

# *State of Science: Falls Prevention Program in Community-Dwelling Elders*

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## **Abstract**

**Background:** For older adults, numerous age-related changes, functional impairments, and risk factors contribute to a high incidence of falls. The phenomenon of falls in community-dwelling elders is a significant global health care problem because of its high potential of increasing morbidity, mortality, reduced functioning or disability. Falls can lead to premature nursing home admissions, hospitalization, psychological and social consequences, and financial burden for individuals and health care systems across the world.

**Objective:** The objective of this study was to describe the state of the science of prevalence fall risk factors, the effects of falls on the elders, and fall prevention programs for elders in Thailand as well as other countries.

**Materials and Methods:** The search strategy was based on electronic searches including CINHAL (OVID ONLINE), the Cochrane Library, handsearch of selected journals, and snowballing from reference lists of selected publications during January 2000 until December 2005. The search terms were accidental falls, risks of falls, falls prevention program, community-dwelling elders, and fall-related injury.

**Results:** The most salient risk factor of fall in community-dwelling elders both in Thailand and in other countries is the impairment of gait and balance. A fall prevention program for the community-dwelling elders should combine strategies including fall prevention education sessions and Tai Chi exercise sessions. These interventions would include physical modification, behavioral modification, and improved environmental safety.

**Conclusions:** Research about the effects of a fall prevention program for the Thai community-dwelling elders should be aimed at improving their gait and balance. An effective fall prevention program is one critical way to enhance the quality of life for the elders in Thailand as well as worldwide.

**Key words:** accidental falls, risks of falls, falls prevention program, community-dwelling elders, and fall-related injury

## INTRODUCTION

The purpose of this paper was to describe the state of the science of prevalence fall risk factors, the effects of falls on the elders, and fall prevention programs for elders in Thailand as well as in other countries.

The major demographic trends affecting the global health care system is the increasing diversity of the older adult population. For older adults, numerous age-related changes, functional impairments and risk factors contribute to a high incidence of unintentional injuries that are a major health problem among elderly people. In the period from 1992 to 1999, falls in older adults were the leading causes of home injury deaths in the United States.<sup>1</sup>

### **Search strategy**

To gain an understanding about the phenomenon of falls in community-dwelling elders, the authors studied several articles that provided epidemiological or other background information related to fall events, fall risks, and fall prevention. The search strategy was based on electronic searches including CINHAL (OVID ONLINE), the Cochrane Library, handsearch of selected journals, and snowballing from reference lists of selected publications. The search terms included accidental falls, risks of falls, falls prevention program, community-dwelling elders, and fall-related injury. Papers were retrieved if they were research studies, review literatures, systematic reviews, meta-analyses, expertopinions, and government reports in community settings during January 2000 until December 2005.

Paper were rejected if they were written in languages other than English or Thai or if they were researches in participants under the age of 60, or researches in hospital settings.

### **Definition of a fall**

A falling event may be the initial sign or an early indication of an underlying illness, representing the onset of new diseases or unstable existing diseases.<sup>2</sup> However, the definitions used for a fall vary between studies.<sup>3</sup> Most studies required a fall to be "unintentional" to have some form of contact with the ground and to exclude falls caused by road accidents and violence. Some studies excluded falls caused by syncope or an acute major intrinsic event such as a stroke.

For the purpose of this study, a fall is defined as a sudden event which results in a person's change in body position in a downward direction toward the ground or other lower level which unintentionally causes the individual to come to rest. This action may or may not result in physical injury and the fall is not the result of a major intrinsic event (such as stroke, syncope) or overwhelming hazard.

### ***Incidence of fall***

Fall incidence, a measure of how often falls occur for a certain period of time, varies among settings, population, and time. According to one study, 30%-50% of generally healthy elderly persons over the age of 65 living in communities reported having fallen at least once over a one-year period. One-half to two-thirds of nursing home residents fall annually and around half of hospitalized patients fall.<sup>4</sup> Studies in Thailand found the incidence of falls in the community-dwelling elders varies from 18.7% within 6 months<sup>5</sup>, 12.1% in male and 24.1% in female<sup>6</sup>, 17.03,<sup>7</sup> 19-20,<sup>8</sup> and 42.7%.<sup>9</sup>

### ***Places of fall***

In Western countries, most falls take place in the bedroom while an individual is attempting to get out of bed unassisted or in the bathroom while the person is attempting non-assisted toileting activities. These events occur most often in those individuals 75 to 80 years of age with underlying medical conditions or medications interfering with safe gait/balance. Studies in Thailand found that 18% to 24% of falls occur in bathrooms and toilets,<sup>9,10</sup> often as a result of slipping on the floor in 52.8%.<sup>10</sup>

### ***Risk factors of fall***

Falls generally result from an interaction of multiple, diverse risk factors, and situations, which can be modified by age, disease, and the presence of hazards in the environment.<sup>11</sup> Risk factors for falling can be classified as either intrinsic (lower extremity weakness, poor grip strength, balance disorders, functional and cognitive impairment, visual deficits) or extrinsic (polypharmacy: four or more prescription medications) and environmental factors such as poor lighting, loose carpets, and the lack of bathroom safety equipment.<sup>12</sup>

Research has identified over 400 potential risk

factors for falling.<sup>13</sup> However, a summary of 16 controlled trials revealed that the most significant individual risk factors for falls in both community-dwelling and institutional-dwelling older people in Western countries included weakness, balance deficits, limitation in mobility, gait deficits, visual deficits, impaired activity of daily living, cognitive impairment, and postural hypotension.<sup>14</sup>

Similar to other countries, studies in Thailand have found that risk factors for falls in the elderly vary. A study of 1,043 older people in communities, Assuntachai et al. (1997)<sup>6</sup> found that risk factors most commonly associated with falls included being a member of the female gender, hypertension, hearing loss, memory loss, low perceived health status, decreased activity in daily living, kyphoscoliosis, use of eye-glasses, high pulse rate in a sitting position and malnutrition (lower lean body mass and lower serum albumin). For the male elders living in the community, the most common risk factors associated with falls included low perceived health status, hypertension, difficulty walking at home, difficulty sitting, and the absence of electricity at home.<sup>5</sup> For the female elders living in the communities, the most common risk factors for falls included low perceived health status, joint disease, an illness influencing activities within the previous year, difficulty sitting, going to the market everyday, loneliness, eating less than 3 meals a day, the absence of electricity at home, and living in a traditional Thai style home or a hut.<sup>5</sup>

In a study of 417 members of an elderly club in Bangkok,<sup>15</sup> risk factors for falls were categorized into two categories: 1) basic conditioning factors, including being a female (71.2%), single marital status (52.4%), and being improperly dressed and 2) home environmental factors, including improper house stairs, poor lighting around the stairs, clutter, and a ragged carpet/door mat.

Lausawatchaikul (2000)<sup>10</sup> studied 130 community-dwelling elders who came to the emergency room and orthopedic out-patient department at Ramathibodi Hospital in Bangkok for examination or follow-up after falls. The results showed that the majority of falls took place in and around the patients' homes, in which the bathroom was the most common location of the incident. The main causes of falls included extrinsic factors, of which slipping (52.8%) was most frequently reported and intrinsic factors, of which acute leg

muscle weakness was found in 42.5%.

#### *The state of science with respect to fall risk factors*

Summarization of evidence regarding the significant fall risk factors in the community-dwelling elders in both Thailand and in other countries share similar terms of intrinsic factors: 1) impairment of gait and balance 2) limitation in general physical function: cognitive impairment, visual deficit, impaired daily living activity, and mobility limitation. On the other hand, regarding intrinsic factors, Thailand is different from other countries in demographic factors, i.e. female gender and previous falls; the presence of certain chronic conditions, i.e. hypertension; and also psychological problems (low perceived health status). Moreover, in Thailand extrinsic factors (more than 1 drug/medication use) and environmental factors (home environment) are different from other countries. In other countries these factors are not significant.

It can be concluded that the most salient risk factor of fall among intrinsic factors in community-dwelling elders both in Thailand and in other countries is the impairment of gait and balance due to a combined effect of normal age-related changes and concurrent diseases.<sup>16</sup> Balance is necessary for maintaining a position, remaining stable while moving from one position to another, performing activities of daily living, and moving freely in the community. This risk results in a loss of muscle strength and balance, and the body mechanisms responsible for compensation or stability fail.<sup>2</sup> Impaired balance greatly increases the probability for falls, fractures, and functional dependency among older adults. It has been estimated that between 10% and 25% of all falls are associated with poor balance and gait abnormalities.<sup>18</sup> This situation requires the gerontologic nurse to observe and analyze older individuals' gait and balance and determine if impairment exists.<sup>16</sup>

#### *The effects of a fall*

A key concern is not only the high incidence of falls in older persons but also the combination of the high incidence and a high susceptibility to injury. Both rise steadily after age 60 and after 75 years of age the rates increase markedly.<sup>14</sup> Although most falls result in no serious injury, studies among older persons in the community found that about 10% of the fallers had a serious fall-related injury, including fractures, joint

dislocations or severe head injuries.<sup>19</sup> Unfortunately, 50% of older adults who were hospitalized because of a fall died within 1 year of hospitalization.<sup>20</sup>

Fall-related injuries in older adults often reduce mobility and independence and are often serious enough to result in a hospitalization and an increased risk of premature death.<sup>21</sup> In 1994, falls were the leading cause of death for adults ages 79 and older in Western countries.<sup>22</sup> National data presented by the United States indicated that falls were the largest single cause of restricted-activity days among older adults.<sup>23</sup> Moreover, falling was a leading precipitating cause of nursing home admissions<sup>24</sup> and accounted for 6% of all medical expenditures for persons 65 years of age and older.<sup>25</sup>

### ***Fear of falling***

Falls can also have significant psychological and social consequences. Fear of falling is defined as the loss of self-confidence to ambulate safely that can result in self-imposed functional limitations.<sup>26</sup> Fear of falling has been shown to be significantly correlated with increased sway in vision-deprived stance as well as decreased single-stance balance in elders who self-report a fear of falling compared with those who do not self-report a fear.<sup>27</sup> Moreover, fear of falling is closely associated with poor functional performance and the incidence of falls.<sup>28</sup>

To summarize, the phenomenon of falls in community-dwelling elders is clearly a significant global health care problem because of its high potential of increasing morbidity, mortality, reduced functioning or disability. Falls can lead to premature nursing home admissions, hospitalization, psychological and social consequences, and financial burden for individuals and health care systems across the world.

### ***Fall prevention programs***

The best protection against falls is prevention. One aim of fall prevention is the reduction of risk factors to promote safer situations for the elders. The state of knowledge about fall prevention programs for community-dwelling elders has increased. Over the past several years numerous strategies have been advocated to reduce falls including single factor interventions such as exercise, health education, home modification, or the withdrawal of psychotropic medications. Multifactorial interventions have been

identified by using a combination of approaches such as identifying individuals who are at high risk, reviewing assessment causes and risk factors related to falls, reducing unnecessary medications, providing home-based exercise programs to improve muscle strength, gait/balance, and joint movement. In addition, home modification has been proposed for modifying hazardous environmental surroundings, helping to provide ambulation devices as appropriate and providing fall prevention education for teaching the elders certain adaptive behaviors to help reduce the persistent risks and the need for expanded referral systems.

To date over 60 randomized controlled trials,<sup>29</sup> 4 of which were meta-analysis, have been completed.<sup>30-33</sup> The publications of this evidence have examined the evidence for strategies to reduce falls among the community-dwelling elders which reach broadly similar conclusions but differ in some details.

### ***Exercise intervention***

Typically, exercise programs have been shown to improve both muscle strength and balance and thus, take a role in the reduction of risk factors and the prevention of falls and injuries.<sup>34</sup> Studies have shown that physical training is effective in improving strength and functional performance in older people.<sup>35</sup> A systematic review and meta-analysis of 40 randomized clinical trials for the prevention of falls in older adults searched up until 2002 concluded that only exercise program interventions, both general physical activities (such as walking, cycling, and aerobic movements) and specific physical activities (training targeted towards balance, gait, and strength such as a Tai Chi training), had a statistically significant beneficial effect on the lowering risk of falls.<sup>33</sup> Similarly, a meta-analysis of 4 controlled trials to investigate the effect of home exercise programs in those aged 80 and older concluded that exercise intervention alone was most effective in reducing fall-related injuries in those aged 80 and older.<sup>31</sup>

Although the exercises performed varied with respect to the type of exercise, as well as the intensity, frequency, and duration of the intervention, one study showed a 13% significant reduction in the risk of falling for the interventions that included exercise as a component. Furthermore a 24% reduction was revealed if the exercise intervention included specific

balance and gait activities.<sup>36</sup>

Different types of exercises have been studied and found to be effective to help the elders reduce their fallings. These have included Tai Chi exercise, an Eastern form of exercise which has emerged as a practical exercise intervention. In a 15-week home-based group program which used Tai Chi for the women community-dwelling elders with a moderate risk for falls, the fear of falling was reduced.<sup>37</sup> In addition, a study demonstrated that the elders who received a six-month Tai Chi intervention showed significant improvements in multiple measures of balance, physical performance and the fear of falling.<sup>38</sup> In contrast, Tai Chi exercise alone appears less effective in a group of the elders who are frail or transitioning into frailty.<sup>39</sup>

A systematic review of the efficacy of 7 studies using Tai Chi with the elders found that the most effective intervention of Tai Chi is a modified Yang style, varying from 10 to 24 forms. The intensity of Tai Chi varies from 1 hour weekly for 10 weeks to 1 hour every morning for 1 year. Because various outcome measures were used, researchers concluded that limited evidence exists for the effect of Tai Chi on reducing the risk of falls and for improving the functional status.<sup>40</sup>

It can be concluded that exercise intervention alone will be effective among the elderly in selected individuals or with high risk group. However, the programs reviewed varied in the type of exercises, the level of intensity and the duration of exercises. Therefore, there is insufficient evidence at this point, to recommend one particular type of exercise program for reducing the risk of falls for the community-dwelling elders.

### ***Educational Intervention***

Education strategies are the cornerstone of fall prevention and management.<sup>16</sup> They play an important role in risk reduction strategies to increase the elders' awareness and knowledge of fall risk factors. This makes them more willing to adopt strategies to modify their fall risk factors. Older individuals may consider falling to be a normal part of the aging process; therefore, the gerontologic nurse should explore the elders' beliefs and any misconceptions about falling. The elders should be educated about the etiology of falling that can be reduced and even prevented by some

interventions.<sup>16</sup> While, both the Cochrane reviews<sup>29</sup> and a meta-analysis<sup>33</sup> concluded that education intervention alone is not beneficial in reducing falls in the elders. However, a structured group educational program among community-dwelling older people achieved short-term benefit in attitudes and self-efficacy.<sup>41</sup> However, little evidence indicates that educational programs alone are effective in modifying fall risk factors or are effective in reducing falls or fall-related injuries.

### ***Other Prevention Strategies***

Home modifications have been targeted in several studies, including removing clutter, securing rugs and electrical cords, improving illumination, and installing handrails, grab bars, and nonskid strips. A meta-analysis reported that home modification alone did not result in an appreciable reduction in the risk of falling.<sup>33</sup> However, the Cochrane reviews showed that home assessment might be effective for people with a history of falls in the previous year; however, this intervention needs further research.<sup>29</sup> Successful home modification programs include those with financial and/or manual assistance in completing the modifications. Success and cost effectiveness of environmental strategies are enhanced by targeting those who are ready for change. In addition, readiness for environmental modifications may be linked to having had a recent fall, and/or an increased understanding of the risks and prevention strategies.<sup>42</sup>

Medications such as Benzodiazepine are shown to increase the risk of falling among elderly. The evidence appears to support psychotropic drug withdrawal as a means to reduce falls, but more studies are needed on the practical application of this strategy.<sup>43</sup> Compliance is an important consideration in psychotropic medication withdrawal, as it appears difficult for psychotropic drug users to stop using the medications, and clinicians may need to consider alternative treatments for anxiety and sleep disorders to enhance compliance. In addition, many participants who had successfully reduced their consumption of psychotropic drugs in the trial returned later to prior medication patterns.<sup>29</sup> This area remains a challenge to further study.

### ***Combined Strategies***

Many studies showed that single component

interventions were less effective than combined strategies. Hill-Westmoreland, Soeken, and Spellbring (2002)<sup>30</sup> showed that the 12 studies included in the meta-analysis for exercise-focus interventions had an effect size of only 0.220; meanwhile exercise and risk modification intervention had an effect size of 0.687. Furthermore, Chang et al. (2004)<sup>33</sup> conducted a systematic review and meta-analysis of 40 studies to assess four categories of intervention programs to prevent falls including multifactorial fall risk assessments and management programs, exercise programs, environmental modification programs, and educational interventions. They found that a multifactorial fall risk assessment and management program had the most statistically significant beneficial effects on both the risk of falls and monthly rate of falling while the exercise program had a statistically significant beneficial effect only on the risk of falls. Environmental modification program and educational interventions were not statistically significant.<sup>33</sup> In community settings, the multifactorial or combined interventions have been shown to reduce falls.<sup>30</sup>

### ***Thai Research of Fall Prevention Programs***

In Thailand the evidence about fall prevention program for the community-dwelling elders included only 3 studies.<sup>6,44,45</sup>

Assuntachai et al. (1999)<sup>6</sup> conducted a 12-month prospective trial comparing study and control groups for fall prevention in 1,043 community-dwelling elders who lived around Siriraj hospital. The hospital and community based interventions were clinician assessments, treatment of risk factors and the act of providing a fall prevention booklet at the hospital. The acts of providing a fall prevention booklet were available at the community center, during the 8<sup>th</sup> and 10<sup>th</sup> month of the study. Postcards alone or postcards and telephone follow-up calls were conducted to measure the fall incidence rate every 2 months for 1 year in both groups. The study found that during the 8<sup>th</sup> and 12<sup>th</sup> month the study group had significantly less incidence of falls than the control group.

Pallit (2001)<sup>44</sup> conducted a 12-week quasi-experimental study one group pre-test post-test design to assess the effects of the program for the prevention of falling accidents at home in 50 community-dwelling elders who lived in Amphur Sriprachan, Suphanburi Province. The Health Belief Model was applied to

develop a community based intervention, consisting of a 2-hour a week for 2 weeks for 3 sessions to provide educational intervention and to provide a handbook describing falling accidents and explaining how to prevent the falls. The results indicated that the participants gained their perceptions of susceptibility, their perceptions of severity of the falls, their perceptions of the benefits and the obstacles to official suggestions on the prevention of falling accidents at home. In addition, behavior of fall prevention, personal practices and changing posture were significantly better than prior to the program. The researcher recommended increasing the period of study time and involving family member participation in the program as well.

Pootong (2002)<sup>45</sup> conducted a 4-week pre-experimental study one group pre-test post-test repeated measures design to compare fall prevention behaviors before and after receiving risk reduction programs in 30 community-dwelling elders in Rachaburi Province, Thailand. The Pender's Health Promotion model and the Experience Learning theory were applied to develop a community based intervention, including a 1.5 hours a week for 3 sessions for educational interventions. The results indicated that the participants gained in fall prevention behaviors significantly more than before the program. However, improved fall prevention behaviors were significantly more apparent than they were after 4 weeks. This researcher suggested increasing the length of the study and having family member participation in the program.

It can be summarized that the evidence for fall prevention programs for community-dwelling elders in Thailand was limited. All 3 studies were educational interventions and combined clinician assessment into one study. In addition, they lacked strong evidence suggesting the best practice for fall prevention in the elders due to lack of a control group, by using different implementations and outcome assessments, performing the studies over such a short time period, having sample selection problems, and without family members participating.

### ***The State of Science in Falls Prevention Programs***

In summary, the previous rigorous evidence of falls prevention programs in community-dwelling elders in other countries conducted by randomized controlled trials, systematic reviews, and meta-analysis, combined

with studies conducted in Thailand found a significant gap of knowledge. The best evidence on the effectiveness of a falls prevention intervention program for the community-dwelling elders is insufficient to make recommendations for any specific intervention practice or for leading decision-making for health care policy makers at all levels.

Synthesis of the evidence found that a fall prevention program for the community-dwelling elders should combine strategies including fall prevention education sessions and Tai Chi exercise sessions. These interventions would include physical modification, behavioral modification, and improved environmental safety.

Research about the effects of fall prevention program for Thai community-dwelling elders is aimed at improving their gait and balance. An effective fall prevention program is one critical way to enhance the quality of life for the elders in Thailand as well as worldwide.

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#### REFERENCES

1. Runyan CW, Casteel C, Perkins D, et al. Unintentional injuries in the home in the United States. *Am J Prevent Med* 2005;28: 73-9.
2. Tideiksaar R. Falls in older people: prevention and management. 2<sup>nd</sup> ed. Baltimore: Health Professions Press; 1998.
3. Masud T, Morris RO. Epidemiology of falls. *Age and ageing* 2001;30:3-7.
4. Rubenstein LZ, Powers CM, MacLean CH. Quality Indicators for the Management and Prevention of Falls and Mobility Problems in Vulnerable Elders. *Ann Intern Med* 2001;135: 686-93.
5. Jitapunkul S, NaSongkhla M, Chayovan N, et al. Falls and their associated factors: a national survey of the Thai elderly. *J Med Assoc Thai* 1998;81:233-42.
6. Assuntachai P, Praditsuwun R, Thammalikit V. The health promotion and prevention of instability and its complication in the elderly by geriatricians. National Research Council of Thailand 1999.
7. Hanjangsit H. Incident and Factors Related to Home Accident of the Elderly in Yasothon Province. A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Science. Faculty of Graduate Studies, Mahidol University, Bangkok, Thailand, 1994.
8. Yompuk S. Factors related to home accidents of the elderly in Ratchaburi province. A Thesis submitted in Partial Fulfillment of the Requirements for the Degree of Master of Science (Epidemiology). Faculty of Graduate Studies, Mahidol University, Bangkok, Thailand, 1997.
9. Treeyawuttiwat S. Factors related to home accidents of the elderly in Nakhonprathom province. A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Science (Public Health Nursing). Faculty of Graduate Studies, Mahidol University, Bangkok, Thailand, 2001.
10. Lausawatchaikul P. Factors and the Consequences of Falls in the elderly. A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Nursing Science. Faculty of Graduate Studies, Mahidol University, Bangkok, Thailand, 2000.
11. Fleming BE, Pendegast DR. Physical condition, activity pattern, and environment as factors in falls by adult care facility residents. *Arch Phys Med Rehabil* 1993; 74: 627-30.
12. American Geriatrics Society, British Geriatrics Society, and American Academy of Orthopaedic Surgeons Panel on Falls Prevention. Guideline for the Prevention of Falls in Older Persons. *JAGS* 2001;49:664-72.
13. Nuffield Institute for Health, University of Leeds and NHS Center for Reviews and Disseminations. Prevention and subsequent injury in older people. *Effective Healthcare* 1996;2:1-16.
14. Rubenstein LZ, Josephson KR. The epidemiology of falls and syncope. *Clin Geriatr Med* 2002;18:141-58.
15. Jitmontri N, Phasynun N, Ronritthiwichai J. The House Environment that Caused the Fall-accident to the Elderly. *J NURS (Mahidol Univ)* 1998; 16: 34-45.
16. Luecknott AG. Gerontologic nursing. 2<sup>nd</sup> ed. St. Louis: Mosby, 2000.
17. Berg K, Wood-Dauphinee S, Williams JI, Maki B. Measuring balance in the elderly: validation of an instrument. *Can J Publ Health* 1992;2 (Suppl):304-11.
18. Nelson RC, Amin MA. Falls in elderly. *Emerg Med Clin North Am* 1990;8:309-24.
19. Tinetti ME, Doucette J, Claus E, Marottoli R. Risk factors for serious injury during falls by older persons in the community. *J Am Geriatr Soc* 1995;43:1214-21.
20. Roach SS. Introductory gerontological nursing. Philadelphia: Lippincott; 2001.
21. Alexander BH, Rivara FP, Wolf ME. The cost and frequency of hospitalization for fall-related injuries in older adults. *Am J Publ Health* 1992;82:1020-3.

22. Schoenfelder DP, Crowell CM. From Risk for Trauma to Unintentional Injury Risk: Falls - A Concept Analysis. *Nursing Diagnosis* 1999;10:149-57.

23. Kosorok MR, Omenn GS, Diehr P, Koepsell TD, Patrick DL. Restricted activity days among older adults. *Am J Publ Health* 1992;82:1263-7.

24. Rubenstein LZ, Josephson KR, Robbins AS. Falls in the nursing home. *Ann Intern Med* 1994;121:442-51.

25. Rubenstein LZ, Powers CM, MacLean CH. Quality Indicators for the Management and Prevention of Falls and Mobility Problems in Vulnerable Elders. *Ann Intern Med* 2001;135: 686-93.

26. Brown AP. Reducing falls in elderly people: A review of exercise interventions. *Physiother Theory Pract* 1999;15:59-68.

27. Maki BE, Holliday PJ, Topper AK. Fear of falling and postural performance in the elderly. *J Gerontol* 1991;46:M123-131.

28. Arfken CL, Lach HW, Birge SJ, Miller JP. The prevalence and correlates of fear of falling in elderly persons living in the community. *Am J Public Health* 1994;84:565-70.

29. Gillespie LD, Gillespie WJ, Robertson MC, Lamb SE, Cumming RG, Rowe BH. Interventions for preventing falls in elderly people (Cochrane Review). The Cochrane Library 2004; Issue 1.

30. Hill-Westmoreland EE, Soeken K, Spellbring AM. A meta-analysis of fall prevention programs for the elderly: how effective are they? *Nursing Research* 2002;51:1-8.

31. Robertson MC, Campbell AJ, Gardner MM, Devlin N. Preventing injuries in older people by preventing falls: a meta-analysis of individual-level data. *J Am Geriatr Soc* 2002;50:905-11.

32. Weatherall M. Preventing of falls and fall-related fracture in community- dwelling older adults: a meta-analysis of estimates of effectiveness based on recent guidelines. *Intern Med* 2004;34:102-8.

33. Chang JT, Morton SC, Rubenstein LZ, et al. Interventions for the prevention of falls in older adults: systematic review and meta-analysis of randomised clinical trials. *Br Med J* 2004; 328:680-3.

34. Gardner MM, Robertson CM, Campbell JA. Exercise in preventing falls and fall related injuries in older people: a review of randomized controlled trials. *Br J Sports Med* 2000; 34:7-17.

35. Fiatarone MA, O'Neill EF, Ryan ND, et al. Exercise training and nutritional supplementation for physical frailty in very elderly people. *N Eng J Med* 1994;330:1769-75.

36. Province MA, Hadley EC, Hornbrook MC, et al. The effects of exercise on falls in elderly patients. A preplanned meta-analysis of the FICSIT Trials Frailty and Injuries: Cooperative Studies of Intervention Techniques. *JAMA* 1995;273:1341-7.

37. Wolf SL, Barnhart HX, Kutner NG, McNeely E, Coogler C, Xu T. Deducing frailty and falls in older persons: an investigation of Tai Chi and computerised balance training. Atlanta FICSIT Group. Frailty and injuries: cooperative studies of intervention techniques. *J Am Geriatric Soc* 1996;44:489-97.

38. Li F, Harmer P, Fisher KJ, McAuley E. Tai Chi: improving functional balance and predicting subsequent falls in older persons. *Medicine & science in sport & exercise* 2004; 2046-52.

39. Wolf SL, Sattin RW, Kutner M, O'Grady M, Greenspan AI, Gregor RJ. Intense Tai Chi exercise training and fall occurrences in older, transitioningally frail adults: a randomized, controlled trial. *J Am Geriatr Soc* 2003;51:1693-701.

40. Verhagen AP, Immink M, van der Meulen A, Bierma-Zeinstra SMA. The efficacy of Tai Chi Chuan in older adults: a systematic review. *Fam Pract* 2004;21:107-13.

41. Tennstedt S, Howland J, Lachman M, et al. A randomized, controlled trial of a group intervention to reduce fear of falling and associated activity restriction in older adults. *J Gerontol B Psychol Sci Soc Sci* 1998;53:384-92.

42. Pynoos J, Sabata D, Abernethy GD, Alley D, Nishita C, Overton J. Prevention falls at home: Home and environmental modification in preventing falls in older Californians: State of the art. A California blueprint for fall prevention: a background document for the conference, 2003.

43. Campbell AJ, Spears GF, Borne MJ. Examination by logistic regression modelling of the variables which increase the relative risk of elderly women falling compared to elderly men. *J Clin Epidemiol* 1990;43:1415-20.

44. Pallit D. The Effects of the Program for the Prevention of Falling Accidents at Home among The Elderly in Sriprachan District Suphanburi Province. A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Science (Public Health Nursing) Faculty of Graduate Studies. Mahidol University, Bangkok, Thailand, 2001.

45. Pootong C. The Effect of Risk Reduction Program on Fall Prevention Behaviors of Elderly at Home. A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Nursing Science. Faculty of Nursing, Chulalongkorn University, Bangkok, Thailand, 2002.