

Effects of a fall prevention program with Ruesie Dutton exercises applied to a revised self-and family management framework on fall prevention behaviors among community-dwelling older adults with diabetes in Bangkok, Thailand: Randomized Controlled Trial

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ABSTRACT

Older adults with diabetes are at increased risk of falls due to complications such as sarcopenia, retinopathy, and peripheral neuropathy. In Bangkok, 94.3% of older adults reported a history of falls, with the highest prevalence observed among those with diabetes (35.3%). Importantly, the risk of falls remains elevated even among individuals with well-controlled blood glucose. This randomized controlled trial aimed to evaluate the effectiveness of a fall prevention program incorporating Ruesie Dutton exercises by applying a revised self- and family- management framework to improve fall prevention behaviors among community-dwelling older adults with diabetes in Bangkok, Thailand. Eighty-six community-dwelling older adults with diabetes aged 60-75 years were selected using multi-stage computer-generated random sampling. Then they were divided into experimental and control groups of 43 each. The control group continued living normal daily lives, while the experimental group participated in 8-week fall prevention program incorporating Ruesie Dutton exercises. The program consisted of activities involving the fall prevention education, Ruesie Dutton exercises, fall preventive dressing, and handbooks. Additionally, the older adults received home visits and infographics about preventing falls were sent through a LINE group. Afterwards, the participants in the experimental group were instructed to perform Ruesie Dutton exercises with 7 postures over a period of 8 weeks. The instruments used in data collection were a demographic data questionnaire and a fall prevention behavior questionnaire. Pre- and post-test data were analyzed using descriptive analysis, independent t-test and paired t-test statistics. The findings revealed that the experimental group had a higher mean posttest score for fall prevention behavior than the mean pretest score and a higher mean score than the control group with statistical significance ($p < .001$). The findings will guide healthcare providers in developing better ways to prevent falls among older adults in communities. Additionally, it will enhance family efforts to keep older adults with diabetes safe from falls in the future.

Keywords:

older adults with diabetes; fall prevention behaviors; revised self- and family management framework; Ruesie Dutton exercises

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INTRODUCTION

The global population over the age of 60 will increase to 42% of the entire global population in 2100.¹ The ongoing rise in the number of older adults has resulted in fragility in physical health due to age-related physical weakness and muscle system deterioration. As a result, the rate of accidents from falls has also increased. Older adults with diabetes are at a greater risk of falling compared to those with other chronic diseases. This is because diabetes is a leading cause of physical deterioration², which increases the likelihood of falls in older adults. In Thailand, 93.30% of older adults reported a history of falls in 2021.³ In the 2024 fiscal year, 5,611 older adults with chronic diseases experienced falls (76.27%). Among them, older adults with diabetes had the highest fall rate at 21.70%.⁴

In Bangkok, 1,342,826 older adults (94.26%) reported a history of falls, with a fall-related mortality rate of 4.87%.⁴ Older adults with diabetes were found to have the highest fall rate at 35.3%. Older adults with normal HbA1c levels were still found to experience falls at a rate of 65%.⁵ This indicates that even when blood glucose levels are well-controlled, the risk of falls remains high-especially among those treated with insulin. Diabetes is a contributing factor to sarcopenia due to increased levels of cytokines, which promote muscle breakdown and thereby increase the risk of falls.⁶ Furthermore, diabetes can cause diabetic retinopathy and peripheral neuropathy, resulting in inactive behaviors or low physical movements.⁷

The effects of falls pose serious physical and psychological threats. Moreover, falls increase family expenses, place a burden on caregivers and family members, and impact the country's public health budget.⁸ Therefore, the problem of falling requires an urgent solution in the

form of fall prevention. Previous literature reviews have revealed that fall prevention programs for older adults consist of four exercises: standing on one leg, heel-to-toe⁹, Ruesie Dutton exercises,¹⁰ and Tai Chi.¹¹ Moreover, multidisciplinary teams have helped care for older adults to prevent falls.¹² In addition, nurses conduct home visits to assess the environment for fall prevention among older adults.¹³ The activities were conducted over 6–12 weeks, and the findings showed that older adults in the experimental group demonstrated significantly improved fall-prevention behaviors compared to before the intervention and significantly more than the control group ($p < .001$).

Previous research has used Ruesie Dutton exercise programs for older adults with various chronic diseases, but no program has specifically tailored activities for older adults with diabetes. Therefore, a fall prevention program based on the revised self- and family management theory by Grey et al.,¹⁴ incorporating Ruesie Dutton exercises as part of its conceptual framework, is essential for the success of exercise programs for older adults with diabetes. This theory has helped encourage the involvement of family members in Ruesie Dutton exercises. This study used only 7 Ruesie Dutton exercise positions to promote the strengthening of muscles in the hips, legs and knees, which are more prominent than previous research, namely, simple exercises that are suitable for older adults to practice continuously. These exercises are widely accessible and commonly used, and no special permission from the original creators is required. Each pose of the Ruesie Dutton exercises promotes muscle strength and improves the quality of life in older adults more effectively than other exercises.¹⁰ This study aimed to promote improved fall prevention behaviors among older adults with diabetes through family involvement

in the activities. The findings are expected to guide community nurses and healthcare providers in developing more effective strategies to prevent falls among older adults in the community and to enhance family efforts to keep older adults with diabetes safe from falls in the future.

METHODS

Randomized Controlled Trial (RCT) Design (TCTR20241030005)

This study was a single-blind RCT with two groups. Participants were randomly assigned, using multi-stage computer-generated random sampling, to one of two groups: (1) a group that continued their usual daily activities, or (2) a group that practiced ruesie dutton. While participants were aware of the activity they performed, they were not informed which group was considered the experimental or the control group. The researchers assessed all outcomes, and no blinding was possible due to the nature of the intervention.

Population and Sample

The population consisted of older adults with diabetes living in 50 districts of Bangkok, Thailand, across 2,016 communities, totaling 97,829 individuals.

The sample size was calculated using G*Power version 3.1.9.7. The power of the test was set at 0.80, with a significance level of 0.05. An effect size of 0.59, determined from a comparable prior study, was adopted for the calculation.⁸ The required total sample size was 74 participants. To account for attrition from the sample size, 15% was added to the sample for a total size of 86 participants divided into experimental and control groups of 43 each. The samples were multi-stage randomly selected from areas in Bangkok. One administrative district was randomly selected out of 6 administrative districts and 17 communities were selected out of a total of 146 communities, with a total of 516 older adults with diabetes. The

researcher had a list of 86 participants and used Microsoft Excel Plus 2021 to randomly assign 43 participants to the control group and 43 participants to the experimental group.

Inclusion Criteria

1) Participants were community-dwelling older adults aged 60–75 years with diabetes, who had blood glucose levels (DTX) ranging from 80 to 200 mg/dL and were capable of performing traditional Ruesie Dutton exercises according to the criteria of the American Diabetes Association.¹⁵ All participants were receiving either oral or injectable antidiabetic medication.

2) Older adults achieved a Barthel Index¹⁶ score of 12 or higher, indicating functional independence in activities of daily living.

3) A cognitive function score of 3 points or more based on the Mini-Cog assessment¹⁷.

4) Possession of a smartphone, notebook or computer with an internet signal to use the LINE application.

5) Ability to read, write, listen, and speak Thai.

6) Having a family member aged 20-65 years who takes care of the older adult while exercising at home.

Exclusion Criteria

1) Older adults with mobility disabilities who are unable to move arms or legs.

2) Older adults with contraindications to exercise such as Parkinson's disease, or heart disease with chest tightness.

3) Older adults with mental symptoms, schizophrenia, or neurological diseases.

4) Older adults who have complications from diabetes such as diabetic retinopathy and diabetic neuropathy.

Research Instruments

1. Screening Instruments

1.1 The Barthel ADL Index

1.2 developed by Mahoney & Barthel¹⁵ was translated into Thai and modified by Jitapunkul et al.¹⁸ The ten daily living activities assess eating, dressing, moving, toileting, mobility, stair use, bathing, and bowel control, with a maximum score of 20. Higher scores indicated better daily living activities.

1.3 The Mini-Cog Assessment developed by Borson et al.¹⁶ and translated by Trongsakul et al.¹⁹ Two questions were used to assess cognitive impairment risks with a maximum score of five points. Older adults with a total score of more than three points were considered to have no cognitive impairment.

2. Data Collection Instruments

2.1 Demographic questionnaire includes gender, age, marital status, education level, occupation, family income/month, family caregivers, weight, height, body mass index, duration of illness with diabetes, comorbidities, complications from diabetes and diabetes treatment methods (14 questions).

2.2 The Fall Prevention Behavior Questionnaire was adapted from the instrument originally developed by Lukman.²⁰ It comprises 20 items assessing fall prevention behaviors, each rated on a four-point scale, with a maximum total score of 60; higher scores reflect better fall prevention practices. The instrument demonstrated good content validity. Reliability testing yielded a Cronbach's alpha coefficient indicating acceptable internal consistency. Permission to use and modify the questionnaire was obtained from the original author.

3. Research Instruments Used in the Experiment

3.1 Ruesie Dutton Fall Prevention Program applying the revised Self- and Family-Management Conceptual Framework.¹⁴ The

program was conducted over a period of 8 weeks. The activities consisted of: 1) a lecture on the factors contributing to falls and solutions including the participation of family members in preventing falls; 2) a handbook^{10,21,22} with infographics for fall prevention and a video of the 7 positions in Ruesie Dutton exercises;²² 3) home visits to make plans together for arranging safety home environments; 4) motivate the participants to perform Ruesie Dutton exercises and encourage them by phone calls and conversations through the LINE application group.

Validation and Reliability Research Instrument

The Ruesie Dutton fall prevention program and the Fall Prevention Behavior Questionnaire were evaluated for content validity by five qualified experts: (1) a nursing professor specializing in surgical nursing and fall prevention, (2) a nursing professor specializing in community health nursing, (3) a physician specializing in Thai traditional and integrative medicine, (4) a physician specializing in geriatric medicine, and (5) a nurse specialist in home care. The program demonstrated acceptable content validity, with the Index of Item-Objective Congruence (IOC) scores as follows: self-management focused on patient needs (IOC = 0.69), self-management support (IOC = 0.62), and living with the conditions of illness (IOC = 0.70). The Fall Prevention Behavior Questionnaire had a Content Validity Index (CVI) of 0.806.

The Ruesie Dutton fall prevention program was pilot-tested with three older adults with diabetes who shared similar characteristics to the study participants. The results showed that all individuals were able to adhere to the program consistently. In addition, the Fall Prevention Behavior Questionnaire was pilot-tested with 30 older adults of comparable characteristics,

yielding a Cronbach's alpha coefficient of 0.880, indicating a high level of internal consistency.

Research Ethics

This study was approved by the IRB, Faculty of Nursing, Mahidol University (COA No. IRB-NS2024/881.1908, dated August 19, 2024). Participants were informed of the objectives, research procedures, risks and benefits before voluntarily consenting and participating in the program. All research information was kept confidential, and participants could withdraw from the study at any time without any consequences.

Data Collection

The study was conducted for a total of 8 weeks from November 2024 to January 2025.

Experimental Group

The 8-week program was conducted as follows:

Week 1: 1) The sample completed pretest questionnaires on demographic data and fall prevention behavior before the

experiment, and a LINE group was set up to distribute fall prevention handbooks and videos of Ruesie Dutton exercises²². The exercise program was performed three times per week, and each session included a family member to assist and ensure participant safety, which took approximately 60 minutes; 2) The older adults received 30 minutes of education on fall risk factors; 3) The older adults practice 7 Ruesie Dutton exercise positions²² until they were able to do them (60 minutes). Seven Ruesie Dutton exercise positions included "Kae Lom Ta Pok Salak Petch", "Kae Khao Khad", "Kae Khao, Kae Kha", "Kae Lom Chanthakat, Lom Khao, Lom Kha", "Kae Klon Pattakhad", "Kae Takew Mue", and "Kae Khao, Kha Taay". The program was reviewed and confirmed safe for older adults with diabetes by five qualified experts: 1) a nursing professor specializing in surgical nursing and fall prevention, 2) a nursing professor specializing in community health nursing, 3) a physician specializing in Thai traditional and integrative medicine, 4) a physician specializing in geriatric medicine, and 5) a nurse specialist in home care.

1. Kae Lom Ta Pok Salak Petch Position Aim: To promote muscle function in the hip area and the joint between the hips and thighs.	
2. Kae Khao Khad Position Aim: To promote knee strength, so the knees can move well and to correct knee tightness.	
3. Kae Khao, Kae Kha Position Aim: To help strengthen the knees and legs.	
4. Kae Lom Chanthakat, Lom Khao, Lom Kha Position Aim: To promote leg strength.	
5. Kae Klom Pattakhad Position Aim: To promote leg strength and tendons.	
6. Kae Takew Mue Position Aim: To promote balance and leg fitness.	
7. Kae Khao, Kha Taay Position Aim: To give legs and knees more energy for better and more vigorous mobility.	

Figure1. Summary of Ruesie Dutton exercise positions.

Week 2: A home visit was conducted personally by the researcher to meet family members caring for the older adults with diabetes. The visit aimed to explain the fall prevention handbook, guide the elderly through Ruesie Dutton exercises, and assist in planning a safe home environment. Each visit took approximately 30 minutes.

Week 3: A home safety infographic was sent via the LINE group.

Weeks 4-5: Two follow-up phone calls were made to encourage and remind participants to practice Ruesie Dutton exercises, lasting 10 minutes.

Week 6: Infographics on appropriate clothing for fall prevention were shared via the LINE group.

Week 7: A LINE group discussion was conducted to offer encouragement, address challenges, and discuss obstacles in practicing Ruesie Dutton exercises, taking 30 minutes.

Week 8: On the first day of the week, a fall prevention infographic was sent via LINE. At the end of the week, data collection was conducted to assess fall prevention behaviors after the intervention.

Control Group:

On Day 1 of Week 1, older adults completed demographic and fall prevention behavior questionnaires (30 minutes). From Day 2 of Week 1 to Week 8, they continued their normal routines. On the final day of Week 8, they completed

the fall prevention behavior questionnaire again (30 minutes).

Data Analysis

Data were analyzed using SPSS. Descriptive statistics for demographic data were presented as frequencies, percentages, means, and standard deviations. Normality was assessed using the Kolmogorov-Smirnov test. Nominal and ordinal variables were compared using the chi-square test or Fisher's exact test, while interval variables were analyzed using the independent t-test. Posttest fall prevention behavior scores were compared between the experimental and control groups using independent t-tests, and pre- and posttest scores within the experimental group were compared using paired t-tests.

RESULTS

Table 1. The comparison of baseline personal data between the control and experimental groups presented is numbers and percentages (N = 86).

Personal Information	Control Group (n=43)	Experimental Group (n=43)	X ²	p-value
Sex			.17 ^F	
Male	11 (25.6%)	5 (11.6%)		
Female	32 (74.4 %)	38 (88.4%)		
Age (years)				
60-69 years	22 (51.2%)	26 (60.5%)		
70 years & up	21 (48.8%)	17 (39.5%)		
Mean (SD)	68.26 (4.8)	68.00 (5.4)		.816 ^T
Mean Body Mass Index (SD)	25.03 (4.0)	24.90 (4.1)		.879 ^T
Mean Monthly Family Income			.50	
Less than 10,000 Baht	7 (16.3%)	1 (2.3%)		
10,000 - 20,000 Baht	26 (60.5%)	41 (95.3%)		
Over 20,000 Baht	10 (23.3%)	1 (2.3%)		
Family Caregiver(s)			.50	
Child	27 (62.8%)	22 (51.2%)		

^FFisher's exact test, ^TIndependent t-test

1. The demographic data revealed that most of the sample were older adult women with diabetes (74.4% and 88.4% in the control and experimental groups, respectively). The mean age of the control group was 68.26 years, while the mean age of the experimental group was 68.0 years. The mean body mass index (BMI) of the control group was 25.03 kg/m², while the experimental group had a mean BMI of 24.90 kg/m². The mean monthly income per family was 10,000 baht to 20,000 baht for most of the sample, with 60.5% and 95.3% in the control and experimental groups, respectively. Lastly, most of the family caregivers of the older adults in the sample were their children (62.8% and 51.2 % in the control and experimental groups, respectively) (Table 1).

Most of the diabetic older adults had been diagnosed with diabetes for 1-5 years (46.5% in the control group and 34.9% in the experimental group). They were treated

for diabetes with oral medications (90.7% each in the control and experimental groups). (Table 2).

Table 2. The comparison of baseline health conditions between the control and experimental groups is presented as numbers and percentages (N = 86).

Health Condition	Control Group (n=43)	Experimental Group (n=43)	χ^2
Duration of Illness with Diabetes			.30
Less than 1 year	2 (4.7%)	6 (14.0%)	
1-5 Years	20 (46.5%)	15 (34.9%)	
6-10 Years	8 (18.6%)	11 (25.6%)	
Over 10 years	13 (30.2%)	11 (25.96%)	
Treatment			
Oral Drug Therapy	39 (90.7%)	38 (90.7%)	1.0
Insulin Injection Therapy	3 (7.0%)	4 (7%)	1.0
Behavior Modification	1 (2.3%)	1 (2.3%)	1.0

2. The mean pretest fall prevention behavior score was ($\bar{x} = 25.56$, $SD = 7.69$) and the mean posttest fall prevention behavior score was ($\bar{x} = 53.09$, $SD = 4.56$). Therefore, the experimental group had a

higher mean posttest score for fall prevention behaviors than the pretest score with statistical significance ($p < .001$) (Table 3).

Table 3. Mean and standard deviations of the fall prevention behavior at pretest and posttest among older adults with diabetes (n=43).

Fall Prevention Behavior	Pretest		Posttest		t	p-value
	M	SD	M	SD		
Experimental Group	25.56	7.69	53.09	4.56	-22.45	< .001

Abbreviations: M=Mean, SD=Standard Deviation, * $p < .001$ = significant.

3. After the fall prevention program, the experimental group had a mean fall prevention behavior score of ($\bar{x} = 53.09$, $SD = 4.56$) and the control group had a mean fall prevention behavior score of ($\bar{x} = 24.16$, $SD = 5.31$). In other words, the mean

posttest fall prevention behavior score of diabetic older adults in the experimental group was higher than that of the control group with statistical significance at $p < .001$ (Table 4).

Table 4. Mean and standard deviations for the fall prevention behaviors at pre-test and post-test between the experimental and control groups (N=86).

Fall Prevention Behaviors	Control Group (n=43)		Experimental Group (n=43)		t	df	p-value
	M	SD	M	SD			
Pretest	25.95	5.88	25.56	7.69	.28	84	.790
Posttest	24.16	5.31	53.09	4.56	27.06	84	<.001

Abbreviations: M=Mean, SD=Standard Deviation, * $p < .001$ = significant, , Cohen's $d = 4.36$ (very large effect).

DISCUSSION

Discussion of the findings according to the two hypotheses is as follows.

Reflecting on the first hypothesis, after the program, the older adults in the experimental group had significantly higher mean scores for fall prevention behaviors than those in the control group ($t = 27.06$, $p < .001$). This can be explained by the following three reasons. The first reason might be that the program was based on the Revised Self- and Family Management Framework. The program was designed to involve family participation in caregiving during exercise, planning for home environment safety, and reducing fall risks. The findings were consistent with a previous study that applied the Revised Self- and Family Management Framework, in which family caregivers were involved in physical activities with the elderly, and provided them with knowledge on correct behavior to prevent falls as well as precautions for preventing falls.²³ The findings were also consistent with a study conducted on a fall prevention program. The results showed that family members had jointly planned to adjust the home environment to prevent falls among older adults. After receiving the program, the experimental group had a significantly higher mean score of fall prevention behavior than the control group ($p < .001$).

The second reason might be that the experimental group performed Ruesi Dutton exercises more consistently than the control group. This is consistent with previous studies applying Ruesie Dutton exercises in older adults to prevent falls. After the experiment, the experimental group had muscle strength and flexibility without losing balance or falling more than the control group, which did not perform Ruesie Dutton exercises ($p < .05$).¹⁰ These improvements may be attributed to the Ruesi Dutton exercises, which enhance neuromuscular coordination, stimulate muscle activation, and promote joint

mobility, thereby supporting functional stability. The third reason is that the experimental group had more knowledge than the control group. In this study, the older adults received instruction on internal and external fall risk factors. This was consistent with studies providing instruction about risk factors and the effects of falling among older adults. After the experiment, the experimental group had a higher mean score for fall prevention behaviors than the control group with statistical significance ($p\text{-value} < .001$).²⁴

Responding to the second hypothesis, after the program, the experimental group had a higher mean score for fall prevention behaviors than before the program with statistical significance ($p\text{-value} < .001$). The findings can be discussed as follows:

1) This was possibly due to clearer exercise program arrangements compared to before the experiment. This study had clear planning of exercises for diabetic older adults. Before Ruesie Dutton exercises, older adults practiced meditation for five minutes. Older adults were instructed to perform seven Ruesi Dutton exercise poses for approximately three minutes per pose, totaling 30 minutes per session, three days per week, for eight weeks. This intervention schedule was selected based on previous studies indicating that moderate-duration exercise performed multiple times per week effectively enhances muscle strength, flexibility, and balance in older adults. The frequency and duration were designed to provide adequate stimulus for neuromuscular adaptation while minimizing fatigue and the risk of injury, ensuring the program was both safe and feasible for community-dwelling older adults. This is consistent with research on effective steps in the Ruesie Dutton exercise schedule aimed at strengthening leg muscles.²⁵ Furthermore, the findings were also consistent with other studies in which participants performed "Tai Chi",¹¹

Otago,¹³ Baslow dance exercises.²⁶ The aforementioned finding found that the mean scores for fall prevention behaviors in the experimental group were higher than before the fall prevention program with statistical significance ($p < .001$).

2) The experimental group regulated and monitored the consistency of fall prevention practices, causing the experimental group to have higher levels of fall prevention behaviors at posttest than at pretest. At Week 2, the researcher visited the older adults at home. In Weeks 4-5, the researcher made follow-up telephone calls. At Week 7, the researcher provided 30 minutes of encouragement via LINE. Ongoing support improved consistency in practice. This aligns with studies using calendars and record forms to promote continuous fall prevention behaviors in older adults,²⁷ including telephone reminders to perform fall prevention practices continually,²⁸ and follow-up visits at home, online encouragement via the LINE application group and private accounts.²⁹ After the program, the experimental group had significantly more fall prevention behaviors than before the program ($p < .001$).

3) The experimental group had sufficient monthly income within a range of 10,000 baht to 20,000 baht per family (95.3 %). During the program, the experimental group used family budgets to support self-management, such as creating safer environments to prevent falls compared to before the program. In the Revised Self-and Family Management Framework, patients and families without sufficient financial status may experience negative effects on health. In addition, Pumri³⁰ stated that older adults without sufficient income to purchase food to cook or eat may experience poor health and be at increased risk of falling. This aligns with a study where the experimental group, with higher income, showed significantly greater fall

prevention behaviors than the control group after receiving a health literacy promotion program ($p < .001$).³¹

This family involvement helps improve fall prevention behaviors. However, uncontrolled external factors, such as previous exercise routines or other fall prevention information, possibly affect the improvement of fall prevention behaviors. Future research should explore these factors to better validate the program's effectiveness.

RECOMMENDATIONS

This study had two main limitations. First, it was difficult to control participants' exposure to external sources of information, which may have influenced their knowledge acquisition. Second, conducting group activities with participants from different communities occasionally caused delays in delivering educational content and practicing the Ruesi Dutton exercises. Therefore, future research should include measures to monitor participants' exposure to external health information in order to minimize potential bias. In addition, organizing smaller group activities within participants' local communities is recommended to reduce travel time and facilitate more effective program delivery.

AUTHOR CONTRIBUTIONS

YJ: Conceptualization, Methodology, Formal analysis, Writing - Original Draft and Writing - Review & Editing TP: Conceptualization, Methodology, Formal analysis, Writing - Original Draft and Data Curation.

ETHICAL CONSIDERATION

This study was approved by the Institutional Review Board of the Faculty of Nursing, Mahidol University (COA No. IRB-NS2024/881.1908; August 19, 2024). Written informed consent was obtained from all participants after they were fully informed of the study's objectives, procedures, potential risks, and benefits. Data confidentiality was strictly maintained, and participants retained the right to withdraw at any time without any consequences.

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CONFLICTS OF INTERESTS

All Authors State that no conflict of interest.

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