplementation, n (%)	19 (12.1)	7 (23.3)	26 (13.9)
Gait aid use, n (%)	3 (1.9)	2 (6.7)	5 (2.6)
BMI, kg/m^2 (mean±SD)	24.2±4.1	18.6±2.9	23.3±4.4
Locomotor capacity impairment, n (%)	28 (17.9)	7 (23.3)	35 (18.7)

detecting malnutrition and limited mobility is shown in the Table 3. Validation of the application of Malnutrition compared with that of the MNA. If a BMI < 20, which is used for diagnosing malnutrition in older adults, was included in the application, the sensitivity and specificity increased to 100% and 81.5%, respectively. When the ROC curve was used to find the best cutoff point, a BMI of 19.38 provided the best results. For limited mobility applications that use the first-step 3-key questions of the STEADI algorithm, the sensitivity and specificity were 94.2% and 76.3%, respectively. For each question, "feeling unsteady when standing or walking" yields the best result. Table 4 shows the validation of the limited mobility application compared with SPPB.

In terms of user satisfaction and experience, the participants rated the application for easy understanding as "excellent" 65%, "good" 32.5%, or "average" 2.5%. They rated their confidence in their ability to use the application by themselves as "excellent" 70%, "good" 25%, or "average" 5%. The time to complete the application averaged less than 2 minutes. Appendix: Figure 5 illustrates user satisfaction with the application (easily understanding point, %), Appendix: Figure 6 illustrates user satisfaction with the application (confidence in their ability to use the application by themselves, %).

DISCUSSION

To date, few studies have included mobile or tablet applications in the process of screening for malnutrition or limited mobility in Thai older adults. To the best of our knowledge, this is the first study using the 2-questions of the WHO-ICOPE and the first step 3-key questions

TABLE 2. Demographic data: Locomotor capacity.

Parameter	Normal locomotor capacity (n=152)	Locomotor capacity impairment (n=35)	Total (n=187)
Age (mean±SD)	69±6.4	76±6.7	70±7
Female, n (%)	105 (69.1)	20 (57.1)	125 (66.8)
Education, years (mean±SD)	13±4.6	10±4.8	12±4.7
Living alone, n (%)	24 (15.8)	5 (14.3)	29 (15.5)
Financial problem, n (%)	7 (4.6)	4 (11.4)	11 (5.9)
Hearing impairment, n (%)	4 (2.6)	4 (11.4)	8 (4.3)
Visual impairment, n (%)	54 (35.5)	18 (51.4)	72 (38.5)
Cognitive impairment, n(%)	11 (7.2)	6 (17.2)	17 (9.1)
Malignancy, n (%)	12 (8)	5 (14.7)	17 (9.2)
Stroke, n (%)	5 (3.3)	2 (5.7)	7 (3.7)
CAD, n (%)	6 (3.9)	3 (8.6)	9 (4.8)
DM, n (%)	32(21.2)	12 (34.3)	44 (23.7)
Osteoporosis, n (%)	9 (5.9)	3 (8.6)	12 (6.4)
Polypharmacy ≥ 5 drugs, n (%)	32 (21.1)	17 (48.6)	49 (26.2)
History of fall in past 1 yr, n (%)	13 (8.6)	11 (31.4)	24 (12.8)
Oral nutritional supplementation, n (%)	21 (13.8)	5 (14.3)	26 (13.9)
Gait aid use, n (%)	0	5 (14.3)	5 (2.6)
BMI, kg/m^2 (mean±SD)	23.1±4.4	24.2±4.7	23.3±4.4
Malnutrition, n (%)	23 (15.1)	7 (20)	30 (16)

TABLE 3. Validation of the malnutrition application compared with the MNA.

Validity/test	Malnutrition App. vs. MNA	Malnutrition App. include BMI<18.5 vs. MNA	Malnutrition App. include BMI<20 vs. MNA	Malnutrition App. include BMI<19.38 vs. MNA
Sensitivity	66.6%	90%	100%	100%
Specificity	96.1%	91%	81.5%	86.6%
PPV	76.9%	65.8%	50.8%	58.8%
NPV	93.7%	97.9%	100%	100%
LR+	16.8	10	5.3	7.1
LR-	0.35	0.11	0	0
Accuracy	96%	90.9%	84.5%	88.7%

Abbreviations: Malnutrition App. = Malnutrition application, MNA = Mini Nutritional Assessment, PPV = Positive predictive value, NPV = Negative predictive value, LR+ = Positive likelihood ratio, LR- = Negative likelihood ratio

TABLE 4. Validation of the limited mobility application compared with the SPPB.

Validity/test	Locomotor App. 3 questions vs. SPPB	Locomotor App. Q1 vs. SPPB	Locomotor App. Q2 vs. SPPB	Locomotor App. Q3 vs. SPPB
Sensitivity	94.2%	31.4%	74.2%	74.2%
Specificity	76.3%	90.1%	90.1%	84.2%
PPV	47.8%	42.3%	63.4%	52%
NPV	98.3%	85.1%	93.8%	93.40%
LR+	3.9	3.1	7.4	4.6
LR-	0.07	0.77	0.28	0.3
Accuracy	79.6%	83.1%	87.2%	82.4%

Abbreviations: Locomotor App. = Limited mobility application, SPPB = Short Physical Performance Battery Test, Q1 = Has fallen in the past year?, Q2 = Feels unsteady when standing or walking?, Q3 = Worries about falling?, PPV = Positive predictive values, NPV = Negative predictive values, LR+ = Positive likelihood ratios, LR- = Negative likelihood ratios

of the STEADI algorithm for screening for malnutrition and locomotor capacity impairment via application by self-screening, respectively. The questions are simple and short; thus, they are appropriate for older adults. The majority of the participants reported their high satisfaction with the application rated their excellent confidence in their ability to use the application by themselves.

In terms of baseline characteristics, there were more females than males, with a ratio of 2:1. This proportion may be higher than that of the general older adult population.[33] Approximately 16% of participants were diagnosed with at-risk malnutrition according to the MNA, which is lower than the pooled prevalence of at-risk malnutrition in Thai older adults as assessed by the MNA.[24] Similarly, when compared with the health survey of monks in the Bangkok Noi area of Bangkok, the monks exhibited a higher prevalence of elevated BMI and a lower prevalence of at-risk malnutrition compared to our participants.[34]

They were diagnosed with limited mobility by the SPPB at a rate of 18.7%, which is lower than that reported in a previous study;[26] this may be because, in this trial, the exclusion criterion excluded individuals with disabilities and severe dementia; those are the majority of malnutrition and mobility impairment patients. The group with locomotor dysfunction was older and had fewer years of education; more financial problems; cognitive impairment; hearing and visual impairment; a history of falls; polypharmacy; greater use of gait aids; and more cases of malnutrition. Thus, there are more comorbidities and fragilities.

The specificity of the malnutrition application tool, which involves two screening questions concerning weight loss and poor appetite, is excellent, but the sensitivity is fair. These results are similar to those of previous ICOPE face-to-face screening trials, but this trial was more sensitive and accurate. In the previous ICOPE face-to-face screening trial, researchers included BMI in screening for malnutrition. Thus, the sensitivity increased; this may be because BMI has high sensitivity by itself. We therefore added BMI to the application. The results show that the sensitivity increased, which is consistent with the previous face-to-face trial.[5,7-8,10,28-32]

In this study, the three questions in the application to screen for locomotor capacity impairment had high sensitivity, specificity, and good diagnostic value. This result resembles that of previous face-to-face studies; the sensitivity of the STEADI's three key questions ranged from 78.9 to 100%.[37-41] Therefore, this application may be used to screen for at-risk malnutrition and limited mobility by online self-screening in Thai older adults, except in an inpatient setting.

The strength of this study is its ability to screen older adults quickly. Compared with previous studies, screening by the MNA takes approximately 7–30 minutes[42], and the SPPB takes approximately 10–15 minutes.[11] However, this application takes almost 1–2 minutes to complete. Therefore, this application is a timesaving and age-friendly tool. Furthermore, the only additional equipment required is the individual's mobile phone or tablet. Moreover, individuals can use it independently, making

it suitable for situations where face-to-face screening is challenging. This tool lowers the barriers to accessing the screening process. However, few studies have validated the screening performance of the first-step ICOPE tool and the first-step STEADI algorithm, especially in mobile or tablet applications.[27-31] This application is available for validation.

The limitations of this study are that the mean age of the participants was 69 years, which favors younger older adults, and the mean number of years of education favors higher education, which introduces selection bias but may be considered usual in a study that focuses on digital technology. Next, they were diagnosed with limited mobility by the SPPB fewer times than in the previous study;[25] this may be because, in this trial, the exclusion criterion excluded individuals with disabilities. Moreover, the use of the MNA as a standard diagnostic tool may be inconsistent because the gold standard for the diagnosis of malnutrition is the GLIM criteria. However, according to the MaNuEL study, the MNA can be used as a standard reference tool for evaluating the validity of nutritional screening instruments; these are considered 'semigold' reference standards and can substitute for the gold standard.[5-6,8,19] In this application, some words of the question can have an ambiguous meaning: "feel unsteady when standing or walking". We evaluated the validity of the test, which provided good sensitivity, and afterward, the question could be used. The BMI is one part of the MNA that is used as a standard reference, which may lead to an increase in its validity. In the MNA, the BMI's point is 2 out of a total score of 30, which is a minimal count and may not produce much change. However, the interpretation should be carefully considered. Next, this research did not test test-retest and interrater reliability because the participants lived in a distant area. As a result, the test's reliability may decrease. Furthermore, the use of electronic devices among Thai older adults is limited. However, the current trend is to increase the use of electronic devices. In the future, if this application is validated for use by caregivers, it can be used by both older adults and caregivers.

For implementation, this application can be used by Thai older adults in noninpatient settings to screen for at-risk for malnutrition and limited mobility. Furthermore, this application can provide self-care information or suggestions for further evaluation when there are at-risk conditions that can be put in the application for immediate feedback. We should assess the test-retest and interrater reliability of the research to reduce the limitations in future research.

CONCLUSIONS

Combining BMI with the 2 questions of the WHO-ICOPE screening for malnutrition provides better sensitivity. However, BMI should be used with caution because it is a body composition metric that is included in the standard reference, the MNA. The first step, the 3-key question of the STEADI algorithm, which is applied to screen for limited mobility and fall risk, has high sensitivity and is appropriate for use as a screening tool in older adults. The majority of the participants reported their high satisfaction with the application rated their excellent confidence in their ability to use the application by themselves. Thus, this application is an age-friendly, time-saving tool that can be used when face-to-face screening is difficult.

ACKNOWLEDGEMENTS

The authors would like to thank all Siriraj Hospital personnel who assisted with data collection and investigation. We acknowledge all participants who enthusiastically participated in this trial.

DECLARATION

Grants and Funding Information

The Siriraj Foundation, Siriraj Hospital, Thailand, who provided funding for this trial, have no influence in the study's design, method, data analysis, or interpretation.

Conflict of Interest

The authors declare that they have no competing interests.

Author Contributions

P.T., W.M., S.I.- conceptualization, methodology, software, validation, resource. P.T., A.J., P.S.- investigation. P.T.- writing original draft. P.T., W.M.- visualization. W.M.-Project administration, funding acquisition. S.I.-supervision. P.T., W.M., S.I.- writing review and editing. All co-authors- final approval of the submitted manuscript.

Use of Artificial Intelligence

No artificial intelligence tools or technologies were used in the writing, analysis, or development of this research.

REFERENCES

1. Cesari M, Keeffe J, Dent E, Kondo N, Laiteerapong A, Izquierdo M, et al. Integrated care for older people (ICOPE):: Handbook: guidance for person-centred assessment and pathways in primary care. 2019.(Cesari, Keeffe et al. 2019)

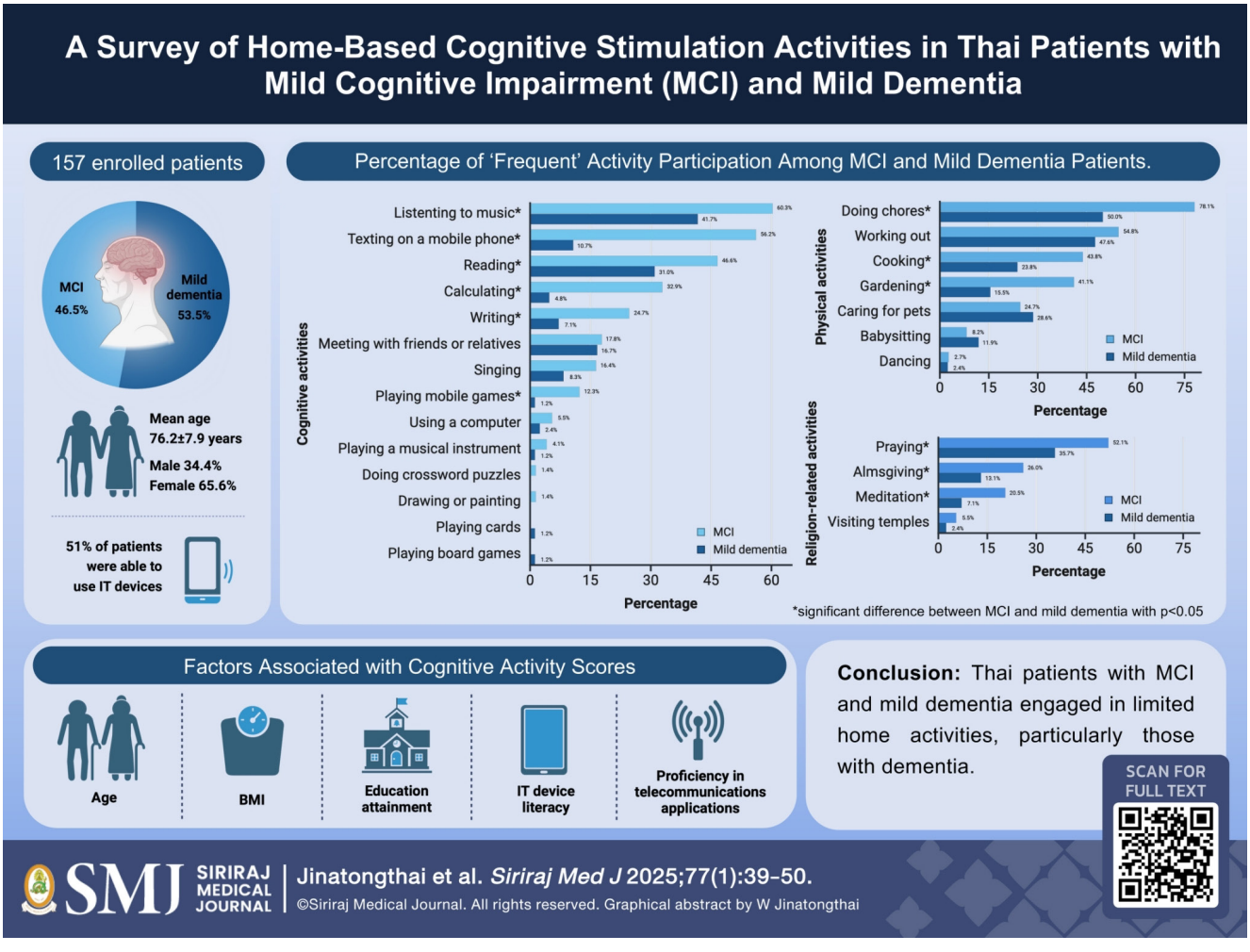
2. Malnutrition among Older People in the Community [Internet]. bapen.org.uk. Available from: https://www.bapen.org.uk/pdfs/malnut_in_the_community.pdf
3. Chalermsri C, Assantachai P, Pramyothin P, Pengsorn N, Muangpaisan W. Prevalence of and factors associated with undernutrition in a geriatric outpatient setting: Results from a multidimensional nutritional assessment. Siriraj Med J. 2018;70(5):413-8.
4. Serón-Arbeloa C, Labarta-Monzón L, Puzo-Foncillas J, Mallor-Bonet T, Lafita-López A, Bueno-Vidales N, et al. Malnutrition screening and assessment. Nutrients. 2022;14(12):2392.
5. Reber E, Gomes F, Vasiloglou MF, Schuetz P, Stanga Z. Nutritional risk screening and assessment. J Clin Med. 2019;8(7):1065.
6. Power L, Mullally D, Gibney ER, Clarke M, Visser M, Volkert D, et al. A review of the validity of malnutrition screening tools used in older adults in community and healthcare settings - A MaNuEL study. Clin Nutr ESPEN. 2018;24:1-13.
7. Ackermans LLGC, Rabou J, Basrai M, Schweinlin A, Bischoff SC, Cussenot O, et al. Screening, diagnosis and monitoring of sarcopenia: When to use which tool? Clin Nutr ESPEN. 2022;48:36-44.
8. Isautier JM, Bosnić M, Yeung SS, Trappenburg MC, Meskers CG, Whittaker AC, et al. Validity of nutritional screening tools for community-dwelling older adults: a systematic review and meta-analysis. J Am Med Dir Assoc. 2019;20(10):1351.e13-1351.e25.
9. Cederholm T, Jensen G, Correia M, Gonzalez MC, Fukushima R, Higashiguchi T, et al. GLIM criteria for the diagnosis of malnutrition–a consensus report from the global clinical nutrition community. J Cachexia Sarcopenia Muscle. 2019;10(1):207-17.
10. Guigoz Y, Vellas B. Nutritional assessment in older adults: MNA® 25 years of a screening tool & a reference standard for care and research; what next? J Nutr Health Aging. 2021;25(4):528-83.
11. Soubra R, Chkeir A, Novella J-L. A systematic review of thirty-one assessment tests to evaluate mobility in older adults. Biomed Res Int. 2019;2019:1354362.
12. Webber SC, Porter MM, Menec VH. Mobility in older adults: a comprehensive framework. Gerontologist. 2010;50(4):443-50.
13. Kaewkan K. Assessment of Physical Performance in elderly with Short Physical Performance Battery Test. J Med Health Sci. 2019;26(2):96-111.
14. Lamb SE, Keene DJ. Measuring physical capacity and performance in older people. Best Pract Res Clin Rheumatol. 2017;31(2):243-54.
15. Volkert D, Beck AM, Cederholm T, Cruz-Jentoft A, Hooper L, Kiesswetter E, et al. ESPEN practical guideline: Clinical nutrition and hydration in geriatrics. Clin Nutr. 2022;41(4):958-89.
16. Lindner-Rabl S, Wagner V, Matijevic A, Herzog C, Lampl C, Traub J, et al. Clinical interventions to improve nutritional care in older adults and patients in primary healthcare–a scoping review of current practices of health care practitioners. Clin Interv Aging. 2022;17:1-13.
17. Phu S, Kirk B, Bani Hassan E, Vogrin S, Zanker J, Bernardo S, et al. The diagnostic value of the Short Physical Performance Battery for sarcopenia. BMC Geriatr. 2020;20(1):242.
18. Beaudart C, Rolland Y, Cruz-Jentoft AJ, Bauer JM, Sieber C, Cooper C, et al. Assessment of muscle function and physical performance in daily clinical practice: a position paper endorsed by the European Society for Clinical and Economic Aspects of Osteoporosis, Osteoarthritis and Musculoskeletal Diseases (ESCEO). Calcif Tissue Int. 2019;105(1):1-14.
19. What is the MNA®? [Internet]. Mna-elderly.com. Available from: http://www.mna-elderly.com
20. Short physical performance battery (sppb) guide [Internet]. sppbguide.com. Available from: https://sppbguide.com
21. Timed Up & go(TUG) [Internet]. Cdc.gov. Available from: https://www.cdc.gov/steadi/media/pdfs/STEADI-Assessment-TUG-508.pdf
22. Miranda-Cantellops N, Tiu TK. Berg Balance Testing. Stat Pearls Publishing; 2023.
23. Totland TH, Krogh HW, Smedshaug GB, Tornes RA, Bye A, Paur I. Harmonization and standardization of malnutrition screening for all adults–A systematic review initiated by the Norwegian Directorate of Health. Clin Nutr ESPEN. 2022;52:32-49.
24. Chuansangeam M, Wuthikraikun C, Supapueng O, Muangpaisan W. Prevalence and risk for malnutrition in older Thai people: A systematic review and meta-analysis. Asia Pac J Clin Nutr. 2022;31(1):128-41.
25. Leung AY, Su JJ, Lee ES, Fung JT, Molassiotis A. Intrinsic capacity of older people in the community using WHO Integrated Care for Older People (ICOPE) framework: a cross-sectional study. BMC Geriatr. 2022;22(1):304.
26. Zhong B-X, Zhong H-L, Zhou G-Q, Xu W-Q, Lu Y, Zhao Q. Physical performance and risk of hip fracture in community-dwelling elderly people in China: a 4-year longitudinal cohort study. Maturitas. 2021;146:26-33.
27. Lu F, Li J, Liu X, Liu S, Sun X, Wang X. Diagnostic performance analysis of the Integrated Care for Older People (ICOPE) screening tool for identifying decline in intrinsic capacity. BMC Geriatr. 2023;23(1):509.
28. Vellas B, Guigoz Y, Garry PJ, Nourhashemi F, Bennahum D, Lauque S, et al. The Mini Nutritional Assessment (MNA) and its use in grading the nutritional state of elderly patients. Nutrition. 1999;15(2):116-22.
29. Kooij L, Vos PJ, Dijkstra A, van Harten WH. Effectiveness of a mobile health and self-management app for high-risk patients with chronic obstructive pulmonary disease in daily clinical practice: mixed methods evaluation study. JMIR Mhealth Uhealth. 2021;9(2):e21977.
30. Ritchey K, Olney A, Chen S, Phelan EA. STEADI self-report measures independently predict fall risk. Gerontol Geriatr Med. 2022;8:23337214221079222.
31. Merchant RA, Tsoi C, Tan W, Lau W, Sandrasageran S, Arai H. Community-based peer-led intervention for healthy ageing and evaluation of the 'HAPPY' program. J Nutr Health Aging. 2021;25(4):520-7.
32. Taheri-Kharameh Z, Malmgren Fänge A, Ekvall Hansson E, Bashirian S, Heidarimoghadam R, Poorolajal J, et al. Development of a mobile application to screen and manage fall risks in older people. Disabil Rehabil Assist Technol. 2022;17(3):362-7.
33. Deapartment of Older Persons. Elderly statistics [Internet]. 2022. [cited 2024 September 13]. Available from: https://www.dop.go.th/th/know/side/1/1/2449
34. Ko-amornsup W, Siriussawakul A, Aosangdeeku K, Preedachitkul R, Srinonprasert V, Somnuke P, et al. Health survey of monks residing in urban areas: The Bangkok Noi model. Siriraj Med J. 2024;76(11):746-57.
35. Coordinated Care Plan to Prevent Older Adult Falls [Internet]. cdc.gov/steadi. Available from: https://www.cdc.gov/steadi/

pdf/Steadi-Coordinated-Care-Plan.pdf
36. Casey CM, Parker EM, Winkler G, Liu X, Lambert GH, Eckstrom E. Lessons Learned From Implementing CDC's STEADI Falls Prevention Algorithm in Primary Care. Gerontologist. 2017; 57(4):787-96.
37. Loonlawong S, Limroongreungrat W, Rattananupong T, Kittipimpanon K, Saisanan Na Ayudhaya W, Jiamjarasrangsi W. Predictive validity of the Stopping Elderly Accidents, Deaths & Injuries (STEADI) program fall risk screening algorithms among community-dwelling Thai elderly. BMC Med. 2022;20(1):78.
38. Lin C-C, Meardon S, O'Brien K. The Predictive Validity and Clinical Application of Stopping Elderly Accidents, Deaths & Injuries (STEADI) for Fall Risk Screening. Adv Geriatr Med Res. 2022;4(3):e220008.
39. Lohman MC, Crow RS, DiMilia PR, Nicklett EJ, Bruce ML, Batsis JA. Operationalisation and validation of the Stopping Elderly Accidents, Deaths, and Injuries (STEADI) fall risk algorithm in a nationally representative sample. J Epidemiol Community Health. 2017;71(12):1191-7.
40. Nithman RW, Vincenzo JL. How steady is the STEADI? Inferential analysis of the CDC fall risk toolkit. Arch Gerontol Geriatr. 2019;83:185-94.
41. Burns ER, Lee R, Hodge SE, Pineau VJ, Welch B, Zhu M. Validation and comparison of fall screening tools for predicting future falls among older adults. Arch Gerontol Geriatr. 2022; 101:104713.
42. Donini LM, Marrocco W, Marocco C, Lenzi A. Validity of the Self- Mini Nutritional Assessment (Self- MNA) for the Evaluation of Nutritional Risk. A Cross- Sectional Study Conducted in General Practice. J Nutr Health Aging. 2018;22(1):44-52.

A Survey of Home-Based Cognitive Stimulation Activities in Thai Patients with Mild Cognitive Impairment and Mild Dementia

Wirarat Jinatongthai, M.D.[1], Kitikan Thana-udom, M.D.[2], Vorapun Senanarong, M.D.[1], Chatchawan Rattanabannakit, M.D.[1,*]

[1]Division of Neurology, Department of Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand, [2]Department of Psychiatry, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand.



*Corresponding author: Chatchawan Rattanabannakit
E-mail: chatchawan.rat@mahidol.ac.th
Received 27 September 2024 Revised 4 November 2024 Accepted 4 November 2024
ORCID ID:http://orcid.org/0000-0001-9769-9556
https://doi.org/10.33192/smj.v77i1.271344

ABSTRACT

Objective: This study investigated the characteristics of home-based activities in individuals with mild cognitive impairment (MCI) and mild dementia, as well as factors related with those activities.

Materials and Methods: A cross-sectional, questionnaire-based study was conducted on patients with MCI and mild dementia at Siriraj Hospital. Data on patient and caregiver characteristics, home cognitive activities, and proficiency in using information technology (IT) devices and telecommunications applications were collected. Home activities were categorized into cognitive, physical, and religion-related activities based on their type and frequency.

Results: Of 157 enrolled patients with a mean age of 76.2±7.9 years, 46.5% were diagnosed with MCI and 53.5% with mild dementia. The MCI group exhibited significantly higher frequencies of activities such as reading, writing, playing mobile games, texting, calculating, music listening, meditation, praying, almsgiving, doing chores, cooking, and gardening (all $p<0.05$). Approximately 51% of patients were able to use IT devices. MCI patients demonstrated greater proficiency in using smart IT devices and teleconferencing applications than those with mild dementia (79.5% vs. 26.2%, and 49.3% vs. 11.9%, both $p<0.001$). Cognitive activity scores were associated with age ($r=-0.34$, $p<0.001$), body mass index ($r=0.16$, $p=0.04$), educational attainment ($r=0.38$, $p<0.001$), IT device literacy ($r=0.41$, $p<0.001$), and proficiency in using telecommunications applications ($r=0.55$, $p<0.001$).

Conclusion: Thai patients with MCI and mild dementia engaged in limited home activities, particularly those with dementia. IT device literacy was surprisingly prevalent and contributed to higher cognitive activity scores. Developing home-based cognitive stimulation programs for Thai patients facing cognitive challenges utilizing telecommunication may be feasible.

Keywords: Home-based activity; cognitive activity; mild cognitive impairment; mild dementia; Thai (Siriraj Med J 2025; 77: 39-50)

INTRODUCTION

Leisure activities impact cognitive decline in geriatric adults. Engaging in activities such as board games, reading, musical instruments, crossword puzzles, dancing, household chores, walking, swimming, and caregiving significantly reduces the risk of cognitive decline.[1]

A survey conducted in 2020 on Thai individuals aged over 60 during the COVID-19 pandemic revealed difficulties in activities such as leaving the house for errands, shopping, medical appointments, religious ceremonies, social activities, and visiting relatives or friends.[2] The pandemic has also notably affected the decline in Mini-Mental State Examination scores in dementia patients, with a more significant decline during the lockdown.[3,4] A systematic review suggests that cognitive training can improve cognitive function in patients with mild to moderate dementia.[5] However, caregiver-led cognitive stimulation therapy at home did not significantly improve cognitive function in dementia patients, likely due to inconsistent engagement in cognitively stimulating activities within the study samples.[6,7]

There is evidence showing that factors such as low education attainment, depression, physical inactivity, obesity, or social isolation can contributed to modifiable risk factors for dementia.[8] In the Thai population, previous studies have identified several factors associated with dementia in the elderly. These factors include male gender, advanced age, low education levels, diabetes, depression, lack of mobile phone use, limited skills in computer and internet use, infrequent social participation, and minimal engagement in religious activities.[9,10] Moreover, advanced ageing people are likely to experience home-activities limitation due to many possible factors, such as health status, depression, psychosocial factors, body mass index (BMI), or education level.[11] Previous research suggests that engaging in activities such as computer use and arts or crafts may lower the risk of mild cognitive impairment (MCI).[12] These activities may also promote cognitive reserve, neuronal function, neural growth, and alternative neural pathways, thereby facilitating the maintenance of cognitive function.[13]

Other studies have shown associations between leisure activities and dementia risk, indicating potential protective effects against dementia.[14-18] However, a large longitudinal study suggested that reduced activity participation may indicate prodromal dementia, despite an unclear association with dementia incidence.[19] Nonetheless, a systematic review in 2016 confirmed the positive association between mentally stimulating leisure activities and cognitive function, as well as decreased cognitive decline.[20]

Clinical guidelines recommend cognitive training for patients with cognitive impairment to slow disease progression. However, previous studies on home-based, caregiver-led cognitive stimulation therapy showed limited effectiveness in improving cognitive function for dementia patients, possibly due to difficulties in consistently engaging participants in cognitively stimulating activities.[6,7] Limited information exists on home-based cognitive training for dementia patients in Thailand. This study aimed to investigate the characteristics of home activities that contribute to cognitive function in individuals with MCI and mild dementia, as well as factors influencing these activities. The findings may facilitate the development of home-based tools or activities to stimulate cognitive function at home.

MATERIALS AND METHODS

Patient population and data collection

This cross-sectional study was conducted at a single center university hospital between September and December 2022 and was approved by the Siriraj Institutional Review Board (COA no. Si 448/2022). Eligible participants were (1) individuals aged 60 years old or older who visited the memory clinic or related clinics at Siriraj Hospital, (2) diagnosed with MCI or mild dementia, and (3) had at least one caregiver. MCI was defined as having a measurable objective cognitive impairment such as a Montreal Cognitive Assessment[21] (MoCA) score below 25, while having the Thai Mental State Examination[22] (TMSE) score of 24 to 30. The TMSE is an adaptation of the Mini-Mental State Examination (MMSE). Patients with MCI were also characterized by having normal activities of daily living, as indicated by a Functional Assessment Staging[23] (FAST) scale score of 3 or a Global Deterioration Scale[24] (GDS) score of 3. Mild dementia was defined as having a TMSE score of 18 to 23, a FAST score of 4, or a GDS score of 4. The diagnosis of MCI or mild dementia was then re-validated by at least two experienced neurologists. The exclusion criteria were (1) severe visual, auditory, or mobility impairments that hindered daily activities and cognitive tests, and (2) cognitive decline caused by reversible processes such as vitamin B12 deficiency or thyroid disorders.

The sample size was calculated using the formula for infinite population proportion and drew upon information from a previous study.[1] The proportion of individuals regularly engaging in leisure and physical activities was set at 0.25, with an acceptable margin of error of 0.07 and a type 1 error of 0.05. The calculated sample size was 147 individuals. After adding 10 percent to account for incomplete data, the adjusted sample size was 162 individuals. However, five participants were excluded after recruitment because they were initially classified as having mild dementia but were later found to have moderate dementia upon further review.

During routine outpatient visits, patients and their caregivers were apprised of the study and subsequently invited to engage in the research. Caregivers who agreed to participate provided written informed consent. The caregivers then completed a comprehensive questionnaire on (1) the patient and caregiver characteristics, (2) patient and caregiver proficiency with information technology (IT) devices and aptitude in utilizing telecommunications applications, and (3) patient engagement in cognitive stimulation activities at home.

Home-based cognitive stimulation activities and activity scores

Twenty-five home-based cognitive stimulation activities were categorized into three groups. The first group consisted of 14 cognitive-related activities: reading; writing; playing cards; board games; crossword puzzles; mobile games; texting; computer use; calculations; drawing/painting; playing musical instruments; listening to music; singing; and socializing with friends/relatives. The second group included four religion-related activities: meditation; praying; almsgiving; and temple visits. The third group encompassed seven physical activities: dancing; chores; cooking; babysitting; pet care; gardening, and exercise. Each activity was rated based on frequency: never; occasionally; 1–2 days/week; 3–5 days/week; and daily.

According to a previous study by Verghese J et al[1], activity scores were calculated as follows: 0 point for never and occasionally; 1 point for 1–2 days/week; 4 points for 3–5 days/week; and 7 points for daily participation received. Thus, the maximum scores in our study for cognitive-related, religion-related, and physical activities were 98, 28, and 49, respectively. Furthermore, Participation was classified as "frequent" for 3–7 days/week engagement and "rare" for 0–2 days/week engagement.

IT device literacy and ability to use telecommunications applications

IT device literacy data from the questionnaires were divided into two categories: simple devices (CD players, radios, and mobile phones for basic calls) and smart devices (smartphones, tablets, and computers). The ability to use telecommunications applications was also classified into two categories: simple applications (such as LINE for texting, Facebook, and YouTube) and smart applications (for example, LINE for video calls, Facetime, or Zoom).

Statistical analysis

Statistical analyses were conducted using PASW Statistics, version 26 (SPSS Inc, Chicago, IL, USA). Age, BMI, TMSE, MoCA, and Thai Geriatric Depression Scale-15[25] are reported as the mean and standard deviation. Nonparametric continuous data are presented as a median with an interquartile range, and categorical data are shown as percentages. Statistical comparisons for categorical data were performed using Pearson's chi-square test, while the Mann–Whitney *U* test was used for continuous variables. The independent samples Kruskal–Wallis test was employed to compare three or more categorical variables with nonparametric data. Spearman's rank correlation coefficient was used to assess variable correlations. Statistical significance was defined as a p-value < 0.05.

RESULTS

The study included 157 patients with a mean age of 76.2 ± 7.9 years, 65.6% of whom were female. Of these, 73 (46.5%) were diagnosed with MCI, whereas 84 (53.5%) were identified with mild dementia. Statistically significant differences were observed in the mean age, generation, BMI, education level, TMSE scores, and MoCA scores of the MCI and mild dementia patient groups (Table 1). The caregivers of the patients in the two groups had no significant differences in their characteristics (Table 2). While the level of confidence and anxiety in caregiving in the two groups did not significantly differ, the caregivers of patients with mild dementia experienced a significantly greater burden of care (p < 0.001).

Table 3 showed significant differences in the IT device literacy and ability to use telecommunications applications of the two groups. A majority (79.5%) of MCI patients were proficient in using smart devices, compared to only 26.2% of mild dementia patients (p < 0.001). Similarly, 49.3% of MCI patients could use video-call or conference applications, while only 11.9% of mild dementia patients possessed this capability (p < 0.001). Conversely, there were no significant differences in IT device literacy and the ability to use telecommunications applications among the caregivers in the two groups. Regarding the activity scores, the patients in the two groups exhibited significant differences in their cognitive (p < 0.001), physical (p < 0.001), and religion-related activity scores (p = 0.004).

Patients with MCI engaged in reading, writing, playing mobile games, texting, calculating, and listening to music more frequently than those with mild dementia. Patients with MCI also had higher frequencies of home physical activities (chores, cooking, gardening) and religion-related activities (meditation, praying, almsgiving). Most patients did not report that COVID-19 had negatively impacted their activities; however, meeting with friends or relatives, visiting temples, and almsgiving were affected, with 47.1%, 28.7%, and 19.1% of patients, respectively, reporting an adverse impact (Table 4).

The results revealed significant associations between cognitive-related activity scores and physical activity scores, religion-related activity scores and BMI (Fig 1). A significant inverse association was found between cognitive activity scores and the Geriatric Depression Scale-15 as well as patient age. Furthermore, patients' cognitive-related, religion-related, and physical activity scores significantly differed based on their IT device literacy and ability to use telecommunications applications (Fig 2). Patients who could use smart devices or video call/conference applications had higher scores for all three cognitive-stimulation activity groups. When comparing the impact of different levels of education and family income on each home-based activities, only a significant difference in level of education was found in the scores of cognitive-related activities.

DISCUSSION

This study is the first to investigate home-based activities in Thai patients with MCI and mild dementia. The findings suggest that home activities, including reading, writing, playing mobile games, texting, calculating, listening to music, meditating, praying, giving alms, doing chores, cooking, and gardening, showed significant differences in frequency between individuals with MCI and those with mild dementia. A previous study compared home activities in elderly individuals who developed dementia with those who did not, indicating that certain activities, such as reading, playing board games, playing musical instruments, and dancing were found to be less common among patients who would go on to develop dementia.1 Despite cultural differences, we also observed that activities like reading were less frequent among patients with dementia in our study. However, our study compared individuals with dementia to those with MCI, rather than assessing the risk of developing dementia as was done in the previous study.

The study found significant associations between older age, lower BMI, lower education level, IT device literacy, and ability to use telecommunications applications with poorer cognitive function. Our study results align with previous research, which consistently identifies age and education level as significant risk factors for cognitive impairment.[26,27] While research on the influence of information and communication technology (ICT)

TABLE 1. Baseline characteristics of patients and comparison between MCI and mild dementia groups.

Characteristics	All patients n=157	MCI n=73	Mild dementia n=84	*p*
Age, years (mean±SD)	76.2±7.9	72.5±6.9	79.4±7.3	**<0.001**
Generation (%)				
Baby boomers	52.9	61.4	38.6	**<0.001**
The silent generation	47.1	29.7	70.3	
Female (%)	65.6	68.5	63.1	0.478
BMI, kg/m² (mean±SD)	23.2±3.8	24.1±3.8	22.5±3.6	**0.005**
Education (%)				
Primary school or lower	34.4	20.5	46.4	**0.001**
Secondary/High school	18.5	19.2	17.9	
Graduate or higher	47.1	60.3	35.7	
Comorbidities (%)				
Hypertension	72.0	68.5	75.0	0.365
Diabetes	38.2	42.5	34.5	0.307
Dyslipidemia	73.2	67.1	78.6	0.106
Cardiac disease	15.3	16.4	14.3	0.709
Stroke	24.2	20.5	27.4	0.319
CKD	13.4	9.6	16.7	0.194
Other	5.7	8.2	3.6	0.211
TMSE (mean±SD)	22.6±4.1	26.0±2.8	21.2±3.8	**<0.001**
MoCA (mean±SD)	20.8±4.7	21.9±4.2	19.2±5.0	**0.006**
TGDS-15 (mean±SD)	3.9±2.8	3.9±2.7	3.8±3.0	0.650

Abbreviations: BMI, body mass index; CKD, chronic kidney disease; MCI, mild cognitive impairment; MoCA, Montreal Cognitive Assessment; TGDS-15, Thai Geriatric Depression Scale; TMSE, Thai Mental State Examination

use on cognition is relatively limited, previous studies have also demonstrated that ICT usage is associated with cognitive benefits, including enhancements in memory and executive function in older adults over time.[28,29]

Surprisingly, 51.0% of patients in our study were able to use IT devices. Patients with MCI showed a high level of proficiency in using smart IT devices and teleconferencing applications than those with dementia. This finding was consistent with a study involving 2,172 people with dementia and MCI in Spain and Sweden, which reported that approximately 54.14% of participants used a smartphone almost every day, while only 9.76% utilized specific application or software to support their memory.[30] In our study, 44.9% of participants were able to use any application; however, we did not collect data on the specific applications they used.

The study also examined the impact of religion-related activities on cognitive status. Previous research has shown a positive association between religious or spiritual involvement and cognitive function.[31-33] However, limited information exists regarding younger individuals and non-Christian groups. Given that nearly all participants in the present study were Buddhist (99%), it appears that common practices in Thai culture, such as meditation, almsgiving, and praying, are significantly associated with cognitive function.

The study has its limitations. this study relied on a questionnaire asking caregivers about the past activities of patients. As such, it may be subject to recall bias, as the accuracy of the responses depends on the caregivers' memory and perception. Moreover, there is a possibility that the accompanying caregiver during the outpatient

TABLE 2. Baseline characteristics of caregivers and group comparison.

Characteristics	All patients n=157	MCI n=73	Mild dementia n=84	*p*
Caregiver's age, years (mean±SD)	52.9±14.9	52.4±15.5	53.4±14.4	0.510
Caregiver, female (%)	70.6	64.3	75.9	0.116
Caregiver's relationship (%)				
Spouse	24.0	29.0	19.8	0.375
Offspring	62.0	56.5	66.7	
Other	14.0	14.5	13.5	
Caregiver's education level (%)				
Primary school or lower	4.7	2.9	6.2	0.091
Secondary/high school	11.9	7.1	16.0	
Graduate or higher	83.4	90.0	77.8	
Caregiver with comorbidities (%)	44.1	41.4	46.3	0.543
Family income, Baht/month (%)				
Less than 20,000	12.5	7.2	16.9	0.218
20,001 – 50,000	48.0	52.2	44.6	
50,001 – 100,000	18.4	15.9	20.5	
More than 100,000	21.1	24.6	18.1	
Caregiver's availability for home cognitive training (%)	77.1	70.0	83.1	0.054
Available hours in a day, median (IQR)	2.0 (1.0-3.0)	2.0 (1.0-3.0)	1.0 (1.0-3.0)	0.084
Available days in a week, median (IQR)	6.0 (3.0-7.0)	6.0 (2.5-7.0)	6.0 (3.0-7.0)	0.848

Abbreviation: MCI, mild cognitive impairment

visit may not be the primary one. Hence, the information accuracy might have been affected. Lastly, our study did not collect data on underlying factors that might influence impaired mobility, which could potentially contribute to a lower activity frequency.

In future research, the cross-sectional design of this study limits the ability to establish clear causality or identify which specific activities may contribute more significantly to a decline in cognitive function in patients with MCI and mild dementia. A longitudinal study will be needed to determine which activities that should be targeted for future intervention. The high prevalence of IT device use among patients with MCI and their caregivers in our study highlights the potential for future interventions using mobile or telecommunication devices in Thai patients with MCI. In dementia patients, IT literacy is lower, so developing interventions through their caregivers may be a more feasible approach.

CONCLUSION

The current investigation provides valuable insights for home-based activities of Thai patients with MCI and mild dementia. Approximately half of them were able to use IT devices, a factor that may be associated with higher cognitive activity scores. Developing home-based cognitive stimulation programs for Thai patients with cognitive issues using telecommunication technology is potentially feasible.

TABLE 3. IT device literacy and telecommunications application proficiency of patients and caregivers, with patients' activity scores.

Variable	All patients n=157	MCI n=73	Mild dementia n=84	*p*
Patient IT device literacy (%)				
Unable to use any device	21.0	4.1	35.7	**<0.001**
Only simple devices *	28.0	16.4	38.1	
Smart devices †	51.0	79.5	26.2	
Caregiver IT device literacy (%)				
Unable to use any device	0.7	1.4	0	0.235
Only simple devices *	1.3	0	2.5	
Smart devices †	98.0	98.6	97.5	
Patient ability to use telecommunications applications (%)				
Unable to use any application	54.1	27.4	77.4	**<0.001**
Simple applications ‡	16.6	23.3	10.7	
VDO call/conference app §	29.3	49.3	11.9	
Caregiver ability to use telecommunications applications (%)				
Unable to use any application	4.6	4.2	4.8	0.382
Simple applications ‡	12.3	8.5	15.7	
VDO call/conference app §	83.1	87.3	79.5	
Cognitive-related activity score (maximum score = 98)				
median (IQR)	10.0 (4.0-20.5)	15.0 (7.5-27.5)	7.0 (1.0-14.0)	**<0.001**
Religion-related activity score (maximum score = 28)				
median (IQR)	4.0 (0.0-8.0)	7.0 (0.0-14.0)	1.0 (0.0-7.0)	**0.004**
Physical activity score (maximum score = 49)				
median (IQR)	14.0 (7.0-21.0)	21.0 (11.0-22.0)	10.0 (4.2-18.0)	**<0.001**

* Simple devices: CD players, radios, or phones for simple calls

† Smart devices: smartphones, tablets, or computers

‡ Simple applications: Line application for texting, Facebook, or YouTube

§ VDO call applications: Line application for video calls, Facetime, or Zoom

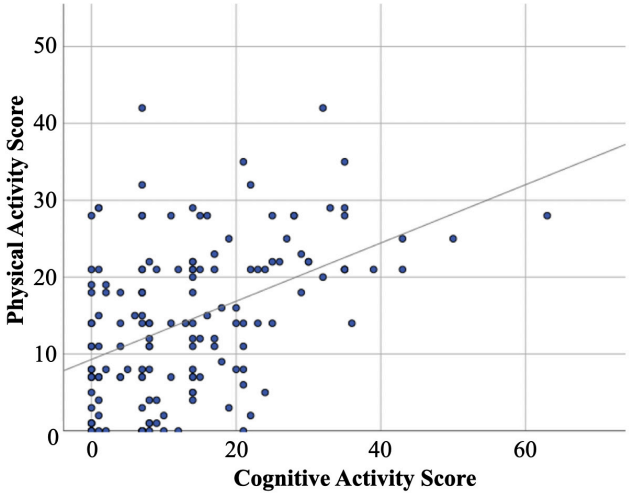
Abbreviations: app, application; MCI, mild cognitive impairment

TABLE 4. Frequency of home activities (cognitive, physical, and religion-related) and group comparison.

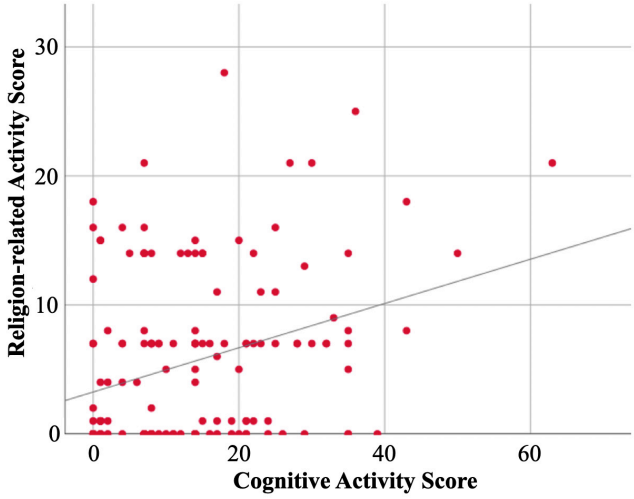
Home activities and frequency (%)	All patients n=157	MCI n=73	Mild dementia n=84	*p*
Cognitive activities				
Reading				
Rare	61.8	53.4	69.0	**0.045**
Frequent	38.2	46.6	31.0	
Writing				
Rare	84.7	75.3	92.9	**0.002**
Frequent	15.3	24.7	7.1	
Playing cards				
Rare	99.4	100.0	98.8	0.350
Frequent	0.6	0.0	1.2	
Playing board games				
Rare	99.4	100.0	98.8	0.350
Frequent	0.6	0.0	1.2	
Doing crossword puzzles				
Rare	99.4	98.6	100.0	0.282
Frequent	0.6	1.4	0.0	
Playing mobile games				
Rare	93.6	87.7	98.8	**0.004**
Frequent	6.4	12.3	1.2	
Texting on a mobile phone				
Rare	68.2	43.8	89.3	**<0.001**
Frequent	31.8	56.2	10.7	
Using a computer				
Rare	96.2	94.5	97.6	0.312
Frequent	3.8	5.5	2.4	
Calculating				
Rare	82.2	67.1	95.2	**<0.001**
Frequent	17.8	32.9	4.8	
Drawing or painting				
Rare	99.4	98.6	100.0	0.282
Frequent	0.6	1.4	0.0	
Playing a musical instrument				
Rare	97.5	95.9	98.8	0.247
Frequent	2.5	4.1	1.2	
Listening to music				
Rare	49.7	39.7	58.3	**0.020**
Frequent	50.3	60.3	41.7	
Singing				
Fare	87.9	83.6	91.7	0.120
Frequent	12.1	16.4	8.3	
Meeting with friends or relatives				
Rare	82.8	82.2	83.3	0.850
Frequent	17.2	17.8	16.7	
Physical activities				
Dancing				
Rare	97.5	97.3	97.6	0.887
Frequent	2.5	2.7	2.4	
Doing chores				
Rare	36.9	21.9	50.0	**<0.001**
Frequent	63.1	78.1	50.0	
Cooking				
Rare	66.9	56.2	76.2	**0.008**
Frequent	33.1	43.8	23.8	
Babysitting				
Rare	89.8	91.8	88.1	0.446
Frequent	10.2	8.2	11.9	
Caring for pets				
Rare	73.2	75.3	71.4	0.581
Frequent	26.8	24.7	28.6	
Gardening				
Rare	72.6	58.9	84.5	**<0.001**
Frequent	27.4	41.1	15.5	
Working out				
Rare	49.0	45.2	52.4	0.370
Frequent	51.0	54.8	47.6	
Religion-related activities				
Meditation				
Rare	86.6	79.5	92.9	**0.014**
Frequent	13.4	20.5	7.1	
Praying				
Rare	56.7	47.9	64.3	**0.039**
Frequent	43.3	52.1	35.7	
Almsgiving				
Rare	80.9	74.0	86.9	**0.040**
Frequent	19.1	26.0	13.1	
Visiting temples				
Rare	96.2	94.5	97.6	0.312
Frequent	3.8	5.5	2.4	

Abbreviation: MCI, mild cognitive impairment

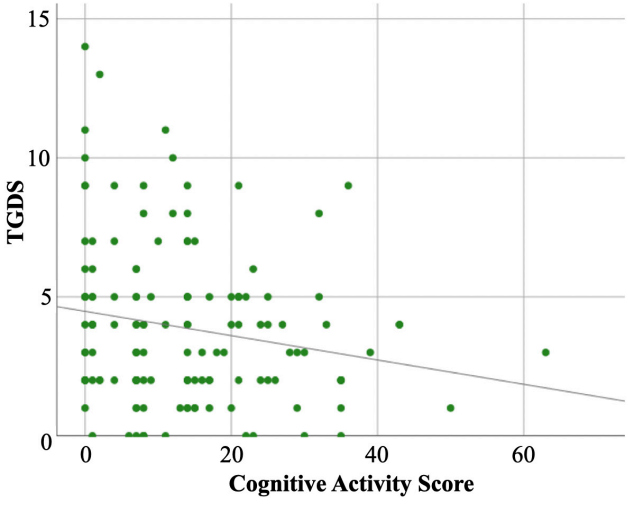
r = 0.436; p<0.001



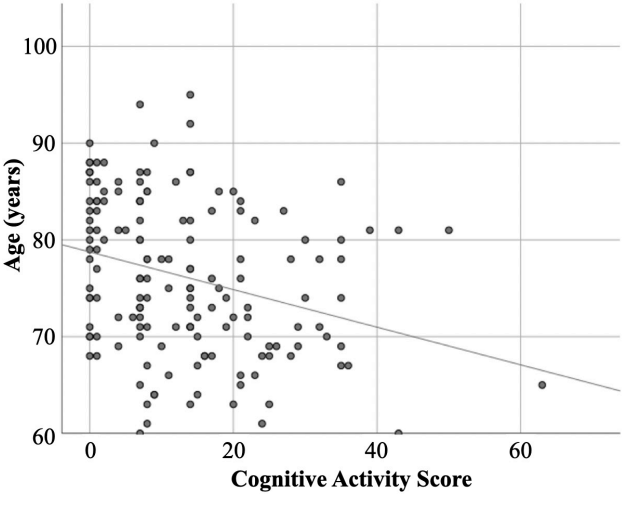
r = 0.276; p<0.001



r = -0.171; p=0.043



r = -0.340; p<0.001



r = 0.163; p=0.043

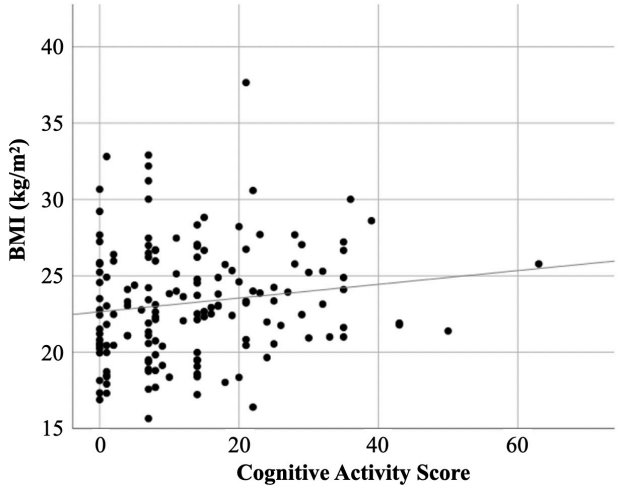


Fig 1. Correlations between scores for cognitive-related, religion-related, and physical activity scores, TGDS-15 scores, age, and BMI of patients.

Abbreviation: TGDS, Thai Geriatric Depression Scale; BMI, body mass index

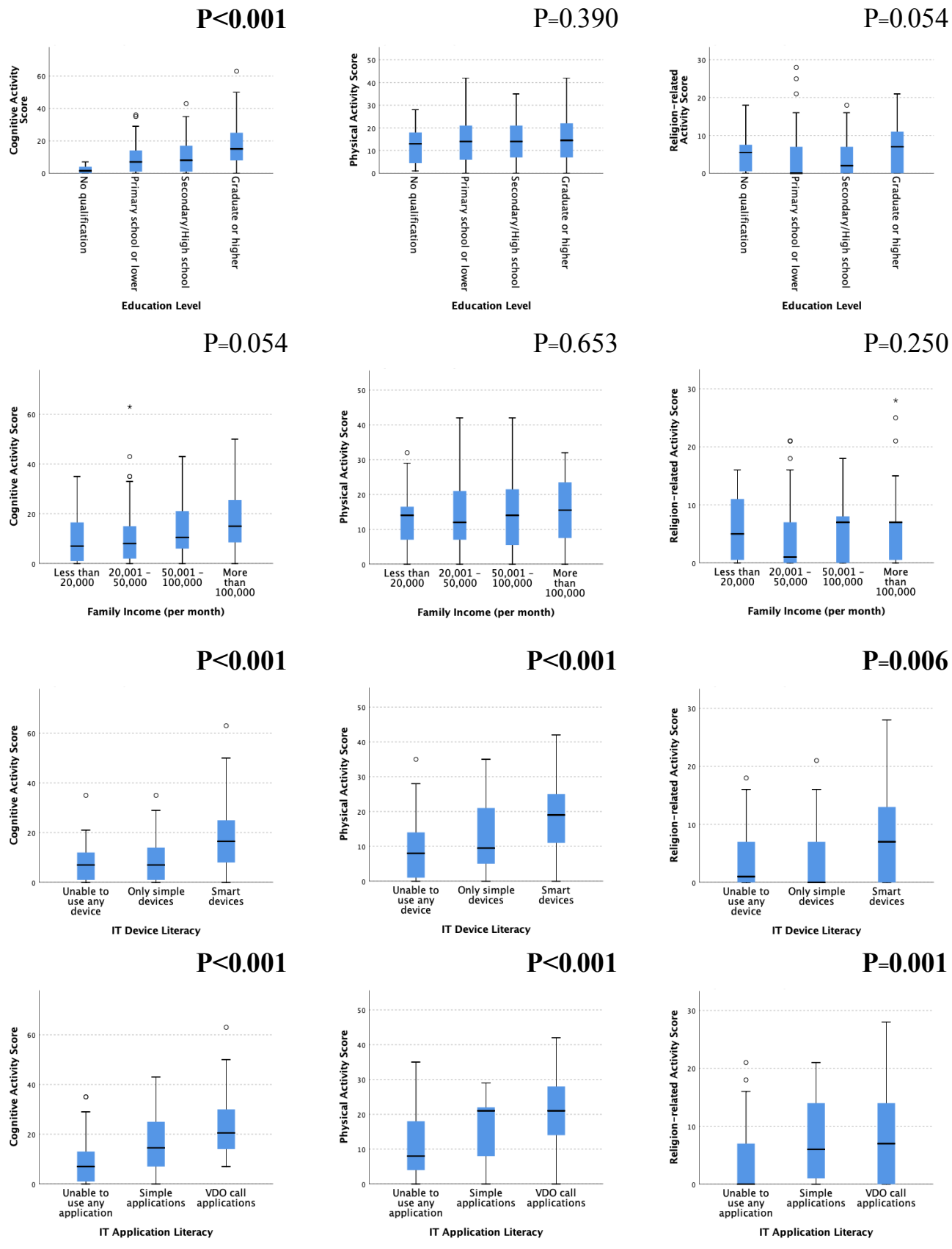


Fig 2. Activity scores stratified by education level, family income, IT device literacy, and telecommunications application proficiency.

ACKNOWLEDGEMENTS

The authors acknowledge Dr. Saowalak Hunnangkul for facilitating the statistical analysis.

DECLARATION

Grants and Funding Information

This research project was supported by the Siriraj Research Development Fund, Faculty of Medicine, Siriraj Hospital, Mahidol University (grant number [IO] R016531077).

Conflict of Interests

The authors declare no conflict of interest.

Author Contributions

Conceptualization and methodology, W.J., K.T., V.S. and C.R. ; Investigation, W.J. and C.R. ; Formal analysis, W.J. and C.R. ; Visualization and writing – original draft, W.J. and C.R. ; Writing – review and editing, K.T., V.S. and C.R. ; Funding acquisition, W.J. and C.R. ; All authors have read and agreed to the final version of the manuscript.

Use of artificial intelligence

The authors declare no use of artificial intelligence.

REFERENCES

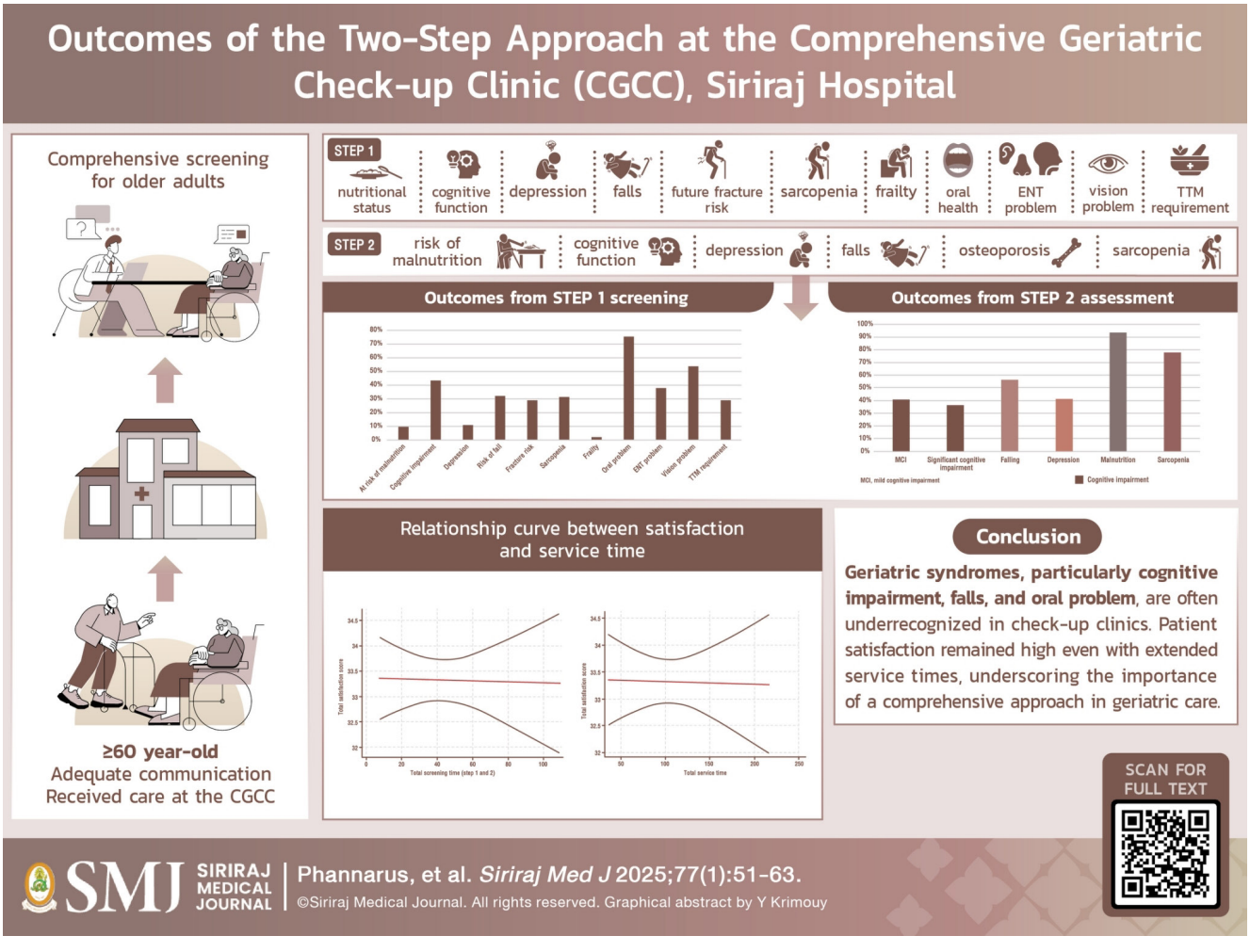
1. Verghese J, Lipton RB, Katz MJ, Hall CB, Derby CA, Kuslansky G, et al. Leisure activities and the risk of dementia in the elderly. N Engl J Med. 2003;348(25):2508-16.
2. Pothisiri W. COVID-19 and older persons: Evidence from the survey in Thailand: The United Nations Population Fund (UNFPA) Thailand; 2020 [cited 2022 Feb 16]. Available from: https://thailand.unfpa.org/sites/default/files/pub-pdf/covid-19_report-online-revised_2021.pdf.
3. Tondo G, Sarasso B, Serra P, Tesser F, Comi C. The Impact of the COVID-19 Pandemic on the Cognition of People with Dementia. Int J Environ Res Public Health. 2021;18(8).
4. Ismail, II, Kamel WA, Al-Hashel JY. Association of COVID-19 Pandemic and Rate of Cognitive Decline in Patients with Dementia and Mild Cognitive Impairment: A Cross-sectional Study. Gerontol Geriatr Med. 2021;7:23337214211005223.
5. Bahar-Fuchs A, Martyr A, Goh AMY, Sabates J, Clare L. Cognitive training for people with mild to moderate dementia. Cochrane Database Syst Rev. 2019;3(3):CD013069.
6. Orrell M, Yates L, Leung P, Kang S, Hoare Z, Whitaker C, et al. The impact of individual Cognitive Stimulation Therapy (iCST) on cognition, quality of life, caregiver health, and family relationships in dementia: A randomised controlled trial. PLoS Med. 2017;14(3):e1002269.
7. Park J, Kim SE, Kim EJ, Lee BI, Jeong JH, Na HR, et al. Effect of 12-week home-based cognitive training on cognitive function and brain metabolism in patients with amnestic mild cognitive impairment. Clin Interv Aging. 2019;14:1167-75.
8. Livingston G, Huntley J, Liu KY, Costafreda SG, Selbæk G, Alladi S, et al. Dementia prevention, intervention, and care: 2024 report of the Lancet standing Commission. Lancet. 2024;404 (10452):572-628.
9. Tantanokit T, Bosittipichet T, Leesri T. The Study of Prevalence and Associated Factors of Dementia in the Elderly. Siriraj Med J. 2021;73(4):224-35.
10. Sukhatunga K, Phattarayuttawat S, Luchom M, Chantra J, Chaiyasit W, Bunnagulrote K. Depression and Dementia in Thai Elderly in Urban and Rural Communities. Siriraj Med J. 1999;51(4):232-43.
11. Miljanovic Damjanovic V, Obradovic Salcin L, Ostojic D, Ostojic L, Gilic B, Geets Kesic M, et al. Exploring Factors Associated with Physical Activity in the Elderly: A Cross-Sectional Study during the COVID-19 Pandemic. Behav Sci (Basel). 2024;14(1):62.
12. Roberts RO, Cha RH, Mielke MM, Geda YE, Boeve BF, Machulda MM, et al. Risk and protective factors for cognitive impairment in persons aged 85 years and older. Neurology. 2015;84(18): 1854-61.
13. Wilson RS, Boyle PA, Yu L, Barnes LL, Schneider JA, Bennett DA. Life-span cognitive activity, neuropathologic burden, and cognitive aging. Neurology. 2013;81(4):314-21.
14. Akbaraly T, Portet F, Fustinoni S, Dartigues J, Artero S, Rouaud O, et al. Leisure activities and the risk of dementia in the elderly Results from the Three-City Study. Neurology. 2009;73:854-61.
15. Almeida OP, Yeap BB, Alfonso H, Hankey GJ, Flicker L, Norman PE. Older men who use computers have lower risk of dementia. PLoS One. 2012;7(8):e44239.
16. Fritsch T, Smyth KA, Debanne SM, Petot GJ, Friedland RP. Participation in novelty-seeking leisure activities and Alzheimer's disease. J Geriatr Psychiatry Neurol. 2005;18(3):134-41.
17. Lindstrom HA, Fritsch T, Petot G, Smyth KA, Chen CH, Debanne SM, et al. The relationships between television viewing in midlife and the development of Alzheimer's disease in a case-control study. Brain Cogn. 2005;58(2):157-65.
18. Wilson RS, Scherr PA, Schneider JA, Tang Y, Bennett DA. Relation of cognitive activity to risk of developing Alzheimer disease. Neurology. 2007;69(20):1911-20.
19. Sommerlad A, Sabia S, Livingston G, Kivimäki M, Lewis G, Singh-Manoux A. Leisure activity participation and risk of dementia: An 18-year follow-up of the Whitehall II Study. Neurology. 2020;95(20):e2803-e15.
20. Yates LA, Ziser S, Spector A, Orrell M. Cognitive leisure activities and future risk of cognitive impairment and dementia: systematic review and meta-analysis. Int Psychogeriatr. 2016;28(11):1791-806.
21. Tangwongchai S, Charernboon T, Phanasathit M, Akkayagorn L, Hemrungrojn S, Phanthumchinda K, et al. The validity of thai version of the montreal cognitive assessment (MoCA-T). Dement Neuropsychol. 2009;3(2):172.
22. Train the brain forum committee. Thai Mental State Examination (TMSE). Siriraj Hosp Gaz. 1993;45:359-74.
23. Sclan SG, Reisberg B. Functional assessment staging (FAST) in Alzheimer's disease: reliability, validity, and ordinality. Int Psychogeriatr. 1992;4 Suppl 1:55-69.
24. Reisberg B, Ferris SH, de Leon MJ, Crook T. Global Deterioration Scale (GDS). Psychopharmacol Bull. 1988;24(4):661-3.
25. Wongpakaran N, Wongpakaran T, Van Reekum R. The Use of GDS-15 in Detecting MDD: A Comparison Between Residents in a Thai Long-Term Care Home and Geriatric Outpatients.

J Clin Med Res. 2013;5(2):101-11.
26. Han F, Luo C, Lv D, Tian L, Qu C. Risk Factors Affecting Cognitive Impairment of the Elderly Aged 65 and Over: A Cross-Sectional Study. Frontiers in Aging Neuroscience. 2022;14.
27. Sun L, Diao X, Gang X, Lv Y, Zhao X, Yang S, et al. Risk Factors for Cognitive Impairment in Patients with Type 2 Diabetes. J Diabetes Res. 2020;2020:4591938.
28. Myhre JW, Mehl MR, Glisky EL. Cognitive Benefits of Online Social Networking for Healthy Older Adults. J Gerontol B Psychol Sci Soc Sci. 2017;72(5):752-60.
29. Choi EY, Wisniewski KM, Zelinski EM. Information and Communication Technology Use in Older Adults: A Unidirectional or Bi-directional Association with Cognitive Function? Comput Human Behav. 2021;121:106813.
30. Guzman-Parra J, Barnestein-Fonseca P, Guerrero-Pertiñez G, Anderberg P, Jimenez-Fernandez L, Valero-Moreno E, et al. Attitudes and Use of Information and Communication Technologies in Older Adults With Mild Cognitive Impairment or Early Stages of Dementia and Their Caregivers: Cross-Sectional Study. J Med Internet Res. 2020;22(6):e17253.
31. Hosseini S, Chaurasia A, Oremus M. The Effect of Religion and Spirituality on Cognitive Function: A Systematic Review. Gerontologist. 2019;59(2):e76-e85.
32. Lin KP, Chou YC, Chen JH, Chen CD, Yang SY, Chen TF, et al. Religious affiliation and the risk of dementia in Taiwanese elderly. Arch Gerontol Geriatr. 2015;60(3):501-6.
33. Kaufman Y, Anaki D, Binns M, Freedman M. Cognitive decline in Alzheimer disease: Impact of spirituality, religiosity, and QOL. Neurology. 2007;68(18):1509-14.

Prevalence of Geriatric Syndromes and Satisfaction of Service in Older People Receiving Annual Health Screening at the Check-up Clinic, Siriraj Hospital

Harisd Phannarus, M.D.[1], Supakorn Chansaengpetch, M.D.[1], Tirathat Virojskulchai, M.D.[1], Napaporn Pengsorn, B.N.S.[2], Pensri Chaopanitwet, B.N.S.[2], Usa Vannachavee, M.N.S.[2], Jirawit Wong-ekkabut, M.Sc.[1], Ananya Treewisoot, B.Sc.[1], Sunun Thanasamut, B.N.S.[2], Angkana Jongsawadipatana, M.Sc.[3], Weerasak Muangpaisan, M.D.[1,4,*]

[1]Department of Preventive and Social Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand, [2]Department of Nursing, Siriraj Hospital, Mahidol University, Bangkok, Thailand, [3]Department of Research, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand, [4]Siriraj Academic Center of Geriatric Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand.



*Corresponding author: Weerasak Muangpaisan
E-mail: drweerasak@gmail.com
Received 18 October 2024 Revised 5 November 2024 Accepted 15 November 2024
ORCID ID:http://orcid.org/0000-0001-5863-3597
https://doi.org/10.33192/smj.v77i1.271734

ABSTRACT

Objective: To assess the prevalence of geriatric syndromes (GSs) and evaluate service satisfaction among older patients attending a comprehensive geriatric check-up clinic (CGCC) at Siriraj Hospital.

Materials and Methods: A cross-sectional study was conducted at the CGCC from December 2021 to November 2022. Participants aged 60 years and older were screened using a two-step approach; short screening by a standard questionnaire followed by an in-depth assessment. GSs were identified through standardized tools, and patient satisfaction was assessed using a structured questionnaire.

Results: Of 159 participants, 67.9% were women, with a mean age of 66.6 ± 6 years. In step 1, 43.7% showed cognitive impairment, 29.1% had a risk of falls, and 76% reported oral health issues. Step 2 confirmed cognitive impairment in 40.6%, malnutrition risk in 93.3%, and sarcopenia in 78%. The mean satisfaction score was 33.3 ± 2.5 out of 35 points. Total service time averaged 104.2 ± 36.9 minutes.

Conclusion: In a health check-up clinic where GSs are often under-recognized, GSs, particularly cognitive impairment, fall risk, and oral health issues, are prevalent. Despite extended service times, patient satisfaction remained high, highlighting the importance of comprehensive screening in geriatric care.

Keywords: Geriatric syndromes; cognitive impairment; comprehensive geriatric assessment; patient satisfaction; health screening (Siriraj Med J 2025; 77: 51-63)

INTRODUCTION

Geriatric syndromes (GSs) comprise a well-defined cluster of conditions that have a significant impact on the health of older individuals. These conditions are influenced by age-related physiological changes, functional stressors, and identifiable chronic diseases, resulting in a multifaceted process of organ system impairment.[1,2] Owing to their substantial impact on the older population, GSs have emerged as a pivotal concern within the field of geriatric care. This burden includes a variety of challenges, including increased disability rates, elevated hospitalization rates, and prolonged lengths of stay in health care facilities.[3-5] GSs are defined and captured under the mnemonic "7Is": inappetence, instability, intellectual impairment, incontinence, immobility, insomnia, and iatrogenesis. In the outpatient setting, a range of screening tools tailored to these specific conditions are employed, contingent upon the nuances of the health care system and the preparedness of health care personnel.[1] The prevalence of GSs reported in previous studies ranged from 36% to 75.3%.[4-6] These results demonstrate the necessity of addressing GSs as a crucial aspect of geriatric health care management.

Thailand, classified as an upper middle-income country, has a life expectancy of approximately 84 and 79 years for females and males, respectively.[7] The demographic landscape reveals a significant shift, with the proportion of individuals aged 60 years and older in Thailand reaching a considerable 20% of the population by 2023.[8,9] However, clinical practices focused on GSs are relatively rare.[5] In addition, the number of GS diagnoses remains inconclusive, with considerable variability observed across different health care providers and regions. This variability highlights the absence of standardized approaches for addressing GSs. While the Thai Ministry of Public Health has introduced screening guidelines for various geriatric issues in the older population[10], implementation difficulties persist. Inadequate infrastructure and a lack of specialists in certain regions make it difficult for health care professionals to comply with these guidelines. This highlights the disparities and complexities surrounding the integration of geriatric care protocols, leading to efforts to bridge the gap between policy and practical execution.

In the context of geriatric care at Siriraj Hospital, notable advancements were realized with the establishment of the comprehensive geriatric check-up clinic (CGCC) in 2021. This initiative was undertaken with the primary purpose of enhancing the quality of care and facilitating the early detection of GSs in a general health check-up clinic. The clinic provides a platform for comprehensive geriatric assessment (CGA) for individuals aged 60 years and older. This assessment protocol is intended to incorporate a holistic evaluation of physical, mental, social, and functional aspects. The outcome of this thorough assessment subsequently guides the diagnostic process, allowing the identification of health-related conditions requiring specialized care.

Despite the substantial range of studies, to our knowledge, investigations into the prevalence of GSs

and the consequential health care utilization resulting from GS screening in a check-up clinic within a tertiary care facility in Thailand are lacking. The present study assumes significance by focusing on the demographics of older outpatients who have undergone geriatric screening. The objectives of this study were to determine the prevalence of GSs, examine the practical implications of screening outcomes by assessing their influence on medical consultations, and assess the level of satisfaction among older outpatients attending Siriraj Hospital's comprehensive check-up clinic.

MATERIALS AND METHODS

Study design and participants

This was a cross-sectional study in which participants were recruited from the CGCC specified for older people at Siriraj Hospital, which was developed in 2020. The study cohort comprised individuals aged 60 years and older who were undergoing a new protocol of comprehensive geriatric screening and assessment within the check-up clinic of the Department of Preventive and Social Medicine, Faculty of Medicine, Siriraj Hospital, Mahidol University, Thailand. The recruitment phase spanned from December 2021 to November 2022. The eligibility criteria for enrollment were as follows: 1) subjects who were 60 years of age or older; 2) subjects who received comprehensive geriatric screening services at the CGCC at Siriraj Hospital; and 3) subjects who did not have communication problems. The exclusion criteria were as follows: 1) older individuals who had not undergone a full battery of comprehensive geriatric screening; and 2) older individuals or representatives who declined to participate in the study. All participants provided written informed consent.

The sample size for this study was determined via Cochran's formula[11] with a 95% confidence level. Previous studies reported that the prevalence of undetected GSs was 6.7% in geriatric clinics and 2.5% in community-dwelling populations. However, as no data were available for the check-up clinic population, we estimated a prevalence of 5% for the calculation. The allowable margin of error was set at 4%, with a corresponding z score of 1.96 at the 95% confidence level. The minimum sample size was 115 participants. To account for an estimated 20% rate of missing data, the final targeted sample size was adjusted to 138 participants. The study protocol was approved by the Siriraj Research Ethics Committee (COA No. Si 218/2565).

CGCC services and measurements

The CGCC was established in 2020 with the primary objective of conducting a comprehensive evaluation of GSs and aging-associated problems in the older population. This specialized facility provides a comprehensive array of services designed to identify and address a spectrum of concerns through systematically organized flow management (Fig 1). The scope of evaluation included malnutrition, cognitive impairment, depression, fall and fracture risks, sarcopenia, frailty, oral health problems, frailty, hearing and visual problems, and a general health assessment stratified by distinct age groups. The assessment embraced a multifaceted approach, integrating thorough patient history-taking, a physical examination, and multiple questionnaire-based assessments focusing on each age-related concern. The majority of questionnaires employed in this service were derived from standardized instruments or were based on screening guidelines from the Ministry of Public Health, Thailand.[10] Some of these were subsequently tailored to specific contexts and constraints of health care services, particularly limitations inherent to the service duration allocated for each patient. The selection of questions ensured practicality and administrative efficiency.

In accordance with the CGCC framework, the screening process was conducted in two steps (Fig 1). During the whole process, the service team administered a comprehensive evaluation focusing on general physical, mental, and social conditions through a structured set of screening questionnaires. These questionnaires encompassed the following key domains:

1) Malnutrition risk assessment: The first step of the malnutrition risk assessment involved the application of an adapted version of the SPENT Nutrition Screening tool.[12] This tool was modified by a panel of experts to enhance its applicability in identifying individuals at high risk for malnutrition. It comprises three questions targeting key indicators of nutritional risk: recent appetite loss, unintentional weight loss of 3 kg or more within the past three months, and body mass index (BMI) values either below 18.5 kg/m^2 or equal to or greater than 30 kg/m^2. A positive response to any of these questions triggered a more comprehensive evaluation in the second stage of screening. In step 2, the Mini-Nutritional Assessment short-form (MNA-SF)[13,14] was employed. The MNA-SF, a widely validated tool, provides a total score of up to 30 points, categorizing individuals into three nutritional statuses: normal nutritional status (24–30 points), at risk of malnutrition (17–23.5 points), and malnourished (<17 points).[13]

2) Cognitive function evaluation: The assessment of cognitive function incorporated both self-reported cognitive-related questions and an adapted version of the

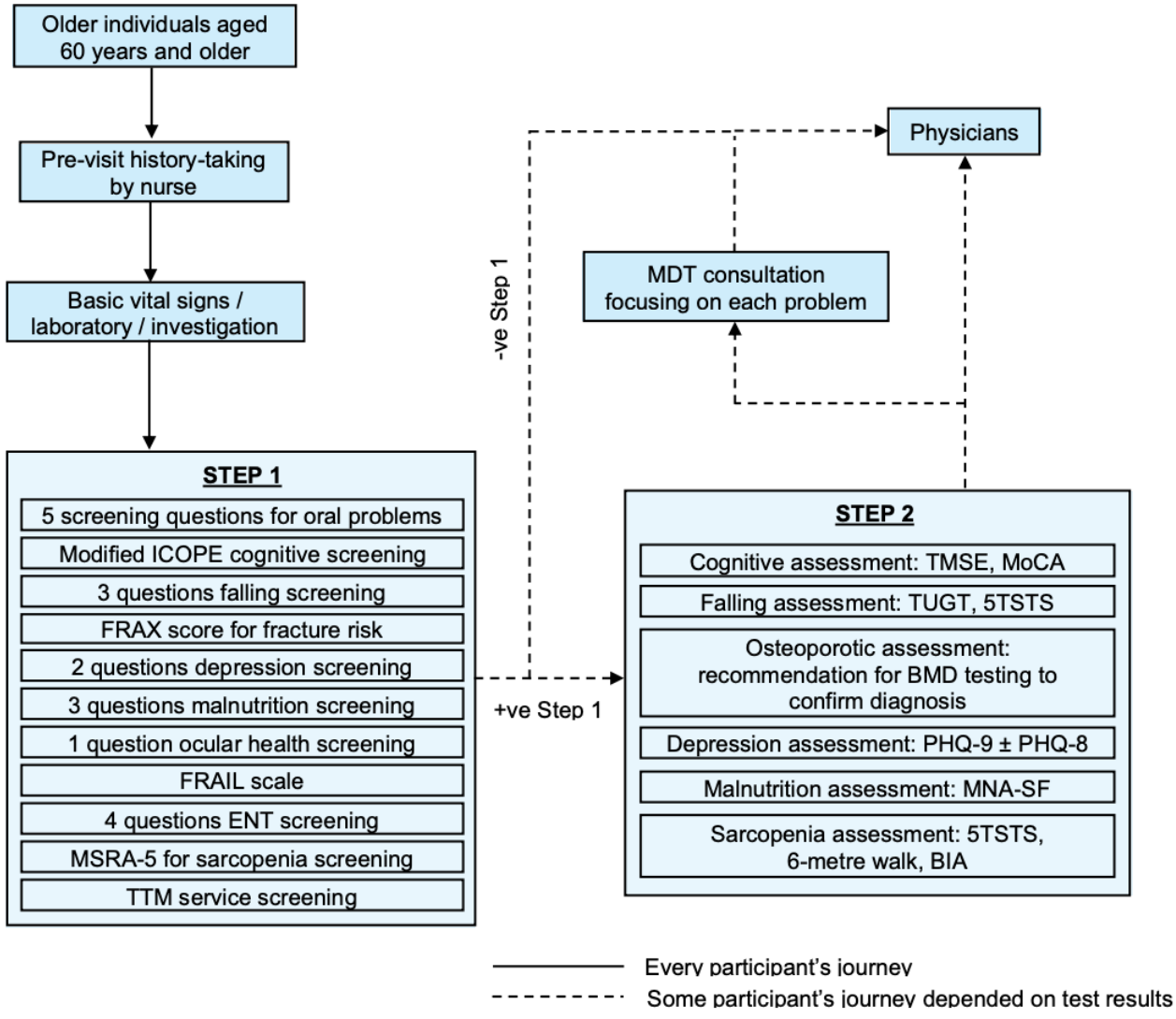


Fig 1. Flow chart of the comprehensive geriatric screening of participants.
Abbreviations: BIA, bioelectrical impedance analysis; BMD, bone mineral density; CGCC, Comprehensive geriatric check-up clinic; ENT, ear nose throat; FRAX, Fracture risk assessment tool; ICOPE, Integrated care for older people; MDT, Multidisciplinary team; MNA-SF, mini-nutritional assessment short-form; MoCA, Montreal cognitive assessment; MSRA, Mini sarcopenia risk assessment; PHQ, patient health questionnaire; TMSE Thai mental stale examination; TUGT, timed up and go test; 5TSTS, five-times-sit-to-stand test

Integrated Care for Older People (ICOPE) framework.[15] The self-reported cognitive assessment encompassed key indicators, including any recent memory loss, functional deficits, and changes in behavior or emotional state. In the adapted version of the ICOPE cognitive screening, the assessment focused on two specific cognitive domains: word recall (three common words) and orientation (date, month, year and place). The positive indicators of the respondents were subsequently assessed using the Thai Mental State Examination (TMSE)[16] and the Montreal Cognitive Assessment (MoCA)[17] in the second step, which were tailored to their educational background. Both the TMSE and MoCA are standardized cognitive assessments, with a total possible score of 30 points. For the TMSE, a cutoff score of 23/24 was employed to identify cognitive impairment[16], whereas for the MoCA, a cutoff score of 24/25 was used to determine mild cognitive impairment (MCI).[17]

3) Depression screening: The depression screening instrument, which was originally validated for the Thai population[18], consists of two questions suggesting depressive symptoms in the past 2 weeks and was designed to identify individuals at high risk for depression. Respondents who provided affirmative responses to at least one of these questions were flagged for further evaluation. High-risk individuals were subsequently assessed via the Patient Health Questionnaire (PHQ-9), a widely recognized instrument for determining the severity of depression.[19]

In cases where the PHQ-9 score exceeded 7 points, the PHQ-8 was employed to evaluate the risk of suicidal ideation, offering an additional layer of insight.[20]

4) Fall risk screening: The fall risk screening tool employed is a tool developed by the Centers of Disease Control and Prevention (CDC) and Stopping Elderly Accidents, Deaths & Injuries (STEADI).[21] This screening tool consists of three essential questions aimed at identifying individuals at high risk for falls. The questions focused on key risk factors, including a history of falls within the past year, a subjective feeling of instability, and a fear of falling. An affirmative response to any of these screening questions triggered a comprehensive fall risk evaluation. The subsequent assessments included the timed up and go test (TUG)[22] and the five-times-sit-to-stand test (5TSTS)[23] in step 2. These objective measures are well-established methods in clinical practice for evaluating mobility and lower limb strength, both of which are indicators of fall risk. Participants identified as high risk on the basis of these tests were initially checked for any reversible conditions and provided fall prevention. For those at high risk, further evaluation was carried out by referral to a specialist, enabling in-depth investigation of the underlying causes and the development of individualized, targeted preventive interventions.

5) Fracture risk assessment: The Fracture Risk Assessment Tool (FRAX)[24] was employed to estimate the risk of major osteoporotic and hip fractures. This tool provides a quantitative measure of fracture risk, with the outcomes indicating the likelihood of fractures at critical sites such as the hip and other major osteoporotic regions. In cases where the calculated fracture risk exceeded thresholds of ≥3% for hip fractures and ≥20% for major osteoporotic fractures, participants were advised to schedule appointments for bone mineral density (BMD) testing to obtain a definite diagnosis.[25]

6) Sarcopenia screening: The modified version of the Mini-Sarcopenia Risk Assessment (MSRA-5)[26], a five-question screening tool, was employed to assess the risk of sarcopenia. A cumulative score of 30 or below signifies a positive result for sarcopenia.[26] Individuals with a positive screening result underwent further evaluations, including the 5TSTS, handgrip strength, and bioelectrical impedance analysis (BIA), to classify them as having normal, sarcopenia, or severe sarcopenia.[27]

7) Frailty identification: The FRAIL scale[28], consisting of five questions, was used to identify frail individuals. Those with three or more affirmative responses were categorized as frail and underwent additional assessments to determine the underlying causes of frailty.

8) Oral health assessment: A battery of five questions aimed at detecting oral health issues, including 1) the presence of pain, 2) pus or bleeding when brushing the teeth, 3) the use of dentures, 4) the presence of cavitated dental lesions or food impaction, and 5) a lack of scaling within 12 months. If a respondent answered yes to Question 1) or 2) or had malnutrition and answer yes to Question 3), 4), or 5), they were referred to a dental clinic for further evaluation. If the responses were yes to 3), 4), or 5) with no malnutrition, they received an appointment to see a dentist.

9) Ear, nose, and throat (ENT) assessment: This screening included questions related to dizziness, hearing difficulties, and swallowing problems. A positive response in any of these areas indicated a high risk for ENT issues, and the respondent was referred to a specialist.

10) Ocular health screening: Participants were asked about their ophthalmologist visits within the past year. Individuals who had not seen an ophthalmologist were referred for further evaluation.

11) Traditional Thai medicine (TTM) services: Respondents were screened for symptoms that aligned with the treatments available through TTM services. Those who met the criteria were referred for TTM services.

Each of these domains provides a targeted approach to screening, enabling early identification of potential health issues and facilitating timely referrals for appropriate interventions.

Data collection

A research assistant approached each participant enrolled in the CGCC to obtain informed consent prior to data collection. The data collection was conducted by members of the clinic, particularly nurses or other health care personnel, and was seamlessly embedded into the CGCC's routine services. A comprehensive dataset was constructed, which included various demographic and health-related details recorded in case record forms. Initially, demographic information such as age, sex, level of education, income, smoking status, and physical activity level was collected. Basic health information, including weight, height, blood pressure, and the presence of underlying diseases, was subsequently recorded. The participants then completed the first step of the screening process via the CGCC's screening instrument. For those who tested positive in the first step of the screening process, a second step of more in-depth assessment followed. Upon completion of the entire check-up process, patient satisfaction with the services provided was assessed via a structured satisfaction questionnaire. Additionally, the time spent on each service was recorded to facilitate a comprehensive evaluation of the quality of care delivered

at the CGCC. The satisfaction survey consisted of seven questions, with a total score of 35 points. Each question was rated on a five-point Likert scale ranging from 5 (very satisfied) to 1 (very dissatisfied).

Statistical analyses

SPSS version 18.0 (SPSS Inc., PASW Statistics for Windows, Chicago, IL, USA) was used for the statistical analysis. Continuous variables are presented as the means, medians, and standard deviations (SDs). Independent t tests, Pearson correlations, Mann–Whitney U tests, and Wilcoxon signed-rank tests were used to analyze continuous data on the basis of the data distribution. Moreover, categorical outcomes are presented as frequencies and percentages. The chi-square test, or Fisher's exact test, was used to compare categorical data. Univariate and multivariate linear regression analyses were used to evaluate the associations between variables. The odds ratios and adjusted odds ratios with 95% confidence intervals are reported. A p value less than 0.05 indicated statistical significance.

RESULTS

Demographic characteristics

The baseline characteristics of the participants are presented in Table 1. A total of 159 participants were included in the study, with a mean age of 66.6±6 years. Women represented 67.9% of the participants. The mean body mass index (BMI) was 22.7±3.4 kg/m^2, and the mean waist circumference was 88.7±7.1 cm for males and 84±9 cm for females. More than half of the participants (56%) had attained at least a bachelor's degree. In terms of health status, 56% had at least one underlying condition, including hyperlipidemia (11.3%) and insomnia (9.4%). Additionally, 39% of the participants reported taking at least one medication regularly. Over half of the participants (52.2%) exercised at least five times per month, and 79.3% had received the COVID-19 vaccine, with 54.1% receiving the influenza vaccine.

Outcomes of the comprehensive screening (step 1)

In the first step of the screening process, oral health problems were the most commonly identified issue, affecting 76% of the participants, followed by ocular problems at 53.8%. Cognitive impairment was detected in 43.7% of the participants, while 29.1% were identified as being at risk of falls. Future fracture risk, as assessed via the FRAX score, was observed in 29.1% of the participants, with an average risk of 3.1±3.9% for hip fractures and 8.6±5.7% for major osteoporotic fractures. Depression and malnutrition were less prevalent, affecting 10.8% and 9.5% of the participants, respectively. Frailty was reported in 1.9% of participants on the basis of the FRAIL scale. ENT problems and sarcopenia were identified in 38% and 31.4% of the participants, respectively. These findings are detailed in Table 2.

Outcomes of the comprehensive screening (step 2)

The participants who tested positive in step 1 underwent further assessment in step 2, and the results are summarized in Table 3. Cognitive impairment, categorized as mild cognitive impairment (MCI) or more significant impairment, was confirmed in 40.6% and 36.2% of those tested, respectively. The average scores for the TMSE, MoCA, and MoCA-B were 22.5±5.8, 20.9±4.3, and 17.1±4.9, respectively. With respect to fall risk, 56.5% of the participants in step 2 tested positive, with an average time of 10.8±2.8 seconds for the TUG test and 15.2±4.7 seconds for the 5TSTS test. Depression was confirmed in 41.2% of the participants, with an average PHQ-9 score of 5.8±3.5. Among those screened for malnutrition, 93.3% were confirmed to be at risk of malnutrition, with an average MNA-SF score of 22±4. Sarcopenia was confirmed in 78% of the participants, with an average 5TSTS time of 15.2±7.6 seconds. Handgrip strength for the dominant hand averaged 30±6.4 kg for males and 19.6±3.4 kg for females.

Service quality and satisfaction

The participants reported a high level of satisfaction with the CGCC services, with an average satisfaction score of 33.3±2.5 out of a possible 35 points. The average time required to complete the baseline characteristics was 8.1±3.8 minutes, while the comprehensive screening process took an average of 34.6±19.9 minutes. The total service time, including waiting time and physical examination by a physician, averaged 104.2±36.9 minutes. These results are presented in Table 4.

Relationship between satisfaction and service time

Fig 2 illustrates the relationships between the total satisfaction score and various service-related times during the CGCC service, including the total screening time, waiting time and total service time. No significant relationships were found between these time metrics and the satisfaction scores. The graphs presented nonlinear relationships, indicating that extended screening and waiting times were associated with a decline in patient satisfaction. The fitted values and 95% confidence intervals (CIs) for these relationships are depicted in the figures.

TABLE 1. Demographic characteristics of CGCC participants (n = 159).

Characteristics	Values
Age, years±SD	66.6±6
Women, n (%)	108 (67.9)
BMI, kg/m^2±SD	22.7±3.4
Waist circumference, cm±SD	
Male	88.7±7.1
Female	84±9
MAP, mmHg±SD	90.7±11.6
Education attainment, n (%)	
<Bachelor's degree	70 (44)
≥Bachelor's degree	89 (56)
Having carers, n (%)	68 (42.8)
Having ≥ 1 underlying disease, n (%)	89 (56)
Hyperlipidemia	18 (11.3)
Insomnia	15 (9.4)
Cataract/Glaucoma	15 (9.4)
Hypertension	11 (6.9)
Having ≥ 1 medication, n (%)	62 (39)
Current smoker, n (%)	3 (1.9)
Current drinker, n (%)	8 (5)
Exercise status, n (%)	
1-4 times/month	42 (26.4)
≥5 time/month	83 (52.2)
Received ≥ 1 vaccination, n (%)	157 (98.7)
COVID-19 vaccine	126 (79.3)
Influenza	86 (54.1)

Abbreviations: BMI, body mass index; CGCC, comprehensive geriatric check-up clinic; cm, centimetre; MAP, mean arterial pressure; mmHG, millimetres of mercury; SD, standard deviation

DISCUSSION

This study provides new evidence on the effectiveness of a two-step comprehensive screening process for older populations, presenting the prevalence of GSs identified in step 1, followed by more detailed assessments in step 2 at a health check-up clinic in a tertiary care unit. This study also highlights the satisfaction scores, time spent on services, and relationships among these variables, offering insights into the operational efficiency of the check-up clinic.

The application of standardized screening tools constitutes a fundamental component of the CGCC service. The tools applied throughout the two-step screening process exhibit varying levels of sensitivity and specificity, reflecting their applicability across different GSs. In the initial step of the screening process (step 1), depression was assessed via the Thai version of the two-question screening questionnaire, which has been shown to have high sensitivity (96.5%) and specificity (85.1%) in detecting depressive symptoms.[18]

TABLE 2. Participant outcomes from the comprehensive screening (step 1).

Positive screening in Step 1	Values
At risk of malnutrition, n (%)	15 (9.4)
Cognitive impairment, n (%)	69 (43.4)
Depression, n (%)	17 (10.7)
Falling, n (%)	51 (32.1)
Fracture risk	
FRAX results, n (%)	
Positive	46 (28.9)
FRAX score, %±SD	
Hip site	3.1±3.9
Major site	8.6±5.7
Sarcopenia, n (%)	50 (31.4)
Frailty, n (%)	3 (1.9)
Oral problem, n (%)	120 (75.5)
ENT problem, n (%)	60 (37.7)
Ocular problem, n (%)	85 (53.5)
Having any symptoms required TTM, n (%)	46 (28.9)

Abbreviations: ENT, ear nose throat; FRAX, Fracture risk assessment tool; SD, standard deviation; TTM, Thai traditional medicine

Additionally, fall risk was evaluated via a three-question screening tool, which has been previously validated among community-dwelling older adults in Thailand and has high sensitivity (93.9%) and specificity (75%).[29,30] Fracture risk was assessed via the FRAX score, a globally recognized, web-based algorithm recommended by the World Health Organization and other organizations, including the National Osteoporosis Foundation, to predict future fracture risk.[24] The modified version of the MRSA-5 tool used for sarcopenia screening in step 1 is another well-validated tool for the Thai population, offering a sensitivity of 82.6% and a moderate specificity of 43.4%.[26] This tool's effectiveness in identifying individuals at risk for sarcopenia has contributed to its widespread use in geriatric screenings. Similarly, frailty was assessed using the FRAIL scale, which has been validated in the Thai population and has high sensitivity (85.8%) and specificity (80.6%).[28] The high sensitivity of these tests is particularly appropriate for the two-step screening process, as they allow for the inclusion of a broad range of at-risk individuals in step 1, who are then further evaluated in step 2 to identify those in need of targeted interventions or treatments.[31] This approach ensures that the screening process is both comprehensive and efficient, allowing for early identification and timely management of GSs.

Some of the adapted questionnaires used in the first step of the screening process may exhibit limited efficacy owing to their development by experts on the basis of previously established standard instruments. The malnutrition screening questionnaire in step 1 could lower the sensitivity of the screening process. Adapted from the SPENT Nutrition Screening tool[12], the questions focus on more severe symptoms and advanced-stage signs of malnutrition, including a BMI of <18.5 and >30 kg/m^2 and significant weight loss over the preceding three months. Moreover, participants attending the check-up clinic predominantly came from higher socioeconomic backgrounds, where malnutrition is less prevalent.[32] As a result, only 9.3% of the participants tested positive for malnutrition during the first step. This finding contrasts with that of a previous study, which reported a 37.8% prevalence of malnutrition risk among older adults in Thailand.[33] However, after further assessment in step 2,

TABLE 3. Participant outcomes from the comprehensive screening (step 2).

Positive screening in Step 2	Values
Cognitive impairment (n =69)	
Assessment results, n (%)	
MCI	28 (40.6)
Significant impairment	25 (36.2)
Test results, point (mean±SD)	
TMSE (n =8)	22.5±5.8
MoCA (n =61)	20.9±4.3
MoCA-B (n =7)	17.1±4.9
Falling, (n =51)	
Positive, n (%)	26 (56.5)
Test results, second (mean±SD)	
TUG	10.8±2.8
5TSTS	15.2±4.7
Depression (n =17)	
Positive, n (%)	7 (41.2)
Test results, point (mean±SD)	
PHQ-9	5.8±3.5
At risk of malnutrition (n =15)	
Assessment results, n (%)	14 (93.3)
Test results, point (mean±SD)	
MNA-SF	22±4
Sarcopenia, (n =50)	
Positive, n (%)	39 (78)
Test results	
5TSTS, second±SD	15.2±7.6
Right hand grip, kg±SD	
Male	30±6.4
Female	19.6±3.4
BIA, kg/m^2±SD	6.4±1.1

Abbreviations: 5TSTS, five times sit-to-stand; BIA, bioelectrical impedance analysis; kg, kilogramme; MCI, mild cognitive impairment; MNA-SF, mini nutritional assessment short-form; MoCA, Montreal cognitive assessment; PHQ, patient health questionnaire; TMSE, Thai mental state examination; TTM, Thai traditional medicine; TUG, timed up and go test; SD, standard deviation

TABLE 4. Participant outcomes from the comprehensive screening (step 2).

Satisfaction	Values	p-value
Satisfaction score, point (mean±SD)	33.3±2.5	ref
Service time	**Values**	
Time to fill baseline characteristic data, minute (mean±SD)	8.1±3.8	0.941
Time to complete comprehensive screening, minute (mean±SD)	34.6±19.9	0.974
Time of waiting and using in examination room, minute (mean±SD)	61.6±36.3	0.810
Total service time, minute (mean±SD)	104.2±36.9	0.987

Abbreviations: CGCC, comprehensive geriatric check-up clinic; SD, standard deviation

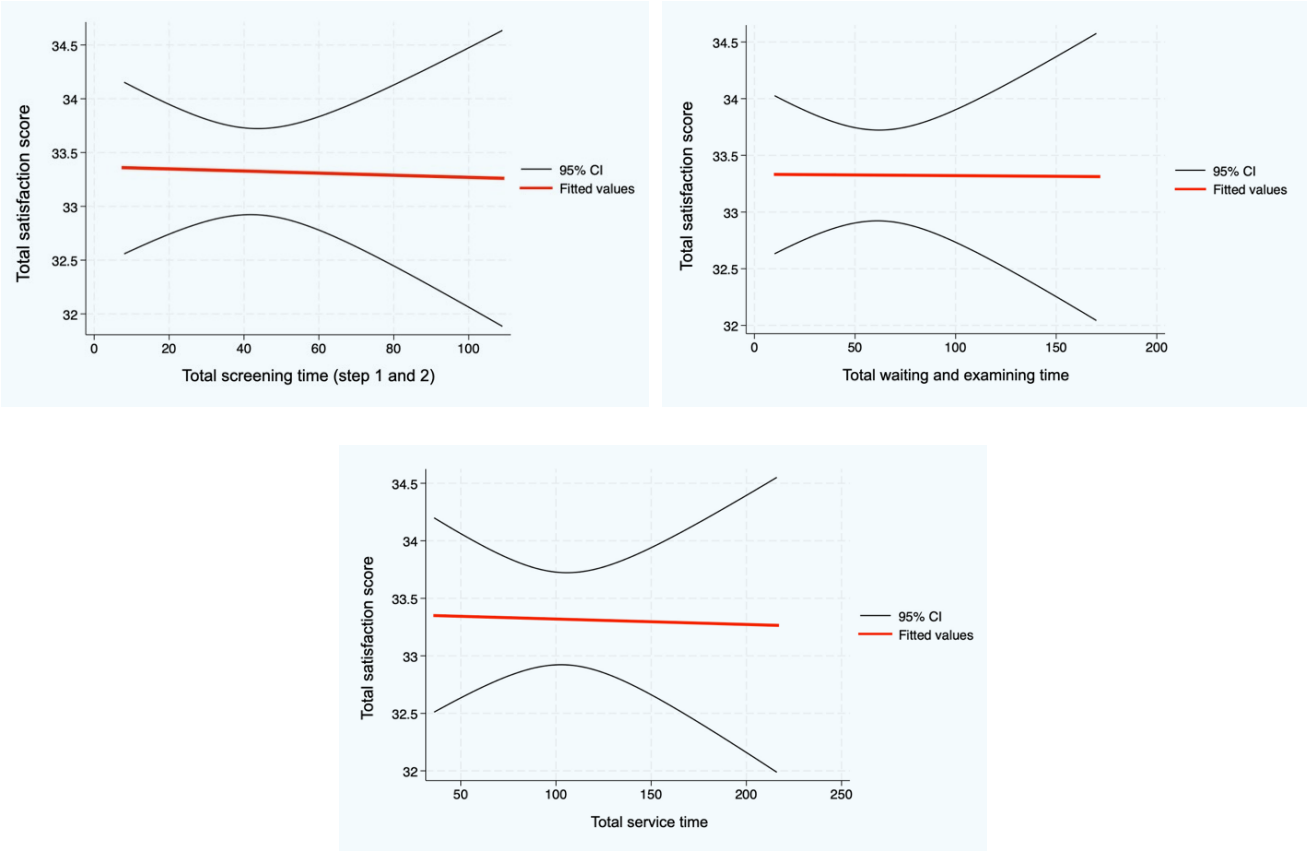


Fig 2. Relationship curve between total satisfaction score and time of service.

98.3% of the participants were confirmed to be at risk of malnutrition or malnourished, demonstrating the high positive predictive value of the step 1 questions. These findings suggest that while the step-one malnutrition screening tool is practical for high-volume clinical settings, its lower sensitivity may necessitate revisions of the incorporation of more sensitive questions to enhance the early detection of at-risk individuals.

The screening for oral health issues, ENT problems, and ocular conditions in step 1 involved the use of expert-designed questionnaires aimed at detecting clinical or urgent symptoms that need further evaluation by specialist clinics. These tools identified oral health problems, ENT issues, and ocular problems in 75%, 37.8%, and 50.6% of the participants, respectively. These results are consistent with those of previous studies. For example, 64% of older adults in the United States were reported to have periodontitis[34], whereas ocular issues, particularly visual impairment, affected 20–33% of older adults.[35,36] Similarly, ENT problems have been reported to affect 25–50% of this population.[37] The results from the step 1 screening in this study align with these previously reported prevalence rates, indicating that these screening questions are likely effective in general clinical practice.

This study highlights the relationship between service time and patient satisfaction, with findings consistent with previous research suggesting that higher satisfaction levels are associated with shorter waiting and service times.[38] However, older adults may prioritize interpersonal aspects of care and the thoroughness of assessments over efficiency alone.[38,39] The present study aligns with these observations, as the comprehensive screening process employed here provides a holistic evaluation, likely contributing to the overall satisfaction of patients despite the extended service time.

Strengths

Several notable strengths of this study can be identified. First, the check-up clinic's ability to detect unrecognized GSs before they lead to further deterioration or hospitalization is a substantial advantage. Early detection through comprehensive assessments allows multidisciplinary teams to intervene promptly, thereby preserving the functional capacity and enhancing the quality of life of older adults.[40] Second, the large sample size used in the primary data collection phase strengthens the generalizability of the findings, providing robust evidence on the efficacy of geriatric assessments in detecting prevalent yet often overlooked conditions. Third, the

implementation of standardized screening tools across both steps of the service process constitutes a key strength of this study. These validated tools, which adhere to international guidelines and established cutoff points, can be easily replicated in other health care settings, both within Thailand and globally, owing to the availability of translations and the use of standardized instruments. Finally, this study examined service-related metrics, including data collection times, waiting periods, and examination durations, providing valuable quantitative data for enhancing service quality. These metrics can be integrated with patient satisfaction data to inform targeted interventions aimed at improving service delivery.[41] By leveraging these data, the service team can optimize both the efficiency of care and the overall patient experience, ensuring that future improvements are data driven and aligned with patient expectations.

Limitations

Some limitations emerged in this study. First, social desirability bias, recall bias, or information bias may have influenced the responses, as participants might have underreported or misremembered relevant details during the self-reported questionnaires. Furthermore, participants may have tended to provide socially desirable responses when completing formal questionnaires.[42] Second, the reliance on the adapted version of screening questionnaires in step 1 is important, particularly for malnutrition and cognitive impairment.[12,15] Even though these adapted versions are based on previously validated instruments, these questionnaires may alter the sensitivity required for early detection, potentially resulting in the under- or over-detection of at-risk individuals. While practical for high-volume settings, incorporating more validated and sensitive questions could enhance the detection of early-stage conditions. Finally, the specific characteristics of the population at a check-up clinic in a high-volume hospital located in an urban setting may limit the generalizability of the results to rural populations or other health care settings with different demographic profiles and health care access challenges.[43] Future research should consider these limitations when designing studies applicable to broader populations.

Clinical implications

The findings from this study have several important implications for clinical practice. First, early detection of GSs through comprehensive geriatric screening can mitigate the progression of these conditions, reducing the need for more intensive health care services and improving overall well-being.[44,45] Second, the two-step comprehensive screening process for older adults offers a replicable model for other health care services. Health care systems can adapt and integrate similar comprehensive screening protocols into their services, particularly those focused on time management and the refinement of questionnaires to fit their specific contexts. Finally, the data on service efficiency and patient satisfaction underscore the importance of streamlining health care delivery without compromising the quality of care. These insights can guide future efforts to optimize service processes, ensuring that care remains both efficient and patient-centered.

CONCLUSION

This study highlights the effectiveness of a two-step comprehensive geriatric screening process in detecting GSs among older adults attending a check-up clinic at a tertiary care hospital. The findings revealed a high prevalence of GSs, including cognitive impairment, fall risk, and oral health issues, highlighting the critical role of early detection and timely intervention. The utilization of standardized screening tools facilitated reliable and consistent assessments, contributing to the reproducibility of the results across different settings. Moreover, despite extended service times, patient satisfaction remained notably high, reflecting the overall quality of care provided. However, this study identified certain limitations in the sensitivity of specific screening instruments, indicating the need for further refinement to improve early detection capabilities. These findings offer important insights into the improvement of geriatric care practices and the optimization of health care service delivery, both within Thailand and globally, through the implementation of structured and efficient screening protocols.

ACKNOWLEDGEMENTS

I would like to express my profound gratitude to the staff and colleagues at the Geriatric Clinic and CGCC at Siriraj Hospital for their invaluable support and assistance throughout the duration of this study. Their expertise and encouragement were instrumental in the successful completion of this research.

DECLARATION

Grants and Funding Information

This project is not funded by any sources.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Author Contributions

Conceptualization and methodology, H.P., and W.M.; Investigation and data collection, S.C., T.V., N.P., P.C., U.V., J.W., A.T., S.T., and A.J.; Formal analysis, H.P., W.M.; Visualization and writing – drafted the original manuscript, H.P.; Writing – review and editing, H.P., W.M.; Supervision, W.M. All authors have read and agreed to the final version of the manuscript.

REFERENCES

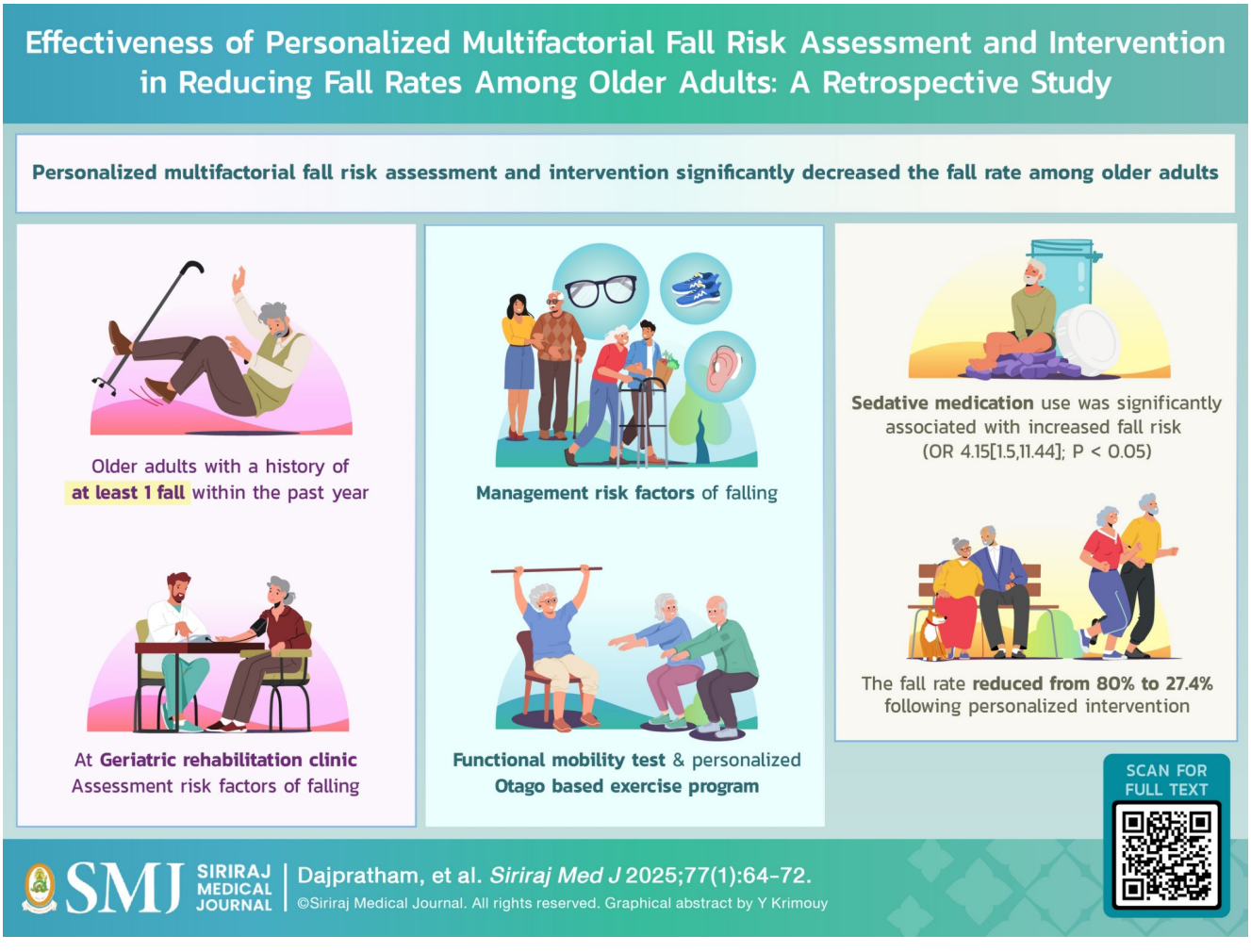
1. Carlson C, Merel SE, Yukawa M. Geriatric syndromes and geriatric assessment for the generalist. Med Clin North Am. 2015;99(2):263-79.
2. Praditsuwan R. Current Knowledge in Geriatric Syndromes. Siriraj Med J. 2007;59(2):79-81.
3. Möller J, Rausch C, Laflamme L, Liang Y. Geriatric syndromes and subsequent health-care utilization among older community dwellers in Stockholm. Eur J Ageing. 2022;19(1):19-25.
4. Rausch C, van Zon SKR, Liang Y, Laflamme L, Möller J, de Rooij SE, et al. Geriatric Syndromes and Incident Chronic Health Conditions Among 9094 Older Community-Dwellers: Findings from the Lifelines Cohort Study. J Am Med Dir Assoc. 2022;23(1):54-9.e2.
5. Cheung JTK, Yu R, Wu Z, Wong SYS, Woo J. Geriatric syndromes, multimorbidity, and disability overlap and increase healthcare use among older Chinese. BMC Geriatr. 2018;18(1):147.
6. Limpawattana P, Phimson K, Sookprasert A, Sirithanaphol W, Chindaprasirt J. Prevalence of Geriatric Syndromes in Elderly Cancer Patients Receiving Chemotherapy. Curr Gerontol Geriatr Res. 2020;2020:9347804.
7. Aging and the Labor Market in Thailand [Internet]. 2021 [cited 2024 September 21]. Available from: https://www.worldbank.org/en/country/thailand/publication/aging-and-the-labor-market-in-thailand.
8. Demographics of Thailand [Internet]. Statista. 2024 [cited 2024 September 21]. Available from: https://www.statista.com/statistics/713667/thailand-forecast-aging-population/.
9. Somnuke P, Pongraweewan O, Siriussawakul A. Optimizing Perioperative Care for Elderly Surgical Patients: A Review of Strategies and Evidence-Based Practices. Siriraj Med J. 2024;76(7):465-72
10. Screening guideline for general population. In: Department of Medical Services, editor.: Institute of Medical Research & Technology Assessment (IMRTA); 2022.
11. Heinisch O. Cochran, W. G. Sampling Techniques, 2. Aufl. John Wiley and Sons, New York, London 1963. Preis s. Biom Z. 1965;7(3):203.
12. Pramyothin P, Keawtanom S, Dawilai S, Sarasak R, Sukaruttanawong C, Triyen W, et al. Performance of a new national nutrition screening tool (spent nutrition screening tool) in hospitalized non-critically ill adults at an academic medical center. Clin Nutr. 2018;37:S236-S7.
13. Rubenstein LZ, Harker JO, Salvà A, Guigoz Y, Vellas B. Screening for undernutrition in geriatric practice: developing the short-form mini-nutritional assessment (MNA-SF). J Gerontol A Biol Sci Med Sci. 2001;56(6):M366-72.
14. Kaiser MJ, Bauer JM, Ramsch C, Uter W, Guigoz Y, Cederholm T, et al. Validation of the Mini Nutritional Assessment short-form (MNA-SF): a practical tool for identification of nutritional status. J Nutr Health Aging. 2009;13(9):782-8.
15. World Health Organization. Integrated care for older people (ICOPE): guidance for person-centred assessment and pathways in primary care. 2019.
16. Train the Brain Forum Committee. Thai Mental State Examination (TMSE). Siriraj Hosp Gaz. 1993;45:359-74.
17. Nasreddine ZS, Phillips NA, Bédirian V, Charbonneau S, Whitehead V, Collin I, et al. The Montreal Cognitive Assessment, MoCA: a brief screening tool for mild cognitive impairment. J Am Geriatr Soc. 2005;53(4):695-9.
18. Arunpongpaisal S, Kongsuk T, Maneethorn N, Maneethorn B, Wannasawek K, Leejongpermpoon J, et al. Development and validity of two-question screening test for depressive disorders in Northeastern Thai community. Asian J Psychiatr. 2009;2(4):149-52.
19. Costantini L, Pasquarella C, Odone A, Colucci ME, Costanza A, Serafini G, et al. Screening for depression in primary care with Patient Health Questionnaire-9 (PHQ-9): A systematic review. J Affect Disord. 2021;279:473-83.
20. Visanuyothin S, Ittivisawakul N. The treatment of people with depression guideline The Journal of Boromrajonani College of Nursing, Nakhonratchasima. 2010;16(1).
21. Centers for Disease Control and Prevention (CDC), Stopping Elderly Accidents Deaths & Injuries (STEADI). Algorithm for Fall Risk Screening, Assessment, and Intervention. 2019.
22. Bischoff HA, Stähelin HB, Monsch AU, Iversen MD, Weyh A, von Dechend M, et al. Identifying a cut-off point for normal mobility: a comparison of the timed 'up and go' test in community-dwelling and institutionalised elderly women. Age Ageing. 2003;32(3):315-20.
23. Lord SR, Murray SM, Chapman K, Munro B, Tiedemann A. Sit-to-stand performance depends on sensation, speed, balance, and psychological status in addition to strength in older people. J Gerontol A Biol Sci Med Sci. 2002;57(8):M539-43.
24. Watts NB. The Fracture Risk Assessment Tool (FRAX®): applications in clinical practice. J Womens Health (Larchmt). 2011;20(4):525-31.
25. Cosman F, de Beur SJ, LeBoff MS, Lewiecki EM, Tanner B, Randall S, et al. Clinician's Guide to Prevention and Treatment of Osteoporosis. Osteoporos Int. 2014;25(10):2359-81.
26. Akarapornkrailert P, Muangpaisan W, Boonpeng A, Daengdee D. Validation of the Thai version of SARC-F, MSRA-7, and MSRA-5 questionnaires compared to AWGS 2019 and sarcopenia risks in older patients at a medical outpatient clinic. Osteoporos Sarcopenia. 2020;6(4):205-11.
27. Chen LK, Woo J, Assantachai P, Auyeung TW, Chou MY, Iijima K, et al. Asian Working Group for Sarcopenia: 2019 Consensus Update on Sarcopenia Diagnosis and Treatment. J Am Med Dir Assoc. 2020;21(3):300-7.e2.
28. Sriwong W, Mahavisessin W, Srinonprasert V, Siriussawakul A, Aekplakorn W, Limpawattana P, et al. Validity and reliability of the Thai version of the simple frailty questionnaire (T-FRAIL) with modifications to improve its diagnostic properties in the preoperative setting. BMC Geriatr. 2022;22(1):161.
29. Lin CC, Meardon S, O'Brien K. The Predictive Validity and Clinical Application of Stopping Elderly Accidents, Deaths & Injuries (STEADI) for Fall Risk Screening. Adv Geriatr Med Res. 2022;4(3).
30. Loonlawong S, Limroongreungrat W, Rattananupong T,

Kittipimpanon K, Saisanan Na Ayudhaya W, Jiamjarasrangsi W. Predictive validity of the Stopping Elderly Accidents, Deaths & Injuries (STEADI) program fall risk screening algorithms among community-dwelling Thai elderly. BMC Med. 2022;20(1):78.
31. Trevethan R. Sensitivity, Specificity, and Predictive Values: Foundations, Pliabilities, and Pitfalls in Research and Practice. Front Public Health. 2017;5:307.
32. Besora-Moreno M, Llauradó E, Tarro L, Solà R. Social and Economic Factors and Malnutrition or the Risk of Malnutrition in the Elderly: A Systematic Review and Meta-Analysis of Observational Studies. Nutrients. 2020;12(3).
33. Chuansangeam M, Wuthikraikun C, Supapueng O, Muangpaisan W. Prevalence and risk for malnutrition in older Thai people: A systematic review and meta-analysis. Asia Pac J Clin Nutr. 2022; 31(1):128-41.
34. Coll PP, Lindsay A, Meng J, Gopalakrishna A, Raghavendra S, Bysani P, et al. The Prevention of Infections in Older Adults: Oral Health. J Am Geriatr Soc. 2020;68(2):411-6.
35. Bourne RRA, Flaxman SR, Braithwaite T, Cicinelli MV, Das A, Jonas JB, et al. Magnitude, temporal trends, and projections of the global prevalence of blindness and distance and near vision impairment: a systematic review and meta-analysis. Lancet Glob Health. 2017;5(9):e888-e97.
36. Guthrie DM, Davidson JGS, Williams N, Campos J, Hunter K, Mick P, et al. Combined impairments in vision, hearing and cognition are associated with greater levels of functional and communication difficulties than cognitive impairment alone: Analysis of interRAI data for home care and long-term care recipients in Ontario. PLoS One. 2018;13(2):e0192971.
37. Hsu AK, Bassett SM, O'Dwyer LC, McHugh M, Heinemann AW, Jordan N, et al. Cost-Effectiveness of Hearing Screening in Older Adults: A Scoping Review. Res Aging. 2022;44(2):186-204.
38. Lee Y, Kasper JD. Assessment of medical care by elderly people: general satisfaction and physician quality. Health Serv Res. 1998;32(6):741-58.
39. Kuo RJ, Wu YH, Hsu TS, Chen LK. Improving outpatient services for elderly patients in Taiwan: a qualitative study. Arch Gerontol Geriatr. 2011;53(2):e209-17.
40. Daure A, Chicoulaa B, Lagourdette C, Escourrou E, Secher M, Oustric S, et al. [General practitioners' satisfaction after a geriatric assessment into primary care: data from FAP study]. Geriatr Psychol Neuropsychiatr Vieil. 2019;17(1):31-7.
41. Batalden PB, Davidoff F. What is "quality improvement" and how can it transform healthcare? Qual Saf Health Care. 2007; 16(1):2-3.
42. Bispo Júnior JP. Social desirability bias in qualitative health research. Rev Saude Publica. 2022;56:101.
43. Kroneman M, Verheij R, Tacken M, van der Zee J. Urban-rural health differences: primary care data and self reported data render different results. Health Place. 2010;16(5):893-902.
44. Sanford AM, Morley JE, Berg-Weger M, Lundy J, Little MO, Leonard K, et al. High prevalence of geriatric syndromes in older adults. PLoS One. 2020;15(6):e0233857.
45. Rafters SL, Schleper J, Lean N, Hwang M, Rohra A, Lillington L. Geriatric Syndrome Screening: Implementing an Evidence-Based Process in Hospitalized Older Adults With Cancer. Clin J Oncol Nurs. 2021;25(3):297-304.

Effectiveness of Personalized Multifactorial Fall Risk Assessment and Intervention in Reducing Fall Rates Among Older Adults: A Retrospective Study

Piyapat Dajpratham, M.D.[1,*], Poungkaew Thitisakulchai, M.D.[1], Rinlada Pongratanakul, M.D.[1], Rachaporn Prapavanond, M.D.[1], Sirapat Haridravedh, M.D.[1], Weerasak Muangpaisan, M.D.[2]

[1]Department of Rehabilitation Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand, [2]Department of Preventive and Social Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand.



**Corresponding author: Piyapat Dajpratham*
E-mail: piyapat.daj@mahidol.ac.th
Received 30 September 2024 Revised 1 November 2024 Accepted 11 November 2024
ORCID ID:http://orcid.org/0000-0002-6067-0319
https://doi.org/10.33192/smj.v77i1.271422

ABSTRACT

Objective: This study aimed to investigate the effectiveness of personalized multifactorial fall risk assessment and intervention in reducing the incidence of recurrent falls after one year.

Materials and Methods: This retrospective study reviewed medical records from the Geriatric Rehabilitation Clinic at Siriraj Hospital, including data from patients with a history of falls (fallers) or gait instability (non-fallers) between April 2016 and April 2021. Upon entering the clinic, older patients received personalized multifactorial fall risk assessment and intervention. Functional mobility was also evaluated using the Timed Up and Go (TUG) test, Functional Reach, and 30-second Chair Stand test. Fallers were followed for one year, and classified into recurrent fallers or zero-fallers based on whether they experienced at least one fall during the follow-up period.

Results: Of the 134 patients initially reviewed, 105 met the criteria for analysis. The cohort was predominantly female (65.5%) with an average age of 81.5 years (SD 6.8). Common risk factors included hypertension, back/leg pain, and cognitive impairment. After 12 months, 27.4% of fallers experienced recurrent falls. Sedative medication use was significantly associated with increased fall risk (OR 4.15[1.5,11.44]; $P < 0.05$). Other risk factors were not statistically significant. The fall rate reduced from 80% to 27.4% following personalized intervention.

Conclusion: Personalized multifactorial fall risk assessment and intervention significantly decreased the fall rate among older patients. Sedative medications were notably linked to increased fall risk, highlighting the need for careful medication management and targeted fall prevention strategies.

Keywords: Aged; balance; exercise therapy; falls; gait disorders; rehabilitation; risk factors (Siriraj Med J 2025; 77: 64-72)

INTRODUCTION

Falls and instability among the older people have significant global repercussions, including disability and increased mortality.[1] On an individual level, falls often lead to a decline in self-care abilities, reduced independence, and even death, emphasizing their severe impact. Nationally, the economic burden of falls is considerable, with healthcare costs escalating due to hospitalizations and long-term care expenses for fall-related injuries. A 2014 study in the United States estimated that the annual cost of elderly fall care ranges from $68 million to $2.8 trillion, underscoring the substantial financial strain associated with falls.[2]

A fall is defined as an unexpected and sudden loss of control, causing an individual to collapse to the ground or assume a seated or prone position, typically due to impaired balance.[3]

To address these challenges, the American Geriatric Society and British Geriatric Society have established guidelines focusing on fall prevention and comprehensive risk assessments for older adults. These guidelines emphasized proactive strategies, including regular evaluations using tools such as the Timed Up and Go Test, the Morse Fall Scale, and the Berg Balance Test.[4] Additionally, the CDC's Stopping Elderly Accidents, Deaths & Injuries (STEADI) Initiative emphasized three key components: Screen, Assess, and Intervene.[5] For individuals experiencing recurrent falls or abnormal gait, thorough assessments by interdisciplinary teams are essential. Evidence-based interventions, such as balance training, muscle strengthening exercises for the hips, knees, and ankles, and joint flexibility exercises were crucial in managing fall risks.[6] Additionally, making appropriate modifications to the home environment was recommended to further reduce fall risks among the older people.[7,8]

At Siriraj Hospital, the Geriatric Rehabilitation Clinic works in conjunction with the geriatric clinic to provide specialized care for individuals aged 70 and older, or those aged 60 and above with cognitive impairments. The clinic focuses on enhancing the functional capacity of older adults at risk of functional decline. Patients with movement or balance issues and a history of falls receive comprehensive, multifactorial fall risk assessments and personalized interventions. This study aimed to investigate the characteristics and fall risk among older patients attending the geriatric rehabilitation clinic. In addition, the incidence of recurrent fall was also examined as an outcome of the fall management interventions in this vulnerable population.

MATERIALS AND METHODS

Study Design

This retrospective study involved a review of medical records from the Geriatric Rehabilitation Clinic at Siriraj Hospital. The research project was reviewed and approved

by the Human Research Ethics Committee of the Faculty of Medicine Siriraj Hospital (Project SI 1003/2020, Code 761/2020 [IRB1]). Authorization to access medical record information was granted by the hospital director.

Participants

We evaluated patients treated at the Geriatric Rehabilitation Clinic for eligibility based on the following inclusion criteria: a history of at least one fall within the past year or walking instability between April 2016 and April 2021, along with abnormal functional mobility tests. Additionally, patients needed to have accessible medical record data from at least one baseline, one follow-up assessment within the year, and one year follow-up visit. Patients were excluded if their data on risk factors, complications from various diseases, functional mobility tests, or dependency status were incomplete at the three specified time points.

Data collection and assessment

Study measurements were recorded at initial and one year follow-up visits. Patients with at least one fall or gait instability underwent a multifactorial fall risk assessment and intervention. This assessment included evaluating various fall risk factors such as comorbidities, medication use (including sedatives and hypnotic drugs), visual and auditory function, cognitive function, frequent urination (≥8 times per day), urinary incontinence (stress, urge, overflow, and mixed incontinence), foot deformities (e.g., hallux valgus, hammer toe, Charcot arthropathy), back/leg pain, and external factors like home environment and presence of pets. Activities of daily living (ADL) were assessed using the KATZ ADL[9] and LAWTON IADL scales.[10]

Fall history was documented by recording the location and time of each fall. Balance impairments were evaluated using functional mobility tests, including the Timed Up and Go (TUG), Functional Reach, and 30-second Chair Stand tests, with results documented in clinic records. According to the CDC's STEADI tool,[5] a TUG score of 12 seconds or more, a low number of 30-second chair stands based on age groups, and a Functional Reach score of less than 10 inches indicate a fall risk.[9]

Patients exhibiting abnormal functional mobility tests were scheduled for regular follow-ups, approximately 2-3 times annually. During these visits, they underwent repeat functional mobility assessments and received personalized advice, counseling, exercise recommendations, and environmental adjustments based on the multifactorial fall risk assessment results. Follow-up visits included a comparison of current functional mobility test results with previous assessments, and patients and their caregivers were provided feedback regarding their performance. Patients were then encouraged to adhere to the recommended interventions, with exercise programs reviewed and adjusted according to each individual's functional capacity.

Multifactorial fall risk interventions

The Geriatric Rehabilitation Clinic collaborated closely with the geriatric clinic, where geriatricians addressed medical issues that could contribute to falls, such as polypharmacy, postural hypotension, and cardiopulmonary conditions. Physiatrists in the rehabilitation clinic assessed and managed neuro-musculoskeletal issues and other risk factors, including gait and balance impairments, back and leg pain, and foot deformities. For specific conditions like visual or auditory impairments that required further assessment by other specialties, consultations were initiated. Living environments were screened, and necessary adjustments were recommended. Exercise recommendations in our clinic were based on the Otago Exercise Program (OEP), a home-based initiative designed for fall prevention in older adults.[11] This program emphasized three key areas: strength, balance, and endurance. Strength and balance training was recommended three days a week, for 15-20 minutes twice daily, while endurance training involved 30 minutes of daily walking, which could be divided into 10-minute sessions throughout the day. These exercise programs were tailored to each patient's functional status and physical capacity. To ensure proper execution of the exercises at home, patients and their caregivers were instructed on the exercises in the clinic. Clinicians demonstrated each exercise, emphasizing proper technique and safety precautions. For patients who experienced instability during standing or walking, additional support was recommended, such as using their hands for balance while performing the exercises. In terms of enhancing exercise adherence, patients were encouraged to record their exercise sessions using smartphones. This self-monitoring strategy helped reinforce their commitment and allowed clinicians to review the patient's progress during follow-up visits. For patients who did not use smartphones, written instructions were provided as an alternative. To further ensure adherence and proper execution, caregivers were asked to supervise the patients during their exercise sessions at home. This support from caregivers was vital for reinforcing the routine and providing assistance if needed. As the program was conducted in an outpatient (OPD) setting, our role was to select the appropriate exercises from the OEP, which patients were expected to perform at home. Adherence was closely monitored

through regular follow-up appointments, during which clinicians reviewed the patients' exercise performance and made any necessary adjustments. We also ensured that all procedures adhered to the Privacy and Data Protection Act (PDPA) of 2019, especially in regard to patients using smartphones to record their exercises.

Data collection and classification

Demographic data, including age, gender, body mass index (BMI), fall risk factors, functional mobility tests, and ADL scores (KATZ ADL and LAWTON IADL), were collected at the initial assessment and again at 12 months. This information was extracted from medical records and entered into a prepared case record form. Participants were initially categorized into two groups: fallers (those with at least one fall in the preceding year) and non-fallers (those without falls). Fallers were further classified into two subgroups: recurrent faller (those with multiple falls) and zero-fall (those with no falls during the follow-up year).

Sample size calculation

The sample size calculation was based on a study involving multifactorial interventions to reduce the risk of falls among elderly individuals living in the community.[12] This study indicated an average decrease in recurrent falls of 33%, an acceptable width of 95% confidence interval (24%, 42%). The sample size would be 105 cases.

Statistical analysis

Statistical analyses were performed using PASW Statistics version 18.0 (SPSS Inc., Chicago, IL, USA).[13] Descriptive statistics were applied to assess demographic characteristics, fall risk factors, functional mobility test results, and ADL abilities at baseline between fallers and non-fallers. Comparisons were also made between recurrent fall and zero fall groups at the one-year follow-up. Categorical variables, such as gender and the presence of common risk factors, were compared using Chi-square tests, while Fisher's exact test was used for the number of 30-second chair stands. Continuous data, including age, BMI, number of medications, functional test times, and ADL scores, were compared using independent sample t-tests. Statistical significance was defined as a p-value < 0.05. Odds ratios with 95% confidence intervals were reported for univariate analyses.

RESULTS

From April 2016 to April 2021, a review of outpatient medical records at the Siriraj Geriatric Rehabilitation Clinic identified 134 patients who underwent multifactorial fall risk assessment and intervention for falls and unsteady walking. Of these, 18 patients did not return for follow-up, seven were unable to participate due to conditions such as cerebrovascular disease or other serious illnesses, and four missed their follow-up appointments. Therefore, data from 105 patients were included in the final analysis. The cohort was predominantly female (65.5%), with an average age of 81.5 years (SD 6.8) and an average body mass index (BMI) of 22.8 kg/m^2 (SD 3.2). The most common risk factors were hypertension (82.9%), back or leg pain (81.0%), and cognitive impairment (61.0%). Falls were most frequently reported at home (82.2%) and during the daytime (74.6%).

Participants were divided into two groups based on their fall history over the past year: 84 patients were categorized as Fallers, individuals with a history of falls, while 21 were classified as Non-fallers, individuals with no fall history. Basic demographic and clinical characteristics, including gender, age, BMI, and common risk factors, were provided in Table 1. The Faller group exhibited higher prevalence rates for several factors compared to the Non-faller group. Specifically, pet ownership was more common among Fallers, as was diabetes, frequent urination, foot deformities, and the use of sedating medications. The Fallers also had longer completion times for the TUG test. Most Fallers reported difficulties in performing activities of daily living. No significant differences were observed in the other functional mobility tests between the Faller and Non-faller groups.

After 12 months of follow-up, 27 patients from both groups experienced falls, while 78 patients did not. Among the 84 patients with a history of falls prior to the study, 23 (27.4%) experienced recurrent falls, while 61 (72.6%) did not. The recurrent fall group had significantly higher use of sedating medications compared to the zero-fall group (OR 4.15 [1.5,11.44]; $P < 0.05$) and this magnitude could be interpreted as large effect size.[14] Other risk factors did not show significant differences between the groups. The recurrent fall group was more likely to have hypertension, diabetes, cognitive impairment, foot deformities, and polypharmacy. Additionally, the recurrent fall group took longer to complete the TUG test compared to zero fall group, suggesting a higher fall risk despite improvements since the initial assessment (Table 2).

DISCUSSION

This study explored the characteristics, prevalent risk factors, and functional mobility among older adults attending a geriatric rehabilitation clinic. Our findings indicated that the majority of participants were elderly

TABLE 1. Demographic characteristics, common risk factors, and functional tests of all participants at baseline (N=105).

Variables	Faller (N=84)	Non-Faller (N=21)	P value	Odds ratio (95%CI)
Demographic characteristic				
Sex : Female	55 (65.5)	13(61.9)	0.759	1.17 (0.43,3.13)
Age (year)[1]	81.21±7	82.5±5.8	0.430	0.97 (0.90,1.04)
Body mass index (BMI: kg/m^2)[1]	22.8±3.2	22.9±3.4	0.943	0.99 (0.81,1.22)
Common risk factor				
Pets	27(32.1)	4(19.0)	0.239	2.01 (0.62, 6.56)
Diabetes Mellitus	36(42.9)	6(28.6)	0.232	1.88 (0.66, 5.31)
Frequency urination	49(58.3)	9(42.9)	0.202	1.87 (0.71, 4.90)
Foot deformity	23(27.4)	4(19.0)	0.435	1.60 (0.49, 5.27)
Sedative drugs	34(40.5)	7(33.3)	0.548	1.36 (0.50, 3.72)
Number of medication[1]	8.2±2.6	8.6±3.5	0.578	0.95 (0.80, 1.13)
Urinary incontinence	33(44.0)	10(47.6)	0.768	0.87 (0.33, 2.26)
Auditory impairment	18(21.4)	5(23.8)	0.775	0.87 (0.28, 2.71)
Cardiovascular disease	28(33.3)	8(38.1)	0.681	0.81 (0.30, 2.19)
Cognitive impairment	50(59.5)	14(66.7)	0.548	0.74 (0.27, 2.01)
Visual impairment	49(58.3)	14(66.7)	0.486	0.70 (0.26, 1.91)
Back/ leg pain	67(79.8)	18(85.7)	0.758	0.66 (0.17, 2.49)
Hypertension	68(81.0)	19(90.5)	0.517	0.45 (0.94, 2.12)
Functional mobility test				
Time up and go (sec)[1]	30.5±14.0	26.7±12.8	0.285	1.02 (0.98, 1.06)
Functional reach (inch)[1]	7.9±3.5	7.7±2.5	0.795	1.02 (0.86, 1.22)
30 sec chair stand (times)[2]	6(2-17)	6(4-11)	0.547	0.98 (0.82,1.16)
KATZ AD[1]	5.1±1.5	5.6±.9	0.068	0.73 (0.46, 1.16)
Lawton IAD[1]	2.3±2.5	3.1±2.6	0.187	0.89 (0.74, 1.06)

Data presented as number (%), [1]mean ± SD, [2]median (Min-Max); *p value< 0.05 indicates statistical significance

females, with hypertension, back and leg pain, cognitive disorders, visual impairment, and frequent urination identified as the most common risk factors for falls, listed in order of prevalence.

Upon comparison of individuals with and without a history of falls at baseline, associations were observed between pet ownership, diabetes mellitus, frequent urination, foot deformities, and the use of sedative medications; however, these associations did not achieve statistical significance. Over the one-year follow-up, we identified significant risk factors for recurrent falls. Specifically, the use of sedative/hypnotic drugs was significantly associated with recurrent falls, with a prevalence of 65.2% in the recurrent faller group compared to 31.1% in the zero-fall group (OR 4.15[1.5,11.44]; $P < 0.05$). While cognitive impairment, hypertension, foot deformities, and polypharmacy were more prevalent among recurrent fallers, these factors did not reach statistical significance.

The Timed Up and Go (TUG) test demonstrated that both the faller and recurrent faller groups took longer to complete the test than the non-faller and zero-fall groups. Notably, no significant differences were found in other balance assessments at baseline or at the one-year follow-up. At baseline, 80% of participants reported

TABLE 2. Demographic characteristic, common risk factors, and functional tests of the faller group at 1-year follow-up (N=84).

Variables	Recurrent fall (N=23)	Zero fall (N=61)	P value	Odd ratio (95%CI)
Demographic characteristic				
Sex : Female	17(73.9)	38(62.3)	0.318	0.58 (0.20, 1.69)
Age (year)[1]	80.7±6.9	81.4±8.1	0.705	0.99 (0.92, 1.06)
Body mass index (BMI: kg/m^2)[1]	22.8±3.3	22.8±3.2	0.980	0.99 (0.84, 1.19)
Common risk factor				
Sedative drugs	15(65.2)	19(31.1)	0.005*	4.15 (1.50, 11.44)
Cognitive impairment	16(69.6)	34(55.7)	0.250	1.82 (0.65, 5.04)
Hypertension	20(87.0)	48(78.7)	0.538	1.81 (0.46, 7.03)
Foot deformity	7(30.4)	16(26.2)	0.700	1.23 (0.43, 3.54)
Number of medication[1]	8.7±2.7	8.0±2.6	0.323	1.10 (0.91, 1.34)
Diabetes Mellitus	10(43.5)	26(42.6)	0.944	1.04 (0.39, 2.73)
Frequency urination	13(56.5)	36(59.0)	0.836	0.90 (0.34, 2.38)
Pets	7(30.4)	20(32.8)	0.837	0.90 (0.32, 2.53)
Back/ leg pain	18(78.3)	49(80.3)	1.000	0.88 (0.27, 2.85)
Visual impairment	12(52.2)	37(60.7)	0.482	0.71 (0.27, 1.86)
Auditory impairment	4(17.4)	14(23)	0.768	0.71 (0.21, 2.42)
Cardiovascular disease	6(26.1)	22(36.1)	0.387	0.63 (0.22, 1.82)
Urinary incontinence	8(34.8)	29(47.5)	0.294	0.59 (0.22, 1.59)
Functional test				
Time up and go (sec)[1]	28.25±14.6	21.9±13.9	0.318	1.03 (0.97, 1.10)
Functional reach (inch)[1]	9.0±0.0	9.9±3.5	N/A	N/A
30 sec chair stand (times)[2]	7(2-13)	6(2-17)	0.882	0.96 (0.77, 1.19)
KATZ ADL[1]	4.6±1.9	5.2±1.6	0.194	0.84 (0.65, 1.09)
Lawton IADL[1]	2.4±2.6	2.7±2.7	0.697	0.96 (0.80, 1.16)

Data presented as number (%), [1]mean ± SD, [2]median (Min-Max), *p value< 0.05 indicates statistical significance

having fallen in the previous year, a higher prevalence than observed in other studies, likely attributable to the specialized nature of our clinic. For instance, Assantachai et al. reported a fall prevalence of 19.8% among elderly individuals in urban Thailand over six months,[15] which aligned with our findings that high blood pressure, cognitive impairment, and functional difficulties are prevalent among fallers.[16]

Our results support a recent review indicating that multifactorial fall risk assessment and intervention strategies could effectively reduce fall rates.[17] *Lee et al.* documented a 32% reduction in falls among participants who received such interventions.[16] Additionally, our study highlighted a fourfold increase in the risk of falling associated with sedative medications among recurrent fallers. This finding corroborated the work of Woolcott et al., who identified sedatives as significant contributors to fall risk.[18] Various medication categories, including antihypertensives, antiarrhythmics, anticholinergics, antihistamines, and other fall-risk-increasing-drugs, have been linked to heightened fall risk.[19-24] Among older patients with comorbidities, cumulative exposure to anticholinergic and sedative medications was associated with poorer performance in multiple gait dimensions,

including slow walking speed and impaired walking balance.[25,26]

Cognitive decline significantly increased fall risk in older adults due to specific associations between gait parameters and cognitive function.[27] In our study, cognitive impairment did not emerge as a statistically significant risk factor for recurrent falls, potentially due to the personalized multifactorial fall risk assessments and interventions including the OEP implemented upon clinic entry. Counseling on home modifications and safety concerns during daily activities was also emphasized, underscoring the effectiveness of home fall-hazard interventions in reducing both fall rates and the number of fallers among high-risk individuals.[28] In addition, the OEP has positive effects on motor function in improving neurocognitive function in older adult.[29]

Hypertension is prevalent in the older population and is recognized as a risk factor for falls, often necessitating medications that may further exacerbate fall risk.[30,31] Orthostatic hypotension, particularly when coupled with hypertension, has been independently associated with an increased risk of future falls. In our study, hypertension was not identified as a significant risk factor for recurrent falls, likely due to the proactive management of medications and efforts to minimize polypharmacy by geriatricians.

Although foot deformities were not statistically significant as a risk factor for recurrent falls, they remained a consistent concern among both baseline and recurrent fallers, suggesting that footwear modifications could enhance safety. Cultural factors, such as the Thai preference for barefoot living at home, may contribute to ongoing fall risks. Additionally, diabetes was recognized as a common risk factor that can lead to falls due to complications such as peripheral neuropathy,[32] retinopathy, vestibular dysfunction, cognitive impairment and hypoglycemic events associated with insulin use.[33] The implementation of diabetic foot problem screening, foot care advice, and appropriate shoe prescriptions in our geriatric rehabilitation clinic may explain the lack of significant association between diabetes and recurrent falls in our study.

Falls among older adults arise from a complex interplay of risk factors, emphasizing the necessity for comprehensive assessment and intervention strategies to mitigate these risks. The recurrent fall group in our study exhibited poorer balance function, as evidenced by longer TUG completion times compared to the zero-fall group. Both multifactorial and exercise interventions were associated with beneficial outcomes related to fall prevention.[34] Given the constraints of time and resources in outpatient settings, some clinicians may opt to implement only a single strategy. However, network meta-analyses indicated that exercise alone was linked to reductions in fall rates, incidence of fallers, and fall-related fractures compared to usual care.[35] A review by Guirguis-Blake et al. supported strength and balance training as effective interventions for older adults with a history of recurrent falls. Promoting such interventions can enhance health, independence, and overall quality of life.[36] The OEP has been demonstrated to effectively reduce falls and related injuries while also improving cognitive function, lower limb strength, and balance abilities, which were critical for fall prevention in older adults.[37] Additionally, it has shown cost-effectiveness for individuals over 80 years of age.[38]

This study possessed several strengths, notably demonstrating the benefits of personalized multifactorial fall risk assessments and interventions among high-risk elderly individuals, and showcasing the feasibility of implementing such strategies in an outpatient setting. However, limitations should be acknowledged. Selection bias may have occurred due to the recruitment of participants with a history of falls or gait instability, resulting in a higher fall rate compared to community-based studies. Furthermore, during the COVID-19 pandemic, the utilization of telemedicine for follow-up visits led to the exclusion of 16% of participants who were unable to attend in-person functional mobility tests. Recall bias concerning fall history may also have influenced outcomes and specific interventions. Lastly, this study was conducted within a tertiary care geriatric clinic, where resources for personalized assessments and interventions were available; therefore, the findings may not be generalizable to other care settings. Future research should consider prospective cohort studies with larger sample sizes to address these limitations, facilitate more comprehensive data collection, and strengthen the robustness of study findings.

CONCLUSION

The personalized multifactorial fall risk assessment and intervention reduced the prevalence of falls among older adults from 80% to 27.4%. Sedative medication was identified as a significant factor associated with an increased risk of falls. The majority of falls occurred during the daytime, highlighting the importance of addressing medication-related fall risks and implementing personalized preventive strategies.

ACKNOWLEDGEMENTS

The authors are grateful to Mr.Suthipol Udompunthurak, of the Faculty of Medicine Siriraj

Hospital, Mahidol University, for his help with the statistical analyses. The authors also appreciate the help of Aditya Rana with English language editing.

DECLARATION

Grants and Funding Information

None

Conflict of Interests

The authors declare no conflict of interest.

Authors Contributions

P.D. : conception and design, interpretation of data, revising it critically for important intellectual content; and final approval of the version to be published. P.T. : acquisition of data, revising it critically for important intellectual content and final approval of the version to be published. R.P. : acquisition of data, revising it critically for important intellectual content and final approval of the version to be published. R.P. : analysis and interpretation of data, drafting the article. S.H. : interpretation of data, drafting the article. W.M. : revising it critically for important intellectual content and final approval of the version to be published.

REFERENCES

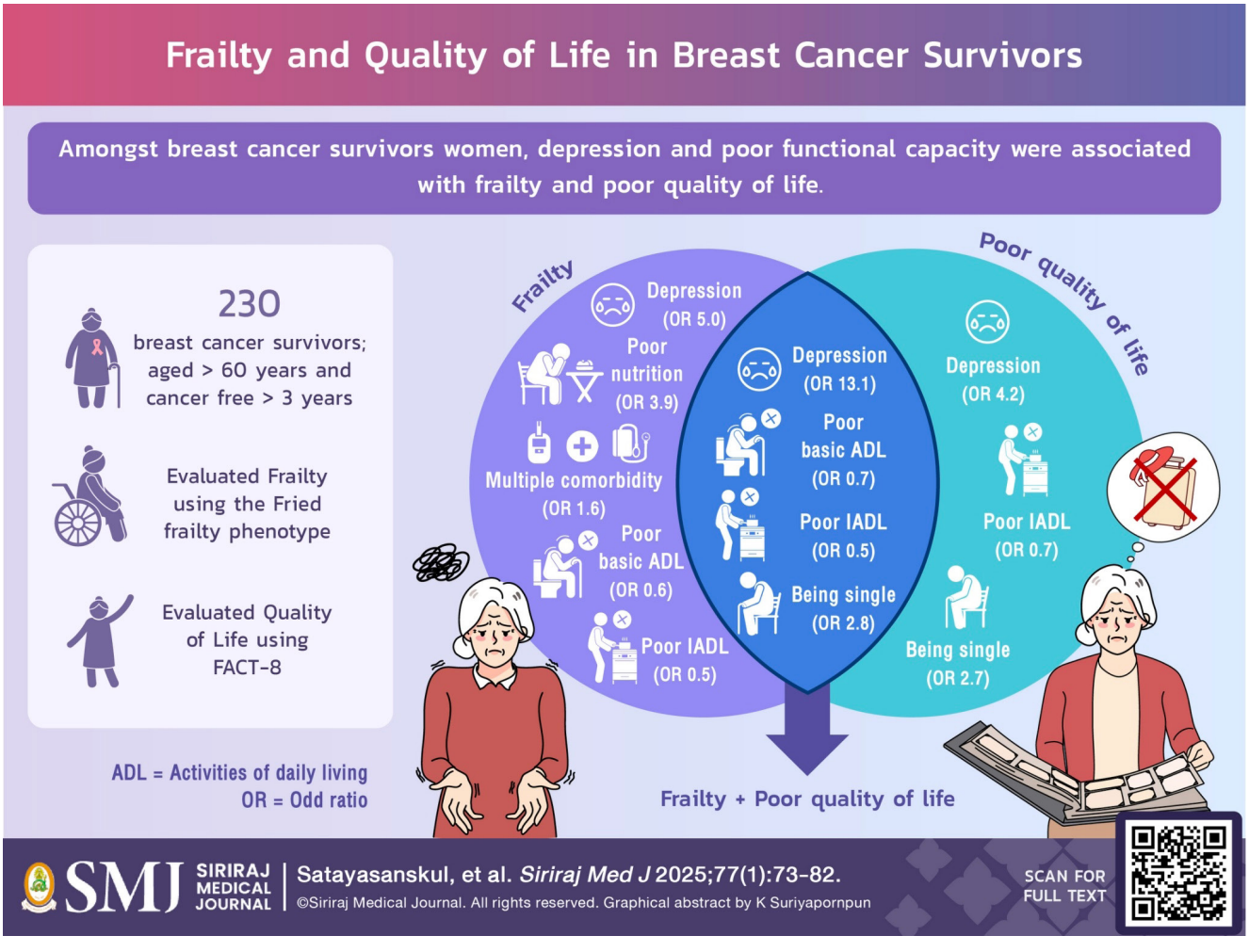
1. Xing L, Bao Y, Wang B, Shi M, Wei Y, Huang X, et al. Falls caused by balance disorders in the elderly with multiple systems involved: pathogenic mechanisms and treatment strategies. Front Neurol. 2023;14(1):1128092.
2. Haddad YK, Bergen G, Florence CS. Estimating the economic burden related to older adult falls by state. J Public Health Manag Pract. 2019;25(2):E17-E24.
3. Chantharamani K, Kaewsarn P, Tipkanjanaraykha K. The development of a fall risk assessment form for elderly patients with visual impairment at the ophthalmic ward. J Royal Thai Army Nurses 2023;24(3):330-8.
4. American geriatrics society and british geriatrics society. Summary of the Updated American Geriatrics Society/British Geriatrics Society clinical practice guideline for prevention of falls in older persons. J Am Geriatr Soc. 2011;59(1):148-57.
5. Center for disease control and prevention. STEADI-older adult fall prevention: clinical resource [Internet]. Atlanta: U.S Department of Health and Human services; [cited 2024 Sep 1]. Available from: https://www.cdc.gov/steadi/hcp/clinical-resources/index.html.
6. Sherrington C, Fairhall NJ, Wallbank GK, Tiedemann A, Michaleff ZA, Howard K, et al. Exercise for preventing falls in older people living in the community. Cochrane Database Syst Rev. 2019;1(1):CD012424.
7. Cheng P, Tan L, Ning P, Li L, Gao Y, Wu Y, et al. Comparative effectiveness of published interventions for elderly fall prevention: a systematic review and network meta-analysis. Int J Environ Res Public Health. 2018;15(3):1-14.
8. Rimland JM, Abraha I, Dell'Aquila G, Cruz-Jentoft A, Soiza R, Gudmusson A, et al. Effectiveness of non-pharmacological interventions to prevent falls in older people: a systematic overview. The SENATOR Project ONTOP Series. PLoS One. 2016;11(8):e0161579.
9. Rehabilitation Institute of Chicago d/b/a Shirley Ryan AbilityLab. AbilityLab Home[Internet]. Shirley Ryan AbilityLab 2022 [cited 2024 Jul 27]. Available from: https://www.sralab.org/.
10. Graf C. The Lawton instrumental activities of daily living scale. Am J Nurs. 2008;108(4):52-62.
11. Gardner MM, Buchner DM, Robertson MC, Campbell AJ. Practical implementation of an exercise-based falls prevention programme. Age Ageing. 2001;30(1):77-83.
12. Tinetti ME, Baker DI, McAvay G, Claus EB, Garrett P, Gottschalk M, et al. A multifactorial intervention to reduce the risk of falling among elderly people living in the community. N Engl J Med. 1994;331(13):821-7.
13. SPSS Inc. Released 2009. PASW Statistics for Windows, Version 18.0. Chicago: SPSS Inc.
14. Rosenthai JA. Qualitative descriptors of strength of association and effect size. J Soc Serv Res 1996;21(4): 37–59.
15. Assantachai P, Praditsuwan R, Chatthanawaree W, Pisalsarakij D, Thamlikitkul V. Risk factors for falls in the Thai elderly in an urban community. J Med Assoc Thai. 2003;86(2):124-30.
16. Assantachai P, Watanapa W, Chiempittayanuwat S, Thipanunt P. Hypertension in the elderly: a community study. J Med Assoc Thai. 1998;81(4):243-9.
17. Lee SH, Yu S. Effectiveness of multifactorial interventions in preventing falls among older adults in the community: A systematic review and meta-analysis. Int J Nurs Stud. 2020;106(1):103564.
18. Woolcott JC, Richardson KJ, Wiens MO, Patel B, Marin J, Khan KM, et al. Meta-analysis of the impact of 9 medication classes on falls in elderly persons. Arch Intern Med. 2009; 169(21):1952-60.
19. Leipzig RM, Cumming RG, Tinetti ME. Drugs and falls in older people: a systematic review and meta-analysis: I. Psychotropic drugs. J Am Geriatr Soc. 1999;47(1):30-9.
20. Leipzig RM, Cumming RG, Tinetti ME. Drugs and falls in older people: a systematic review and meta-analysis: II. Cardiac and analgesic drugs. J Am Geriatr Soc. 1999;47(1):40-50.
21. de Vries M, Seppala LJ, Daams JG, van de Glind EMM, Masud T, van der Velde N. Fall-risk-increasing drugs: a systematic review and meta-analysis: I. cardiovascular drugs. J Am Med Dir Assoc. 2018;19(4):371.e1-.e9.
22. Seppala LJ, van de Glind EMM, Daams JG, Ploegmakers KJ, de Vries M, Wermelink A, et al. Fall-Risk-Increasing Drugs: a systematic review and meta-analysis: III. others. J Am Med Dir Assoc. 2018;19(4):372.e1-.e8.
23. Seppala LJ, Wermelink A, de Vries M, Ploegmakers KJ, van de Glind EMM, Daams JG, et al. Fall-Risk-Increasing Drugs: a systematic review and meta-analysis: II. psychotropics. J Am Med Dir Assoc. 2018;19(4):371.e11-.e17.
24. Xue L, Boudreau RM, Donohue JM, Zgibor JC, Marcum ZA, Costacou T, et al. Persistent polypharmacy and fall injury risk: the health, aging and body composition study. BMC Geriatr. 2021;21(1):710.
25. Wouters H, Van Campen JP, Kuitert MJ, Kikkert L, Hilmer SN, Taxis K, et al. Anticholinergic and sedative medications and dynamic gait parameters in older patients. Drugs Aging. 2021;38(12):1087-96.
26. Gnjidic D, Bell JS, Hilmer SN, Lönnroos E, Sulkava R, Hartikainen

S. Drug Burden Index associated with function in community-dwelling older people in Finland: a cross-sectional study. Ann Med. 2012;44(5):458-67.
27. Herrero A, Velilla N, Renedo F. Deterioro cognitivo y riesgo de caída en el anciano [cognitive impairment and the risk of falling in the elderly]. Rev Esp Geriatr Gerontol. 2011;46(6): 311-8.
28. Clemson L, Stark S, Pighills AC, Fairhall NJ, Lamb SE, Ali J, et al. Environmental interventions for preventing falls in older people living in the community. Cochrane Database Syst Rev. 2023;3(3):CD013258.
29. Yang Y, Wang K, Liu H, Qu J, Wang Y, Chen P, Zhang T, Luo J. The impact of Otago exercise programme on the prevention of falls in older adult: A systematic review. Front Public Health. 2022;10:953593.
30. Xu Q, Ou X, Li J. The risk of falls among the aging population: a systematic review and meta-analysis. Front Public Health. 2022; 10:902599. DOI: 10.3389/fpubh.2022.902599.
31. Ha VT, Nguyen TN, Nguyen TX, Nguyen HTT, Nguyen TTH, Nguyen AT, et al. Prevalence and factors associated with falls among older outpatients. Int J Environ Res Public Health. 2021; 18(8):4041.
32. Vongsirinavarat M, Kraiwong R. Falls among older adults with type 2 diabetes mellitus with peripheral neuropathy. Siriraj Med J. 2021;73(2):92-8.
33. Yang Y, Hu X, Zhang Q, Zou R. Diabetes mellitus and risk of falls in older adults: a systematic review and meta-analysis. Age Ageing. 2016;45(6):761-7.
34. Montero-Odasso MM, Kamkar N, Pieruccini-Faria F, Osman A, Sarquis-Adamson Y, Close J, et al. Evaluation of clinical practice guidelines on fall prevention and management for older adults: a systematic review. JAMA Netw Open. 2021;4(12):e2138911.
35. Dautzenberg L, Beglinger S, Tsokani S, Zevgiti S, Raijmann R, Rodondi N, et al. Interventions for preventing falls and fall-related fractures in community-dwelling older adults: a systematic review and network meta-analysis. J Am Geriatr Soc. 2021;69(10): 2973-84.
36. Guirguis-Blake JM, Michael YL, Perdue LA, Coppola EL, Beil TL. Interventions to prevent falls in older adults: updated evidence report and systematic review for the US Preventive Services Task Force. JAMA. 2018;319(16):1705-16.
37. Yang Y, Wang K, Liu H, Qu J, Wang Y, Chen P, et al. The impact of Otago exercise programme on the prevention of falls in older adult: a systematic review. Front Public Health. 2022;10: 953593.
38. Duckham RL, Masud T, Taylor R, Kendrick D, Carpenter H, Iliffe S, et al. Randomised controlled trial of the effectiveness of community group and home-based falls prevention exercise programmes on bone health in older people: the ProAct65+ bone study. Age Ageing. 2015;44(4):573-9.

Depressive Symptoms and Poor Functional Status are Factors Associated with Frailty and Decreased Quality of Life in Thai Older Breast Cancer Survivors

Arpa Satayasanskul, M.D.[1], Prasert Assantachai, M.D., MRCP (UK), FRCP[2], Suebwong Chuthapisith, M.D., M.Sc., Ph.D., FRCST, FICS[3,*], Monthira Thammasalee, B.N.S.[2], Thapanee Chimchanwet, B.S.W.[3], Suthipol Udompunturak, M.Sc.[4]

[1]Geriatric Department, Ratchaphiphat Hospital, Bangkok, Thailand, [2]Department of Preventive and Social Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand, [3]Division of Head, Neck, and Breast Surgery, Department of Surgery, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand, [4]Research Department, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand.



*Corresponding author: Suebwong Chuthapisith
E-mail: suebwong.chu@gmail.com
Received 1 October 2024 Revised 3 December 2024 Accepted 5 December 2024
ORCID ID:http://orcid.org/0000-0002-6177-4099
https://doi.org/10.33192/smj.v77i1.271452

ABSTRACT

Objective: This study examines the prevalence and clinical factors associated with frailty, poor health-related quality of life (HR-QoL), and the combined presence of both in older breast cancer survivors.

Materials and Methods: In this cross-sectional study, 230 BSC patients aged > 60 years and > 3 years cancer free were recruited. Frailty and HR-QoL were evaluated using the Fried Frailty Phenotype and the Functional Assessment of Cancer Therapy-Breast (FACT-B), respectively. As well, overall health status was assessed through a comprehensive geriatric assessment (CGA). Logistic regression was used to identify factors independently associated with frailty and reduced HR-QoL.

Results: Of all 230 BCS, 16.5% were frail, 47.4% were pre-frail, and 36.1% were robust. Depressive symptoms were strongly associated with frailty (OR: 13.1, 95% CI: 4.04–42.74), indicating that individuals with these symptoms were 13 times more likely to be frail. Low physical activity (OR: 5.7, 95% CI: 2.1–15.08) and unmarried status (OR: 2.75, 95% CI: 1.47–19.57) were also significant predictors of frailty. Frail participants had notably lower HR-QoL scores than those who were non-frail.

Conclusion: This study highlights the significant impact of depressive symptoms, reduced physical function, and social factors on frailty and HR-QoL in old-age BCS. Comprehensive geriatric assessment, including mental health and social support evaluations, are essential for early identification and intervention. Further research should focus on additional interventions aimed at reducing frailty and enhancing HR-QoL.

Keywords: Breast cancer survivors; frailty; health-related quality of life; depression; older adults (Siriraj Med J 2025; 77: 73-82)

INTRODUCTION

Frailty, characterized by increased vulnerability to endogenous and exogenous stressors, presents significant public health challenges, especially among aging populations. The prevalence of frailty, ranges from 4% to 59% in older adults living in the community, increasing with age and being significantly higher in women than in men.[1] This condition imposes substantial risks, including falls, hospitalizations, and increased mortality, amplifying the urgency to effectively address this problem.[2,3] The impact of frailty is not only societal, but also personal, worsening quality of life, inducing feelings of loneliness, and imposing significant financial burdens due to escalating care costs.[4-6]

In the context of breast cancer survivors (BCS), frailty assumes a unique dimension. Previous studies have shown that a substantial proportion of older BCS, particularly those aged 70-79, experience frailty or pre-frailty, highlighting the need for tailored healthcare interventions.[7] Additionally, the combination of breast cancer and its treatments further complicates the health aspects of these survivors, affecting not only their physical well-being, but also their mental health and quality of life (QoL).[8] Previous research have demonstrated that predictors of psychological well-being among BCS were resilience, stress, and social support.[9] However, recent advances in breast cancer therapies have led to treatments that are less aggressive but more effective, potentially altering the landscape of frailty prevalence and health-related quality of life (HR-QoL) among older BCS.[10-13]

With the complexities of recent advances in adjuvant endocrine therapy and chemotherapy through intensive therapeutic escalation[14], it is challenging in daily clinical practice to deliver comprehensive care to older breast cancer survivors (BCS) who are already suffering from declining cognitive abilities and physical frailty without a comprehensive geriatric assessment.[15] However, recent evidence has shown that various types knowledge sharing for geriatric patients are important and can serve as effective tools for increasing patient satisfaction.[16] Therefore, a specific study is needed to investigate all associated factors of frailty and HR-QoL, within the context of physical, mental, social, and functional aspects of a comprehensive geriatric assessment.[17] Through this exploration, we aim to facilitate targeted interventions and improved healthcare strategies tailored to the unique needs of this population.

MATERIALS AND METHODS

Ethical issues

The research protocol was approved by the Human Research Ethics Committee of the Faculty of Medicine Siriraj Hospital, Mahidol University (Si 213/2022). The research was also registered through the Thai Clinical Trials Registry (TCTR20230811012).

Participants and sample size

Breast cancer survivors were recruited from the Breast Clinic, Department of Surgery, Faculty of Medicine Siriraj Hospital, Mahidol University, Thailand. The eligibility criteria included individuals who were 60 years or older, and cancer-free for more than 3 years. Exclusion criteria included communication problems, moderate to severe dementia, end-stage renal disease, or receiving renal replacement therapy, as well as women with cancers other than breast cancer (except non-melanoma skin cancer).

The prevalence of frailty in cancer patients has previously been reported to be 48% (p = 0.48) at a confidence level of 95%, with a margin of error of 6.5% (d = 0.065).[18] Using the sample size formula to estimate the proportion of a population, the calculated number of samples was 227. Consequently, 230 subjects were ultimately recruited for the study.

Data collection and assessment

Relevant demographic data, clinical and pathological data, and breast cancer treatment were retrieved from medical records. The variables related to comprehensive geriatric assessment (CGA) were directly evaluated by well-trained research assistants using structured questionnaires. Physical Performance and muscle strength were also measured on site.

Frailty status was diagnosed using the Fried frailty phenotype.[19] The cutoff points for each were as follows.

- The grip strength less than 28 kg for men and 18 kg for women
- Unintentional loss of body weight of more than 4.5 kg in the past year.
- 6-meter walk with gait speed less than 1 m/s.
- Feeling exhausted by 1 or 2 positive questions established by Center for Epidemiology Studies Depression Scale (CES-D)
- Global Physical Activity Questionnaire (GPAQ) less than 20th percentile.

Those who met 1-2 of 5 abnormalities were categorized as pre-frailty, and those with 3 or more abnormalities were categorized as frailty. The Functional Assessment of Cancer Therapy-Breast (FACT-B) was used to assess HR-QoL.[20] Individuals with FACT-B scores lower than the 50th percentile were categorized as having a poor HR-QoL. Other important variables included body weight, height, BMI, calf circumferences, Charlson's comorbidity index[21], Mini-Cog test[22], Six-item version of the Thai Geriatric Depression Scale (TGDS-6)[23], Short-form Mini Nutritional Assessment-Short Form (MNA-SF)[24], Barthel's index of activities of daily living (iADL)[25] and Lawton's iADL.[26]

Statistical analysis

The mean with standard deviation (SD) or median (interquartile range) were used for quantitative variables. Qualitative data were presented as numbers and percentage. To compare quantitative variables, Student's t tests and Mann-Whitney U tests were used for normal and non-normal distribution data, respectively. Chi-square tests or Fisher's exact tests were used to compare qualitative variables. Stepwise forward logistic regression analysis was used to identify independent factors associated with frailty, poor HR-QoL, and the combination of frailty and poor HR-QoL.

Statistical significance was set at a p-value <0.05. PASW Statistics for Windows, Version 18.0. Chicago: SPSS Inc; 2009, was used for all statistical analysis.

RESULTS

The prevalence of frailty, pre-frailty, and robust groups diagnosed by the Fried frailty phenotype was 16.5%, 47.4%, and 36.1%, respectively. The baseline characteristics of the three groups shown in Table 1.

Almost half of the participants were married (44.3%) and had received education for 12 years or more (70.4%). 17.4% had a history of breast cancer among their first-degree relatives. Invasive ductal carcinoma was the most common pathology (91.2%), followed by intralobular carcinoma, mucinous carcinoma, and malignant phyllodes breast cancer. The staging distribution was as follows: stage 0 (15%), stage 1 (33%), stage 2 (33%), stage 3 (15%), and stage 4 (1.3%). Triple-negative breast cancer (poor prognosis) breast cancer was present in 11.2% of the cases.

Regarding cancer treatment, all of them had undergone surgery, specifically mastectomy in 71.7% and breast-conserving therapy (BCT) in 28.3%. More than half of them received chemotherapy (CMT) (55.1%), while 91.1% had completed CMT. The commonly used chemotherapies were as follows: 60.2% had doxorubicin and cyclophosphamide (AC), 22.8% had their combination with taxane (AC+T), 5.7% had CMT with targeted therapy, and 14% had other regimens such as methotrexate. Among them, 72.2% had received endocrine therapy and 52.6% had received radiotherapy.

Comparisons between the frailty and non-frailty groups are presented in Table 1. Sequentially, the independent factors associated with frailty among BCS were identified by a stepwise forward binary logistic

TABLE 1. Baseline characteristics, and relevant clinical data of the three frailty status groups (n = 230).

		Total	Robust (n = 83)	Prefrail (n=109)	Frail (n=38)	Non-Frailty* (n=192)	p-value (Frailty
		Mean ±SD or N (%)	Mean ±SD or N (%)	Mean ±SD or N (%)	Mean ±SD or N (%)	Mean ±SD or N (%)	VS Non-Frailty)
Age (years)		68.6 ±7.0	66.08 ±5.1	68.52 ±6.3	74.16 ±9.0	67.47 ±5.9	<0.01*
Age at diagnosis		59.1 ±8.5	56.70 ±7.1	59.33 ±7.3	63.76 ±11.9	59.2 ±7.3	<0.01*
Years after diagnosis		9.5 ±5.7	9.39 ±5.6	9.19 ±4.9	10.39 ±7.6	9.28 ±5.2	<0.01*
BMI (kg/m^2)		24.5 ±4.3	24.25 ±3.8	24.38 ±4.7	25.20 ±4.6	24.32 ±4.29	0.52
Grip strength (kg)		18.2 ±4.6	21.53 ±2.4	17.24 ±4.1	13.36 ±4.2	19.1 ±4.04	<0.01*
Gait speed (m/s)		1.15 ±0.32	1.32 ±0.21	1.12 ±0.31	0.83 ±0.31	1.2 ±0.29	<0.01*
Charlson's Comorbidity Index		2.5 ±0.65	2.37 ±0.8	2.51 ±0.83	3.24 ±1.4	2.45 ±0.8	<0.01*
Calf circumference (cm)		34.8 ±3.6	35.10 ±3.1	34.58 ±3.9	34.57 ±3.7	34.8 ±3.56	0.56
Barthel iADL		19.5 ±1.2	19.66 ±0.5	19.62 ±0.6	18.5 ±2.6	19.64 ±0.56	<0.01*
Lawton iADL		7.4 ±1.4	7.88 ±0.4	7.61 ±1.0	5.87 ±2.5	7.73 ±0.79	<0.01*
Status	Married	102 (44.3)	44 (53.0)	48 (53.0)	10 (26.3)	92 (47.9)	
	Divorced/widow	83 (36.1)	21 (25.3)	42 (38.5)	20 (52.6)	63 (32.8)	0.206
	Single	45 (19.6)	18 (21.7)	19 (17.4)	8 (21.1)	37 (19.3)	
Education (year)	0-12	68 (29.6)	20 (24.1)	29 (26.6)	19 (50)	22 (11.5)	0.09
	>12	162 (70.4)	63 (75.9)	80 (73.4)	19 (50)	19 (9.9)	
Caregiver	No	75 (32.6)	36 (43.4)	30 (27.5)	9 (23.7)	30 (15.6)	
	Informal caregiver	148 (64.3)	45 (54.2)	75 (68.8)	28 (73.7)	28 (14.6)	0.04*
	Formal caregiver	7 (3.0)	2 (2.4)	4 (3.7)	1 (2.6)	14 (7.3)	
Smoking		10 (4.3)	4 (4.8)	5 (4.6)	1 (2.6)	49 (25.5)	0.85
History of alcohol drinking		28 (12.2)	13 (15.7)	14 (12.8)	1 (2.6)	66 (34.4)	0.12
Polypharmacy (≥5 medication use/day)		74 (32.2)	19 (22.9)	76 (69.7)	22 (57.9)	52 (27.1)	<0.01*
Physical activity (GPAQ)	High	42 (18.3)	22 (26.5)	14 (12.8)	6 (15.8)	36 (18.8)	<0.01*
	Moderate	122 (53)	47 (56.6)	69 (63.3)	6 (15.8)	116 (60.4)	
	Low	66 (28.7)	14 (16.9)	26 (23.9)	26 (68.4)	40 (20.8)	
Depressive symptoms (TGDS -6 score ≥2)		19 (8.3)	2 (2.4)	8 (7.3)	9 (23.7)	10 (5.2)	<0.01*
Exhaustion (CES-D positive)		31 (13.5)	0 (0.0)	92 (84.4)	14 (36.8)	17 (8.9)	<0.01*
MNA-SF (<12 = at risk or malnutrition)		29 (12.6)	4 (4.8)	11 (10.1)	14 (36.8)	15 (7.8)	<0.01*
Cognitive impairment (Minicog score ≥ 2)		54 (23.5)	13 (15.7)	30 (27.5)	11 (28.9)	43 (22.4)	0.11

Note: The Nonfrailty group comprises individuals from both the pre-frail and frail groups.
** = statistically significant; iADL = index of activities of daily living; GPAQ = Global Physical Activity Questionnaire; TGDS = Thai Geriatric Depression Scale; CES-D = Center for Epidemiology Studies Depression Scale; MNA-SF = Mini Nutritional Assessment-Short Form*

regression analysis, as shown in Table 4. Comorbidities assessed by Charlson's comorbidity index, activities of daily living (Barthel's index for basic ADL and Lawton's index for instrumental ADL), depressive symptoms and poor nutritional status were found to be associated with frailty.

Likewise, the comparisons of clinical characteristics between the good and poor HR-QoL groups and the independent factors associated with the poor HR-QoL groups were demonstrated in Table 2 and 4, respectively. The only independent factors associated with poor HR-QoL were depressive symptoms, poor instrumental ADL, and being single. Interestingly, the total FACT-B score for the frailty group (115.95±17.14) was significantly lower than that of the non-frailty group (128.91±11.87), p <0.01. All other subdomains of the FACT-B score of the frailty group were also lower than those of the non-frailty group, as shown in Table 5.

Finally, comparisons of clinical characteristics between those with and without the combination of frailty and poor HR-QoL and the factors independently associated with the combination are shown in Tables 3 and 4, respectively. Again, depressive symptoms and poor Lawton iADL, Barthel index ADL scores, and being single were found to be statistically significant associated factors.

DISCUSSION

Depression increased the risk of frailty through physical inactivity and decreased motivation, which are commonly observed in depression, leading to a loss of energy and overall functioning.[27,28] Depression and frailty are also important risk factors for malnutrition in older adults with cancer.[29] Our results revealed an independent association between malnutrition and frailty (Table 4). Some common risk factors for depression and frailty have previously been highlighted, for example, oxidative stress, hypothalamic-pituitary-adrenal axis, and mitochondrial dysregulation.[30-32] Our subjects with depressive symptoms had a higher probability of frailty (OR=13.1, 95%CI:4.0-42.7), whereas a meta-analysis in older adults conducted by Soysal et al reported an OR of 4.07 (95%CI 1.93-8.55).[33] These findings highlight significantly higher risk of frailty in older adult with breast cancer compared to healthy older adults.(Fig 1)

Due to the atypical presentation of depression in older adults, overcoming these barriers and recognizing the impact of depression on cancer outcomes are crucial for improving overall well-being and prognosis in older cancer patients.[27,34] Given that depression is a treatable disease and associated with a poor HR-QoL among older BCS, healthcare personnel involved in their care should be aware of these relationships. Integrating depression screening into routine clinical services is essential, as it can reduce risk of frailty, and improve HR-QoL.[35] Treatment options for depression include psychotherapy, medication, lifestyle modifications, increased physical activity, and enhanced social support and connection.

BCS who reported a higher HR-QoL were able to maintain higher levels of physical activity and the ability

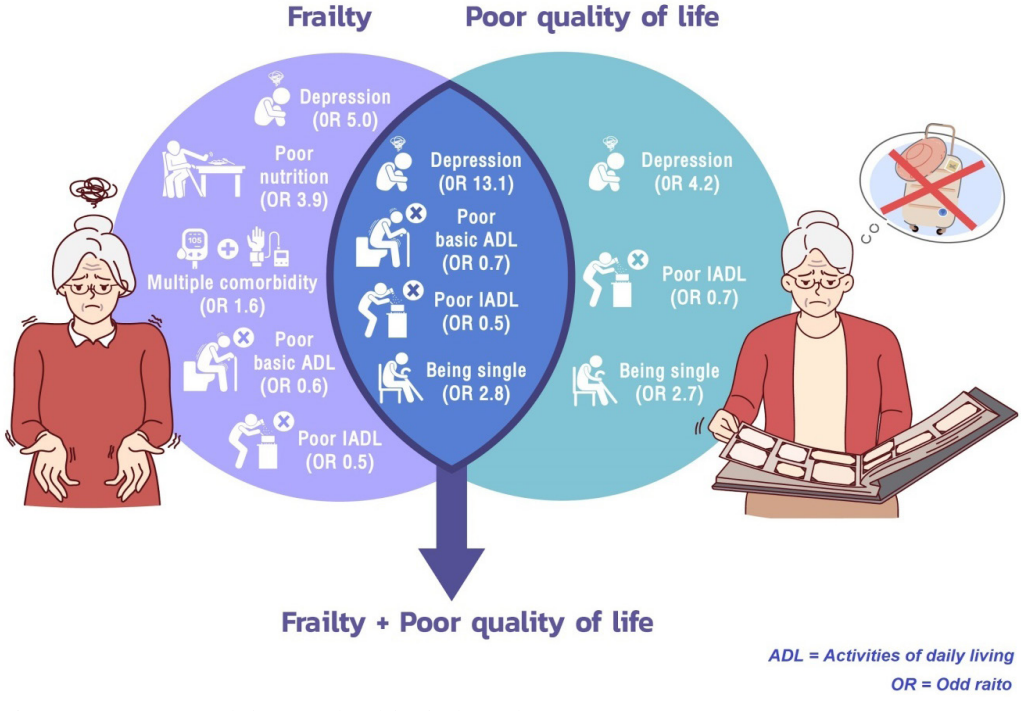


Fig 1. Schematic figure summarizing risk factors related for frailty and poor HR-QoL.

TABLE 2. Comparisons of baseline characteristics, staging, and treatments, as well as relevant clinical data between the good and poor HR-QoL groups.

Characteristics		Poor QoL (n=115) Mean ±SD or N (%)	Good QoL (n=115) Mean ±SD	p -value or N (%)
Age (years)		70.03 ±8.17	67.12 ±5.12	<0.01*
Age at diagnosis (years)		60.67 ±9.70	57.56 ±6.6	<0.01*
Years after diagnosis (years)		14.37 ±1.85	14.12 ±2.0	0.78
BMI (kg/m^2)		24.8 ±4.3	24.13 ±4.4	0.25
Grip strength (kg)		17.04 ±4.75	19.31±4.1	<0.01*
Gait speed (m/s)		1.05 ±0.34	1.26 ±0.27	<0.01*
Charlson Comorbidity Index		2.77 ±1.05	2.4 ±0.86	<0.01*
Calf-circumference (cm)		34.56 ±3.8	34.96 ±3.4	0.4
Barthel iADL		19.3 ±1.4	19.6 ±1.04	0.07
Lawton iADL		7.08 ±1.82	7.77 ±0.67	<0.01*
Smoking		4 (3.5)	6 (5.2)	0.52
History of alcohol consumption		9 (7.8)	19 (16.5)	<0.01*
Marital status	married	39 (33.9)	63 (54.8)	0.03*
	divorced/widow	54 (47.0)	29 (25.2)	
	single	22 (19.1)	23 (20.0)	
Education (years)	0-12	42 (36.5)	26 (22.6)	0.022*
	>12	73 (63.5)	89 (77.4)	
Caregiver	No	32 (27.8)	43 (37.4)	0.034*
	Formal caregiver	6 (5.2)	7 (6.1)	
	Paid caregiver	7 (6.1)	0 (0.0)	
Polypharmacy (≥5 medications use/day)		45 (39.1)	29 (25.2)	0.02
Physical activity (GPAQ)	High	23 (20.0)	19 (16.5)	0.17
	Moderate	54 (47.0)	68 (59.1)	
	Low	38 (33.0)	28 (24.3)	
Exhaustion (CES-D positive)		21 (18.3)	10 (8.7)	0.03*
Depressive symptoms (TGDS-6 score ≥2)		15 (13.0)	4 (3.5)	<0.01*
Poor nutritional status (MNA-SF <12)		18 (15.7)	11 (9.6)	0.16
Cognitive impairment (Minicog score ≥2)		27 (23.5)	27 (23.5)	1.00

** = statistically significant; QoL = quality of life; iADL = index of activities of daily living; GPAQ = Global Physical Activity Questionnaire; TGDS = Thai Geriatric Depression Scale; CES-D = Center for Epidemiology Studies Depression Scale; MNA-SF = Mini Nutritional Assessment-Short Form*

TABLE 3. Comparisons of baseline characteristics, staging, and treatments, as well as relevant clinical data between those with and without the combination of frailty and poor HR-QoL.

Characteristics		Frail + Poor QoL (n=30) Mean ±SD or N (%)	Other (n=200) Mean ±SD or N (%)	p-value
Age (years)		75.07 ±9.5	67.6 ±5.9	<0.01*
Age at diagnosis (years)		64.7 ±13.0	58.28 ±7.26	0.01*
Years after diagnosis (years)		10.37 ±8.29	9.33 ±5.18	<0.01*
BMI (kg/m^2)		25.88 ±4.2	24.3 ±4.3	0.06
Grip strength (kg)		13.2 ±4.5	18.9 ±4.1	<0.01*
Gait speed (m/s)		0.8 ±0.34	1.20 ±0.29	<0.01*
Charlson Comorbidity Index		2.43 ±0.62	2.9 ±0.67	<0.01*
Calf-circumference (cm)		35.13 ±3.7	34.71 ±3.57	0.56
Barthel iADL		18.43 ±2.4	19.61 ±0.87	<0.01*
Lawton iADL		5.53 ±2.6	7.71 ±0.83	<0.01*
Smoking		1 (3.3)	9 (4.5)	0.08
History of alcohol consumption		1 (3.3)	27 (13.5)	0.11
Marital status	married divorced/widow single	6 (20.0) 19 (63.3) 5 (16.7)	96 (48.0) 64 (32.0) 40 (20.0)	<0.01*
Education (years)	0-12 ≥12	15 (50) 15 (50)	53 (26.5) 147 (73.5)	<0.01*
Caregiver	No Informal caregiver Formal caregiver	8 (26.7) 21 (70) 1 (3.3)	67 (33.5) 127 (63.5) 6 (3.0)	0.14
Polypharmacy (≥5 medication use /day)		17 (56.7)	57 (28.5)	<0.01*
Physical activity (GPAQ)	High Moderate Low	3 (10.0) 6 (20.0) 21 (70.0)	39 (19.5) 116 (58.0) 45 (22.5)	<0.01*
Exhaustion (CES-D positive)		11 (36.7)	20 (10.0)	<0.01*
Depressive symptoms (TGDS-6 score ≥2)		9 (30.0)	10 (5.0)	<0.01*
Poor nutritional status (MNA-SF <12)		10 (33.3)	19 (9.5)	<0.01*
Cognitive impairment Mini-cog (score ≤2)		8 (26.7)	46 (23.0)	0.66

** = statistically significant; QoL = quality of life; iADL = index of activities of daily living; GPAQ = Global Physical Activity Questionnaire; TGDS = Thai Geriatric Depression Scale; CES-D = Center for Epidemiology Studies Depression Scale; MNA-SF = Mini Nutritional Assessment-Short Form*

TABLE 4. Crude and adjusted odds ratios of the independent factors associated with BCS with frailty, poor HR-QoL, and those who had the combination of frailty and poor HR-QoL.

	Crude odds ratio	Adjusted odds ratio
Independent factors associated with frailty and poor HR-QoL		
Lawton iADL score	0.48 (0.36-0.62)	0.47 (0.35-0.62)
Barthel iADL score	0.53 (0.36-0.80)	0.68 (0.52-0.91)
Depressive symptoms	8.14 (2.98-22.30)	13.13 (4.04-42.74)
Marital status (single)	4.75 (1.80-12.54)	2.75 (1.47-19.57)
Independent factors associated with frailty		
Charlson comorbidity index	1.14 (1.08-1.20)	1.58 (1.09-2.30)
Barthel iADL	0.43 (0.27-0.68)	0.64 (0.45-0.91)
Lawton iADL	0.48 (0.37-0.63)	0.54 (0.41-0.72)
MNA-SF (poor nutritional status)	6.89 (2.96-16.01)	3.85 (1.28-11.56)
Depressive symptoms	5.65 (2.12-15.08)	5.04 (1.42-17.95)
Independent factors associated with poor HR-QoL		
Depressive symptoms	4.16 (1.34-12.96)	4.17 (1.29-13.48)
Lawton iADL	0.63 (0.47-0.83)	0.67 (0.51-0.93)
Marital Status (single)	3.01 (1.65-5.50)	2.65 (1.391-5.05)

QoL = quality of life; iADL = index of activities of daily living; MNA-SF = Mini Nutritional Assessment-Short Form

TABLE 5. Comparisons of the FACT-B score between the frailty and non-frailty groups.

FACT-B score	Total (n=230)	Frailty (n=38)	Non-frailty (Prefrail + Robust) (n=192)	p value
FACT-B GP	25.93 ± 2.72	24.42 ± 3.89	26.22 ± 2.32	<0.01*
FACT-B GS	22.29 ± 5.07	20.23 ± 5.97	22.69 ± 4.78	<0.01*
FACT-B GE	21.89 ± 3.05	20.71 ± 3.51	22.13 ± 2.9	0.02*
FACT-B GF	23.48 ± 4.36	19.78 ± 5.60	24.22 ± 3.67	<0.01*
FACT-B breast	33.18 ± 5.30	30.81 ± 7.18	33.64 ± 4.73	0.02*
FACT-G	94.77 ± 10.87	85.79 ± 12.99	96.54 ± 9.48	<0.01*
FACT-B total	126.76 ± 13.72	115.95 ± 17.14	128.91 ± 11.87	<0.01*

** = statistically significant; FACT-B = Functional Assessment of Cancer Therapy-Breast; FACT-G =Functional Assessment of Cancer Therapy - General; GP = general physical well-being score; GS = general social/family well-being score; GE = general emotional well-being score; GF = general functional well-being score; FACT-B breast = FACT-B Breast cancer subscale*

to live independently over time.[18] This underscores the crucial role of a comprehensive geriatric assessment of functional decline by multidisciplinary approaches during cancer treatment, integrated with therapy itself, to prevent frailty and preserve HR-QoL among survivors in their later years.[35]

Our results also highlighted the significant impact of social factors on single breast cancer survivors, linking them to reduced HR-QoL (p=0.03) and compounded frailty and poor HR-QoL (adj. OR 2.8, 95%CI 1.5-19.6). A study in Korea revealed that single cancer patients exhibited a more significant decline in HR-QoL compared to individuals with other marital statuses.[36] These findings are consistent with previous research on Thai breast cancer survivors, emphasized the importance of family ties in the spirituality of Thai women. Enhanced spiritual well-being was influenced by positive family connections, strong social support, and a deep connection with nature or a higher being, regardless of religious beliefs.[37] Despite this influence, healthcare providers often overlook spirituality due to cultural disparities and the absence of guidelines in many low- and middle-income countries. Regarding single marital status, a previous study demonstrated associations between depression and single BCS.[38] Another systematic review showed that single cancer survivors are more likely to experience physical frailty.[39] However, to the best of our knowledge, no publication has shown an association between both depression and frailty in single BCS. Our study is the first to report that single marital status was significantly related to both depression and frailty in BCS.

Due to similar living cultures among other Asian countries, we anticipate that the result from this study could apply to other Asian populations. Women who are BCS should receive a comprehensive geriatric approach and appropriate intervention to prevent frailty and enhance HR-QoL. These interventions include diet monitoring, regular exercise programs, mental health intervention and social support.

Although previous studies have examined frailty and HR-QoL in older BCS[40], the strengths of our study lie in the use of specific clinical tools in this particular setting, i.e., comprehensive geriatric assessment used in routine clinical practice, the Fried frailty phenotype for frailty diagnosis, and FACT-B to assess HR-QoL in BCS. To our knowledge, this study is the first clinical study on frailty and HR-QoL among Thai BCS. However, due to the cross-sectional study design, we were unable to establish causal relationships between independent risk factors and frailty or HR-QoL.

CONCLUSION

Depressive symptoms and physical inactivity in older BCS are associated with frailty and poor HR-QoL. Single marital status and BCS in Thailand is associated with a poor HR-QoL, with or without frailty. Poor nutritional status is also an independently associated factor of frailty. Therefore, the comprehensive geriatric approach, including diet counseling, exercise programs, mental health assessment and intervention, as well as social support, should be discussed with older BCS to prevent and manage frailty in order to promote good HR-QoL.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the patients that agreed to participate in this study.

DECLARATION

Grants and Funding Information

This was an unfunded study.

Conflict of Interest

All authors declare that they have no personal or professional conflicts of interest related to any aspect of this study.

Author Contributions

Conceptualization and methodology: A.S., P.A., S.C.; Data collection and data acquisition: A.S., M.T., T.C.; Data analysis and interpretation: A.S., P.S., S.C., M.T., T.C., S.U.; Drafting the manuscript: A.S., P.S.; Critical revision of the manuscript: A.S., P.S., S.C. All authors have read and agreed to the final version of the manuscript.

Use of Artificial Intelligence

No artificial intelligence tools or technologies were used in the writing analysis, or development of this research and manuscript.

REFERENCES

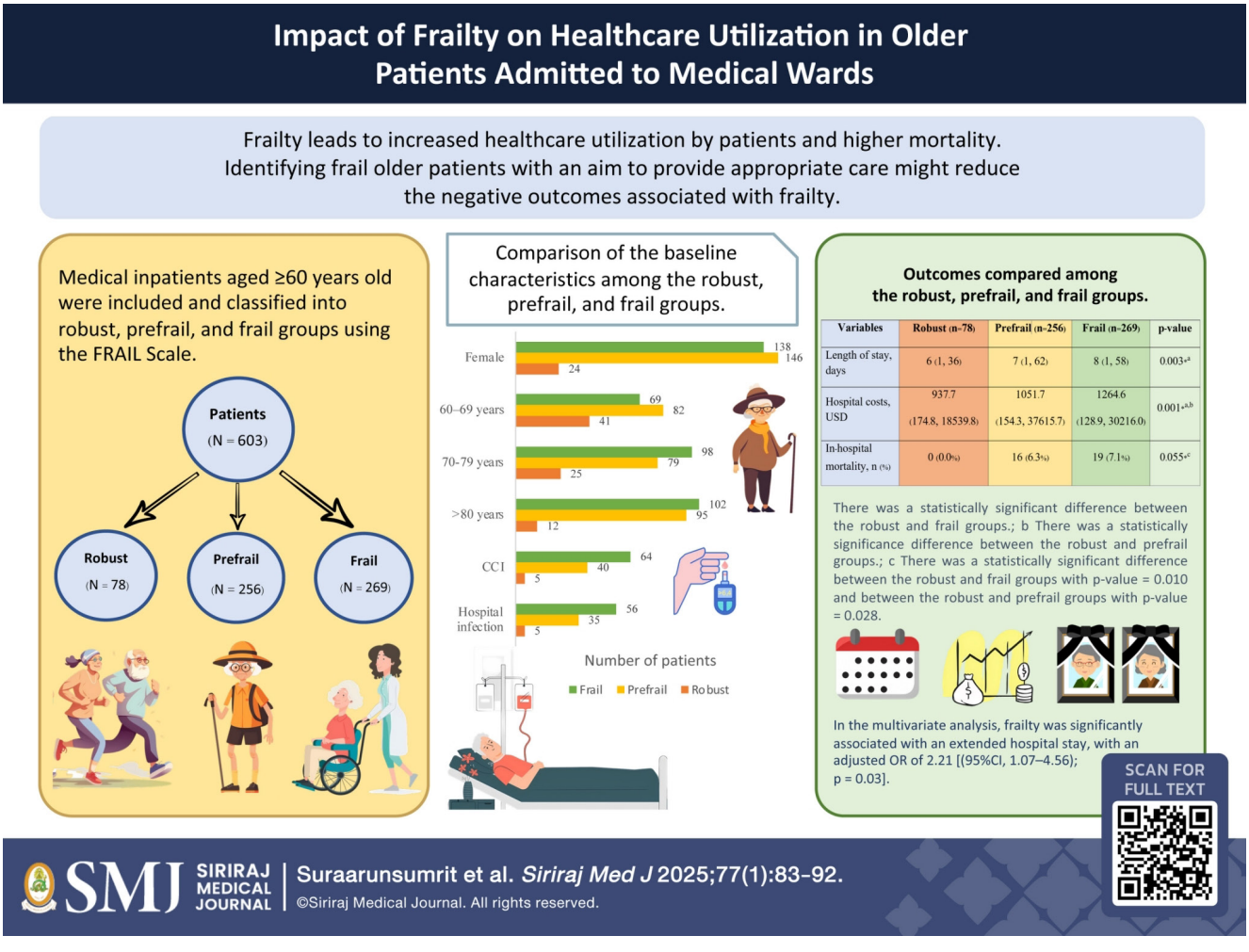
1. Proietti M, Cesari M. Frailty: What Is It? Adv Exp Med Biol. 2020; 1216:1-7.
2. Rohrmann S. Epidemiology of Frailty in Older People. Adv Exp Med Biol. 2020;1216:21-27.
3. Hoogendijk EO, Afilalo J, Ensrud KE, Kowal P, Onder G, Fried LP. Frailty: implications for clinical practice and public health. Lancet. 2019;394:1365-75.
4. Kojima G, Iliffe S, Jivraj S, Walters K. Association between frailty and quality of life among community-dwelling older people: a systematic review and meta-analysis. J Epidemiol Community Health. 2016;70:716-21.

5. Hoogendijk EO, Suanet B, Dent E, Deeg DJ, Aartsen MJ. Adverse effects of frailty on social functioning in older adults: Results from the Longitudinal Aging Study Amsterdam. Maturitas. 2016;83:45-50.
6. Sareh S, Ugarte R, Dobaria V, Hadaya J, Sirody J, McCallum JC, et al. Impact of Frailty on Clinical and Financial Outcomes Following Minor Lower Extremity Amputation: A Nationwide Analysis. Am Surg. 2020;86: 1312-7.
7. Bennett JA, Winters-Stone KM, Dobek J, Nail LM. Frailty in older breast cancer survivors: age, prevalence, and associated factors. Oncol Nurs Forum. 2013;40:E126-34.
8. Stover AM, Mayer DK, Muss H, Wheeler SB, Lyons JC, Reeve BB. Quality of life changes during the pre- to post diagnosis period and treatment-related recovery time in older women with breast cancer. Cancer. 2014;120:1881-9.
9. Singtaweesuk N, Thanoi W, Vongsirimas N, Kesornsri S, Klainin-Yobas P. Factors predicting psychological well-being among survivors of breast cancer in a tertiary care hospital, Thailand. Siriraj Med J. 2024;76(5):244-54.
10. Lopes JV, Bergerot CD, Barbosa LR, Calux N, Elias S, Ashing KT, et al. Impact of breast cancer and quality of life of women survivors. Rev Bras Enferm. 2018;71:2916-21.
11. Moshina N, Falk RS, Hofvind S. Long-term quality of life among breast cancer survivors eligible for screening at diagnosis: a systematic review and meta-analysis. Public Health. 2021;199: 65-76.
12. Williams GR, Deal AM, Sanoff HK, NyropKA, Guerard EJ, Pergolotti M, et al. Frailty and health-related quality of life in older women with breast cancer. Support Care Cancer. 2019; 27:2693-8.
13. Ho PJ, Gernaat SAM, Hartman M, Verkooijen HM. Health-related quality of life in Asian patients with breast cancer: a systematic review. BMJ Open. 2018;8:e020512.
14. Pondé NF, Zardavas D, Piccart M. Progress in adjuvant systemic therapy for breast cancer. Nat Rev Clin Oncol. 2019;16:27-44.
15. Ahles TA, Schofield E, Li Y, Ryan E, Root JC, Patel SK, et al. Relationship between cognitive functioning and frailty in older breast cancer survivors. J Geriatr Oncol. 2022;13:27-32.
16. Jirakulsawat A, Noocharoen A, Srinimit B, Anakmeteeprugsa S. Assessment on knowledge and satisfaction level of delirium video for education in geriatric patients undergoing elective noncardiac surgery. Siriraj Med J. 2024;76(7):415-21.
17. Lemij AA, Liefers GJ, Derks MGM, Bastiaannet E, Fiocco M, et al. Physical Function and Physical Activity in Older Breast Cancer Survivors: 5-Year Follow-Up from the Climb Every Mountain Study. Oncologist. 2023;28:e317-e23.
18. Farrugia M, Erickson K, Wendel E, Platek ME, Ji W, Attwood K, et al. Change in Physical Performance Correlates with Decline in Quality of Life and Frailty Status in Head and Neck Cancer Patients Undergoing Radiation with and without Chemotherapy. Cancers (Basel). 2021;13(7):1638.
19. Fried LP, Tangen CM, Walston J, Newman AB, Hirsch C, Gottdiener J, et al. Frailty in older adults: evidence for a phenotype. J GerontolA Biol Sci Med Sci. 2001;56(3):M146-56.
20. Brady MJ, Cella DF, Mo F, Bonomi AE, Tulsky DS, Lloyd SR, et al. Reliability and validity of the Functional Assessment of Cancer Therapy-Breast quality-of-life instrument. J Clin Oncol. 1997;15:974-86.
21. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Dis. 1987;40: 373-83.
22. Borson S, Scanlan J, Brush M, Vitaliano P, Dokmak A. The mini-cog: a cognitive 'vital signs' measure for dementia screening in multi-lingual elderly. Int J Geriatr Psychiatry. 2000;15:1021-7.
23. Wongpakaran N, Wongpakaran T, Kuntawong P. Evaluating hierarchical items of the geriatric depression scale through factor analysis and item response theory. Heliyon. 2019;5:e02300.
24. Nestlé Nutrition Institute, Mini Nutritional Assessment form: Thai version, 2021. https://www.mna-elderly.com/sites/default/files/2021-10/mna-mini-thai.pdf (accessed 12 January 2024).
25. Collin C, Wade DT, Davies S, Horne V. The Barthel ADL Index: a reliability study. Int Disabil Stud. 1998;10:61-63.
26. Graf C. The Lawton instrumental activities of daily living scale. Am J Nurs. 2008;108:52-62.
27. Parajuli J, Berish D, Valenti KG, Jao YL. Prevalence and predictors of depressive symptoms in older adults with cancer. J Geriatr Oncol. 2021;12: 618-22.
28. Zhang Y, Jiang X. The effects of physical activity and exercise therapy on frail elderly depression: A narrative review. Medicine (Baltimore). 2023;102:e34908.
29. Zhang X, Edwards BJ. Malnutrition in Older Adults with Cancer. Curr Oncol Rep. 2019;21:80.
30. Varghese FP, Brown ES. The Hypothalamic-Pituitary-Adrenal Axis in Major Depressive Disorder: A Brief Primer for Primary Care Physicians. Prim Care Companion J Clin Psychiatry. 2001; 3:151-5.
31. Song Y, Cao H, Zuo C, Gu Z, Huang Y, Miao J, et al. Mitochondrial dysfunction: A fatal blow in depression. Biomed Pharmacother. 2023;167:115652.
32. Lee CH, Giuliani F. The Role of Inflammation in Depression and Fatigue. Front Immunol. 2019;10:1696.
33. Soysal P, Veronese N, Thompson T, Kahl KG, Fernandes BS, Prina AM, et al. Relationship between depression and frailty in older adults: A systematic review and meta-analysis. Ageing Res Rev. 2017;36:78-87.
34. Saracino RM, Nelson CJ. Identification and treatment of depressive disorders in older adults with cancer. J Geriatr Oncol. 2019;10:680-4.
35. Frick E, Tyroller M, Panzer M. Anxiety, depression and quality of life of cancer patients undergoing radiation therapy: a cross-sectional study in a community hospital outpatient center. Eur J Cancer Care (Engl). 2007;16:130-6.
36. KT Han, Kim SJ, Song H, Chun SY, Kim CO, Kim JS, et al. Associations between quality of life and marital status in cancer patients and survivors. Asian Pac J Cancer Prev. 2014;15:5287-91.
37. Phenwan T, Peerawong T, Tulathamkij K. The Meaning of Spirituality and Spiritual Well-Being among Thai Breast Cancer Patients: A Qualitative Study. Indian J Palliat Care. 2019;25:119-23.
38. Qiu J, Yan M, Chen W, Gao S, Liu S, Shi S, et al. Prevalence and correlates of major depressive disorder in breast cancer survivors in Shanghai, China. Psychooncology. 2012;21(12):1331-7.
39. Kojima G, Walters K, Iliffe S, Taniguchi Y, Tamiya N. Marital status and risk of physical frailty: a systematic review and meta-analysis. J Am Med Dir Assoc. 2020;21:322-30.
40. Williams GR, Deal AM, Sanoff HK, Nyrop KA, Guerard EJ, Pergolotti M, et al. Frailty and health-related quality of life in older women with breast cancer. Support Care Cancer. 2019;27(7): 2693-8.

Impact of Frailty on Healthcare Utilization in Older Patients Admitted to Medical Wards: A Study from a Large Medical School in a Middle-income Setting

Patumporn Suraarunsumrit, M.D.[1,2,3], Pacha Sinthornkasem, M.D.[1], Ponnapa Petchthai, B.N.S.[3], Supawadee Sainimnuan, B.Sc., M.Sc.[3], Rinrada Preechitkul, B.Sc., M.Sc.[3], Varalak Srinonprasert, M.D.[1,2,3,*]

[1]Department of Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok 10700, Thailand, [2]Division of Geriatric Medicine, Department of Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok 10700, Thailand, [3]Siriraj Health Policy Unit, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok 10700, Thailand.



**Corresponding author: Varalak Srinonprasert*
E-mail: varalaksi@gmail.com, varalak.sri@mahidol.ac.th
Received 4 October 2024 Revised 11 December 2024 Accepted 12 December 2024
ORCID ID:http://orcid.org/0000-0001-5311-7657
https://doi.org/10.33192/smj.v77i1.271497

ABSTRACT

Objective: The study aimed to evaluate healthcare utilization and mortality in patients stratified by frailty status and explore the factors associated with a prolonged length of hospital stay (LOS).

Materials and Methods: This retrospective cohort study included medical inpatients aged ≥60 years old. They were classified into robust, prefrail, and frail groups using the FRAIL Scale. The primary outcome was LOS, while the secondary outcomes were hospital costs, in-hospital mortality, and factors associated with a prolonged LOS. Multivariate analysis was used to explore the factors that influenced the prolonged LOS, and the results were expressed using an adjusted odds ratio (AOR).

Results: Of the 603 enrolled participants, 269 (44.6%) were classified as frail, 256 (42.5%) as prefrail, and 78 (12.9%) as robust. The frail group had longer hospital stays than the robust group (8 days [1,58] vs. 6 days [1,36]; p=0.003). Healthcare costs in the frail and prefrail groups were higher than in the robust group (1264.6 USD [128.9, 30216.0], 1051.7 USD [154.3, 37615.7], and 937.7 USD [174.8, 18539.8], respectively; p=0.001). Frail and prefrail patients were also more likely to die in hospital than the robust ones (7.1% vs. 0.0%, p=0.010; 6.3% vs. 0.0%, p =0.028, respectively). The multivariate analysis also revealed that frailty was associated with a prolonged LOS [AOR of 2.21(95%CI, 1.07–4.56); p=0.031].

Conclusion: Frailty leads to increased healthcare utilization by patients and higher mortality. Identifying frail older patients with an aim to provide appropriate care might reduce the negative outcomes associated with frailty.

Keywords: Frailty; length of hospital stay; healthcare cost; mortality; older patients (Siriraj Med J 2025; 77: 83-92)

INTRODUCTION

Frailty is a clinical condition caused by the age-related deterioration of various systems in the body.[1] The syndrome increases a person's vulnerability to stress, which can lead to them experiencing more severe conditions and delays in the resolution of acute illnesses.[1,2] Frailty is more prevalent in hospitalized older patients, accounting for 13%-41% of those population.[3,4] Frailty is related to unfavorable health outcomes, including functional impairment and disability[5,6], as well as increased mortality[5,7,8], and increased healthcare utilization by such patients.[9,10]

Existing evidence on the impact of frailty has mostly been gathered from studies conducted in high-income countries (HICs). Those studies have found higher medical costs, higher rates of complications, and higher mortality rates among prefrail and frail older people compared to robust groups of similar aged people.[11-13] Frailty is also a significant concern in low- and middle-income countries (LMICs), with the number of frail older individuals growing with the aging population in many countries.[14,15] In such countries, high medical costs could be an important barrier to accessibility to healthcare services at the individual level. The increasing healthcare expenditure of dealing with such a group can also be a critical challenge for society, particularly in resource-limited settings. In this regard, quantifying the impact of frailty on medical expenses in LMICs might provide more insights into the issue and enable better decision-making by policymakers to assist healthcare planning.

Thailand is an upper-middle-income country, in which the proportion of older people is rising and is projected to significantly increase over the next decade.[16] The Thailand Development Research Institute (TDRI) has estimated that medical costs could triple from 0.68 to 2 trillion baht in 15 years as the country becomes an aging society.[17] This emphasizes the tremendous effect of the increasing number of older people on the healthcare costs of Thai society. However, in-depth studies of the medical costs for different segments of older people are limited to date, and, to the best of our knowledge, none has yet explored the frailty status in Thailand.

Thus, the present study aimed to investigate the healthcare utilization (length of hospital stay (LOS) and healthcare costs) and mortality rate of robust, prefrail, and frail older inpatients at a university hospital in Thailand. Furthermore, factors affecting a prolonged LOS were also investigated to explore potential amendable and preventable factors that could reduce the need for a lengthy LOS.

MATERIALS AND METHODS

Study design and participants

This retrospective cohort study was carried out at Siriraj Hospital, a university hospital in Thailand.

The inclusion criteria were consecutive patients over 60 years old who resided in the local vicinity and were admitted to general medical wards from September 2019 to December 2020. The assessment of frailty was attempted in all patients from the local area near the hospital. The study flow is demonstrated in Fig 1.

Frailty assessment

The Thai version of the FRAIL Scale, validated in the Thai context and with excellent accuracy[18], was applied to screen older patients prospectively. The tool consists of 5 questions covering: Fatigue, Resistance, Ambulation, Illnesses, and Loss of Weight. Each question needs a self-reported answer in the form of a rating as 0 or 1 point, depending on the presence of certain characteristics in each criterion. The total score thus ranges from 0 to 5, with a higher score indicating more frailty characteristics. A cutoff point of 3 or above is classified as frailty, while a score of 1 to 2 indicates prefrail and 0 indicates a robust status, respectively. Here, well-trained research assistants assessed the patients using the FRAIL Scale to evaluate the patients and classified them into robust, prefrail, and frail groups.

Data collection

The patients' demographic data, including age, gender, comorbidities, and Charlson comorbidity index (CCI)[5], as well as admission laboratory results, were retrieved from the hospital databases for all the patients who underwent a frailty assessment. The 10th revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-10) codes used to compute the CCI are shown in Additional file 1 (Appendix 1). Data on the length of hospital stay (LOS), reasons for admission (Appendix 2), in-hospital complications (Appendix 3), in-hospital mortality, and 1-month readmissions at Siriraj

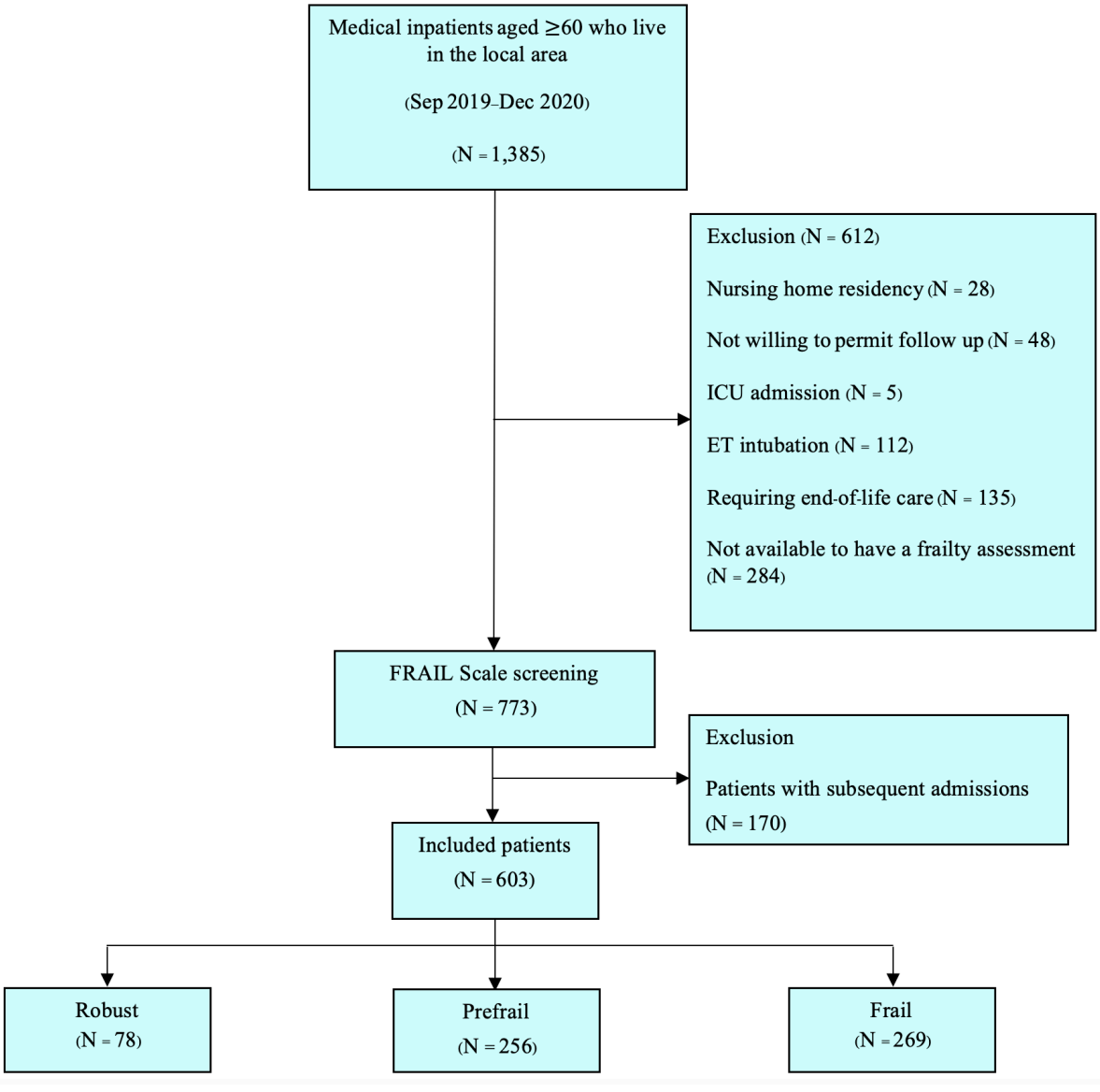


Fig 1. Study flow

Hospital were also collected from the same databases. The direct medical costs of the entire index admissions were also collected from the hospital database. The accreditation teams carried out the data quality control procedure to ensure accurate details were used for the ICD-10 codes after the medical residents had written the discharge summary. Moreover, all the medical records were reconfirmed by the attending staff to make sure that the information in the medical database was correct.

Factors associated with prolonged LOS

With regard to defining what constitutes a prolonged LOS, we utilized the mean LOS in our study, which was in accordance with a previous study in an acute care setting that defined LOS as ≥10 days.[19] Several studies exploring the factors associated with prolonged LOS were identified.[20-23] We chose factors related to an extended LOS that were relevant to our context to explore in our analysis. We identified several factors, namely, age ≥70 years old, female gender, CCI more than 5, comorbidities, frailty status, laboratory values (low serum albumin and hematocrit level), and reasons for admission, to be investigated in our analysis.

Statistical analysis

The patients' demographic data, reasons for admission, hospital complications, readmissions, and in-hospital mortality are reported herein as numbers and percentages for the categorical variables. Continuous variables, including CCI, albumin level, hematocrit level, LOS, and total costs, are presented using the mean ± SD or median (minimum, maximum) for normal and non-normal distributions when appropriate.

The Kruskal–Wallis test was used to analyze the LOS and direct medical costs among the robust, prefrail, and frail groups for continuous outcomes. Differences between the two groups were calculated using Dunn's test. Chi-square and Bonferroni tests were used for assessing the mortality outcomes to estimate the differences between the three groups. To investigate the factors associated with prolonged LOS, we used 10 days as the cutoff point. This figure was derived from a prior study that provided care in contexts similar to the circumstances in our study.[19] The Mann–Whitney U test or Independent t-test was used to investigate the continuous data in the univariate analysis. Chi-square or Fisher's exact test was used to analyze the significant differences between the categorical variables. The possible factors related to prolonged LOS are reported using the odds ratio (OR) and 95% confidence interval (95%CI) in the univariate logistic regression models. The potentially contributing factors were considered regarding their clinical relevance and a statistical consistency of $P < 0.20$ from the univariate analysis and were put into a multiple logistic regression model. The associations between a prolonged LOS and the related factors are presented as an adjusted OR along with 95%Cl. P-value < 0.05 was considered as indicating a statistically significant difference. All the analyses were done using SPSS 26 (SPSS, Inc., Chicago, IL, USA).

The sample size was calculated using nQuery Advisor 6.0.1 software. A prior study reported a mean LOS ranging from 8 ± 8.6 days for non-frail, to 11.2 ± 12.2 days for prefrail, and 13 ± 12 days for frail older patients.[5] Therefore, with 90% power, it was determined that 148 participants were needed per group.

RESULTS

Overall, 1,385 older patients were admitted to the medical wards of Siriraj Hospital during the study period (Fig 1). Among those, 773 were interviewed using the FRAIL Scale. After excluding the patients with subsequent admissions during the study period, 603 participants were enrolled and categorized into 3 groups according to their frailty status; specifically, 78 (12.9%) were assigned to the robust group, 256 (42.5%) to the prefrail group, and 269 (44.6%) to the frail group, respectively. Table 1 shows the baseline characteristics of the participants. The participants in the prefrail and the frail groups were more likely to be female, older, and to have a higher CCl than those in the robust group. Infection was the most common reason for admission among the 3 groups. During hospitalization, the prefrail and frail patients were more likely to experience hospital infections compared to the robust patients. The percentage of 1-month readmissions in the frail group was higher than that in the prefrail and the robust groups, although the difference among them was not statistically significant.

Table 2 lists the primary outcomes, showing that frail patients had a longer LOS than the robust ones (8 days (1, 58) vs. 6 days (1, 36); $p = 0.003$). Moreover, the direct medical costs in the frail and prefrail groups were significantly higher than in the robust group (1264.6 USD [128.9, 30216.0], 1051.7 USD [154.3, 37615.7], and 937.7 USD [174.8, 18539.8], respectively; $p = 0.001$). Additionally, post-hoc analysis revealed that prefrail and frail patients were more likely to die in hospital than patients with a robust status, although this difference was not statistically significant (6.3%, 7.1%, and 0.0%; $p = 0.055$; and 6.3% vs. 0.0%, $p = 0.028$, and 7.1% vs. 0.0%, $p = 0.010$ for the individual comparisons, respectively).

Table 3 lists the factors associated with a prolonged LOS. In the univariate analysis, the factors significantly

TABLE 1. Comparison of the baseline characteristics among the robust, prefrail, and frail groups.

Variables	Total (n=603)	Robust (n=78)	Prefrail (n=256)	Frail (n=269)	p-value
Female	308 (51.1%)	24 (30.8%)	146 (57.0%)	138 (51.3%)	<0.001*
Age, years					<0.001*
60–69	192 (31.8%)	41 (52.6%)	82 (32.0%)	69 (25.7%)	
70–79	202 (33.5%)	25 (32.1%)	79 (30.9%)	98 (36.4%)	
>80	209 (34.7%)	12 (15.4%)	95 (37.1%)	102 (37.9%)	
Charlson comorbidity index(CCI) > 5	109 (18.1%)	5 (6.3%)	40 (15.2%)	64 (24.6%)	<0.001*
Comorbidity					
Myocardial infarction	10 (1.7%)	0 (0.0%)	6 (2.3%)	4 (1.5%)	0.40
Congestive heart failure	22 (3.6%)	4 (5.1%)	5 (2.0%)	13 (4.8%)	0.13
Cerebrovascular disease	26 (4.3%)	5 (6.4%)	11 (4.3%)	10 (3.7%)	0.57
Dementia	37 (6.1%)	2 (2.6%)	18 (7.0%)	17 (6.3%)	0.38
Type 2 diabetes	275 (45.6%)	29 (37.2%)	108 (42.2%)	138 (51.3%)	0.03*
Reasons for admission[a]					
Infection	114 (18.9%)	8 (10.3%)	52 (20.3%)	54 (20.1%)	0.12
Organ failure	77 (12.8%)	9 (11.5%)	34 (13.3%)	34 (12.6%)	0.92
Emergency events	26 (4.3%)	1 (1.3%)	9 (3.5%)	16 (5.9%)	0.14
Serum albumin, g/dl	2.99 ± 0.58	3.06 ± 0.68	3.02 ± 0.59	2.95 ± 0.55	0.61
Hematocrit, %	30.31 ± 6.38	32.35± 6.01	30.38 ± 5.98	29.68 ± 6.73	0.06
Hospital complications[b]					
Infection	96 (15.9%)	5 (6.4%)	35 (13.7%)	56 (20.8%)	0.004
Organ failure	61 (10.1%)	5 (6.4%)	31 (12.1%)	25 (9.3%)	0.29
Emergency events	30 (5.0%)	5 (6.4%)	15 (5.9%)	10 (3.7%)	0.43
Delirium	36 (6.0%)	1 (1.3%)	16 (6.3%)	19 (7.1%)	0.15
1-month readmission	104 (17.2%)	12 (15.4%)	38 (14.8%)	54 (20.1%)	0.26

Data are presented by n (%) or mean±SD.

* Indicates statistical significance (<0.05).

[a] Reasons for admission are described in Appendix 2.; [b] Hospital complications are described in Appendix 3.

TABLE 2. Outcomes compared among the robust, prefrail, and frail groups.

Variables	Robust (n=78)	Prefrail (n=256)	Frail (n=269)	p-value
Length of stay, days	6 (1, 36)	7 (1, 62)	8 (1, 58)	0.003*[a]
Hospital costs, USD	937.7 (174.8, 18539.8)	1051.7 (154.3, 37615.7)	1264.6 (128.9, 30216.0)	0.001*[a,b]
In-hospital mortality, n (%)	0 (0.0%)	16 (6.3%)	19 (7.1%)	0.055*[c]

* Indicates statistical significance (<0.05); [a] There was a statistically significant difference between the robust and frail groups.; [b] There was a statistically significance difference between the robust and prefrail groups.; [c] There was a statistically significant difference between the robust and frail groups with p-value = 0.010 and between the robust and prefrail groups with p-value = 0.028.
(All costs were calculated in Thai Baht (THB) and converted to USD using the average exchange rate of 1 USD = 36.73 THB (31 Dec 2020 mean exchange rate)).

TABLE 3. Factors associated with a prolonged hospital stay

Variables	Univariate analysis Crude OR (95%CI)	p-value	Multivariate analysis Adjusted OR (95%CI) (Backward Stepwise Likelihood Ratio)	p-value
Frailty				
Robust	1		1	
Prefrail	1.54 (0.85-2.81)	0.16	1.77 (0.85-3.69)	0.13
Frail	2.06 (1.14-3.72)	0.02*	2.21 (1.07-4.56)	0.03*
Sex		0.01*		
Male	1			
Female	1.69 (1.19-2.39)			
Age, years				
60–69	1			
70–79	1.03 (0.66-1.59)	0.90		
>80	1.48 (0.97-2.58)	0.07		
Comorbidity				
Charlson Comorbidity Index > 5	1.58 (1.03-2.43)	0.04*		
Myocardial infarction	2.17 (0.62-7.59)	0.22		
Congestive heart failure	2.21 (0.94-5.20)	0.07	3.39 (1.09-10.57)	0.04*
Cerebrovascular disease	1.36 (0.60-3.05)	0.46		
Dementia	1.37 (0.67-2.64)	0.42		
Type 2 diabetes	0.92 (0.66-1.30)	0.65		
Laboratory results at admission				
Albumin level	0.54 (0.38-0.77)	<0.001*	0.54 (0.37-0.77)	0.001*
Hematocrit	1.00 (0.97-1.03)	0.82		
Reasons for admission				
Infection	1.99 (1.32-3.03)	0.001*		
Organ failure	1.84 (1.13-2.99)	0.01*		
Emergency events	0.78 (0.32-1.89)	0.58		

[a] Reasons for admission are described in Appendix 2.
* Indicates statistical significance (<0.05).
** Adjusted frailty, sex, age, congestive heart failure, albumin level, infection, and organ failure.

associated with a prolonged LOS were frailty status, with an OR of 2.06 [(95%CI, 1.14–3.72); p = 0.02]; female gender, with an OR of 1.69 [(95%CI, 1.19–2.39); p = 0.01]; congestive heart failure (CHF), with an OR of 2.21 [(95%CI, 0.94–5.20); p = 0.07]; albumin level, with an OR of 0.54 [(95%CI, 0.38–0.77); p < 0.001]; infection, with an OR of 1.99 [(95%CI, 1.31–3.03); p = 0.001]; and organ failure, with an OR of 1.84 [(95%CI, 1.13–2.99); p = 0.014]. In the multivariate analysis adjusted for gender, age, CHF, albumin level, infection, and organ failure, frailty was significantly associated with an extended hospital stay, with an adjusted OR of 2.21 [(95%CI, 1.07–4.56); p = 0.03]. Also, patients with CHF had a prolonged LOS, with an adjusted OR of 3.39 [(95%CI, 1.09–10.57); p = 0.04]; whereas patients with high albumin levels were less likely to experience extended hospitalization, with an adjusted OR of 0.54 [(95%CI, 0.37–0.77); p = 0.001].

DISCUSSION

The present study demonstrated there was an association between frailty status and negative consequences, including a prolonged LOS, higher healthcare costs, and increased mortality, in older patients in acute medical wards of a university hospital in middle-income settings. Also, older patients with a prefrail status had higher healthcare costs and increased mortality compared to robust older patients. Congestive heart failure was one important clinical condition that was found to contribute to extended hospitalization, whereas a high serum albumin level, which could indicate the good nutritional status of patients, was a protective factor against a prolonged hospital stay.

Frailty can contribute to an increased mortality risk due to its pathophysiology.[13,24] Frail individuals experience a decline in multiple organ systems, leading to a loss of homeostatic capability to withstand stressors and resulting in vulnerabilities that can have adverse outcomes on such individuals when they are exposed to acute illnesses or physical stress.[24] Supporting evidence from a previous meta-analysis showed that frail and prefrail statuses were associated with a higher risk of in-hospital, medium-term, and long-term mortality compared to non-frail groups.[5] Our study demonstrated a similar association, showing higher in-hospital mortality among frail and prefrail patients.

The association between frailty and mortality in older patients has been established in several contexts in previous studies, though primarily in acute care settings, similar to in our study.[8,25,26] Most studies were conducted using the frailty index, frailty phenotype, or Clinical Frailty Scale (CFS), while limited studies have used the FRAIL Scale as the diagnostic tool for identifying frailty to predict mortality.[8,25] The FRAIL Scale has been validated in the Thai context and shown to have a good correlation with the Thai frailty index[18], making it an ideal tool for our study. Additionally, the tool requires minimal skill and time for its administration. Overall, this study included additional evidence from using the FRAIL Scale for stratifying the mortality risk among older patients admitted to an acute medical setting.

Furthermore, the study highlighted the fact that prefrail and frail patients are more likely to utilize healthcare resources than robust patients in an upper-middle-income country. This increased utilization was evidenced by their prolonged LOS and the higher costs for their treatment, which represent healthcare costs from a provider perspective. This result was in accordance with previous studies conducted in both HICs and LMICs.[5,9,10,27] It was emphasized in a prior study that multi-comorbid conditions were not the sole contributor to the higher healthcare cost and utilization found among the study's frail group.[28] Multiple deficits in other domains, such as the ability to independently ambulate, the ability to perform self-caring, and impaired cognition, which are more common in frail older persons, might contribute to a higher risk of them experiencing other geriatric syndromes, such as hospital complications, and lead to higher costs and a longer hospital stay.

In addition, a prolonged LOS was selected as a representative measure to explore the potential contributing factors to the negative consequences of frailty. It would also be beneficial if some factors were found to be potentially modifiable. This study showed that frailty was associated with extended hospitalization. Frailty has long been considered a strong indicator correlated with prolonged hospitalization, with different tools used to define frailty status.[5,29] This study contributes to the field by adding evidence from using the FRAIL Scale to strategize the risk of a prolonged LOS among older patients admitted to an acute medical setting. Moreover, our results showed that CHF independently contributed to a prolonged LOS, whereas high serum albumin was a protective factor against a prolonged LOS. These findings were similar to those of other studies with respect to their correlation with LOS.[23,30]

The study addressed the negative consequences of frailty among older inpatients. Despite the study being conducted in a large single center only, our findings could have a tremendous impact on the healthcare system in Thailand and how frailty is considered and managed. This is a serious issue for the healthcare system as the number of frail older people is increasing along with the aging

population, and this is placing an increasing burden on the healthcare system. Frail older patients should receive a comprehensive geriatric assessment (CGA) to evaluate their physical, psychological, functional, and social aspects in order to ensure they receive appropriate interventions. Interventions from a multidisciplinary team would be beneficial for helping prevent complications, which could lead to decreased healthcare utilization among frail older patients.[31-34] One of the possible solutions in the Thai context, where a guideline for caring for hospitalized older patients is not yet available, is to screen for frailty at the beginning of older patient's admission. Integrated interventions could, therefore, be implemented early on for the frail group and could ensure the healthcare provider can better utilize their workforce to ensure that vulnerable patients are identified and cared for appropriately.

There are several strengths of this study to note. First, we prospectively defined frailty status using the FRAIL Scale based on our setting. Second, we enrolled consecutive patients during the study period, which should minimize selection bias. Third, the data were retrieved from medical databases with a standard procedure to ensure the accuracy of the clinical information, including the use of ICD-10 code data. However, there are some limitations of our study that should be addressed too. First, the healthcare costs in our study included only direct medical expenses without taking into account direct non-medical and indirect costs. Nevertheless, it could be estimated that the healthcare costs for frail older persons would be even more than their initial expenditure, with any deficits requiring recovery after the illnesses. Second, we could not disentangle the association between frailty and the in-hospital mortality outcome using multivariate analysis as there was no mortality in the robust group during the study. Third, the study was carried out among frail older inpatients in a large tertiary hospital, which may limit the generalizability of these findings. However, considering the limited resources and workforce across the country as a whole as a resource-limited setting, it could be assumed that the care setting for older people might not be much different in other settings in Thailand, or even in other LMIC countries. The magnitude of impact might be different in other settings, but the influence of frailty should remain the same. Last, because of the nature of the retrospective study design, some potential confounders, such as socioeconomic status and functional status, were not available at the time of analysis and so were not considered. A prospective cohort study should be conducted to investigate these potential contributing factors better. Identifying modifiable factors in a resource-limited setting, where long-term care remains mostly at home for older people with multiple deficits, would also be beneficial.

CONCLUSION

Frailty status significantly increased the length of hospital stay, mortality and healthcare costs of older patients in an acute care setting. Identifying frail older patients using the FRAIL Scale, with an aim to ensure they receive CGA provided by a multidisciplinary team and transition to a proper intermediate care setting, might be an option for healthcare systems to appropriately allocate resources for caring for older patients in an aging society, particularly in resource-limited settings.

Data Availability Statement

The datasets used and analyzed during the current study are available from the corresponding author upon reasonable request.

ACKNOWLEDGMENTS

This study was supported by the Faculty of Medicine of Siriraj Hospital, Mahidol University. The authors gratefully acknowledge Mr. Noppon Siangchin and the team from Siriraj Informatics and Data Innovation Center of Siriraj Hospital, Mahidol University, for their support with the data aspects. The authors also thank Mr. Monai Sauejui for his assistance in formatting the manuscript.

DECLARATION

Grants and Funding Information

This study was supported by the Faculty of Medicine, Siriraj Hospital Mahidol University (grant number [IO] R016531023). The funders had no role in the study design, data collection, analyses, publishing decisions, or manuscript preparation.

Conflict of Interest

The authors declare that they have no competing interests related to this study.

Author Contributions

PSi, PSu: study design, data analysis, and interpretation, and manuscript preparation and review. VS: study design, data interpretation, and manuscript review and revision. PP: data collection and data interpretation. SS: data management. RP: data collection and analysis. All authors approved the final version of the manuscript.

Ethics Approval

This study was a database research project and did not involve interventions or patient contact. Therefore, individual patients were not identifiable. The analyses were approved by the Human Research Protection Unit, Faculty of Medicine Siriraj Hospital, Mahidol University (reference number Si 976/2021).

Consent for Publication

Not applicable.

REFERENCES

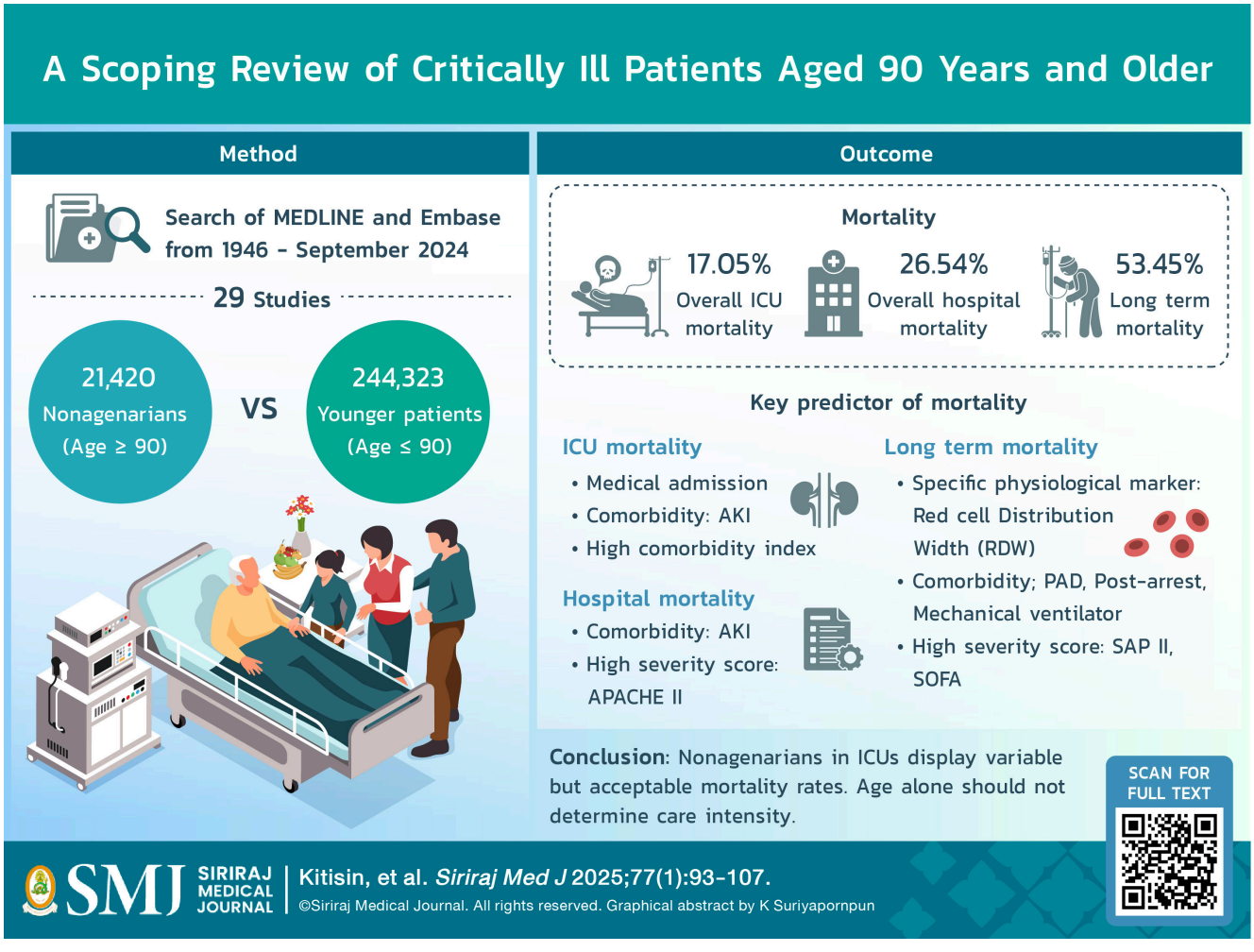
1. Clegg A, Young J, Iliffe S, Rikkert MO, Rockwood K. Frailty in elderly people. Lancet. 2013;381(9868):752-62.
2. Dent E, Martin FC, Bergman H, Woo J, Romero-Ortuno R, Walston JD. Management of frailty: opportunities, challenges, and future directions. The Lancet. 2019;394(10206):1376-86.
3. Gómez Jiménez E, Avendaño Céspedes A, Cortés Zamora EB, García Molina R, Abizanda P. [Frailty prevalence in hospitalized older adults. A systematic review.]. Revista espanola de salud publica. 2021;95.
4. Suraarunsumrit P, Pathonsmith C, Srinonprasert V, Sangarunakul N, Jiraphorncharas C, Siriussawakul A. Postoperative cognitive dysfunction in older surgical patients associated with increased healthcare utilization: a prospective study from an upper-middle-income country. BMC Geriatr. 2022;22(1):213.
5. Cunha AIL, Veronese N, de Melo Borges S, Ricci NA. Frailty as a predictor of adverse outcomes in hospitalized older adults: A systematic review and meta-analysis. Ageing Res Rev. 2019; 56:100960.
6. Chang SF, Cheng CL, Lin HC. Frail Phenotype and Disability Prediction in Community-Dwelling Older People: A Systematic Review and Meta-Analysis of Prospective Cohort Studies. The journal of nursing research : JNR. 2019;27(3):e28.
7. Srinonprasert V, Chalermsri C, Aekplakorn W. Frailty index to predict all-cause mortality in Thai community-dwelling older population: A result from a National Health Examination Survey cohort. Archives of gerontology and geriatrics. 2018;77: 124-8.
8. Kojima G, Iliffe S, Walters K. Frailty index as a predictor of mortality: a systematic review and meta-analysis. Age Ageing. 2018;47(2):193-200.
9. Hajek A, Bock JO, Saum KU, Matschinger H, Brenner H, Holleczek B, et al. Frailty and healthcare costs-longitudinal results of a prospective cohort study. Age Ageing. 2018;47(2): 233-41.
10. García-Nogueras I, Aranda-Reneo I, Peña-Longobardo LM, Oliva-Moreno J, Abizanda P. Use of Health Resources and Healthcare Costs associated with Frailty: The FRADEA Study. J Nutr Health Aging. 2017;21(2):207-14.
11. Bock J-O, König H-H, Brenner H, Haefeli WE, Quinzler R, Matschinger H, et al. Associations of frailty with health care costs – results of the ESTHER cohort study. BMC Health Services Research. 2016;16(1):128.
12. Comans TA, Peel NM, Hubbard RE, Mulligan AD, Gray LC, Scuffham PA. The increase in healthcare costs associated with frailty in older people discharged to a post-acute transition care program. Age and ageing. 2016;45(2):317-20.
13. Vermeiren S, Vella-Azzopardi R, Beckwée D, Habbig AK, Scafoglieri A, Jansen B, et al. Frailty and the Prediction of Negative Health Outcomes: A Meta-Analysis. J Am Med Dir Assoc. 2016;17(12):1163.e1-.e17.
14. Ara R, Monisha UK, Nova TJ, Chowdhury S, Nabi MH, Hawlader MDH. Potential nonpharmacological interventions to prevent frailty among elderly in low-and middle-income countries: A protocol for systematic review. Medicine. 2022;101(4).
15. Gray WK, Richardson J, McGuire J, Dewhurst F, Elder V, Weeks J, et al. Frailty Screening in Low- and Middle-Income Countries: A Systematic Review. J Am Geriatr Soc. 2016;64(4):806-23.
16. Foundation of Thai Gerontology Research and Development institute (TGRI). Situation of Thai Elderly 2020. In: Foundation of Thai Gerontology Research and Development Institute, editor. Bangkok2021.
17. TDRI study report. Estimate public health expenditure in the next 15 years. 2562. Available from: htttps://tdri.or.th/2019/12/public-healthcare-evaluation/.
18. Sriwong W, Mahavisessin W, Srinonprasert V, Siriussawakul A, Aekplakorn W, Limpawattana P, et al. Validity and reliability of the Thai version of the simple frailty questionnaire (T-FRAIL) with modifications to improve its diagnostic properties in the preoperative setting. BMC geriatrics. 2022;22(1):161.
19. Subramaniam A, Tiruvoipati R, Green C, Srikanth V, Soh L, Yeoh AC, et al. Frailty status, timely goals of care documentation and clinical outcomes in older hospitalised medical patients. Intern Med J. 2021;51(12):2078-86.
20. Toh HJ, Lim ZY, Yap P, Tang T. Factors associated with prolonged length of stay in older patients. Singapore medical journal. 2017;58(3):134-8.
21. Bo M, Fonte G, Pivaro F, Bonetto M, Comi C, Giorgis V, et al. Prevalence of and factors associated with prolonged length of stay in older hospitalized medical patients. Geriatr Gerontol Int. 2016;16(3):314-21.
22. Marfil-Garza BA, Belaunzarán-Zamudio PF, Gulias-Herrero A, Zuñiga AC, Caro-Vega Y, Kershenobich-Stalnikowitz D, et al. Risk factors associated with prolonged hospital length-of-stay: 18-year retrospective study of hospitalizations in a tertiary healthcare center in Mexico. PLoS One. 2018;13(11): e0207203.
23. Liu T, Xuan H, Wang L, Li X, Lu Z, Tian Z, et al. The association between serum albumin and long length of stay of patients with acute heart failure: A retrospective study based on the MIMIC-IV database. PLoS One. 2023;18(2):e0282289.
24. 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.
25. Kojima G. Frailty Defined by FRAIL Scale as a Predictor of Mortality: A Systematic Review and Meta-analysis. J Am Med Dir Assoc. 2018;19(6):480-3.
26. Hao Q, Zhou L, Dong B, Yang M, Dong B, Weil Y. The role of frailty in predicting mortality and readmission in older adults in acute care wards: a prospective study. Sci Rep. 2019;9(1):1207.
27. Ambagtsheer RC, Moussa RK. Association of frailty with health service utilisation and health care expenditure in sub-Saharan Africa: evidence from Côte d'Ivoire. BMC Geriatr. 2021;21(1):446.
28. Lujic S, Randall DA, Simpson JM, Falster MO, Jorm LR. Interaction effects of multimorbidity and frailty on adverse health outcomes in elderly hospitalised patients. Sci Rep. 2022;12(1):14139.
29. Xia F, Zhang J, Meng S, Qiu H, Guo F. Association of Frailty

With the Risk of Mortality and Resource Utilization in Elderly Patients in Intensive Care Units: A Meta-Analysis. Front Med (Lausanne). 2021;8:637446.
30. Tal S. Length of hospital stay among oldest-old patients in acute geriatric ward. Archives of Gerontology and Geriatrics. 2021; 94:104352.
31. Ekdahl AW, Sjöstrand F, Ehrenberg A, Oredsson S, Stavenow L, Wisten A, et al. Frailty and comprehensive geriatric assessment organized as CGA-ward or CGA-consult for older adult patients in the acute care setting: A systematic review and meta-analysis. European Geriatric Medicine. 2015;6(6):523-40.
32. Ellis G, Gardner M, Tsiachristas A, Langhorne P, Burke O, Harwood RH, et al. Comprehensive geriatric assessment for older adults admitted to hospital. Cochrane Database Syst Rev. 2017;9:CD006211.
33. Chen Z, Ding Z, Chen C, Sun Y, Jiang Y, Liu F, et al. Effectiveness of comprehensive geriatric assessment intervention on quality of life, caregiver burden and length of hospital stay: a systematic review and meta-analysis of randomised controlled trials. BMC Geriatr. 2021;21(1):377.
34. Jirakulsawat A, Noocharoen N, Somnuke P. Prehabilitation in Clinical Practice: A Review of Concepts and Implementation in Enhancing Post-operative Outcomes. Siriraj Med J. 2024; 76(9):646-54.

Outcomes in Critically Ill Patients Aged 90 Years and Older: A Scoping Review

Nuanprae Kitisin, M.D.[1], Nuttapol Pattamin, M.D.[2], Nirinrada Thongpibul, M.D.[3], Nattaya Raykateeraroj, M.D.[1,*]

[1]Department of Anaesthesiology, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand, [2]Kidney Excellence Centre, Bhumibol Adulyadej Hospital, Royal Thai Air Force, Bangkok, Thailand, [3]Princess Srisavangavadhana College of Medicine, Chulabhorn Royal Academy, Bangkok, Thailand.



**Corresponding author: Nattaya Raykateeraroj*
E-mail: raykageeraroj@gmail.com
Received 3 October 2024 Revised 24 October 2024 Accepted 24 October 2024
ORCID ID:http://orcid.org/0000-0002-1212-2115
https://doi.org/10.33192/smj.v77i1.271484

ABSTRACT

The growing population of nonagenarians has led to increased intensive care unit (ICU) admissions among elderly patients. However, evidence on their outcomes and optimal management strategies remains limited and fragmented. This scoping review aimed to explore mortality outcomes, factors associated with mortality, and treatment intensity in nonagenarians, comparing them to younger patients. A systematic search of MEDLINE and Embase from 1946 to September 2024 identified studies reporting ICU, in-hospital, and long-term mortality in nonagenarians. Twenty-nine studies involving 21,420 nonagenarians and 244,323 younger patients were included. ICU mortality among nonagenarians ranged from 1.42% to 66.7%, with an overall rate of 17.05% (2,738/16,062). In-hospital mortality ranged from 5.6% to 47%, with an overall rate of 26.54% (5,563/20,962). Long-term (one-year) mortality varied from 19% to 77%, with an overall rate of 53.45% (7,020/13,134). Key predictors of mortality included comorbidities, high severity scores (APACHE II, SAPS II), and less aggressive treatment. Despite these factors, nonagenarians had comparable mortality rates to younger patients when adjusted for illness severity. Nonagenarians in ICUs display variable but acceptable mortality rates, suggesting that age alone should not determine care intensity. Their heightened vulnerability after discharge calls for more effective and personalized post-ICU and post-hospital discharge care plans to better address their ongoing risks.

Keywords: Nonagenarians; Intensive Care Units; Mortality Outcomes; Critical Illness; Elderly Patients; ICU Admission (Siriraj Med J 2025; 77: 93-107)

INTRODUCTION

The global population is aging rapidly, leading to a significant increase in the number of very elderly individuals, particularly nonagenarians. By 2030, more than 30 million nonagenarians are projected to reside in 35 industrialized countries.[1] Alongside this trend, the number of patients aged 80 years and older in intensive care units (ICUs) is steadily increasing[2-5], presenting substantial challenges for healthcare systems, especially in the management of critically ill elderly patients.[6,7] Despite the growing presence of nonagenarians in ICUs, there remains a significant gap in the evidence regarding their specific outcomes and optimal management strategies.

Existing studies provide some insights, but the evidence remains limited and fragmented. For example, Garrouste-Orgeas et al.[8] found that nonagenarians received fewer interventions, such as arterial line monitoring and renal replacement therapy, than octogenarians. However, their ICU and hospital mortality rates were similar. Likewise, Bruno et al.[9] also reported that nonagenarians had ICU mortality rates comparable to octogenarians, despite greater frailty and fewer organ support interventions. After adjusting for confounders, there was no significant increase in risk of 30-day mortality. These findings suggest that nonagenarians might have outcomes similar to those of slightly younger elderly patients, even with less intensive care. Still, the limited number and scope of these studies leave questions about the best way to care for nonagenarians in ICUs.

Recent data suggest improvements in long-term survival rates for nonagenarians.[10] Yet, few comprehensive analyses have explored how advances in medical care and treatment strategies have contributed to these outcomes. This gap in research leaves healthcare providers with insufficient guidance on optimizing care for this growing patient population.

This scoping review aims to explore the outcomes of nonagenarians in ICUs, focusing on mortality rates and comparing them to younger age groups. Additionally, the review will identify key risk factors for death in critically ill nonagenarians and evaluate how the intensity of treatment affects outcomes. Treatment is categorized based on its intensity, such as less aggressive (involving limited use of invasive catheters, mechanical ventilation, vasopressors, inotropes, and renal replacement therapy) or more aggressive. By synthesizing the literature, this study seeks to provide a clearer understanding of survival factors and offer guidance for optimizing care for this unique patient population.

METHODOLOGY

This scoping review adhered to the Cochrane and Joanna Briggs Institute (JBI) methodologies for scoping reviews, with reporting following Preferred Reporting Items for Systematic Reviews and Meta-analyses extension for scoping reviews (PRISMA-ScR) guidelines.[11] It focused on collecting data on mortality rates, factors associated with mortality, and treatment intensity among critically ill nonagenarian ICU patients.

Eligibility Criteria

Inclusion

- Studies involving nonagenarian patients (aged ≥90 years old)admitted to ICUs.
- Studies reporting on mortality (e.g., 30-day mortality, ICU mortality) and other relevant clinical outcomes.

Exclusion

- Studies without ICU-specific outcomes (e.g., those focused solely on quality of life).
- Studies focused exclusively on patients younger than 90 years of age, unless nonagenarian-specific data could be extracted.
- Studies not published in English
- Reviews, letters, commentaries, correspondence, conference abstracts, expert opinions, and editorials were excluded.

Information sources

Searches were conducted in MEDLINE Ovid ALL and Embase Ovid Classic the period from 1946 to September 18, 2024.

Search strategy

We performed preliminary searches in MEDLINE and Embase to identify relevant studies, indexing terms, and keywords (e.g., nonagenarian, aged over 90, very elderly, extreme aged, mortality, intensive care). Next, we conducted a comprehensive search using all indexed terms and keywords across the selected databases, without applying any limits or filters (as detailed in Appendix II: Search strategy). Finally, we manually reviewed the references from the included studies and assessed those that met the eligibility criteria for inclusion in the review.

Selection of evidence

We uploaded all citations to Covidence and removed duplicates. Two independent reviewers (NK and NR) screened the titles and abstracts based on the inclusion criteria. Any disagreements during the full-text screening were resolved through discussion.

Data extraction

The two reviewers (NK and NR) created a data extraction table to record key variables. These included study details, publication year, design, the mean or median age of the nonagenarian group, and mortality outcomes, with comparisons to younger cohorts when available.

RESULTS

Search results and included studies

The search strategy identified 303 references from two databases: MEDLINE (n = 178) and Embase (n = 125). Two additional studies were found through citation searching, yielding a total of 305 articles. After the removal of 45 duplicates via Covidence, 260 studies remained for screening. Following title and abstract screening as well as full-text review, 29 publications met the inclusion criteria for the final analysis (Fig 1).

Types of Included Papers

The selected publications spanned from 1984 to September 18, 2024, with a noticeable increase in studies in recent years. Among the 29 publications, 4 (13.8%) were prospective studies[12-15], whereas the remaining 25 (86.2%) were retrospective cohort studies.[3,6,8-10,16-35] The types of ICUs represented were diverse and included mixed ICUs, surgical ICUs, cardiac ICUs, respiratory ICUs, nephrology ICUs, and trauma and surgical ICUs (Table 1).

Among these publications, 58.6% (17 studies) reported mortality outcomes specific to ICU settings[6,8-10,12,13,17,20-24,27,28,31-33], while others addressed in-hospital mortality, long-term mortality, or ICU-related complications. Several studies focused on specific medical conditions affecting nonagenarians, such as acute kidney injury[16,32], peripheral vascular disease[27], and postoperative outcomes following major surgeries, particularly cardiac surgery.[18,19]

Most of the publications incorporated various illness severity risk scores to predict mortality outcomes, including the Acute Physiology and Chronic Health Evaluation (APACHE)[13,17,23,25,28,31], Simplified Acute Physiology Score (SAPS II)[8,10,12,21,22,31,33], Sequential Organ Failure Assessment (SOFA)[8-10,22,33], Charlson Comorbidity Index (CCI)[10,16,22,24,27,30,32,33], Elder Risk Assessment (ERA)[29], Global Registry of Acute Coronary Events (GRACE)[36], New York Heart Association (NYHA) Functional Classification[18], Clinical Frailty Scale (CFS)[9], and Mortality Probability Model (MPM).[35] These scores are used to assess the severity of illness and guide clinical decisions concerning critically ill nonagenarians, with the APACHE II, SAPS II and CCI scores being the most commonly used scores.

Demographics and geographic distribution of the studies

Most studies were conducted in Germany (34.5%, 10 studies)[6,10,16,18,22,24,27,28,33,34], followed by the United

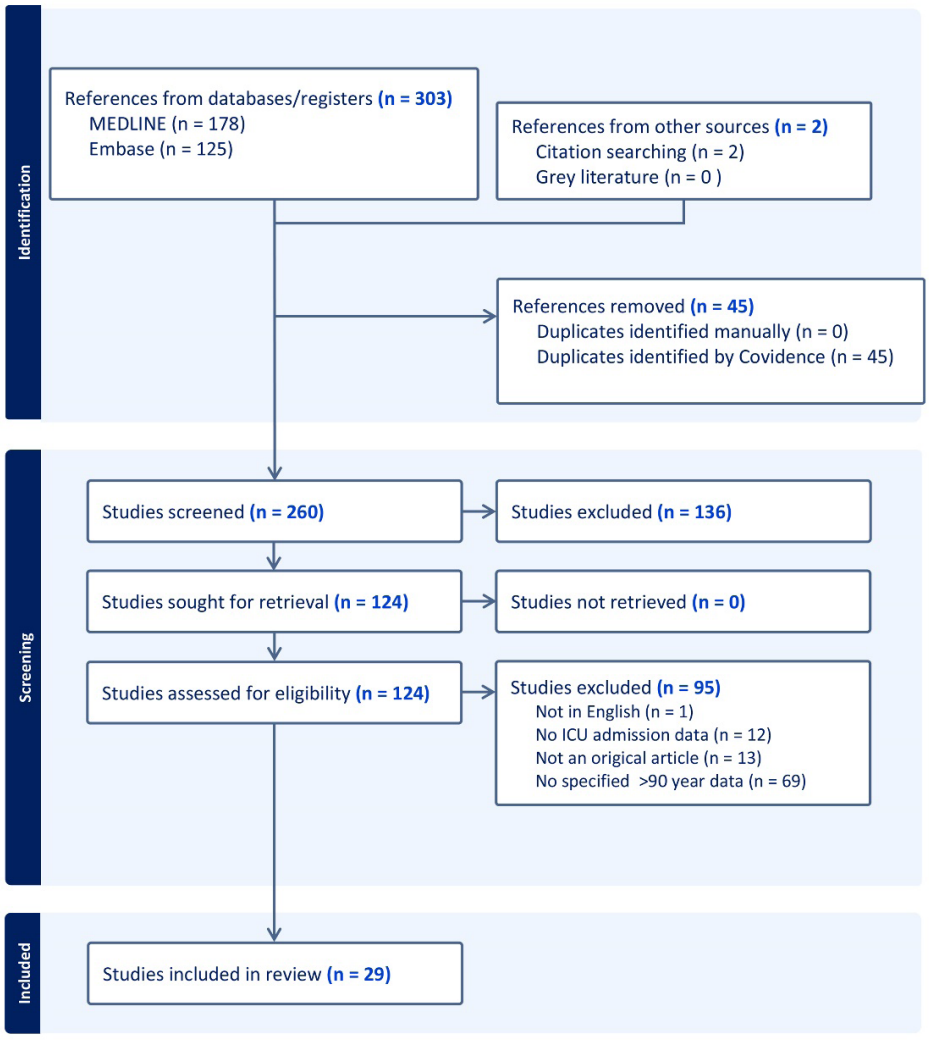


Fig 1. PRISMA flow diagram

TABLE 1. Study characteristics.

Author, Year, Country	Study design	Population	Type of ICU	Age (years)	Comparison	Nonagenarian mortality	Younger group mortality
Michel, 1984, United States[26]	Retrospective cohort study	225 nonagenarian who underwent major surgeries	Surgical ICU	92.1	Nonagenarian: Elective surgery vs Emergency surgery	In-hospital mortality: 17/225 (7.5%)	Not reported
Margulies, 1993, United States[12]	Prospective data collection	5,792 surgical ICU patients - Nonagenarians: 140 - Aged < 90: 5,652	Surgical ICU	92.1 (0.2)	Nonagenarians vs. Younger patients (< 90 years)	SICU mortality: 6/140 (4.3%) In-Hospital mortality: 24/140 (17.1%)	SICU mortality: 130/5652 (2.3%) In-hospital mortality: 298/5652 (5.3%)
Bacchetta,2003, United States[19]	Retrospective analysis	42 nonagenarian patients who underwent open-heart procedures	Cardiac surgical ICU	91.2	Not determined	In-hospital mortality: 3/42 (7%) Long-term mortality (mean 2.53 years, range: 0.16 to 7.1 years): 19%	Not reported

TABLE 1. Study characteristics. (Continue)

Author, Year, Country	Study design	Population	Type of ICU	Age (years)	Comparison	Nonagenarian mortality	Younger group mortality
Demoule, 2005, France[21]	Case-control	108 ICU patients - Aged ≥90 years: 36 - Aged 20-69 years: 72	Respiratory ICU	92.8 (2.4)	Patient aged ≥90 years vs. Age 20-69 years	ICU mortality: 10/36 (28%) In-hospital mortality: 17/36 (47%)	ICU mortality: 13/72 (18%), In-hospital mortality: 20/72 (27%)
Rellos, 2006, Greece[13]	Prospective Cohort Study	5,505 ICU patients - Nonagenarians: 60 - Aged < 90 years: 5445	Mixed ICU	92 (2.8)	Nonagenarians vs. Age <90 years	ICU mortality: 12/60 (20%) In-hospital mortality: 24/60(40%)	ICU mortality: 365/5445 (6.7%), In-hospital mortality: 485/5445 (8.9%)
Nathanson, 2011, United States[35]	Retrospective cohort study	124,885 ICU patients - Aged ≥90 years: 2,576 - Aged < 90 years: 122,309	Mixed ICU	Not specified	18-29 years vs. 30-39 years vs. 40-49 years vs. 50-59 years vs. 60-69 years vs. 70-79 years vs. 80-89 years vs. ≥90 years	In-hospital mortality: 716/2576 (27.8%)	In-hospital mortality: 18-29 years: 505/8709 (5.8%) 30-39 years: 648/9523 (6.8%) 40-49 years: 1449/15928 (9.1%) 50-59 years: 2275/19960 (11.4%) 60-69 years: 3165/22933 (13.8%) 70-79 years: 4722/27941 (16.9%) 80-89 years: 3757/17315 (21.7%)
Yayan, 2012, Germany[34]	Retrospective cohort study	8,554 ICU patients - Aged ≥90 years: 212 - Octogenarians: 1,715	Mixed ICU	92.7 (6.98)	Patient aged ≥90 years vs. Octogenarians	In-hospital mortality rate: 3/212 (1.42%)	In-hospital mortality rate: 44/1715 (2.57%)
Assmann, 2013, Germany[18]	Retrospective data analysis	49 nonagenarians who underwent cardiac surgery	Cardiac surgical ICU	91.2 (3.1)	Not determined	In-hospital mortality: 5/49 (10%)	Not reported
Becker, 2015, Germany[6]	Retrospective observational study	372 critically ill patient ≥90 years	Mixed ICU	92.2 (91–94.3)	Patient aged ≥90 years: ICU-survival vs. ICU-non-survival	ICU mortality: 68/372 (18.3%) In-hospital mortality: 115/372 (30.9%) 1-year mortality: 242/372 (34.9%)	Not reported

TABLE 1. Study characteristics. (Continue)

Author, Year, Country	Study design	Population	Type of ICU	Age (years)	Comparison	Nonagenarian mortality	Younger group mortality
Sim, 2015, Korea[31]	Single-centre retrospective cohort study	155 critically ill patient ≥90 years	Mixed ICU	92 (91–94)	Patient ≥90 years: ICU survival vs. Non-survival	ICU Mortality: 50/155 (32.3%) In-hospitality mortality: 52/155 (33.5%)	Not reported
Garrouste-Orgeas, 2016, France[8]	Retrospective observational, multicentre study	2,419 ICU patient age ≥80years, matching compared nonagenarian vs octogenarians - Age >90 years: 176 - Age 80-90 years: 176	Mixed ICU	92 (90.8-93.7)	Patient age >90 years vs. 80-90 years old	ICU mortality: 44/176 (25%) In-hospital mortality: 36/176 (39.8%)	ICU mortality: 36/176 (20.5%) In-hospital mortality: 64/176 (36.4%)
Lai, 2016, Taiwan[25]	Retrospective cohort study	510 patients who required prolonged mechanical ventilation (PMV) for over 21 days - Patient ≥90 years: 41 - Octogenarians: 469	Mixed ICU	91.6 (1.6)	Patient ≥90 years vs. Octogenarians	In-hospital mortality: 7/41 (17.1%) (22.2%)	In-hospital mortality: 104/469
Rosenbaum, 2017, United States[29]	Retrospective cohort study	453 nonagenarians (age ≥90 years) admitted to or transferred to the Cardiac Intensive Care Unit (CICU)	Cardiac Intensive Care Unit	92 (2)	Nonagenarian: Elder Risk Assessment (ERS) score: 4-8 vs. 9-15 vs. ≥16	Overall in-hospital Mortality: 70/453 (15%) - ERS 4-8: 34/109 (18%) - ERS 9-15: 28/227(12%) - ERS≥16: 22/117 (19%) Overall 30-day mortality: 104/453 (23%) Overall 6-month mortality: 181/453 (40%) Overall 1-year mortality: 213/453 (47%)	Not reported
Roedl, 2018, Germany[28]	Single-centre retrospective cohort study	48 nonagenarian (age ≥90 years) who suffered from cardiac arrest (CA) and achieved return of spontaneous circulation	Mixed ICU	91.7 (90.7-92.6)	Nonagenarian: Postcardiac arrest survival vs. Postcardiac arrest non-survival	ICU Mortality: 26/48 (54%) In-hospital mortality: 30/48 (62.5%) 1-year mortality rate:37/48 (77%)	Not reported

TABLE 1. Study characteristics. (Continue)

Author, Year, Country	Study design	Population	Type of ICU	Age (years)	Comparison	Nonagenarian mortality	Younger group mortality
E.M.Haas, 2020, Netherlands[23]	Retrospective national cohort study	104,754 critically ill patients - Aged ≥90 years: 9,495 - Octogenarians: 95,259	Mixed ICU	Not specified	Aged ≥90 years vs. Octogenarians	ICU mortality: 1310/9495 (13.8%) In-hospital mortality: 2478/9495 (26.1%) 3-month mortality: 4092/9495 (43.1%) 1-year mortality: 5222/9495 (55%)	ICU mortality: 15337/95259 (16.1%) In-hospital mortality: 24482/95259 (25.7%) 3-month mortality: 32102/95259 (33.7%) 1-year mortality: 40676/95259 (42.7%)
Sousa, 2020, Brazil[32]	Retrospective cohort study	436 nonagenarians (age ≥90 years) hospitalized patients - ICU admitted: 333 - Ward admitted: 103	Mixed ICU	93.5 (3.3)	Nonagenarian: with AKI vs. without AKI	Overall ICU mortality: 170/333 (51.1%) - AKI: 124/173 (71.7%) - Non-AKI: 46/160 (28.8%) Overall hospital mortality (ICU and ward mortality): 188/436 (43.1%) - AKI: 131/196 (66.8%) - Non-AKI: 57/240 (23.8%)	Not reported
Kochlya, 2020, France[36]	Retrospective cohort study	403 patients admitted to ICU with acute coronary syndrome (ACS) - Age ≥90 years: 92 - Octogenarians: 311	Cardiac Intensive Care Unit	92.6 (2.2)	Age ≥90 years vs. Octogenarians	In-hospital mortality rate: 14/92 (15.2%) 5-year overall mortality: 34/92 (37%)	In-hospital mortality: 29/311 (9.3%) 5-year overall survival: 84/311 (27%)
Arikan, 2020, Turkey[17]	Retrospective observational study	107 critically ill nonagenarians (age ≥90 years)	Mixed ICU	92.65 (2.36)	Nonagenarian: Medical vs. Surgical patients	Overall ICU Mortality: 68/107 (63.55%) - Surgical: 4/25 (16%) - Medical: 64/82 (78.04%)	Not reported

TABLE 1. Study characteristics. (Continue)

Author, Year, Country	Study design	Population	Type of ICU	Age (years)	Comparison	Nonagenarian mortality	Younger group mortality
Bardak, 2021, Netherland[20]	Retrospective cohort study	176 critically ill patients - Nonagenarians (age ≥90 years): 18 - Octogenarians: 70 - Elderly patients (65-79 years): 88	Nephrology ICU	92.8	Nonagenarians vs. Octogenarians vs. Elderly (65–79 years)	ICU mortality: 12/18 (66.7%) 1-month mortality rate post-discharge: 40%	ICU mortality - Octogenarians: 34/70 (48.6%) - Elderly 33/88 (37.5%) 1-month mortality rate post-discharge - Octogenarians: 18.6% - Elderly: 11.4%
Bruno, 2021, England[9]	Retrospective cohort study	7,900 critically ill patients - Nonagenarians (age ≥90 years): 790 - Octogenarians: 7110	Mixed	91 (90-94)	Nonagenarians vs. Octogenarians	ICU Mortality: 213/790 (27%) 30-Day Mortality: 337/790 (45%)	ICU Mortality: 1921/7110 (27%) 30-Day Mortality: 2743/7110 (40%)
Higuchi, 2023, Japan[14]	Prospective observational analysis	2,242 critically ill patients - Nonagenarians: 197 - Octogenarians: 655 - Patient < 80 years: 1,390	Cardiac Intensive Care Unit	92.5 (2.5)	Nonagenarians vs. Octogenarians vs. Patient <80 years	In-hospital: 11/197(5.6%) 1-Year Mortality: 37/197 (19%)	In-hospital/ 30-day Mortality - Octogenarians: 25/655 (3.8%) - Patient < 80 years: 28/1390 (2%) 1-Year Mortality - Octogenarians: 79/655 (11.9%) - Patient < 80 years: 57/1390 (4.1%)
Roedl, 2023, Germany[27]	Retrospective cohort study	1,108 critically ill nonagenarian and centenarian (age ≥90 years)	Mixed	92.3 (91-94.2)	Nonagenarian and centenarian: PAD vs. without PAD	Overall ICU mortality: 201/1108 (18%) - PAD: 62/391 (23%) - Non-PAD: 139/717 (16%) Overall in-hospital mortality: 311/1108 (30%) - PAD: 108/391 (41%) - Non-PAD: 223/717 (26%)	Not reported

TABLE 1. Study characteristics. (Continue)

Author, Year, Country	Study design	Population	Type of ICU	Age (years)	Comparison	Nonagenarian mortality	Younger group mortality
Theile, 2023, Germany[33]	Retrospective cohort study	863 critically ill nonagenarians (age ≥90 years) with available RDW measurements	Mixed	92.2 (90.0-94.0)	Nonagenarians: ICU survival vs. Non-survival	Overall ICU Mortality: 132/863(15%) - Low RDW (≤14.5%): 34/327 (10%) - High RDW (>14.5%): 98/536 (18%) Overall in-hospital mortality: 275/863 (32%) - Low RDW (≤14.5%): 66/327 (20%) - High RDW (>14.5%): 179/536 (33%) Overall 1-year mortality: 361/863 (42%) - Low RDW (≤14.5%): 148/327 (45%) - High RDW (>14.5%): 339/536 (63%)	Not reported
Bruoha, 2023, Israel[15]	Prospective study	3,807 patients admitted to the Intensive Coronary Care Unit (ICCU) - Nonagenarians (age ≥90 years): 178 - Younger patients (age < 90 years): 3,629	Cardiac Intensive Care Unit	92.5 (2.5)	Nonagenarians vs. younger patients	In-hospital mortality: 10/178 (5.6%) 310 days after discharge mortality: 30%	In-hospital mortality: 91/3629 (2.5%) 310 days after discharge mortality: 14%
Schmidt, 2024, Germany[16]	Retrospective cohort study	1,054 critically ill nonagenarian (aged ≥90 years)	Mixed	92.3 (IQR 3.1)	Nonagenarian: with AKI vs. without AKI	Overall in-hospital mortality: 304/1054 (28.84%) - AKI 129/257 (50.19%) - Non-AKI 175/797 (21.96%)	Not reported
Daniels, 2024, Germany[10]	Retrospective observational cohort study	1,108 critically ill nonagenarian (aged ≥90 years) patients	Mixed	92.3 (91-94.2)	1st period: Nonagenarians in ICU during January 1, 2008 – August 30, 2013 vs. 2nd period: Nonagenarians in ICU during September 1, 2013 – April 30, 2019	Overall ICU mortality: 201/1108 (18.14%) - 1st period: 72/391 (18.41%) - 2nd period: 129/717 (17.99%) Overall in-hospital mortality: 311/1108 (29.87%) - 1st period: 123/391 (31.46%) - 2nd period: 208/717 (29.01%) Overall 1-year mortality: 635/1108 (57.31%) - 1st period: 237/391 (60.61%) - 2nd period: 398/717 (55.51%)	Not reported

TABLE 1. Study characteristics. (Continue)

Author, Year, Country	Study design	Population	Type of ICU	Age (years)	Comparison	Nonagenarian mortality	Younger group mortality
Heuer, 2024, Germany[24]	Retrospective cohort study	145 nonagenarians (aged ≥90 years) with proximal femur fracture (PFFs) or periprosthetic femur fractures	Trauma and surgical	94.1 (3.0)	Nonagenarians: 365-day survival vs. decreased before 365-days	ICU mortality: 14/145 (9.66%) In-hospital mortality: 32/145 (22.07%) 1-year mortality: 81/145 (56%)	Not reported
Sarma,2024, United States[30]	Retrospective cohort study	239 nonagenarians (aged ≥90 years) admitted to the cardiac intensive care unit (CICU) with acute coronary syndrome (ACS) - No CAG: 103 - CAG/No PCI: 46 - PCI= 90	Cardiac Intensive Care Unit	92.3 (91.0-94.4)	Nonagenarians: No CAG vs. CAG/No PCI vs. CAG/PCI	Overall in-hospital mortality: 50/239 (20.8%) - No CAG: 22/103 (21.4%) - CAG/No PCI: 10/46 (21.3%) - CAG/PCI: 18/90 (20.0%) Overall 1-year mortality: 133/239 (55.6%) - No CAG: 63/103 (61.2%) - CAG/No PCI: 24/46 (52.2%) - CAG/PCI: 52/90 (57.8%)	Not reported
Haar, 2024, Germany[22]	Retrospective analysis	1,108 nonagenarians (aged ≥90 years) critically ill patients	Mixed	92.3 (91.0-94.2)	Nonagenarians: ICU-cardiac arrest vs. No ICU-cardiac arrest (CA)	Overall ICU mortality: 201/1108 (18.14%) - ICU-CA: 22/25 (88%) - No ICU-CA: 179/1083 (17%) Overall in-hospital mortality: 311/1108 (29.87%) - ICU-CA: 25/25 (100%) - No ICU-CA: 306/1083 (28%)	Not reported

The data is presented in Mean (Standard deviation) or Median (interquartile range)

Abbreviations: AKI = Acute kidney injury, ACS = acute coronary syndrome, CA = Cardiac arrest, CAG = Coronary angiography, CICU = cardiac intensive care unit, ERS = Elder Risk Assessment, ICU = Intensive Care Unit, IQR = Interquartile range, PAD = Peripheral vascular disease, PCI = Percutaneous coronary intervention, RDW = Red Cell Distribution width, SICU = Surgical ICU

States (20.69%, 6 studies)[12,19,26,29,30,35] and France (10.3%, 3 studies).[8, 21,36] Other contributing countries included the England[9], Netherlands[20,23], Japan[14], Israel[15], Korea[31], Brazil[32], Taiwan[25], Greece[13], and Turkey[17], each accounting for 3.45% to 6.9% of all contributing countries.

Regarding temporal distribution, there has been a notable increase in publications in recent years, with 27.6% of the studies published in 2024[10,16,22,24,30] and 20.7% in 2023.[14,15,27,33] This trend reflects a growing interest in the outcomes of very elderly patients, particularly nonagenarians, in critical care settings.

Mortality

A total of 29 studies involving 21,420 nonagenarians and 244,323 younger patients (aged less than 90 years) were included, examining outcomes related to ICU mortality, in-hospital or 30-day mortality, and 1-year or long-term mortality (Fig 2).

ICU mortality

ICU mortality was reported in 17 of 29 studies[6,8-10,12,13,17,20-24,27,28,31-33], with rates among nonagenarians showing considerable variation, ranging from as low as 1.42%[34] to as high as 66.7%.[20] The overall ICU mortality rate across all studies was 17.05% (2,738 out of 16,062 patients).

Comparisons between nonagenarians and younger groups have produced mixed results. Margulies et al.[12] reported a slightly higher ICU mortality rate for nonagenarians (4.3%) compared to patients younger than 90 years old (2.3%) in United States (U.S.) surgical ICUs. Demoule et al.[21] observed higher ICU mortality among nonagenarians (28%) than patients aged between 20–69 years (18%) in French respiratory ICUs. Conversely, Bruno et al.[9] found equal ICU mortality rates of 27% for both nonagenarians and octogenarians in England. Across all studies that reported ICU mortality rates, the mortality rate for patients younger than 90 years old was 15.61% (17,766 out of 244,093 patients), slightly lower than that of nonagenarians (17.05%).

In-hospital mortality

In-hospital or 30-day mortality was reported in 26 of 29 studies[6,8-10,12-16,18,19,21-31,33-36], with rates among nonagenarians ranging from 5.6% to 47%. Michel et al.[26] documented a 7.5% in-hospital mortality rate for nonagenarians undergoing major surgeries in the United States. Margulies et al.[12] observed a higher in-hospital mortality rate for nonagenarians (17.1%) compared to patients younger than 90 years of age (5.3%) in surgical ICUs. Demoule et al.[21] reported an in-hospital mortality rate of 47% among nonagenarians, significantly higher than the 27% seen in patients aged 20–69 years.

Comparative studies with octogenarians presented various findings. Garrouste-Orgeas et al.[8] reported similar in-hospital mortality rates between nonagenarians (39.8%) and octogenarians (36.4%) in French mixed ICUs. Higuchi et al.[14] reported an in-hospital mortality rate of 5.6% among nonagenarians in a Japanese cardiac care

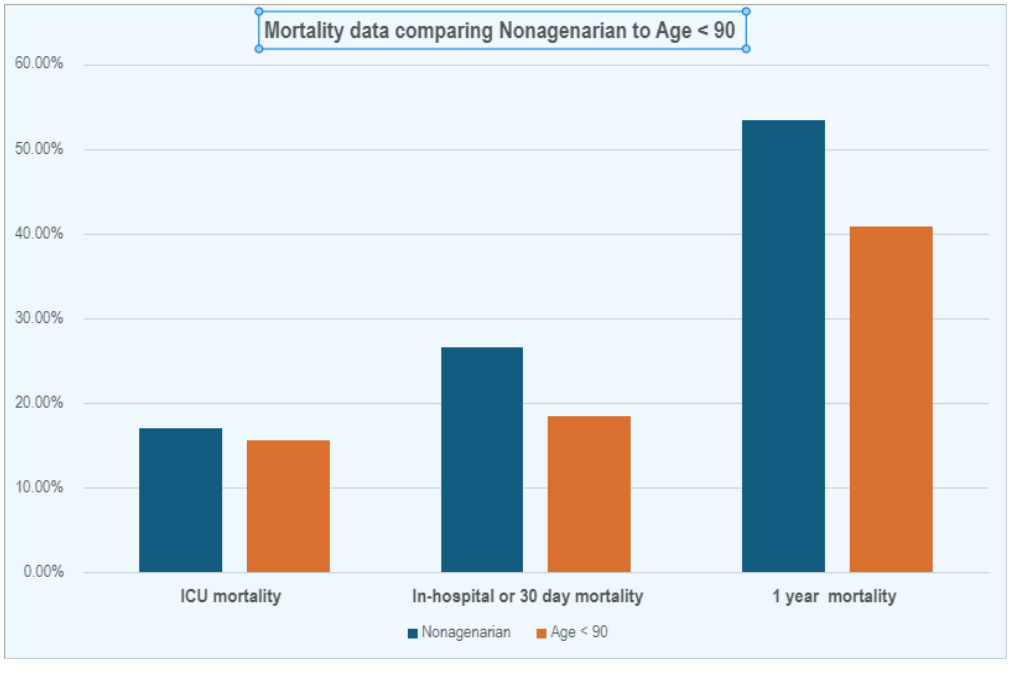


Fig 2. Comparison of Mortality Rates (%) between Nonagenarians and Patients under 90 Years of Age in ICU, In-Hospital, and 1-Year Outcomes

unit, which was slightly higher than the 3.8% observed in octogenarians and the 2% reported in patients younger than 80 years of age. Bruoha et al.[15] reported in-hospital mortality rates of 5.6% for nonagenarians versus 2.5% for younger patients in Israeli intensive coronary care units. When considering studies that reported in-hospital or 30-day mortality, the pooled overall rate for nonagenarians was 26.54% (5,563/20,962 patients), which was higher than the rate for patients younger than 90 years of age, at 18.4% (44,914/244,093 patients).

Long-term mortality

One-year mortality was reported in 12 studies [6,10,14,15,19,23,24,28-30,33,36], consistently showing higher rates among nonagenarians relative to younger age groups: 53.45% (7,020/13,134 patients) for nonagenarians versus 40.88% (41,260/100,933 patients) for those under 90 years of age. Becker et al.[6] reported a one-year mortality rate of 34.9% in Germany, while Rosenbaum et al.[29] observed a rate of 47% among nonagenarians admitted to U.S. cardiac intensive care units. Roedl et al.[28] reported the highest one-year mortality rate, at 77%, among German nonagenarians who had suffered cardiac arrest. Daniels et al.[10], who compared mortality between two periods, reported a one-year mortality rate of 57.31% among nonagenarians in German ICUs, with a slight decrease in recent years, reflecting improvements in ICU care for this population over time.

Comparative analyses consistently indicated higher long-term mortality among nonagenarians. Haas et al.[23] reported a one-year mortality of 55% for nonagenarians in the Netherlands, compared with 42.7% for octogenarians. Higuchi et al.[14] reported a one-year mortality rate of 19% for nonagenarians, which was higher than the 11.9% reported for octogenarians and the 4.1% reported for patients younger than 80 years old.

Factors associated with mortality

Various studies have reported that factors such as the type of admission, comorbidities, severity scores, and specific physiological markers influence ICU, in-hospital, and long-term mortality rates in nonagenarians.

Of the 29 studies, 17 were conducted in mixed ICUs, which included both surgical and medical patients, with ICU mortality rates ranging from 1.42% to 63.55%.[6,810,13,16,17,22,23,25,27,28,31-35] Other studies varied: 5 studies were in cardiac ICUs with mortality rates between 5.6% and 20.8%[14,15,29,30,36], 1 in a nephrology ICU[20], 1 in a respiratory ICU[21], and 5 in surgical ICUs[12,18,19,24,26], of which 2 focused on post-cardiac surgery patients[18,19] and 1 focused on trauma.[24]

ICU mortality is primarily influenced by the type of admission, comorbidities and illness severity. Arikan et al.[17] reported a 63.55% ICU mortality rate among nonagenarians in Turkey, with significantly higher rates in medical patients (78.04%) than surgical patients (16%). Similarly, Sousa et al.[32] found that nonagenarians with acute kidney injury (AKI) had a much higher ICU mortality rate (71.7%) than those without AKI (28.8%). The Charlson Comorbidity Index (CCI) was also independently associated with ICU mortality, highlighting the impact of comorbidities.[32]

In-hospital mortality is closely associated with comorbidities and illness severity. Nonagenarians with AKI had significantly higher in-hospital mortality, as reported by Schmidt et al.[16] and Sousa et al.[32], relative to those without AKI (50.19% vs. 21.96% and 66.8% vs. 23.8%, respectively). Additionally, elevated severity scores, such as the Acute Physiology and Chronic Health Evaluation II (APACHE II), were consistently linked to increase in-hospital mortality.[25]

Long-term mortality is influenced by similar factors, including specific physiological markers, comorbidities, and illness severity. Theile et al.[33] found that nonagenarians with elevated red cell distribution width (RDW) had a one-year mortality rate of 63%, compared to 45% in those with lower RDW. Comorbidities such as peripheral vascular disease[27] and cardiac arrest during ICU stay[22] were also associated with higher mortality rates. Higher SAPS II scores[10,17,24] and SOFA scores[24], along with the need for mechanical ventilation and inotropic support[10,17], were linked to increased long-term mortality. However, Margulies et al.[12] found no significant difference in mortality between nonagenarians and younger patients after adjusting for SAPS scores, indicating that illness severity, rather than age alone, plays a more critical role in mortality outcomes.

The impact of ICU treatment intensity was notable. Some studies found that nonagenarians often received less aggressive treatments, such as invasive arterial catheter and renal replacement therapy, yet had mortality rates comparable to younger cohorts.[8] Additionally, Bruno et al.[9] reported that nonagenarians were more likely to have treatment limitations but did not face an increased risk of care withdrawal compared to octogenarians.

Detailed data on factors associated with mortality and treatment intensity are provided in Appendix I: Supplemental Table.

DISCUSSION

This scoping review highlights several important themes relevant to clinical practice and future research.

Key findings

Across 29 studies, ICU mortality among nonagenarians averaged 17.05%, slightly higher than the 15.61% observed in younger patients. In-hospital mortality was 26.54%, exceeding the 18.4% rate in younger groups, while one-year mortality reached 53.45%, compared to 40.88% in younger patients. Key factors influencing mortality included comorbidities, illness severity (e.g., APACHE II, SAPS II, SOFA), and acute conditions like AKI. Although nonagenarians often received less aggressive interventions, they still achieved comparable outcomes to younger patients in some instances, suggesting that age alone should not dictate the intensity of care.

Progressive increase in mortality rates

Mortality rates among nonagenarians increase progressively from ICU admission through to hospital discharge and over the long term. These results are consistent with those from the largest cohort study by Haas et al.[23] which reported ICU, in-hospital, and 1-year mortality rates of 16.1%, 25.7%, and 42.7%, respectively, in a cohort of 9,495 nonagenarian ICU patients. This progressive increase emphasized the ongoing vulnerability of critically ill nonagenarians even after ICU discharge, suggesting that they require more comprehensive care and follow-up to improve long-term outcomes.

Variability and factors associated with mortality

There is significant variability in mortality rates across different studies, reflecting differences in patient populations, healthcare systems, and ICU practices worldwide. Mortality rates for ICU admissions among nonagenarians varied widely, which can be attributed to factors such as geographic location, type of ICU, patient comorbidities, and illness severity. Medical admissions were linked to higher mortality rates compared to surgical admissions[10,17,35], suggesting that the underlying cause for ICU admission has a major impact on patient outcomes.

In nonagenarians, mortality is driven by factors other than age, including the severity of illness, comorbidities, and the reason for ICU admission. Specific physiological markers, such as red cell distribution width (RDW), have also been linked to higher mortality, reflecting the need for a comprehensive assessment of health status. While nonagenarians generally had higher mortality rates compared to younger patients, some studies reported similar outcomes after adjusting for illness severity[12], suggesting that age alone may not determine mortality in the ICU. Severity scores, such as APACHE II[13,17,23,25,28,31,] SAPS II [8,10,12,21,22, 31,33], and CCI[10,16,22,24,27,30,32,33], play a crucial role in assessing physiological reserve and comorbidities. These tools allow for more nuanced and individualized decision-making for both nonagenarians and younger patients, guiding clinical care and optimizing treatment strategies for this vulnerable population.

Less aggressive interventions and mortality rates

Nonagenarians often receive less aggressive interventions, such as mechanical ventilation or renal replacement therapy[8], and a higher likelihood of treatment limitations but did not face an increased risk for withdrawal of care.[9] However, their mortality rates remained within acceptable ranges. This may result from various factors, including patient or family preferences for less invasive care, concerns about the risks of aggressive treatments, or clinical judgments regarding the benefits of such interventions. The acceptable mortality rates, despite less aggressive care, suggest that a more tailored approach—one that weighs the risks and benefits of interventions—may be appropriate for nonagenarians.

Strengths and limitations

This research presents several key strengths. It is the first scoping review to systematically explore mortality outcomes for critically ill nonagenarians, addressing a significant gap in the literature while ensuring a geographically diverse and relevant perspective on nonagenarian ICU outcomes. The review offers a comprehensive overview by examining multiple studies across diverse ICU settings, including both surgical and medical ICUs, providing a broad perspective on patient outcomes. Additionally, it identifies critical factors influencing mortality, such as illness severity, comorbidities, and physiological markers like red cell distribution width (RDW). Finally, the research establishes a strong foundation for future studies by identifying knowledge gaps and proposing directions for further investigation, particularly regarding long-term care and post-ICU outcomes, thus contributing to the optimization of care for this growing and vulnerable population.

This review has several limitations. First, the majority of the included studies were retrospective, which may introduce missing data, bias, and variability in mortality reporting. Some studies focused on ICU mortality, others on in-hospital mortality, with only a few addressing long-term outcomes, contributing to heterogeneity. Second, while we did not perform statistical or qualitative analyses or assess the risk of bias across studies, this was intentional, as the review serves as a precursor to a more comprehensive future meta-analysis and systematic review. Third, nonagenarians have only recently become the focus of research, meaning that

additional data and insights are likely to emerge in the coming years, potentially expanding the evidence base. Lastly, the exclusion of non-English studies may limit the generalizability of findings, particularly in regions where non-English research is more common.

Future research direction

There is still a lack of data on the factors that strongly influence outcomes in this patient population. Common severity scores used in general ICU populations, such as SAPS or APACHE, and the frailty index[37], may not fully capture the unique characteristics of nonagenarians and require revalidation in this group. Future prospective studies should focus on protocolized management after ICU discharge, including rehabilitation and nutritional support, to improve long-term outcomes for nonagenarian patients.

CONCLUSION

Critically ill nonagenarians in ICUs experience varied, yet often acceptable, mortality rates, suggesting that age alone should not determine ICU admission or treatment intensity. However, the rise in mortality from ICU discharge to long-term follow-up demonstrates their continued vulnerability and emphasizes the importance of developing comprehensive, individualized care plans that extend beyond the ICU setting.

ACKNOWLEDGEMENTS

The authors thank Miss Chayanan Thanakiattiwibun for helping with the submission process.

DECLARATION

Grants and Funding Information

This project is not funded by any external sources.

Conflict of Interest

The authors confirm that we have no conflicts of interest to declare.

Author Contributions

N.K. and N.R. had the idea for the article, performed the literature search, data extraction and analysis, drafted and critically revised the work, and approved the version to be published. N.T. performed data extraction and approved the version to be published. N. P. approved and revised the version to be published.

Use of Artificial Intelligence:

No artificial intelligence tools were used for generative editorial work or autonomous content creation.

REFERENCES

1. Kontis V, Bennett JE, Mathers CD, Li G, Foreman K, Ezzati M. Future life expectancy in 35 industrialised countries: projections with a Bayesian model ensemble. Lancet. 2017;389(10076):1323-35.
2. Guidet B, Leblanc G, Simon T, Woimant M, Quenot JP, Ganansia O, et al. Effect of Systematic Intensive Care Unit Triage on Long-term Mortality Among Critically Ill Elderly Patients in France: A Randomized Clinical Trial. JAMA. 2017;318(15):1450-9.
3. Boumendil A, Somme D, Garrouste-Orgeas M, Guidet B. Should elderly patients be admitted to the intensive care unit? Intensive Care Med. 2007;33(7):1252.
4. Flaatten H, Garrouste-Orgeas M. The very old ICU patient: a never-ending story. Intensive Care Med. 2015;41(11):1996-8.
5. Guidet B, de Lange DW, Flaatten H. Should this elderly patient be admitted to the ICU? Intensive Care Medicine. 2018;44(11):1926-8.
6. Becker S, Müller J, de Heer G, Braune S, Fuhrmann V, Kluge S. Clinical characteristics and outcome of very elderly patients ≥90 years n intensive care: a retrospective observational study. Ann Intensive Care. 2015;5(1):53.
7. Nielsson MS, Christiansen CF, Johansen MB, Rasmussen BS, Tonnesen E, Norgaard M. Mortality in elderly ICU patients: a cohort study. Acta Anaesthesiol Scand. 2014;58(1):19-26.
8. Garrouste-Orgeas M, Ruckly S, Grégoire C, Dumesnil AS, Pommier C, Jamali S, et al. Treatment intensity and outcome of nonagenarians selected for admission in ICUs: a multicenter study of the Outcomerea Research Group. Ann Intensive Care. 2016;6(1):31.
9. Bruno RR, Wernly B, Kelm M, Boumendil A, Morandi A, Andersen FH, et al. Management and outcomes in critically ill nonagenarian versus octogenarian patients. BMC Geriatrics. 2021;21(1):576.
10. Daniels R, Muller J, Jafari C, Theile P, Kluge S, Roedl K. Evolution of Clinical Characteristics and Outcomes of Critically Ill Patients 90 Years Old or Older Over a 12-Year Period: A Retrospective Cohort Study. Crit Care Med. 2024;52(6):e258-e67.
11. Aromataris E LC, Porritt K, Pilla B, Jordan Z, editors. JBI Manual for Evidence Synthesis. JBI. 2024.
12. Margulies DR, Lekawa ME, Bjerke HS, Hiatt JR, Shabot MM. Surgical intensive care in the nonagenarian. No basis for age discrimination. Arch Surg. 1993;128(7):753-6; discussion 6-8.
13. Rellos K, Falagas ME, Vardakas KZ, Sermaides G, Michalopoulos A. Outcome of critically ill oldest-old patients (aged 90 and older) admitted to the intensive care unit. J Am Geriatr Soc. 2006;54(1):110-4.
14. Higuchi R, Nanasato M, Furuichi Y, Hosoya Y, Haraguchi G, Takayama M, et al. Outcomes of Octogenarians and Nonagenarians in a Contemporary Cardiac Care Unit - Insights From 2,242 Patients Admitted Between 2019 and 2021. Circ Rep. 2023;5(11):430-6.
15. Bruoha S, Maller T, Loutati R, Perel N, Tabi M, Taha L, et al. Nonagenarians admission and prognosis in a tertiary center intensive coronary care unit - a prospective study. BMC Geriatr. 2023;23(1):152.
16. Alba Schmidt E, De Rosa S, Muller J, Husing P, Daniels R, Theile P, et al. Acute kidney injury predicts mortality in very elderly critically-ill patients. Eur J Intern Med. 2024;127:119-25.

17. Arikan M. Do Surgical Patients Older Than 90 Years More Benefit From Intensive Care Unit? Turkish Journal of Geriatrics/Türk Geriatri Dergisi. 2020;23(1).
18. Assmann A, Minol JP, Mehdiani A, Akhyari P, Boeken U, Lichtenberg A. Cardiac surgery in nonagenarians: not only feasible, but also reasonable? Interact Cardiovasc Thorac Surg. 2013;17(2):340-3; discussion 3.
19. Bacchetta MD, Ko W, Girardi LN, Mack CA, Krieger KH, Isom OW, et al. Outcomes of cardiac surgery in nonagenarians: a 10-year experience. Ann Thorac Surg. 2003;75(4):1215-20.
20. Bardak S, Demir S, Dolarslan ME, Karadurmus B, Akcali E, Turgutalp K, et al. Clinical characteristics and cost of hospital stay of octogenarians and nonagenarians in intensive care nephrology unit. Int Urol Nephrol. 2021;53(1):147-53.
21. Demoule A, Cracco C, Lefort Y, Ray P, Derenne JP, Similowski T. Patients aged 90 years or older in the intensive care unit. J Gerontol A Biol Sci Med Sci. 2005;60(1):129-32.
22. Haar M, Muller J, Hartwig D, von Bargen J, Daniels R, Theile P, et al. Intensive care unit cardiac arrest among very elderly critically ill patients - is cardiopulmonary resuscitation justified? Scand J Trauma Resusc Emerg Med. 2024;32(1):84.
23. Haas LEM, Bakhshi-Raiez F, van Dijk D, de Lange DW, de Keizer NF. Outcomes of Intensive Care Patients Older Than 90 Years: An 11-Year National Observational Study. J Am Geriatr Soc. 2020;68(8):1842-6.
24. Heuer A, Muller J, Strahl A, Fensky F, Daniels R, Theile P, et al. Outcomes in very elderly ICU patients surgically treated for proximal femur fractures. Sci Rep. 2024;14(1):1376.
25. Lai CC, Ko SC, Chen CM, Weng SF, Tseng KL, Cheng KC. The Outcomes and Prognostic Factors of the Very Elderly Requiring Prolonged Mechanical Ventilation in a Single Respiratory Care Center. Medicine (Baltimore). 2016;95(2):e2479.
26. Michel SL, Stevens L, Amodeo P, Morgenstern L. Surgical procedures in nonagenarians. West J Med. 1984;141(1):61-3.
27. Roedl K, Daniels R, Theile P, Kluge S, Muller J, Behrendt CA. The Independent Impact of Peripheral Arterial Disease on Mortality in Nonagenarians and Centenarians Who Were Treated in an Intensive Care Unit: A Consecutive Cohort of 1,108 Patients. Eur J Vasc Endovasc Surg. 2023;65(4):582-9.
28. Roedl K, Jarczak D, Becker S, Fuhrmann V, Kluge S, Muller J. Long-term neurological outcomes in patients aged over 90 years who are admitted to the intensive care unit following cardiac arrest. Resuscitation. 2018;132:6-12.
29. Rosenbaum AN, Naksuk N, Gharacholou SM, Brenes-Salazar JA. Outcomes of Nonagenarians Admitted to the Cardiac Intensive Care Unit by the Elders Risk Assessment Score for Long-Term Mortality Risk Stratification. Am J Cardiol. 2017;120(8):1421-6.
30. Sarma D, Padkins M, Smith R, Bennett CE, Murphy JG, Bell MR, et al. Patients Aged 90 Years and Above With Acute Coronary Syndrome in the Cardiac Intensive Care Unit: Management and Outcomes. Am J Cardiol. 2024;215:19-27.
31. Sim YS, Jung H, Shin TR, Kim DG, Park SM. Mortality and outcomes in very elderly patients 90 years of age or older admitted to the ICU. Respir Care. 2015;60(3):347-55.
32. Sousa ALB, de Souza LM, Santana Filho OV, VHF EL, Rocha PN. Incidence, predictors and prognosis of acute kidney injury in nonagenarians: an in-hospital cohort study. BMC Nephrol. 2020;21(1):34.
33. Theile P, Muller J, Daniels R, Kluge S, Roedl K. Association between Red Cell Distribution Width and Outcomes of Nonagenarians Admitted to the Intensive Care Unit-A Retrospective Cohort Study. Diagnostics (Basel). 2023;13(20).
34. Yayan J. Trends in intensive care in patients over 90 years of age. Clin Interv Aging. 2012;7:339-47.
35. Nathanson BH, Higgins TL, Brennan MJ, Kramer AA, Stark M, Teres D. Do elderly patients fare well in the ICU? Chest. 2011;139(4):825-31.
36. Kochly F, Haddad C, Harbaoui B, Falandry C, Lantelme P, Courand PY. Therapeutic management and outcome of nonagenarians versus octogenarians admitted to an intensive care unit for acute coronary syndromes. Arch Cardiovasc Dis. 2020;113(12):780-90.
37. Somnuke P, Pongraweewan O, Siriussawakul A. Optimizing Perioperative Care for Elderly Surgical Patients: A Review of Strategies and Evidence-Based Practices. Siriraj Med J [Internet]. 2024 Jul. 1 [cited 2024 Oct. 23];76(7):465-72.