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Integrated Falls and Hip Fractures Prevention in Thai Older Adults (Thai-IFHP), The Falls Surveillance System to Prevent Hip Fractures and Hip Fracture Care to Prevent Re-fracture : A Study Protocol of a Pragmatic Clinical Trial

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Study protocol

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Abstract

Background:

Falls and fall-related hip fractures are major causes of morbidity, mortality, and loss of independence among older adults, particularly in low- and middle-income countries. In Thailand, prevention and post–hip fracture care remains fragmented across levels of care. Despite evidence supporting multifactorial interventions, scalable, system-integrated models adapted to Southeast Asian settings are limited. This study aims to develop and evaluate an integrated system for fall and hip fracture prevention among Thai older adults.

Methods:

We will conduct a 12-month pragmatic cluster trial with an embedded cost-effectiveness evaluation across 538 health-promoting hospitals and primary care units in 12 provinces in Thailand, allocated 1:1 to intervention or control clusters. Participants include community-dwelling adults aged ≥70 years, stratified by fall risk, and patients with hip fractures.

The program uses an integrated digital platform (“App Paotang”), serving as a digital wallet for government subsidy projects and several other national-level projects, to support data collection and care coordination. Participants in both groups receive fall-risk screening, health education, and home visits, but with different intensities. The intervention group receives community-based exercise (≥1 session/month) and risk-stratified home visits, while the control group receives advice for home-based exercise and uniform home visits every three months. Patients with hip fractures in both groups receive standardized integrated multidisciplinary care from hospitals to communities.

Primary outcomes are ≥1 fall and incidence of fall-related hip fractures over 12 months. Secondary outcomes include 30-day mortality and readmission, 1-year recurrent fractures and mortality, health-related quality of life (EQ-5D-5L), timeliness of home visits, and osteoporosis treatment uptake. Analyses will use cluster-adjusted generalized estimating equations and mixed-effects models, with cost-effectiveness evaluated from a societal perspective.

Trial registration:

The study is registered with the Thai Clinical Trials Registry (TCTR20250905013), registered on 5 September 2025. https://www.thaiclinicaltrials.org/#.

Discussion:

The Thai-IFHP study evaluates a scalable, digitally enabled model integrating fall and hip fracture prevention across different care levels in multi-province nation-wide. Findings will inform policy and support the development of value-based, integrated care for older adults in Thailand and similar resource-constrained settings.

Background

Falls and fall-related fractures are leading causes of morbidity, mortality, and loss of independence among older adults worldwide (1). The World Health Organization reports that 28–35% of adults aged ≥ 65 years experience at least one fall annually, with rates rising to 32–42% in those aged > 70 years (2). Falls are the primary cause of injury-related hospitalization and hip fractures, leading to substantial healthcare costs, functional decline, and reduced quality of life in older adults (3, 4). Amid the global phenomenon of population aging, fall prevention and the management of its subsequent impacts have become indispensable priorities for the global public health system (1, 2).

Despite this recognition, falls remain overlooked and undertreated, particularly in low- and middle-income countries, where health policy and preventive services remain limited (5, 6). In Thailand, where the population is rapidly aging, the prevalence of falls among community-dwelling older adults has been reported to range from 16% to 25% annually, with higher rates observed in individuals with chronic diseases, frailty, or impaired mobility (7). Fall-related injuries, including hip and vertebral fractures, contribute substantially to long-term disability and healthcare utilization in Thai older adults (8). However, fall prevention services in Thailand remain fragmented, with limited coordination between primary care, community health programs, and hospital-based rehabilitation services.

Current international evidence demonstrates that multifactorial interventions—combining risk assessment, balance and strength training, home hazard modification, medication review, and health education—can significantly reduce fall risk in older adults (9, 10). Several systematic reviews and randomized controlled trials have confirmed their effectiveness in various populations (9). Nevertheless, most of these interventions have been developed and implemented in high-income settings, where healthcare infrastructure and resources differ substantially from those in Thailand (11). The lack of integrated surveillance and preventive systems that are tailored to local healthcare delivery and cultural contexts represents a critical research gap (5).

Furthermore, existing fall prevention strategies in Thailand rely primarily on periodic assessments or health education sessions, rather than continuous surveillance or proactive monitoring of fall risk. The absence of an integrated data system and standardized risk management pathway limits the ability to identify high-risk individuals, implement timely interventions, and evaluate outcomes effectively (12). Therefore, there is an urgent need to develop a surveillance and prevention system that integrates evidence-based interventions with digital technologies and promotes multidisciplinary collaboration within the Thai healthcare framework.

This study aims to develop and evaluate an integrated system for fall surveillance and prevention among Thai older adults. It will assess the acceptability, effectiveness, and cost-effectiveness of the intervention in reducing falls and fractures among community-dwelling older adults. This article presents the study protocol, including the design, intervention components, implementation strategies, and evaluation framework, to inform the development of a scalable model for fall prevention in Thailand.

Methods

Study Design

This study is designed as a multi-center pragmatic cluster trial conducted across 12 provinces representing all regions of Thailand. The intervention comprises two components: (1) primary prevention: screening for fall risk and applying fall prevention strategies among community-dwelling older adults to reduce incident fractures (Figure 1); and (2) secondary prevention: fall prevention among patients with hip fractures to reduce recurrent fractures (Figure 2).

An economic evaluation will be conducted alongside the trial from a societal perspective, estimating costs and outcomes, including quality-adjusted life years (QALYs) gain, and reporting incremental cost-effectiveness ratios (ICERs) comparing intervention and comparison clusters.

The pragmatic design reflects real-world implementation conditions to support scalability within the health system. The study is registered with the Thai Clinical Trials Registry (TCTR20250905013) and has received ethical approval from the Institutional Review Board of the Faculty of Medicine Siriraj Hospital (Si 265/2025). The conduct of the study will fully comply with international guidelines for human research protection, including the Declaration of Helsinki, the Belmont Report, CIOMS guidelines, and the International Conference on Harmonization–Good Clinical Practice (ICH-GCP) standards.

Study Setting and Recruitment

The study will be conducted in 12 provinces distributed across Thailand as follows:

· Northern region: Lamphun, Phrae, Nan

· Northeastern region: Chaiyaphum, Sisaket, Roi Et, Nakhon Ratchasima

· Central region: Suphanburi, Samut Sakhon, Bangkok

· Southern region: Ranong, Nakhon Si Thammarat

A total of 538 health-promoting hospitals (HPHs) and primary care units (PCUs) across 12 provinces in Thailand will be allocated to intervention and control groups in a 1:1 ratio within each province. Study sites will be identified based on implementation capacity, including the availability of health volunteers, the ability to use the digital platform, and the time available to support active screenings at the community level. Intervention clusters (i.e., subdistrict HPHs and PCUs) will be selected based on the feasibility of providing community-based interventions.

As allocation is not randomized and reflects real-world implementation conditions, the study is designed as a pragmatic cluster trial with non-randomized allocation between intervention and comparison groups. Regular meetings with orthopedists in each province and with provincial administrators will be conducted to monitor recruitment and address challenges. Workshops will be held to identify barriers

and develop solutions. An online support system will be provided to assist with application use and respond to inquiries, ensuring efficient and consistent participant enrollment.

Primary Prevention Strategies

Eligibility Criteria

Inclusion criteria: Community-dwelling adults aged ≥70 years who provide written informed consent and agree to home visits by village health volunteers (VHVs).

Exclusion criteria: Individuals with 1) significant cognitive impairment that precludes meaningful participation; 2) active musculoskeletal or joint disorders of the lower limbs; 3) uncontrolled medical conditions that contraindicate exercise; and 4) limited mobility and unable to walk independently despite using gait aids.

Discontinuation Criteria: Participants will be discontinued from the study if they choose to withdraw their consent at any time without providing a reason. Older adults experiencing a medical condition that prevents them from participating in exercise training.

Screening and Baseline Assessment.

All eligible participants will undergo screening for falls risk and baseline assessments using the following tools: Timed Up and Go Test (TUG), Five-Time Sit-to-Stand Test (FTSST), 2-Minute Walk Test (2MWT), Hand-grip strength, 3-screening questions for primary care setting in STEADI checklist (13), Thai-FRAT assessment (14), Fracture Risk Assessment Tool (FRAX) (15), Osteoporosis Self-Assessment Tool for Asians (OSTA) (16), FRAIL Scale (17), Barthel Index of Activities of Daily Living (ADL), and EQ-5D-5L health-related quality of life questionnaire (18). Physical examinations, including body weight and height, will be performed at HPHs and PCUs. Baseline characteristics, existing fall-prevention policies, human resources, and budgets of participating HPHs and PCUs will be collected as contextual factors that may influence program effectiveness.

Risk Stratification

All participants will be stratified into low-, moderate-, or high-fall-risk groups based on TUG test performance and predefined clinical risk. Participants with TUG < 12 seconds and TUG 12-20 seconds will be classified as low- and moderate-fall-risk, respectively. Participants with TUG > 20 seconds or having one of the following conditions: dementia; previous vertebral or hip surgery; active cardiac or pulmonary conditions within 3 months, or being prescribed a fall-risk-increasing-drug (FRIDs), will be classified as the high-fall-risk group. Considering the large number of FRIDs and the practicality in the community setting, a decision was made for this study to include only 4 groups of FRIDs as follows: 1. Benzodiazepine and related hypnotic drugs, 2. Antidepressants, 3. Antipsychotics, 4. First-generation antihistamines.

Interventions

Control Group: all participants in the control group will receive the Health Education Program (HEP) as follows: health education on fall prevention, guidance for home-based exercise (with advice to carry out for at least 150 minutes/week, 3 sessions per week), nutritional counseling, and advice for environmental risk modification. The high-fall-risk group will be advised to seek referral to a geriatric clinic, where they are eligible for a comprehensive fall-risk assessment and can receive appropriate interventions. VHVs will conduct home visits every 3 months to record exercise adherence, safety issues, and fall events. All participants will be assessed at their local HPH/PCU every 3 months for 12 months to evaluate physical performance and clinical outcomes.

Intervention Group: In addition to HEP activities and referrals to the geriatric clinic for the high-fall-risk group, all participants in the intervention group will be asked to participate in the Community-Based Exercise (CBE) program, conducted by HPH staff or VHVs at community facilities at least once a month. Additional advice will be provided for daily endurance exercise, such as walking at a normal pace for 30 minutes per day. Home visits by VHVs will be conducted every 3, 2, and 1 month for low-, moderate-, and high-fall-risk groups, respectively. The aim will also be to monitor exercise adherence and record outcomes over a 12-month period.

Secondary Prevention Strategies

For participants who sustain a hip fracture during the study, the hip fracture care pathway will be activated at the local hospital with adequate surgical facilities.

1. Pre-operative period: upon hospital admission under the orthopedic team, patients will be assessed, and aiming for surgical management within 48–72 hours. Frail older patients with multiple comorbidities will be managed for preoperative optimization by internists or geriatricians with details according to hospital policy.

2. Peri-operative period: a physician-led multidisciplinary team care will ensure smooth recovery using several strategies, including adequate pain control, early ambulation, and adequate nutritional support. Active surveillance and prevention of common complications, such as delirium, will also be encouraged. The component of multidisciplinary team would comprise orthopedist, geriatrician/internist, anesthesiologist, rehabilitation team (rehabilitation physician/physiotherapist), coordinate-nurse, ward-nurse, pharmacist, social workers, nutritionist and community team.

3. Discharge planning: a multidisciplinary team will carry out discharge planning, which includes the evaluation for risk of readmission within 30 days (Table 1). The risk will guide the home visit plan, which will be shared with the community HPH team, as well as the individual care plan.

4. Post-discharge period:
Continuity of care will include:

o Outpatient follow-up: participants will attend orthopedic clinics for fracture and osteoporosis management and advance-geriatric clinics led by geriatricians for comprehensive care to ensure optimal medical condition, functional, and cognitive recovery, if available in the area.

o **Home visits:** the multidisciplinary team for home visits, which might comprise physicians, nurses, physiotherapists, and public health officers. Other disciplines such as pharmacists, social workers or occupational therapist might be available to be part of the team in some area. The composition of the team and the frequency of the visit for each patient will be determined by risk level (Table 2):

- High risk: home visit within 1 week
- Moderate risk: home visit within 2 weeks
- Low risk: home visit within 4 weeks

The goal for the first home visit will include pain assessment, medication reconciliation, dietary monitoring, surveillance for complications, and personalized mobility guidance. The follow-up visits could be planned during the first home visit. The VHVs will continue follow-up visits every 1 month.

Outcomes

Primary outcomes will include:

1)the proportion of participants experiencing at least one fall during the 12-month follow-up. A fall is defined as “an event in which a person inadvertently comes to rest on the ground, floor, or a lower level,” excluding falls due to major intrinsic events or overwhelming external forces (3).

2) theincidence of fall-related hip fractures over 12 months.

Secondary outcomes will comprise:

1) the 30-day all-cause mortality among patients with hip fractures;

2) the 30-day hospital readmission rate following the first hip fracture admission;

3) the 1-year recurrent hip fracture rate;

4) the 1-year all-cause mortality rate among patients with hip fractures;

5) health-related quality of life using EQ-5D-5L;

6) the rate of home visits to at-risk older adults by VHVs;

7) the rate of timely home visits for post-hip fracture patients according to risk level; and

8) the proportion of hip fracture patients receiving osteoporosis treatment.

Participant retention will be promoted through regular follow-up reminders, flexible scheduling, and ongoing support from study staff. Efforts will be made to maintain contact with participants who discontinue or deviate from the intervention in order to complete outcome assessments. Key outcome data to be collected, where possible, include Timed Up and Go (TUG), Activities of Daily Living (ADL), EQ-5D, and fall incidence. The participant timeline is described in Fig. 3.

A standardized 2-day workshop will be conducted in each province to train assessors and intervention providers (village health volunteers, staff in primary healthcare units, and health professionals in geriatric clinics and orthopedic wards). The training will cover procedures for delivering the intervention, outcome measurement protocols, and data collection methods to ensure consistency and quality across study sites. Participants will also have the opportunity to provide feedback on the design, conduct, and reporting of the trial.

Cost-effectiveness analysis

A prospective, trial-based cost-effectiveness analysis will be conducted alongside the pragmatic cluster trial over the 12-month follow-up. As per the Thai Health Technology Assessment (HTA) Guideline (19), the analysis will be conducted from a societal perspective to estimate costs and health outcomes, measured in QALYs. The estimated costs will be included as follows: 1) direct medical costs including program development and implementation, healthcare utilisation, and medical costs related to falls and hip fractures, and 2) direct non-medical costs related to service deliveries for the prevention, fall or hip fractures, e.g., transportation, paid caregiving, home modifications, and other out-of-pocket expenditures. Indirect costs will be omitted from this analysis to prevent potential double-counting (19). Health outcomes will include QALYs derived from EQ-5D-5L utilities collected at baseline and at 3, 6, and 12 months, integrated over time using the area-under-the-curve approach; additional effectiveness metrics will include falls and fall-related hip fractures averted. Incremental costs and outcomes will be compared between intervention and comparison clusters to estimate ICERs (cost per QALY gained, and cost per fall/hip fracture averted). Parameter and sampling uncertainty will be explored using deterministic sensitivity analyses and a probabilistic sensitivity analysis, producing cost-effectiveness planes and cost-effectiveness acceptability curves across a range of willingness-to-pay thresholds.

Data management and digital platform

A digital application was specifically developed and integrated into one of the national digital platforms ‘App Paotang’ to support data collection, monitoring, and clinical coordination throughout this study. The ‘App Paotang’ served as a is a Thai digital wallet developed by Krungthai Bank to facilitate government financial aid, economic stimulus projects, and digital transactions. It serves as a secure platform for mobile payments, banking, government lottery purchases, and accessing health services. For this project, the sub-application was specifically developed under the name ‘dern dee dee’ (walk well in Thai) to serve as an integrated surveillance and prevention system for falls and subsequent fractures among older adults in the study. Participants in both groups will register through the application, either

independently or with assistance from healthcare personnel at primary care units (PCUs). Upon registration, demographic data, medical history, and fall-related information are recorded in the system.

The application incorporates a standardized fall risk assessment tool, enabling older adults or healthcare providers to complete the evaluation electronically. The results are automatically analyzed and stratified by risk category. High-risk individuals are flagged within the system for further evaluation and follow-up.

Data entered by the primary care teams is securely transmitted through the digital platform to secondary or tertiary care facilities. This facilitates referrals to specialists such as geriatricians, family physicians, or orthopedic specialists for comprehensive assessment, diagnosis, and management of modifiable conditions contributing to fall risk, including osteoporosis screening and appropriate management. The platform supports bidirectional communication between primary care teams and specialists, enabling consultations, treatment planning, and feedback on patient progress.

All collected data are stored on a secure, encrypted server compliant with national data protection standards. Access to identifiable information is restricted to authorized research personnel. Routine data quality checks and system audits are conducted to ensure data integrity, completeness, and confidentiality. The platform also enables longitudinal data tracking, allowing ongoing monitoring of fall incidents, treatment adherence, and clinical outcomes throughout the study period.

Sample Size Calculation

Primary prevention

The required sample size was estimated using the n4Studies Plus program(20-23) to compare fall-risk outcomes between the intervention and control groups.

$$n_{trt} = \left[\frac{z_{1-\frac{\alpha}{2}} \sqrt{\overline{pq}\left(1+\frac{1}{r}\right)} + z_{1-\beta} \sqrt{p_{trt}q_{trt} + \frac{p_{con}q_{con}}{r}}}{\Delta} \right]^2$$

$$\Delta = p_{trt} - p_{con}\,, \quad \overline{p} = \frac{p_{trt}+p_{con}r}{1+r}\,, \quad r = \frac{n_{con}}{n_{trt}}$$

$$q_{trt} = 1 - p_{trt}\,, \quad q_{con} = 1 - p_{con}\,, \quad \overline{q} = 1 - \overline{p}$$

$$n_{trt(adjust)} = n_{trt}[1 + \rho(m-1)]$$

The input parameters were specified as follows: 1) n_{trt}, the sample size for the intervention group; 2) n_{con}, the sample size for the control group; 3) the expected proportions of participants at risk of falls in the intervention and control groups (p_{trt} = 0.167 and p_{con} = 0.14, respectively), derived from a previous cluster randomised controlled trial (24); 4) a type I error (α) of 0.05; 5) a type II error probability (β) of 0.2 (power = 80%); 6) an allocation ratio of 1:1 between control and intervention groups; 7) an average number of sample per cluster (m) of 100 participants; and 8) an intra-cluster correlation coefficient (ICC, ρ) of 0.04.

Based on these parameters, the required sample size was 13,857 participants per group. Allowing for an anticipated 20% loss to follow-up, the adjusted sample size is 16,630 participants per group, yielding a total sample size of 33,260 participants.

Statistical analysis

All analyses will follow the intention-to-treat principle, with participants analyzed according to their cluster's allocated group. Baseline characteristics will be summarized at participant and cluster levels, including fall-risk and functional assessments (e.g., TUG, FTSST, FRAIL scale, Thai-FRAT, EQ-5D-5L, and FRAX/OSTA). Primary analyses will use marginal regression models estimated with generalized estimating equations (GEE) and robust standard errors, clustering at the HPH/PCU level to account for the clustered design. Intervention effects on primary outcomes: 1) the proportion experiencing ≥1 fall over 12 months; and 2) fall-related hip fracture incidence over 12 months, which are binary outcomes that will be analyzed using modified Poisson GEE with log link to estimate risk ratios (RRs) with 95% confidence interval (95% CI). Hip fracture incidence will be modelled using mixed-effects Poisson/negative binomial models with a person-time offset (incidence rate ratios or IRRs). Models will adjust for prespecified covariates (e.g., age, sex, baseline fall risk and functional status, environmental hazards, history of prior falls, frailty status, and comorbidities or polypharmacy) and include province/region indicators as appropriate.

Repeated measures collected at baseline, 3, 6, and 12 months (e.g. TUG, grip strength, ADL, and EQ-5D-5L) will be analyzed using GEE with appropriate distributions (Gaussian/identity for continuous outcomes; modified Poisson/log for binary outcomes), including fixed effects for time and a group×time interaction; robust standard errors will remain clustered at HPH/PCU. Secondary outcomes among hip fracture patients (30-day mortality/readmission, 1-year recurrent hip fracture and mortality, and osteoporosis treatment uptake) and process indicators (home-visit rates and timeliness) will be analyzed using analogous GEE models matched to outcome type (binary, count, or rate), with results presented as RRs and IRRs with 95% CI. Missing data patterns will be described by group and time point; primary analyses will use multiple imputations under a missing-at-random assumption, with complete-case analyses and alternative model specifications as sensitivity analyses. Prespecified subgroup analyses will be assessed via interaction terms (e.g., baseline risk category, age group, sex), and per-protocol analyses will be reported as supportive. Analyses will be conducted using STATA 19 (25).

Implementation fidelity and process evaluation: fidelity of intervention delivery will be monitored using predefined indicators, including frequency and completeness of home visits, participation in community-based exercise sessions, and adherence to referral pathways. Process indicators will be extracted from the digital platform and supplemented by periodic audits and supervision reports from provincial coordinators.

Safety monitoring and adverse events: adverse events related to exercise participation or intervention activities, including injuries or medical complications, will be recorded and reported through the digital platform. Serious adverse events will be reviewed by the study steering committee and managed in accordance with national clinical guidelines. In addition, the steering committee will meet quarterly to review trial conduct, recruitment progress, protocol adherence, and any operational issues. Additional meetings may be convened as needed.

Discussion

This study protocol outlines the design and analysis plan for an integrated intervention of a comprehensive program for falls and hip fracture prevention embedded in the health care system, implemented from primary care through tertiary care settings. The Thai-IFHP study aims to scale up the success of the previous study (26) and comprehensively integrate it into the existing health system at the national level. The project also utilizes the digital platform to enhance and facilitate collaborative work among providers across different settings, which will also provide real-time monitoring and support for the implementation process.

Previous international organizations recommendations from the World Health Organization (WHO) and the US Centers for Disease Control and Prevention (CDC)(2, 27) have encouraged the initiation of comprehensive fall prevention programs for older persons across different care settings, but there is a lack of guidance on integrating providers from different settings into these programs. A recent proposal from the European Geriatric Medicine Society (EuGMS)(28) also calls for action to establish a Europe-wide agenda for integrated falls-prevention strategies across all European nations. All those statements emphasize the crucial role of integrated falls-prevention strategies at the national level for an aging society, but do not yet suggest a program or demonstrate a success story. A recent study from China (29) demonstrated a reduction in risk of falls in the prevention program in a primary health care system. Nevertheless, the success of implementing the program in a larger healthcare system, linking to the secondary and tertiary systems, at the national level, remains uncertain.

With an aging population, the global burden of hip fracture attributable to falls (HFAF) is increasing, but the age-standardized years lived with disability (ASYR) for HFAF has trended to decrease over the last few decades (4, 30). Nevertheless, the ASYR differences are substantial across regions of the world, particularly in Southeast Asia (SEA). Thailand is a middle-socioeconomic index (SDI) country in SEA, where the incidence of HFAF among older people is on the rise, but the trend for ASYR is decreasing(4). The increasing incidence of HFAF might, to some extent, be attributed to the lack of effective primary

prevention for falls and hip fractures. Meanwhile, the reduction in ASYR might represent that the care for hip fractures has been improving over the last few decades. We expect that this prospective study will test some of these hypotheses regarding the burden of falls and hip fractures and could serve as a model for other countries with comparable contexts.

There are several potential limitations of these trial results. Firstly, the study design is not a randomized controlled trial where several confounding factors and potential biases may be present. Nevertheless, we aimed for this study to be generalizable to health care centers nationwide; the effectiveness of our non-randomized pragmatic trial might be more meaningful for implementation in health care systems similar to ours. Moreover, we planned to use statistical analysis to assess which confounding factors might be more informative. Secondly, our study involves the care process across multiple service points, many of which have a 'standard of care' in place and may differ somewhat across provinces. This might introduce bias if the intensity and effectiveness of those models differ across centers. We plan to compare outcomes across groups defined by their models of care and baseline risk. Thirdly, variation in compliance with the intervention may have introduced bias. To address this, we will systematically monitor compliance and conduct analyses across different compliance levels.

Conclusions

The Thai-IFHP represents one of the first comprehensive fall-risk screening programs with individualized interventions, integrated into the health system, conducted across several regions of the country. The program is initiated in primary care and linked to tertiary care centers to provide both primary and secondary prevention for falls and hip fractures. This study has the potential to be fully implemented in the country and scaled up in other countries, particularly in resource-limited settings, within robust primary care units. It might also inform policy development for a value-based health care model and payment model with the information collected in our study.

Abbreviations

• Thai-IFHP
Integrated Falls and Hip Fractures Prevention in Thai Older Adults
• HPH
health-promoting hospitals
• PCU
primary care unit
• QALY
quality-adjusted life years
• EQ-5D-5L
EuroQol 5-Dimension 5-Level instrument
• ICER
incremental cost-effectiveness ratio

• VHV
village health volunteers
• TUG
Timed Up and Go Test
• FTSST
Five-Time Sit-to-Stand Test
• 2MWT
2-Minute Walk Test
• FRAX
Fracture Risk Assessment Tool
• OSTA
Osteoporosis Self-Assessment Tool for Asians
• ADL
Activities of Daily Living

Declarations

Ethics approval and consent to participate

The protocol has been approved by the Institutional Review Board of the Faculty of Medicine Siriraj Hospital (COA No. Si 265/2025). The conduct of the study will fully comply with international guidelines for the protection of human subjects, including the Declaration of Helsinki, the Belmont Report, the CIOMS guidelines, and the International Conference on Harmonization–Good Clinical Practice (ICH-GCP) standards. Written informed consent will be obtained from all participants by healthcare staff at participating health-promoting hospitals or primary care units. Participants who experience harm related to trial participation will receive appropriate medical care in accordance with their healthcare entitlements. Important protocol modifications will be communicated promptly to investigators, study sites, ethics committees, and relevant authorities. Updated documents will be distributed, and the trial registry will be updated accordingly.

Consent for publication

Not applicable.

Availability of data and materials

This protocol reports no participant-level data. Upon completion of the study, deidentified data and analytic code will be available to the corresponding author upon reasonable request, subject to ethics approval and data protection regulations. The full study protocol is available upon request from the corresponding author.

Competing interests

The authors declare that they have no conflicts of interest.

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Authors' contributions

WS and VS led the conception, study design, and protocol development. TV, WS, and VS provided clinical expertise and contributed to the development of the intervention for secondary and tertiary care, including care pathways and the clinical variables incorporated into the digital data platform. RK and PL contributed to the development of the primary care intervention and the referral pathways from primary care to higher-level care. TV coordinated engagement with orthopaedic teams nationwide. RK and PL were responsible for planning data acquisition, data management, and statistical analyses, and served as coordinators for participating study sites and primary care units. All authors contributed to drafting the initial manuscript, critically revised the content, and approved the final version.

Dissemination Policy: Study findings will be disseminated through stakeholder meetings with the public and healthcare providers, policy briefs for policymakers and health professionals, and publication on the study website https://www.xn--l3caas8kib5f.com/. Results will also be published in peer-reviewed journals and presented at conferences.

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Statement on AI use

ChatGPT (GPT-5.2, OpenAI) and Grammarly were used to assist with language editing and paraphrasing. The authors reviewed, verified, and approved all content and took full responsibility for the accuracy and integrity of the manuscript.

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Tables

Table1. Stratification of patients according to risk of developing immediate complications after discharge

Criteria	High risk	Moderate risk	Low risk
1.Age	≥ 85 歲	71 – 84 歲	≤ 70 歲
2. Caregiver	No	Yes, not all day	Yes
3. ADL level	ADL <11	ADL 11-14	ADLI ≥ 15
4. Ambulation	Unable to sit or walk	Sit up and walk with assistance	Sit up and walk without assistance
5. History of refracture	Refracture within 1 year	Refracture between 1-3 years	No history or refracture > 3 years
6. Underlying diseases: Stroke, Parkinson's disease, Dementia, or the following diseases ≥ 4 types: CKD, DM, COPD, CAD, Heart failure	≥ 1	No	No
7. Nutrition	Eat ≤ 50% or GI symptoms	Eat between 50-75% or GI symptoms	Eat ≥ 75% and no GI symptoms
8. Treatment	Conservative	Surgery	Surgery
9. Medications that increase risk of falls: sedatives, anti-anxiety, Psychotic drugs, and antihistamines	≥ 2	1	no
10. Complications during hospitalization: Delirium, UTI, Pneumonia, Pressure sore, Sepsis	≥ 1	No	No
11. Frail scale	4-5	2-3	0-1

Table 2. Risk-stratified plan for initial home visits in patients with hip fractures, including team composition, visit objectives, timing, and follow-up.

Criteria	High risk	Moderate risk	Low risk
1.Composition of team	Family physician, nurse, physiotherapist, social worker	Nurse, physiotherapist, social worker (Family physician: optional)	Nurse or physiotherapist or social worker
2. Goal for the visit	Comprehensive assessment. Monitoring the recovery according to plan. Surveillance for complications and provide an appropriate management plan	Monitoring the recovery according to plan. Surveillance for complications and consultation if identify warning signs/symptoms	Monitoring the recovery according to plan. Surveillance for complications and consultation if identify warning signs/symptoms
3. Time for first home visit	Within 1 week	Within 2 weeks	Within 4-6 weeks
4. Duration for follow-up visit	Depending on needs (functional and overall needs), identify from the first home visit. At least within 2 weeks	Depending on needs (functional and overall needs), identify from the first home visit. At least within 4 weeks	Depending on needs (functional and overall needs), identify from the first home visit. At least within 4-6 weeks

Figures

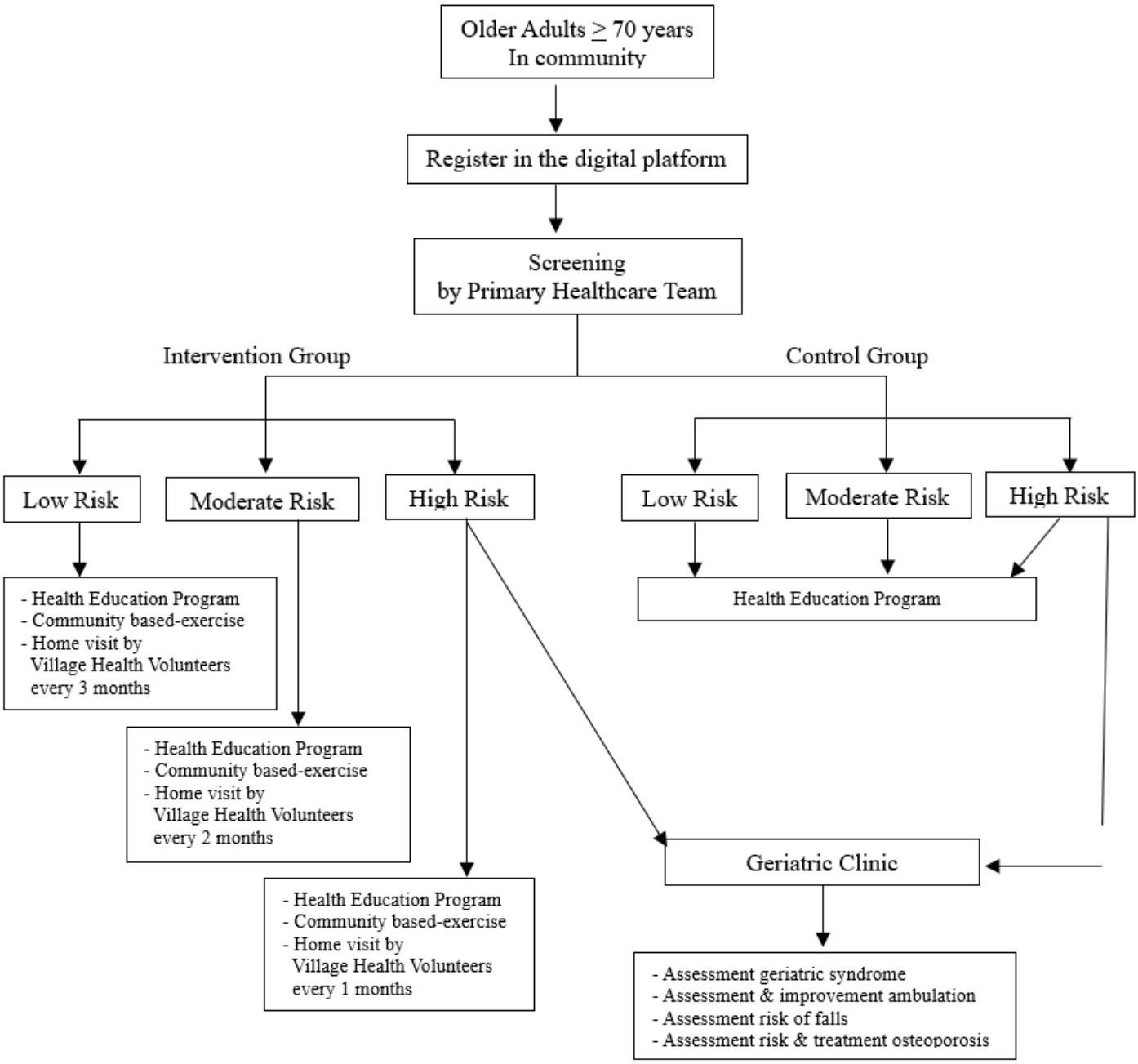


Figure 1

Flow Diagram for the Primary Prevention Component

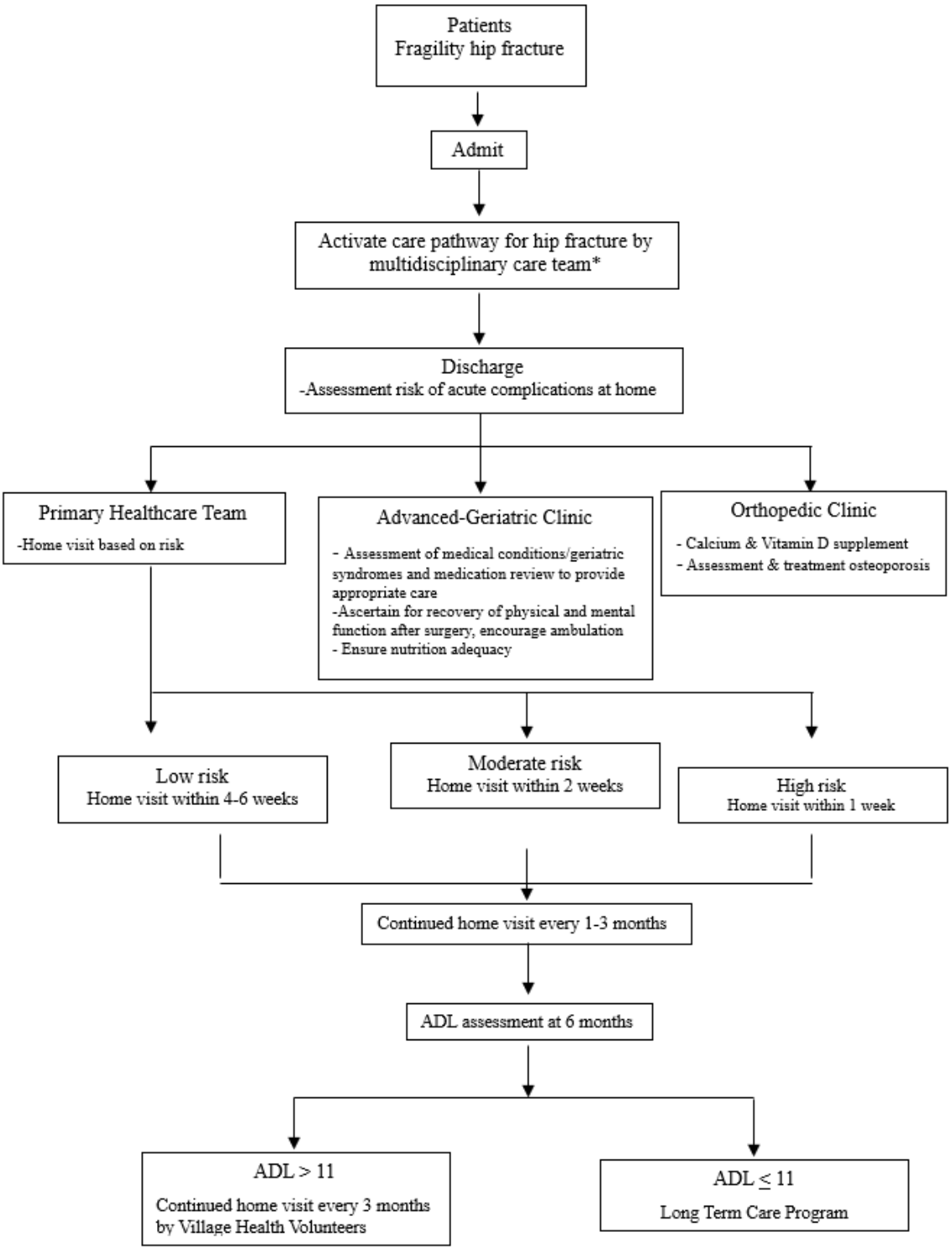


Figure 2

Flow Diagram for the Secondary Prevention Component

	TRIAL PERIOD					
	Enrollment		Intervention			Close out
TIMEPOINT	$-t_i$ to 0	t_0	t_1 90 ± 10 days	t_2 120 ± 10 days	t_3 360 ± 10 days	t_x 380 days
Screening and registration on the digital platform by village health volunteers	X					
ENROLLMENT by primary health care units:		X				
Eligibility screening by primary health care units		X				
Informed consent		X				
Stratify patients into risk groups		X				
Allocate to the intervention or the control group		X				
INTERVENTION/ COMPARATOR:						
[group exercise and education program, home visits based on risk][a]		X →	→	→	→	X
[exercise advice and education program, home visit every 3 months][a]		X →	→	→	→	X
ASSESSMENTS:						
[TUG, FTSST, 2MWT, Hand-grip strength, STEADI, Thai-FRAT, FRAX, OSTA, FRAIL Scale, ADL, EQ-5D]		X			X	
[TUG, Hand-grip strength, EQ-5D]			X	X		

Figure 3

Participant timeline: Schedule of enrollment, interventions, and assessments for Integrated Falls and Hip Fractures Prevention in Thai Older Adults (Thai-IFHP) program (31).

[a] An Arrow indicates continuous delivery of intervention

Supplementary Files

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