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THE USE OF MINI-BESTEST TO PREDICT FALL IN THE ELDERLY

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Presented in Partial Fulfillment of the Requirements for the
Master of Science Degree in Physical Therapy
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THE USE OF MINI-BESTEST TO PREDICT FALL IN THE ELDERLY



AN ABSTRACT
BY
ANYAMANEE YINGYONGYUDHA

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Balance impairment is a significant predictor of falls in the elderly. The Mini-Balance Evaluation Systems Test (Mini-BESTest) are the potential fall predicting tools but their abilities and accuracies in fall prediction have not been addressed. Therefore, this study aims to determine whether or not the Mini-BESTest can be used to predict the elderly subjects who are at risk of fall. Methods: Two hundreds healthy elderly with the mean age of 70 years were classified into faller and non-faller groups based on the 12 month fall history. Balance abilities were assessed using the Mini-BESTest, Berg balance scale (BBS) and Timed up and go (TUG). The analysis of receiver operating curve was performed on the balance scores to calculate the area under the curve (AUC), sensitivity, specificity, cutoff score, and posttest accuracy. Results: The Mini-BESTest showed the highest AUC (0.84) compared to the BBS (0.69) and TUG (0.35), suggesting that the Mini-BESTest had the highest accuracy in identifying the elderly fallers. At the cutoff score of 16/28, the Mini-BESTest demonstrated 85% posttest accuracy with 85% sensitivity and 75% specificity. In addition, the Mini-BESTest posttest accuracy was the highest compared to the other tests; BBS (60%) and TUG (65%). Our results suggested the "Stability in Gait" domain showed moderate ability to identify elderly fallers. Conclusion: The Mini-BESTest is the most accurate scale in identifying risks of falls in the elderly compared to the BBS and TUG.

การใช้แบบประเมิน Mini-BESTest เพื่อพยากรณ์การหกล้มในผู้สูงอายุ



เสนอต่อบัณฑิตวิทยาลัย มหาวิทยาลัยศรีนครินทรวิโรฒ เพื่อเป็นส่วนหนึ่งของการศึกษาตาม
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ความบกพร่องของการควบคุมการทรงตัวเป็นปัจจัยบ่งชี้ที่สำคัญกับอุบัติการณ์การล้มในผู้สูงอายุ แบบประเมิน รูปแบบย่อ Mini-Balance Evaluation Systems Test (Mini-BESTest) เป็นเครื่องมือที่มีศักยภาพในการประเมินการหกล้ม แต่ความสามารถและความถูกต้องในการทำนายการหกล้มยังไม่ได้ได้รับการตรวจสอบ ดังนั้นการศึกษามีวัตถุประสงค์เพื่อตรวจสอบว่า Mini-BESTest สามารถใช้ในการทำนายผู้สูงอายุที่มีความเสี่ยงในการหกล้มได้หรือไม่ ประชากรผู้สูงอายุจำนวน 200 คน ที่เข้าร่วมการศึกษามีผู้ที่มีสุขภาพดี ค่าเฉลี่ย อายุ 70 ปี และแบ่งกลุ่มออกเป็นสองกลุ่ม กลุ่มที่มีประวัติการหกล้ม กับ กลุ่มที่ไม่มีประวัติการหกล้ม อ้างอิงจากข้อมูลประวัติการหกล้มในเวลา 12 เดือนที่ผ่านมาของอนามัยชุมชน ประเมินการทรงตัวด้วยแบบประเมิน Mini-BESTest, Berg balance scale (BBS) และ Timed up and go (TUG) วิเคราะห์ Receiver Operating Curve (ROC) จากคะแนนประเมินเพื่อคำนวณพื้นที่ใต้กราฟ (AUC), sensitivity, specificity, cutoff score และ posttest accuracy ผลการศึกษาพบว่า แบบประเมิน Mini-BESTest (0.83) มีค่า AUC สูงกว่าเมื่อเปรียบเทียบกับ BBS (0.69) และ TUG (0.31) แสดงให้เห็นว่าแบบประเมิน Mini-BESTest มีค่าความถูกต้องในการจำแนกผู้สูงอายุที่มีประวัติการหกล้มที่จุดตัดของคะแนน 16/28 แบบประเมิน Mini-BESTest มีค่า posttest accuracy ที่ 85% โดยมี sensitivity 85% และ specificity 75% นอกจากนี้ค่าความถูกต้องหลังทดสอบของ Mini-BESTest มีค่าสูงกว่า เมื่อเปรียบเทียบกับแบบประเมินอื่น BBS (60%) และ TUG (65%) ผลการศึกษาชี้ให้เห็นว่าหัวข้อ stability in gait มีความสามารถในการจำแนกผู้สูงอายุที่ล้ม สรุป Mini-BESTest มีความถูกต้องในการระบุความเสี่ยงในการหกล้มในผู้สูงอายุเมื่อเปรียบเทียบกับ BBS และ TUG

The thesis titled
"The use of Mini-BESTest to predict fall in the elderly"

By
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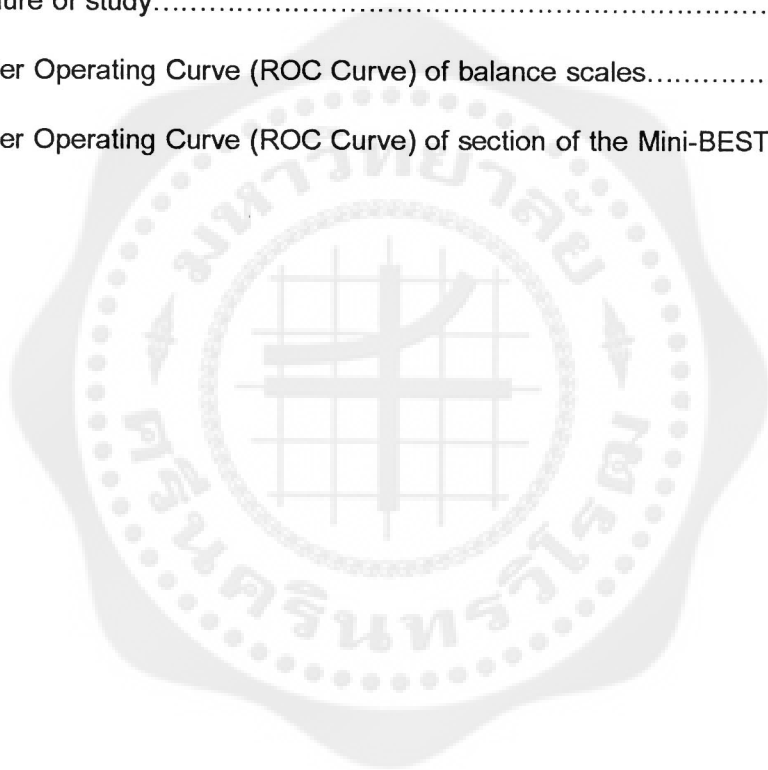
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CHAPTER 1

INTRODUCTION

Background

Falls in the elderly occur more frequently than in the young (1). One third of community-dwelling elderly persons fall each year (2). Thirty-three percents of older persons aged 65 years and over reported experience one or more falls per year (3) and first fall is often referred to as accident (4). Falls are one of the major health problems and recognized as the fifth leading cause of injury and death in the elderly (5, 6). More than 90 percent of hip fractures occur as a result of falls, with most of these fractures found in persons over 70 years of age (7-9). The fall related complication results in fear of fall, which in turn, leads to an increased risk of fall and decrease in quality of life (9).

There are several factors that could lead to fall. Fall risk factors can be categorized into 2 types; extrinsic and intrinsic factors (10). Most intrinsic factors are an age-related degeneration of the multiple systems in elderly (11). Important change in the elderly affecting the occurrence of falls is balance. Decline in balance in the elderly can be caused by various deterioration of systems in the body such as sensory system, motor system, sensori-motor integration and cognition (12). The most common extrinsic factors include environmental hazards such as slippery floors and poor lighting (13). Risk of fall is usually a combination of both intrinsic and extrinsic factors (10). Nevertheless, more than 50 percent of falls in the elderly are from the slip or trip during walking (14). Older people with problems in slipping or tripping usually showed lack of good balance or righting mechanisms for preventing the fall (14, 15). Most slip and fall accidents are caused by unexpected changes in the walking surface and lighting (16).

Since balance performance is the major risk factors for fall in the elderly, assessment of balance and mobility in the clinical settings is necessary to identify the balance problem in this population. Clinical balance scales are useful to assess balance impairments of the elderly persons in the clinical settings. Some of those clinical balance assessments, including 1) Berg Balance Scale, 2) Timed Up and Go test, 3) Trail Walking Test, 4) Fullerton Advance Balance Test and 5) Performance Oriented Mobility Assessment, can also be used as screening tools for identifying the elderly who have

higher fall risks in order to employ a suitable fall prevention strategy (17). Although these scales may be able to identify the elderly fallers, those previous clinical balance scales may not be sensitive enough to predict falls due to their limitations in clinical usage. For example, the Berg Balance Scale showed ceiling effects in the elderly populations of individuals who have experienced or high functioning (18). The Timed up and go test does not assess the fall mechanism (19-21). The Trail Walking Test focused on walking with cognitive processing only (22). The Fullerton Advance Balance Test not had been widely used due to its low sensitivity (2). The Performance Oriented Mobility Assessment showed significantly larger ceiling effects in elderly (23).

In addition, the previous clinical scales may not truly represent the fall risk factors because those scales do not assess the balance ability during external perturbations or sensory conflicts. A shorter version of the BESTest; the Mini-BESTest designed for specific balance assessment is helpful in directing treatment and to ensure that a meaningful deficit is not overlooked, especially dynamic balance problem (12, 24). The Mini-BESTest includes only 14 dynamic balance of the original 36 BESTest items, belonging to four of the six sections from the original. Four sections of the Mini-BESTest consist of section III Anticipatory Postural Adjustments (sit to stand, rise to toes, stand on one leg); section IV Postural Responses (stepping in four different directions); section V Sensory Orientation (stance - eyes open; foam surface - eyes closed; incline - eyes closed); and section VI Balance during Gait (gait during change speed, head turns, pivot turns, obstacles; timed 'Get Up and Go' with dual task) (12). The psychometric properties of the Mini-BESTest in Parkinson's disease (PD) reported high test-retest reliability ($ICC = .92$) and inter-rater reliability ($ICC = .91$). The Mini-BESTest's overall accuracy for identifying a PD faller was comparable to the BESTest, with an area under the curve of 0.86 (95% CI: 0.76-0.95) for the Mini-BESTest and 0.84 (95% CI: 0.75-0.93) for the BESTest. The Mini-BESTest was shown to be sensitive (88%) and specific (78%) in identifying PD patients with a history of falls. The cut-off point for the Mini-BESTest for identifying PD patients who fall was a score of 20 out of 32 (18). With the items to assess balance ability during external perturbation and sensory integration, the Mini-BESTest may be able to accurately screen the elderly people who have balance problems and predict the older people who are at high risk of fall. However, the Mini-BESTest has not been validated in the elderly fallers and non-fallers.

Therefore, this study aims to determine whether or not the Mini-BESTest can be used to predict the elderly subjects who are at risk of fall.

Research question

1. Was there any difference between the Mini-BESTest score of the elderly fallers and non-fallers?
2. Can the Mini-BESTest predict the elderly subjects who are at risk of fall?

Objective

Objectives of this study were

1. to compare the Mini-BESTest score in the elderly fallers and non-fallers
2. to determine whether or not the Mini-BESTest can predict the elderly subjects who are at risk of fall by examining sensitivity, specificity and percentage of accuracy in determining fallers.

Hypotheses of the study

The Mini-BESTest was able to accurately predict the elderly subjects who are at risk of fall and to differentiate score of the elderly fallers from the non-fallers.

Research Design

This was a retrospective cohort study in the elderly.

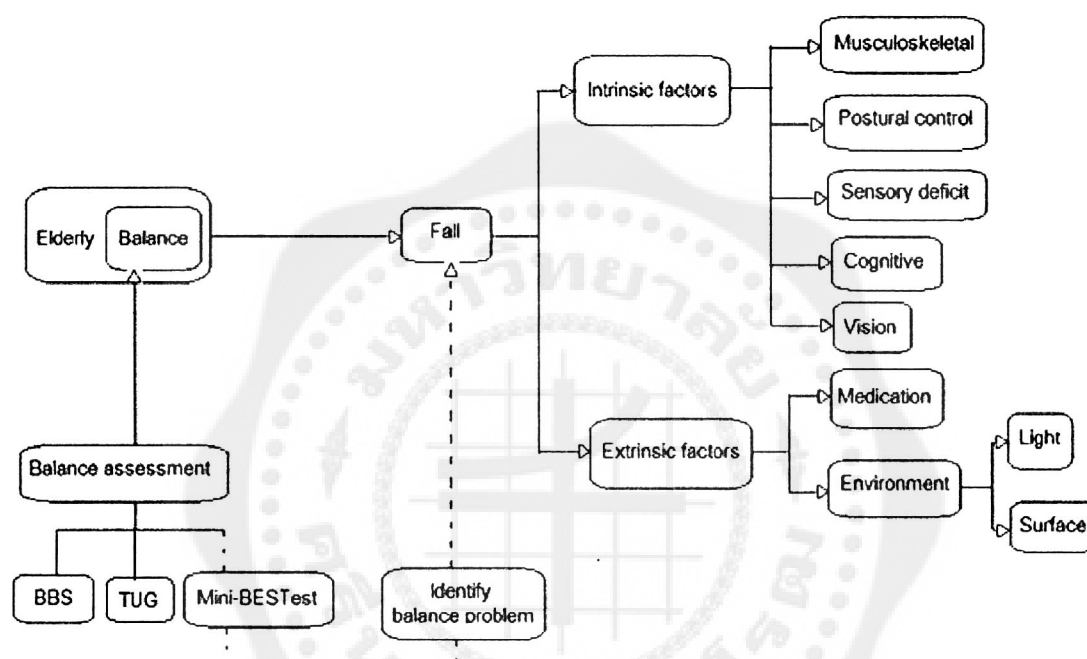
Advantages of the study

This study presented a potential clinical balance scale that can identify the balance related impairment that could lead to fall in the elderly subjects. The proposed clinical balance scale was covering a larger range of fall mechanism in the elderly subjects, as compared to the currently used clinical balance measures. In addition, the proposed scale predicted the elderly subjects with the high risk of fall. Early detection of fall risk led to the fall prevention program that reduce the fall related injuries and complications.

Key words

Geriatrics, Fall prediction, Dynamic balance, Tests and Measurements

Conceptual framework of this study



CHAPTER 2

LITERATURE REVIEWS

Fall in the elderly

Falls are major health problems among the elderly in both developed and developing countries (11). Falls is often defined as "unintentionally coming to rest on the ground, floor or other lower level, excluding intentional change in position to rest in furniture, wall or other objects with or without loss of consciousness" (12-13). Falls are associated with increased morbidity, mortality, and nursing home placement (14). Approximately 30 percent, or one-third of the elderly population aged 65 years are likely to fall every year (5). The number of falls in the elderly increases to 50 percent at the age of 80 years and tends to increase further with increasing age (15). In Thailand, 35.6 percent of elderly fell within 6 months and 18.7 percent of those elderly fell at least once (15). The influence of gender on fall has been reported in the retrospective study such that women (24.1%) fell more often than men (12.1%) (20). Previous studies have also shown that the rate of fall increased to 50% in the elderly who lived in a nursing home due to their poorer health status (22-23).

The impact of fall could lead to illness, physical disability, loss of ability to perform daily living as well as the burden on caregivers and society as a whole (10, 17). Falls were reported as the most common cause of injuries and hospital admissions for trauma (25). More than 90 percent of hip fractures occur as a result of falls, with most of these fractures found in persons over 70 years of age (1, 3-4). It was found that approximately 87 percent of these falls lead to movement limitation as a result of psychological impairments such as fear of falling, depression and loss of confidence in walking (4, 26). Some falls can result in mortality in which its rate increases dramatically with age in both genders (1). The vast impact of fall emphasizes the fact that fall is a serious threat to the health and quality of life in the elderly.

Causes of fall

The majority of falls in the elderly occurs during common daily activities, such as walking or changing position or from tripping, slipping or tangling of the feet (27). Falls are rarely resulted from a single cause, and are often due to complex interactions between sensory loss and other physiological changes with age, environmental factors, medication side effects, and underlying illness (28). Risk factors for falls can be broadly classified into two categories: intrinsic factors and extrinsic factors (29). Fall is a multi factorial problem due to both extrinsic and intrinsic risk factors but usually a combination of both factors is responsible for fall (28).

Intrinsic factors

Most intrinsic factors contributing to falls are an age-related degeneration of the multi systems in elderly as well as other co-morbidity and other factors such as nutrition (30). Gait and balance problems are a major cause of falls in the elderly. Persons with gait and balance deficits will be three times more likely to fall than those without gait and balance problems (16). Gait disturbances can be defined as the slower gait or abnormalities of walking pattern or difficulties of gait initiation (31). Multiple factors contribute to gait and balance problems in elderly. Several studies have demonstrated detrimental changes in sensori-motor functions in adults over 65 years as the major cause of gait and balance disturbances leading to fall. Decline in sensori-motor functions leads to slow movement velocity and slow reaction time (16, 32-33). In addition, sensations of older adults are impaired so they may not be able to detect changes in environment (34-35). Sarcopenia, the loss of muscle mass, can also lead to reduced muscle strength is commonly found in the elderly (36-37). It has been reported that muscle weakness is highly correlated with postural instability and falling (38, 16). Previous studies also demonstrated a 10 to 20 percent reduction in gait velocity and stride length in the elderly who had lower limb muscle weaknesses (39-40). Petrella et al. (2005) reported that the age-related loss muscle strength is principally determined by slow contraction velocity resulted from loss of type II muscle fibers (41). Weakness may be originated from decline in peripheral nervous system or from the central nervous system disorders, such as increased muscle tone, ataxia, weakness and abnormal motor programs (42). Reduced muscle power is reported to be associated with mobility limitations and decline in functional performance (43-44).

The high incidence of fall-related injuries in elderly persons is due to a high prevalence of clinical diseases such as osteoporosis (16). Osteoporosis is a condition where bones become more porous and more prone to fractures, hormonal changes, calcium and vitamin D deficiency, and decrease in physical activity (1). Lack of calcium and vitamin D deficiency has also been found to be highly correlated to fall in the elderly (16). Another issue that has caused the fall as foot problems such as bunions, ulcers, toe deformities, and pain in walking increase balance difficulties and risk of falls (28, 45).

Visual impairments in elderly contribute to risk of falls (46-47). Age-related vision diseases such as glaucoma, cataracts or macular degeneration can increase the risk of falling. Multifocal glasses impair depth perception and edge-contrast sensitivity at critical distances for detecting obstacles in the environment or negotiating stairs (48). These limitations hinder their ability to navigate safely in their environment. Young people use visual cues to perceive an imminent fall and take corrective action but older adults with visual impairments would be too slow to detect and react to these threats of fall (1).

Community ambulation is a highly complex skill which requires the ability to adapt to increased environmental complexity and perform multiple tasks simultaneously. This ability has been associated with the cognitive processing and attention demand which have been found to be crucial for controlling posture and balance (49). Problems with cognition and attention will hinder the elderly subjects to perform both tasks simultaneously as well as to learn new skills. Previous studies have reported strong association between the impaired cognition and risk of fall (2, 19). Five or more errors on a short mental status questionnaire (28), score <26 (50) or score <24 (51) on the Mini-Mental State Examination is associated with increased risk of fall (52).

Congenital conditions such as heart disease, hypertension and hypotension also appear to contribute to increased risk of falling in the elderly (9, 53). Elderly persons can fall during changing position due to hypotension in person with low blood pressure. On the other hand, high blood pressure can be the most important risk factors for the occurrence of postural hypotension due to decreased baroreceptor sensitivity (54).

Other factors are nutrients which can lead to fall. Nutritional deficiencies in elderly as indicated by low body mass index suggesting malnutrition and vitamin D deficiency is particularly common in elderly and may lead to abnormal gait, muscle weakness, and osteoporosis (50, 55-56).

Extrinsic factors

Extrinsic factors include medication effects and environment or home hazards. Medications may contribute to gait and balance disorders for a variety of reasons, such as causing dyspnea, imbalance, decline strength or fatigue, limited range of motion, poor posture, decreased sensory perception and decreased awareness and ability to adapt to hazardous surroundings (36). Use of four or more medications such as psychotropic medications, cardiac drugs has been strongly associated with increased risk of falls (16, 57-58). The previous study showed that elderly who received 3-4 types of medications are at the higher risk of adverse drug affects as well as risk of fall (OR = 1.61 - 3.16) as compared to those who did not receive many medications (57).

Environmental hazards are the leading cause of falls, accounting for about 25 to 45 percent in most studies. Most falls occur during the day and only 20% of falls occur at night and the most common causes of falls include environmental hazards (16). Most slip and fall accidents are caused by unexpected changes in the walking surface and lighting (59). At least one-third of all falls in the elderly involve environmental hazards in or around the home (28). Fifty-six percent of falls occur outside the house such as in the yard, on the street, or in a public place. A fall that occurs inside the house happens most frequently in the bedrooms, kitchens and dining rooms. Relatively few falls occur in the bathroom, on the stairs, or from ladders and step stools (60). Other factors leading to fall include poor lighting, loose rugs, lack of grab bars or poorly located/mounted grab bars, and unsteady furniture (1, 34-35). Other factors such as footwear and clothing increase balance difficulties and risk of falls (28, 45).

Previous research has found that the fall mechanism and injury severity were related to the impact of falls. Older people often have problems during slipping or tripping due to lacking good balance or righting mechanisms for preventing the fall (29). Falls precipitated by slipping are the leading causes of injuries (61). In most cases, falls are labeled as mechanical indicating that the person tripped, stumbled or slipped, and were unable to correct their balance and keep upright on two feet (61). In some cases, there is an underlying problem which causes the person to lose control of their muscles, feel faint or lose consciousness and so fall. Mechanical falls should not be considered to be insignificant or just a simple accident which could happen to anyone. The biomechanical analysis of such events is a necessary component of the slips or fall prevention research (61).

In brief, approximately one half of falls in the elderly can be attributed to accidents and extrinsic causes such as slippery floors, and the remainder are due to intrinsic causes such as lower extremity weakness, gait disorders, effects of medications or acute illness (25).

Balance assessment and fall prediction

Balance is the ability to maintain the center of body mass (CoM) in the base of support together with the ability to maintain the body in normal alignment (30, 62-63). These abilities depend on the individual motor and sensory systems as well as the integration of sensori-motor functions (64). Balance is an important factor in stabilizing the body position while performing the activities of everyday life (62). Loss of balance and posture are the main reasons leading to the fall which is a major problem that causes the serious physical and mental injuries in the elderly.

Assessment of balance and mobility in the clinical settings can help to determine both intrinsic and extrinsic risks of falling (6, 15). Balance assessment focused on the fall risk screening and physical performance could help to identify the people who have higher fall risks in order to employ a suitable fall prevention strategy (5). The purposes of balance assessment are to identify balance problem and determine cause of problem or help to predict risk of fall. It has been suggested that the appropriate balance assessment tools used in clinical setting should include measures that reflect the functional capabilities and quality of postural strategies as well as those measures need to be sensitive, reliable, valid, easy to use and inexpensive (65).

A vast number of functional balance assessments that can be used to identify the people with high risk of fall are available but it is often difficult for therapists or researchers to decide which one to use (27). Many different balance tests and measurements have been developed and present to obtain appropriate information of balance capabilities during standing. The selection of a suitable method generally depends on the goals, populations and results (8). Moreover, only a few measure scales addressed the ability to maintain the Center of Mass (CoM) during different body postures and under the influence of many systems in the body. For example, many different balance tests have been developed to obtain the information about balance capabilities during standing or during walking only (66). Balance is a complex ability that involves the function of multi-systems in the body,

therefore, the assessment of only one dimension of balance may not be sufficient to accurately predict the people with high risk of fall.

The previous study defined a faller as a subject who fell at least once (7). A recurrent falls was defined as a subject who fell at least twice and should be evaluated for treatable causes (1). Even with a single fall, there was always a sign of a major problem and an increased risk for subsequent falls. Therefore, a faller in this study was defined as an individual with 1 or more falls in the prior 12 months and a non-faller was defined as a person who never fall.

Assessment tools used in screening and diagnosis enable clinicians to diagnose and predict a particular characteristic, symptom or disease. However, these tools have limitations in their interpretation and application. The important characteristic of the screening tool is the ability to accurately stratify individuals into different categories of clinical importance (67). The ability of the tool to predict or screen depends on the Receiver Operating Characteristic (ROC) curve, sensitivity, specificity, likelihood ratio and cut off score.

Sensitivity

Sensitivity is the ability of the test to correctly identify affected individuals (disease cases) (68). Sensitivity measures the proportion of actual positives which are correctly identified and relates to the test's ability to identify positive results. If a test has high sensitivity then a negative result would suggest the absence of disease (69).

Specificity

The specificity is the ability of the test to correctly identify non-affected individuals (non-cases) (68). Specificity measures the proportion of negatives which are correctly identified and relates to the ability of the test to identify negative results. If a test has high specificity, a positive result from the test means a high probability of the presence of disease (69).

Table 1 Sensitivity and specificity calculation (68)

Test	Disease present	Disease absent	Total
Positive	a	c	a+ c
Negative	b	d	b + d
Total	a+ b	c + d	a+b+c+d

Sensitivity : $a / (a+b)$

Specificity : $d / (c+d)$

Sensitivity and specificity are statistical measures of the performance of a binary classification test, also known in statistics as classification function. These two measures are closely related to the concepts of type I and type II errors. A perfect predictor would be described as 100% sensitivity that predict all people from the sick group as sick and 100% specificity that not predict anyone from the healthy group as sick (70).

Likelihood ratio (LR)

Likelihood ratios are (LRs) a ratio of the probability that a test result is correct to the probability that the test result is incorrect (71). LRs are used to assess the potential utility of a particular diagnostic test, and how likely it is that a patient has a disease or condition. LRs are the likelihood that a certain outcome will occur given a particular performance on a screening measure. LRs in conjunct with specificity and sensitivity data, allow useful guidance to researchers who need to decide whether full evaluation is warranted given a particular screening outcome. As with sensitivity and specificity, LRs change depending on the screening cut score selected (72).

A positive LR (LR+) is the probability of a positive outcome given a positive screening (i.e., performance on the screener at or above the cut score). The formula for calculating the positive likelihood ratio is: $LR+ = \text{sensitivity} / 1 - \text{specificity}$ (72). A negative LR (LR-) is the probability of a negative outcome given a negative screening. The formula for calculating the negative likelihood ratio is: $LR- = 1 - \text{sensitivity} / \text{specificity}$ (72).

Receiver Operating Characteristic (ROC) curve

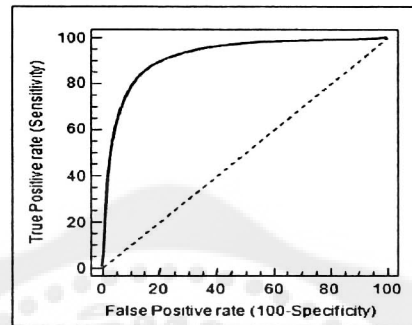


Figure 1 Receiver Operating Characteristic (ROC) curve (69)

Receiver Operating Characteristic (ROC) curve is an effective method for evaluating the quality or performance of diagnostic tests. It shows the tradeoff between sensitivity and specificity (73). ROC curve is used to determine a cutoff value for a clinical assessment. Using a gold standard technique, one group is known to be normal without disease (negative), and the other is known to have disease (positive). The ROC curve is a graph of sensitivity in y-axis versus 1-specificity in x-axis that offers a summary of sensitivity and specificity across a range of cut points for a continuous predictor (74). A good first choice for a test cutoff value is that value which corresponds to a point on the ROC curve nearest to the upper left corner of the ROC graph (75). A rough guide for classifying the accuracy of a diagnostic test is the traditional academic point system: 0.90-1 = excellent; 0.80-0.90 = good; 0.70-0.80 = fair; 0.60-0.70 = poor; 0.50-0.60 = fail (73).

Cutoff score

The goal of an ROC curve analysis is to determine the cutoff value. Cutoff values are created between each test data value in the data set. If there are a large number of data points and several tests then there will be a large number of cutoff values (75).

Balance assessments

The clinical scales that are currently used to screen the elderly fallers and predict the high risks of fall in the elderly are the Berg Balance Scale (BBS), the Timed Up and Go test (TUG), Trail Walking Test (TWT), Fullerton Advance Balance Test (FAB) and Performance Oriented Mobility Assessment (POMA).

Berg Balance Scale (BBS)

The Berg Balance Scale (BBS) provides a quantitative assessment of balance in older adults in clinical practice and research (7, 66). BBS measures a number of different aspects of balance, both static and dynamic (76-78). This scale was intended for using to monitor clinical status of patients or to determine the effectiveness of treatment interventions over time (79). BBS was originally designed to use in the frail elderly and is developed to measure balance among older people with impairment in balance function by assessing the performance of functional tasks. It is a valid instrument used for evaluating the effectiveness of interventions. BBS is considered as a reference standard for assessing balance, as it is one of the most commonly used balance assessments in the clinic and in research (7).

The BBS consists of 14 items that focus on a variety of self-initiated task-related functions and requires the subjects to maintain positions or complete movement tasks of varying levels of difficulty. However, most of the items assess balance ability during standing with little concern in the balance during gait. Administration of the BBS requires simple equipments such as a ruler, a stopwatch, chair, step or stool, sufficient space to turn 360°. It requires 10 – 15 minutes to complete the tasks and the scores are given through direct observation of task completion (79-80). Items receive a score of 0-4 based on the ability to meet the specific time and distance requirements of the test. A score of zero represents inability to complete the item and a score of 4 represents the ability to complete the task independently. A total score of the BBS is 56 points. It is generally accepted that scores of less than 45 are an indicator of balance impairment (78, 81). The advantages of The BBS are that it measures a number of different aspects of balance, both static and dynamic with relatively little equipment or space required (76-78). In addition, no specialized training is required to be able to administer the BBS (77).

Berg and colleagues (1989) reported internal consistency of 0.96 when testing in the elderly with item to total correlation ranged from 0.38-0.64 (66). Good to excellent inter-rater reliability was also reported for the BBS in the elderly (ICC = 0.88-0.98) (66, 79, 82). The results are similar for intra-rater reliability (ICC = 0.99) (66) and test-retest reliability (ICC's = 0.88-0.98) when administering in general elderly (15, 79, 83). Moderate to high levels of construct validity have been reported with several clinical tests such as Barthel Index (BI) scores ($r=0.80$), Fugl-Meyer scale scores (0.62 – 0.94) in the elderly (81). BBS reported moderate correlation with the TUG (0.53) in a community-dwelling elderly resident population (84).

For fall prediction in the elderly, previous studies showed the result of sensitivity 91% in positive prediction of falls, specificity 82-96% for predicting non-fallers and prediction rate of 91% (15, 64). However, the BBS has limitation such that it shows a ceiling effect in elderly individuals who have experienced or high functioning level (7). A recent Rasch analysis of the Berg Balance Scale revealed that some item ratings such as tandem stance was not used at all or were underutilized, and others such as alternating foot, standing on one leg and look behind were unable to distinguish between individuals with different levels of ability (85).

Timed up and go test (TUG)

The Timed Up and Go Test (TUG) is a general physical performance test used to assess mobility, balance and locomotors performance in the elderly with balance disturbances (86). More specifically, it assesses the ability to perform sequential motor tasks relative to walking and turning. However, TUG does not include the test items that evaluate impairments in the multiple sensory systems that contribute to balance and high fall risk among independently function elderly (86-87). The TUG is easy to use for assessing a population of frail elderly patients or can be used with the community dwelling persons. This scale is quick and easy to perform without special equipment, just the stop watch is required, or training (88).

The TUG measures in seconds, the time a person takes to stand up from a standard armchair, walk 3 meters (about 10 feet), turn, walk back to the chair, and sit down again. The test is performed by the person who wears regular footwear, uses customary assistive devices, if any, and walks at a comfortable and safe pace. A practice trial is given,

followed by 2 timed trials. The results of the timed trials are averaged. The time is then compared to normative values for age, gender, and research-based guidelines that measure risk of falls and functional decline. Observations of the transition phases (rising from the chair, initiating walking, turning, and sitting in the chair) are also documented (89). Older adults who take longer than 14 seconds to complete the TUG have a high risk for falls with an overall correct prediction rate of 90% (7, 87, 90).

Previous studies have shown excellent inter-rater reliability ($ICC = .98-.99$) (82, 86, 88, 91) and intra-rater reliability of the TUG ($ICC = .97-.99$). (82, 88-89, 91-92) For fall prediction, Shumway-Cook et al., (2000) (86) showed sensitivity of 86-87%, specificity of 86-87% and fall prediction rate of 87% in the elderly fallers. Currently, the Timed Up and Go Test was popular due to the ease and flexibility in the assessment. Moreover, it does not suffer from the ceiling effect (86, 88, 93). Therefore, the TUG may be more appropriate than the BBS to identify fallers who have high functional level without reaching the ceiling effect. However, since the test assess only balance during changing from sitting to standing; walking and turning, its focus does not cover the balance activities related to the risk of fall in the elderly such as slip recovery, limited visual information and gait with shift in attention.

Trail Walking Test (TWT)

The trail-walking test (TWT) was designed as an improved version of the ambulatory version of the Trail Marking Test (TMT), as the TMT has a low level of difficulty for community-dwelling older adults (94). TWT is a measurement that is related to dynamic balancing ability and attention. It consists of walking from numbered flags in the ascending or descending order. When performing these walking tasks, the person needs to distribute the attention to a number stimulus. Therefore, the cognitive (visual search function, short-term memory) and motor functions (locomotion and turning) are simultaneously required to successfully execute the TWT (27).

The test-retest reliability of TWT was high ($ICC = 0.95-0.99$) (27). The TWT showed sensitivity of 66%, specificity of 84% and prediction rate of 71% for detecting elderly fallers (27). Since the TWT requires the integration of cognitive, sensory and motor functions, inability to perform the TWT do not simply reflect the balance impairment. For example, a person may not be able to complete the task due to impaired cognitive function,

or poor visual or hearing functions. As a result, the analysis of the result from the TWT is not simple as it could represent the function of individual system as well as the integration of multiple systems.

Fullerton Advance Balance Test (FAB)

The FAB Scale is a relatively new multi-item balance-assessment test designed specifically to measure balance in higher-functioning active older adults. FAB includes items intended to better identify older adults who may experience increased fall risk as a result of sensory system impairments (5). The FAB is a newly developed functional balance test which has a shorter administration time than the BBS and includes more challenging tasks that assess dynamic balance and challenge sensory components (5). The test is composed of 10 items and its content validity is based on theoretical analysis of components of static balance and dynamic balance control, sensory reception and integration, and anticipatory and reactive postural control (95). A four point ordinal scale is used to score for each task and requires less time than BBS to administer (96).

High test-retest reliability (0.96) as well as excellent intra-reliability (0.92-1.00) and inter-reliability (0.91-0.95) of the FAB have been reported. Concurrent validity of the FAB was good correlation with BBS (0.75) (96). In predicting fall, the FAB scale reported the sensitivity of 74.6% and specificity of 52.6% in predicting faller status determined by retrospective survey with a cut-off score 25 of 40. From the sensitivity and specificity, the FAB showed relatively less sensitive in predicting elderly fallers, as compared to the BBS and TUG (5).

Performance Oriented Mobility Assessment (POMA)

The Performance Oriented Mobility Assessment (POMA) developed by Tinetti is widely used instrument that assess balance and gait in the elderly. It is easily applied in clinical settings but requires special training (97). The POMA assessment can be completed in less than 15 minutes (98). The POMA is scored on a three point ordinal scale which ranges from 0 to 2. The two part scale includes a total balance score of 16 and total gait score of 12, for a total possible score of 28. Scores of 25-28 indicate low fall risk, 19-24

medium fall risk, and < 19 high fall risk (97). A previous study reported concurrent validity of 0.64 – 0.70, sensitivity 61.5% and specificity 69.5% that tested in a group of 60 community dwelling older persons (97). The usefulness of the POMA scales for predicting falls is limited. Moderate to high interrater reliability (0.75 to 0.90) and high test-retest reliability (0.88-0.97) were reported for different populations studied (99-100). For using with the elderly, the POMA has not yet been established as a reliable test or validated for using against a gold standard functional balance measure such as the BBS (101).

New Clinical Balance Scales

Balance Evaluation Systems Test (BESTest) and Mini-Balance Evaluation Systems Test (Mini-BESTest)

The previously mentioned clinical balance assessments can be used to evaluate balance performance and also are possible to predict the risk of fall in the elderly. However, those balance scales focus on the examination of balance performance during daily activities that are not directly related to the fall exposure or risks of fall such as slipping, obstacles or decreased visual inputs. Recently, a new balance assessment called the Balance Evaluation Systems Test (BESTest) is developed to identify the underlying postural control systems that may be responsible for poor functional balance. (8)

A theoretical construct of the BESTest is based on Bernstein's concept that postural control results from a set of interacting system (102-104). (Figure 1) The BESTest is uniquely designed as a comprehensive clinical tool for evaluating six different balance control systems: biomechanical, stability limits/verticality, anticipatory, reactive, sensory orientation, and stability in gait. (Figure 2) Such system-specific assessment is helpful in directing treatment and to ensure that a meaningful deficit is not ignored. The BESTest consists of 27 items but some of them are subdivided into 2-4 sub-items (e.g. for right and left sides) for a total of 36 tasks. Each item of the BESTest is scored on a 4 category ordinal scale from worst performance (0) to best performance (3) (9). The tasks of the BESTest have been borrowed from the following previously validated balance assessment such as BBS, TUG, Dynamic Gait Index (DGI), single limb stand test, Functional Reach Test (FRT) and modified Clinical Test of Sensory Integration and Balance test (mCTSIB) (9).

The BESTest has been validated in person with PD and fibromyalgia who have balance deficits (106). This scale showed good inter-rater reliability ($ICC=.91$) and moderate validity with individual's self perceived balance ($r=.636$) in normal subject and neurological patient (8). In Parkinson's disease, the BESTest reported excellent test-retest reliability ($ICC = .88$) and inter-rater reliability ($ICC = .96$). The BESTest showed excellent convergent validity with BBS ($r=.87$). Cutoff scores to identify fall in Parkinson's were 69% (106). Recent studies demonstrated that the BESTest can differentiate patients with PD who fell from those who did not fall (7). The only drawback of the BESTest is that it requires 35 minutes to complete the balance evaluation which is longer than other balance scales (7).

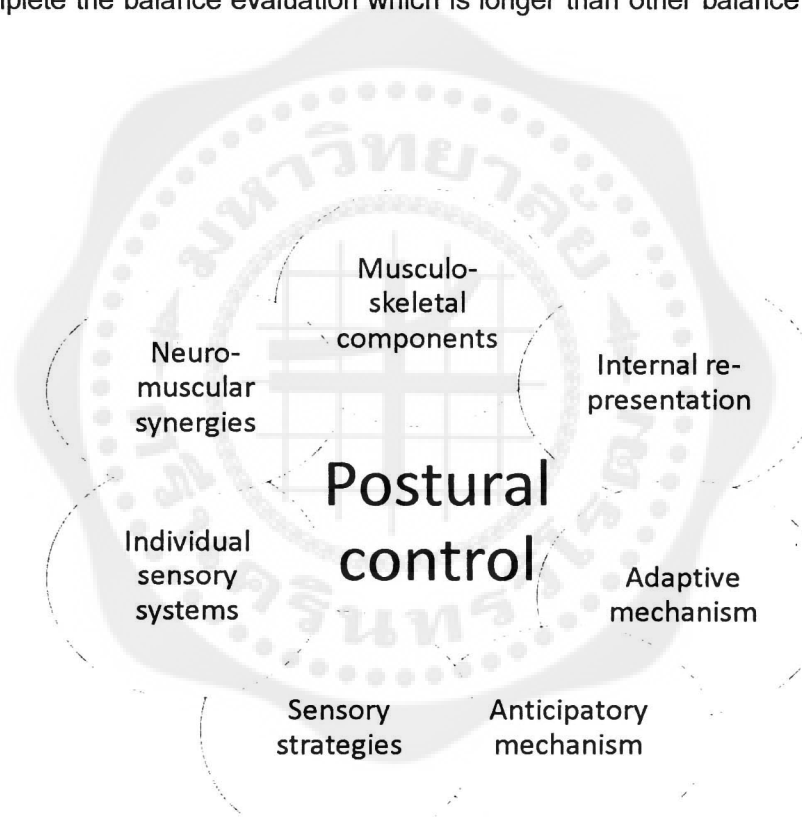


Figure 2 theoretical construct of BESTest based on conceptual model of postural control (8)

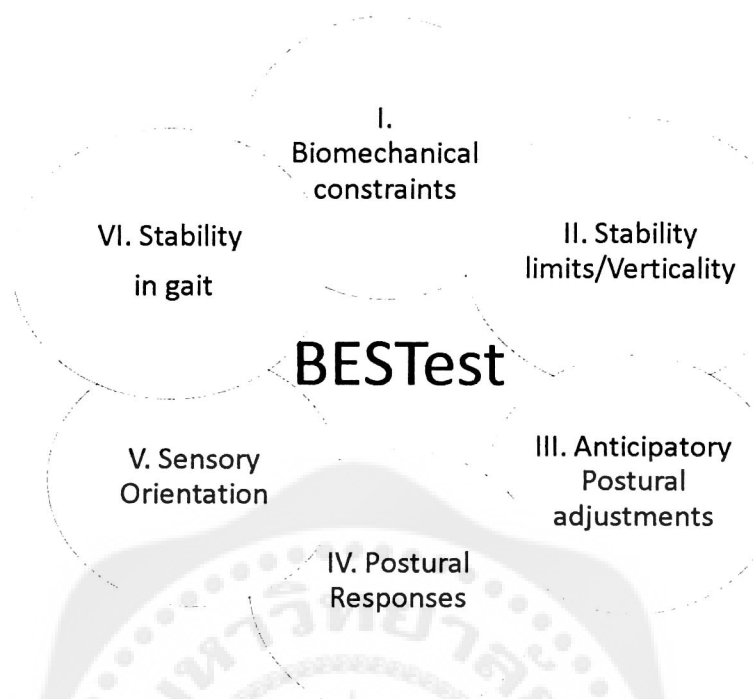


Figure 3 Six performance domains of the BESTest (8)

A shorter version of the BESTest, the Mini-BESTest, is developed using the psychometric techniques to reduce item redundancy and simplify scoring. This tool is uniquely designed as a comprehensive clinical tool for evaluating dynamic balance (9). Franchignoni and colleagues (2010) examined performance of the BESTest in adult patients with diverse neurological diagnoses and disease severities, referred to rehabilitation for balance disorders (9). Factor (both explorative and confirmatory) and Rasch analysis were used to process the data in order to produce a new, reduced and coherent balance measurement tool (9). Assessment extracted 24 out of the 36 original BESTest items assumed to define “dynamic balance”. As a result, the Mini-BESTest test reduces the number of tasks in the BESTest down to 14 tasks and reduced rating categories from 0-3 level to 0-2 level of rating categories. Therefore, the Mini-BESTest consists of 14 tasks that focus on dynamic balance with the assessment time less than the original BESTest. It contains items belonging to 4 of the 6 sections from the original BESTest (Table 1). This process excludes section of Biomechanical Constraints and Stability Limits/Verticality. The final version of the Mini-BESTest consists of Transitions anticipatory postural adjustment, Reactive postural response, Sensory orientation and Stability on gait. This shorter version has excellent interrater ($ICC \geq 0.91$), and test-retest ($ICC \geq 0.88$) reliability and similar in

length to the BBS (105). This shorter version of the BESTest takes 10-15 minutes to conduct, so it is more possible to use in a busy clinical settings than the BESTest.

Table 2 Summary of the Mini-BESTest items (9)

III. Transitions-anticipatory postural adjustment	IV. Reactive postural response	V. Sensory orientation	VI. Stability on gait
Sitting to standing	Compensatory stepping correction - Forward	Eyes open, Firm surface (feet together)	Change gait speed
Rise to toes	Compensatory stepping correction - Backward	Eyes close, Foam surface (feet together)	Walk with head turns- Horizontal
Standing on one leg	Compensatory stepping correction - Lateral	Incline – eyes close	Walk with pivot turn Strep over obstacles Timed up and go with dual task

The Mini-BESTest is highly correlated with the BBS ($r = 0.79$) in Parkinson's disease (PD) populations (106). King and colleagues (2012) suggested that the Mini-BESTest did not have the ceiling effect like the BBS. In addition, the Mini-BESTest test had better sensitivity and specificity than the BBS to identify people with PD who fell. The previous studied in individual with PD showed sensitivity 62-89% and specificity 74-81% (105-106, 118). A cut-off point for the Mini-BESTest for identifying patients with PD who fell was a score of 20 out of 32 (assessment performance of both the right and left side for

additional 2 items). Tsang and colleagues (2013) showed a cut off 17.5 out of 28, sensitivity 64% and specificity 64.2% for individual with stroke (115).

With the assessment of external perturbation and sensory integration, the Mini-BESTest may be able to accurately screen the elderly people who have balance problems and predict the people who are at high risk of fall (7). However, the Mini-BESTest has not been validated in the elderly fallers and non-fallers. Therefore, this study aims to determine whether or not the Mini-BESTest can be used to predict the elderly subjects who are at risk of fall.



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CHAPTER 3

METHODOLOGY

Participants

Both healthy male and female elderly subjects were recruited from the suburban communities in Thailand. Detailed characteristics of participants were included in Appendix J and K. Participants were included in the study if they met the following criteria:

- (1) age 60 years or more;
- (2) can walk without using walking aids;
- (3) independence and autonomy to carry out basic daily activities;
- (4) no history of neurological diseases such as Parkinson's disease, stroke;
- (5) no severe knee pain that perturb walking in the day of assessment;
- (6) no severe musculoskeletal problems such as scoliosis, kyphosis or problems that impact on daily activities or independent walking;

Participants meeting these criteria were excluded if they were

- (1) on medications that affect balance (see appendix B);
- (2) having disorders signs or symptoms of vestibular disorders such as vertigo, nystagmus in the day of assessment;
- (3) having blindness or severely impaired sight that impacts on the ability to walk independently;
- (4) unable to follow instructions;
- (5) having cognitive impairments determined by the score of Mini-Mental State Examination Thai version 2002 (MMSE-Thai) lower than 24/30 (107-109);
- (6) having cardiovascular diseases such as heart disease, hypertension or congenital diseases such as diabetes mellitus, unless be maintained and controlled by doctors.

Sample size

Sample size was calculated from the sensitivity (P_1) to detect fall (53 percent), the specificity (P_2) to detect non fall from the Berg Balance Scale and the prevalence rate of fall (30 percent) (prevalence rate) from Thorbahn; et al. (15).

Sample size for this study was calculated by following equation;

$$n_0 = \frac{Z_{1-\alpha/2}^2 \sqrt{2P(1-P)} - Z_\beta \sqrt{P_1(1-P_1) + P_2(1-P_2)}}{(P_2 - P_1)^2}^2,$$

$$n = \frac{n_0 \times 100}{\text{prevalence rate}}$$

From the calculation, the sample size for this study was 80 people per group. To compensate for the drop-out, additional 20 participants were added to each group, resulting in 100 each in faller and non-faller groups. The sample size for this study was the total of 200 participants.

Equipments

Equipments in this study composed of an approximately 60 cm x 60 cm (2 X 2 ft) block of 4-inch, medium-density, Tempur® foam, 10 degree incline ramp (at least 2 x 2 ft), 2 stacked shoe boxes for obstacle, standard chair with arms, a tape measure, the height and weight measurement tools and a stopwatch.

Reliability

Intra-rater reliability was determined by both raters. Prior to the study, both raters participated into training workshops for using the scales. Rater no.1 received training for using TUG and rater no.2 received the training on administration of the Mini-BESTest and BBS until their scorings were accurate. After the training, intra-rater reliability of rater no. 1 for scoring on the TUG and rater no. 2 for scoring on the Mini-BESTest and BBS were calculated in 12 elderly subjects by using an interclass correlation coefficient (ICC). ICC value of 0.80 and above indicates excellent correlation (good reliability), 0.80 to 0.60

indicates adequate correlation (moderate reliability) and 0.60 to 0.40 indicates poor correlation (weak reliability) (109).

Results of the reliability test demonstrated excellent intra-rater reliability in using the TUG (ICC=0.92), the BBS (ICC=0.92) and the Mini-BESTest (ICC=0.90).

Procedures

The elderly in this study, 200 participants from the sample size calculation were recruited based on the inclusion and exclusion criteria. Subject characteristics and other related information were gathered using the questionnaire (appendix A) by rater no.1. The elderly participants were categorized at entry into two groups based on their fall history within the last 12 months from the District Health Station database by rater no.1. Those who had 1 fall or more were classified as faller and those who never fall were identified as a non-faller. If the elderly participants ever fall before 12 months were identified as a non-faller.

The light touch, pinprick and proprioception were assessed at both ankles using the Nottingham sensory testing. Vestibular disorder was using the Dix-Hallpike test. The lower extremities were using the manual muscle testing. Elderly subjects were asked to rate their confidence that they were lose their balance or become unsteady in the course of daily activities by using The Activities-specific Balance Confidence (ABC) Scale (appendix D) by rater no.1. Since the ABC scale was written in English, the researcher was read each item in Thai using the same translation to all participants. The cognitive function and comprehension were assessed by using the Mini-Mental State Examination Thai version 2002 (MMSE-Thai) (appendix C) by rater no.1. MMSE assesses 5 components; orientation, memory, language, calculation and attention. A person with the MMSE score below 24 (out of 30) which is the indicator of cognitive impairment was excluded from the study.

Rater no. 2 evaluated balance abilities using the Mini-BESTest and BBS that commanded each item in Thai using the same translation to all participants, whereas rater no.1 administered the TUG. Each rater carried out the evaluation in a separate room and rater no. 2 was also blinded to the subject characteristics and grouping. When administering the tests, the sequence of the balance tests (i.e., Mini-BESTest and BBS,

was randomly selected for each participant such that at the end of the study there was equal number of participants who started first with one of the three tests. (see appendix I for sequence of Randomization) The BBS and the Mini-BEST were scored once with the exception of the TUG that was carried out 3 times at comfortable pace and the average of the three trials was recorded. The evaluation was performed in the same laboratory setting and all participants received the same verbal instruction. Vital sign and blood pressure were measured prior to and after the testing. During testing, participants were allowed to rest as long as they needed if they were too tired to perform the next task. The total duration of testing was approximately 35 minutes for each participant.



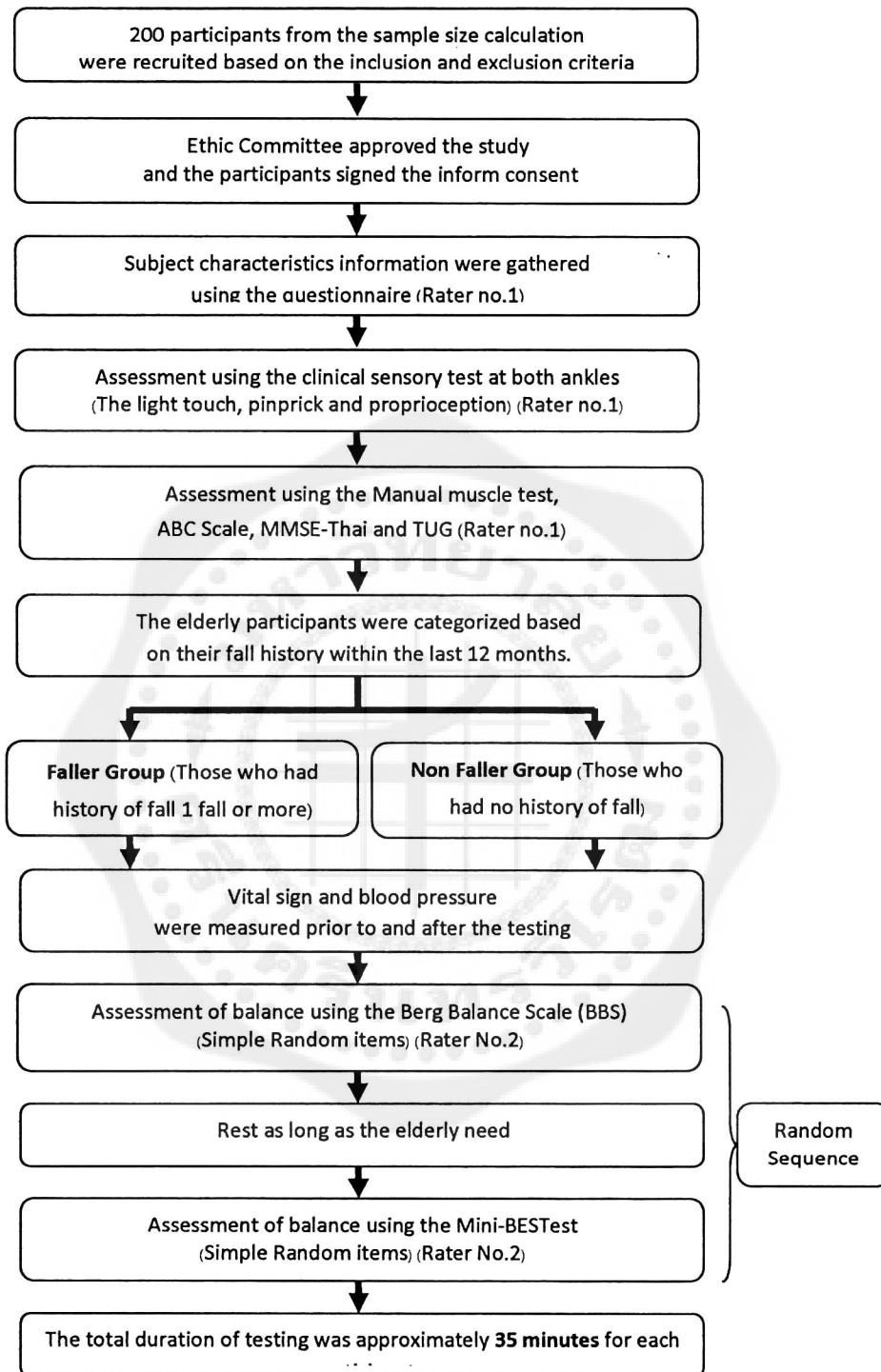


Figure 4 Procedure of study

Statistical Analysis

Statistical analysis was performed using the SPSS version 11.5. Descriptive statistical analysis of demographic and baseline clinical characteristics of participants were conducted. Mann Whitney U test was used to compare the balance scores between fallers and non-fallers and a p value of less than 0.05 was considered as significantly different.

The receiver operating characteristic (ROC) curves were used to determine the relative performance of the Mini-BESTest score, the BBS score and the TUG score for classifying participants into fallers and non fallers. The accuracy of each balance test to discriminate fallers and non-fallers was assessed using the area under the curve (AUC). AUC value of 0.9 and above indicates high accuracy, 0.7 to 0.9 indicates moderate accuracy, 0.5 to 0.7 indicates low accuracy and 0.5 and below indicates test due to chance (110). The cutoff score was chosen by selecting the score that provided the best balance between high sensitivity and high specificity (111).

A positive likelihood ratio (LR+) and a negative likelihood ratio (LR-) were also calculated. A LR+ over 5 and a LR- less than 0.2 indicate that the test is useful due to its high probability to correctly identify fallers and non-fallers, but the LR values that close to 1.0 indicates that the test is useless as the probability to correctly and incorrectly identify fallers is the same (111). To determine whether the selected cutoff score could correctly identify the elderly fallers, the percentage accuracy of the elderly who actually fell was calculated using the cutoff score.

The floor and ceiling effects were calculated as the percentage of sample scoring the minimum or maximum possible scores, respectively. Ceiling and floor effects of 20% or greater are considered significant (112). In this study, we also presented the "Responsive ceiling effect" that was determined by using the score within the top 10% which allows a sufficient amount of scores to measure change over time (7).

Posttest accuracy was calculated whether the selected cutoff score could correctly identify the elderly fallers, the percentage accuracy of the elderly who actually fell was calculated using the cutoff score (119).

$$\text{Posttest accuracy} = \frac{\text{person with fall history}}{\text{person with fall history and received score less than cutoff point}} \times 100$$

Ethical Considerations

This research protocol was approved by the research and ethical committee of the Faculty of Health Science, Srinakharinwirot University's Ethic Committee and the participants signed the inform consent before participating in the study. (HS2013-011)



CHAPTER 4

FINDINGS

Two hundred elderly, 100 in each faller and non-faller group, participated in the study (Table 3). Ninety five percent of the elderly in the faller group had single fall in the past 12 months. Of note, most falls occurred outdoor as a result of trip, slip and postural transition such as sit on a chair and sit to stand/stand to sit. Fallers and non-fallers did not differ in age, BMI, lower limb muscle strength and MMSE score. However, fallers demonstrated significantly lower ABC score than the non-fallers ($p<0.05$), indicating less balance confidence in performing daily activities in the non-faller group.

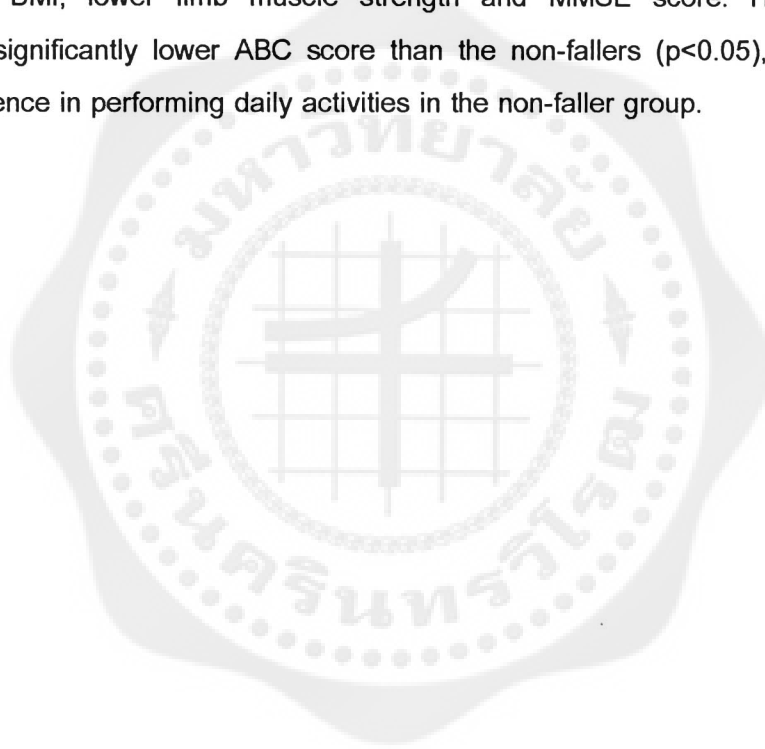


Table 3 Subject characteristics

Characteristics		Non-fallers(n=100)	Fallers(n=100)
Age: (years)		70.22 (6.76)	70.30 (7.26)
Gender (%)	Female	57%	69%
	Male	43%	31%
Fall history within 12 months	0	100	0
	1	0	95
	More than 1	0	5
Fall locations:	Indoor	-	38
	Outdoor	-	67
Types of fall:	Slip	-	49
	Trip	-	33
	Postural transition	-	23
LE Muscle strength (/5):		4.00	4.00
BMI:		21.89 (4.54)	22.85 (4.68)
MMSE Score (/30):		24.89 (1.21)	24.69 (1.06)
ABC Score (/100):		83.59 (13.34)*	75.12 (20.04)*

Values are shown in mean+SD, except the LE muscle strength is presented as median.

BMI = Body mass index; MMSE = The Mini Mental State Examination;

ABC = The Activities-specific Balance Confidence (ABC) Scale.

*Significant difference between fallers and non-fallers at $p < 0.05$.

Results of balance evaluation using the BBS, Mini-BESTest and TUG compared between fallers and non-fallers are presented in Table 4. Fallers and non-fallers exhibited significantly different scores in all balance scales. Scores from the BBS ($p<0.05$), and Mini-BESTest ($p<0.05$) were significantly lower in the fallers than in the non-fallers, suggesting that the fallers had lower balance ability than the non-fallers. Similar results were seen in the TUG scores where the fallers spent longer time than the non-fallers ($p<0.05$) to complete the test. The calculation of ceiling and floor effects revealed that none of the test scales, except the BBS, had ceiling and floor effects. Thus, the BBS demonstrated a trend of ceiling effect as seven participants (5 non-fallers and 2 fallers) showed maximum score (56 points). However, when the Responsive ceiling effect was considered, there were 142 participants (82 non-fallers and 60 fallers) or 71% of participants, who had BBS scores within 10% maximum score, whereas none of the Mini-BESTest and TUG demonstrated Responsive ceiling effect (data not shown).

Table 4 Balance Scores between faller and non-faller groups

Assessment scale	Non-fallers (n=100)	Fallers (n=100)
BBS Score (/56)	52.28 (2.07)	50.76 (2.27)*
Mini-BESTest /28)	17.68 (2.19)	14.10 (3.01)*
TUG (s)	7.73 (2.69)	9.67 (2.75)*

All values are shown as mean $\pm$ SD. BBS = Berg balance scale;

Mini-BESTest = Mini- balance evaluation systems test; TUG Timed up and go test.

*Significant difference between fallers and non-fallers at $p < 0.05$.

Results from the ROC analysis are shown in Figure 5 and Table 5. As seen in Table 5, the Mini-BESTest had moderate accuracy to classify fallers and non-fallers (AUC between 0.7-0.9), whereas the accuracy of the BBS and TUG was low (AUC<0.7) and very low (AUC<0.5), respectively. The cutoff scores for each scale and their sensitivity and

specificity are also presented in Table 5. The Mini-BESTest showed the highest sensitivity (0.85) and specificity (0.75) compared to the other scales as well as the highest percentage of posttest accuracy (85%) using the selected cutoff score (16/28).

Also, the LR+ and LR- analyses indicated that the Mini-BESTest was the most appropriate scale to classify fallers and non-fallers compared to the other tests. It should also be noted that the cutoff score of the BBS was closed to the maximum score (51 out of 56).

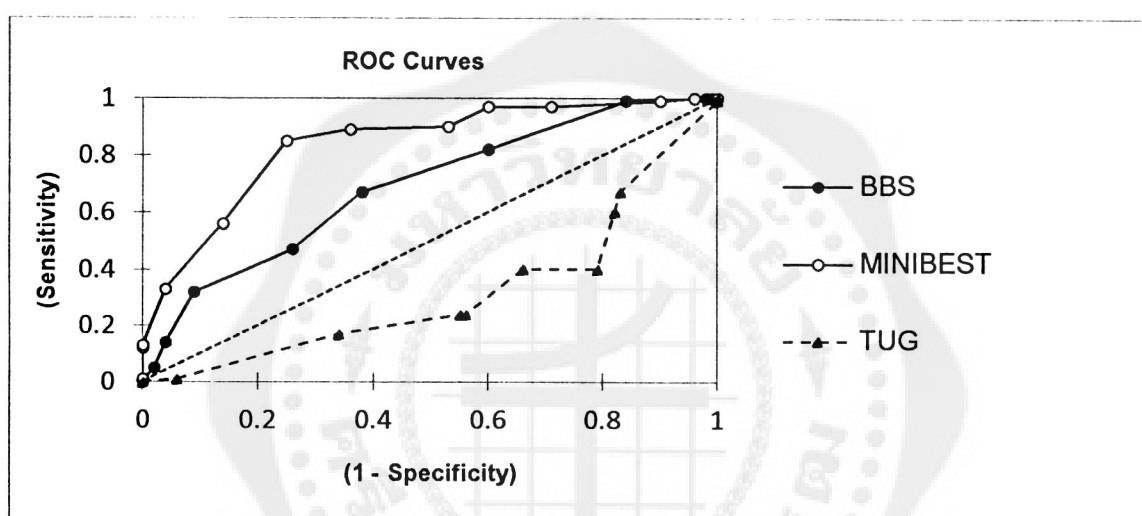


Figure 5 Receiver Operating Curve (ROC Curve) to identify the fallers using the scores from the Berg Balance Scale (BBS), the Mini- Balance Evaluation System Test (Mini-BESTest) and the Timed Up and Go Test (TUG).

Table 5 AUC, Cut off score, sensitivity, specificity and percentage of posttest accuracy at the selected cutoff score

	Mini-BESTest (/28)	BBS (/56)	TUG
AUC	0.84	0.69	0.32
Cutoff score	16	51	8
Sensitivity	0.85	0.77	0.40
(95%CI)	(0.77-0.90)	(0.57-0.85)	(0.31-0.49)
Specificity	0.75	0.42	0.34
(95%CI)	(0.66-0.83)	(0.38-0.57)	(0.26-0.44)
Positive likelihood ratio	3.40	1.76	0.61
Negative likelihood ratio	0.20	0.53	1.77
Posttest Accuracy (%)^a	85	60	65

AUC = Area Under the Curve; BBS = Berg balance scale; Mini-BESTest = Mini- Balance Evaluation Systems test; BESTest = Balance Evaluation Systems test; TUG = Timed up and go test;

^a Posttest accuracy was calculated using the selected cutoff score

Results from the ROC analysis each sections of the Mini-BESTest are shown in Figure 6 and the AUC of the section score is shown in Table 6. Two sections of the Mini-BESTest (Section 6: Stability in Gait and Section 5: Sensory Orientation) produced larger AUC (>0.7) than the other sections, suggesting that Stability in Gait and Sensory orientation sections had higher accuracy to classify fallers and non-fallers than the rest of the sections.

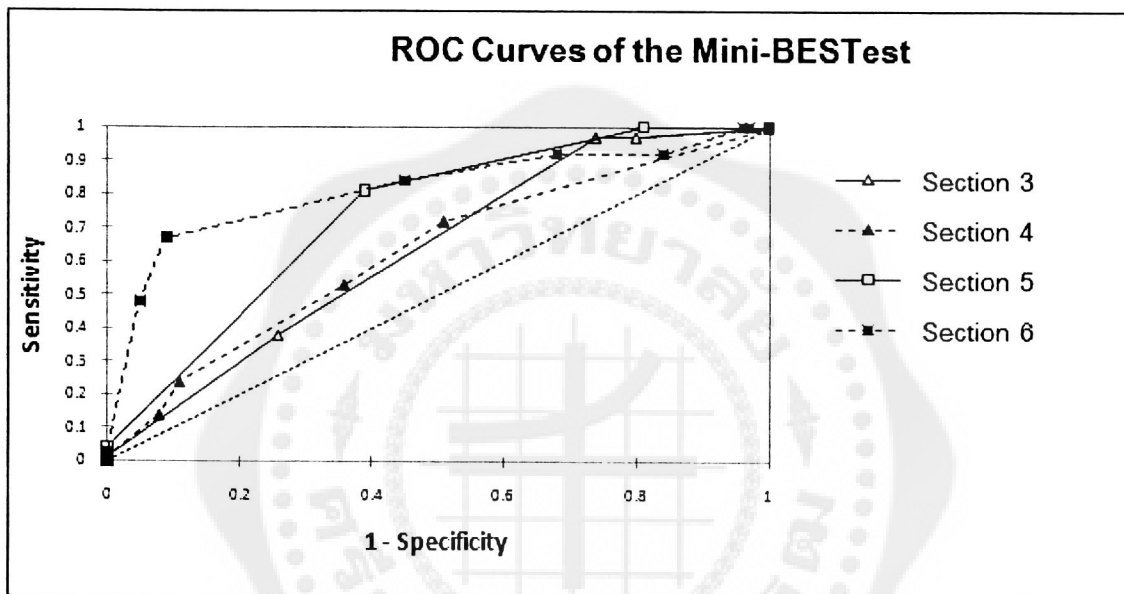


Figure 6 Receiver Operating Curve (ROC Curve) of each section of the Mini- Balance Evaluation System Test (Mini-BESTest); Section 3 = Anticipatory postural adjustments, Section 4 = Postural responses, Section 5 = Sensory orientation and Section 6 = Stability in gait.

Table 6 The area under the curve (AUC) of each section of the Mini- Balance Evaluation Systems test (Mini-BESTest)

Section		Mini-BESTest
III	Anticipatory Postural adjustments	0.63
IV.	Postural Responses	0.62
V	Sensory Orientation	0.74
VI	Stability in gait	0.81

CHAPTER 5

DISCUSSION AND CONCLUSION

Discussion

This study is the first to explore the accuracy of the Mini-BESTest in identifying the elderly subjects who had fell compared to the previous balance scales, the BBS and TUG. Our results demonstrated that the Mini-BESTest was the most accurate scale to identify the elderly fallers, based on the highest AUC (0.84), sensitivity (0.85), specificity (0.75) and posttest accuracy (85%). These findings were in line with previous studies that compared the Mini-BESTest with other clinical scales such as BBS, Five-Time-Sit-to-Stand Test, and Unified Parkinson's disease Rating Scale (105, 113-114). For example, the prospective and retrospective studies in people with PD reported higher sensitivity and specificity of the Mini-BESTest than the BBS in fall prediction (105, 113). It was also evident that the Mini-BESTest had less floor and ceiling effects than the BBS (106).

In our study, we introduced the Responsive ceiling effect, referred to the range of the score within 10% of maximum score that indicated the capability of the scale to detect change over time. The Responsive ceiling effect was 71% for the BBS, suggesting the limited ability of the BBS to detect changes of balance ability over time. In contrast, we did not find the ceiling effect and the Responsive ceiling effect of the Mini-BESTest. In addition, this study suggested the score of 16 (out of 28) as the cutoff score for the Mini-BESTest to predict elderly fallers. This cutoff score is in the same range as the prospective study, which reported the cutoff score of the Mini-BESTest at 17.5 in predicting fallers with stroke (64% sensitivity and 64.2% specificity) (115). In the present study, we demonstrated that the TUG was the least accurate scale in identifying elderly fallers. This finding was in accordance with the meta-analysis of TUG that reported moderate prediction ability and poor diagnosis accuracy in discriminating healthy elderly fallers (116).

The reason that the Mini-BESTest is more accurate than the BBS and TUG to identify elderly fallers may be because the Mini-BESTest assessed balance ability that is related to the nature of falls in the elderly. Our results showed that most falls in the elderly occurred during walking as a result of trip and slip (Table 3). It has been shown that falls during slip or trip were caused by lack of automatic postural responses, impaired postural control during dual tasks and impaired cutaneous sensation and vestibular functions (116-

117). The Mini-BESTest could capture these abilities as the test contains the items that assess automatic postural responses and postural control during dual tasks (9).

Supported by the ROC analysis of the Mini-BESTest domain, the “Stability in Gait” and “Sensory orientation” sections could be correctly identifying fallers better than other sections. In contrast, the BBS is developed to be used in frail elderly, thus, it assesses general balance ability without posing any challenge to individuals (66).

The Mini-BESTest, on the other hand, had been found to account for both dynamic balance control and stability during complex gait activities that were challenged by changing in gait speed and with a secondary cognitive task (9). Higher AUC in the “Sensory orientation” corresponded to the fact that sensation of older adults was impaired so they may not be able to detect changes in environment (34-35). When blindfolded, the elderly had difficulty using proprioceptive sensation to maintain their balance while standing on compliant and inclined surfaces, and would be predisposed to falls (46-48).

Our findings, however, do not agree with those of the previous studies which demonstrated similar ability of the Mini-BESTest in identifying persons with PD who fall (118). Thus, the reported scores of the Mini-BESTest based on the 6-month retrospective fall data were, respectively, AUC (0.86), sensitivity (0.88) and the specificity (0.78). The disparity of the findings could possibly be due to the differences in population group such that the impairments underlying falls may be different.

In this study, the sensitivity, specificity and the accuracy of the BBS in identifying the elderly fallers were lower than those of the previous studies. The discrepancy of the findings could arise from the differences in age that the previous studies recruited older participants (mean age of 79 years or older) than this study (mean age of 70 years), difference method of classifying fallers (non fall / who had 1 or more vs. non fall / who had 1-2 fall, 3-4 fall and 4 or more) and whether it is retrospective (this study) or prospective (previous study) (15, 64). Differences in the age of subjects suggest that the Mini-BESTest is more suitable to be used in the younger elderly, as it is more accurate than the BBS in this age group. Although the classification of fallers whether those who had one or more falls or those who had two or more falls, could contribute to the inconsistent findings. The result of previous studies did not show significant differences in the sensitivity or specificity with either fall classification (105-106,113-115,119).

The retrospective and prospective methods of gathering the fall data are also another major concern. The prospective studies in older adults reported a range of

sensitivity between 25% to 69% and specificity between 92% and 96% (15, 119). In contrast, the retrospective studies demonstrated a range of higher sensitivity (88% - 95%), and lower specificity (76% - 95%) (64, 120). It has been documented that the retrospective study may be susceptible to recalled bias.

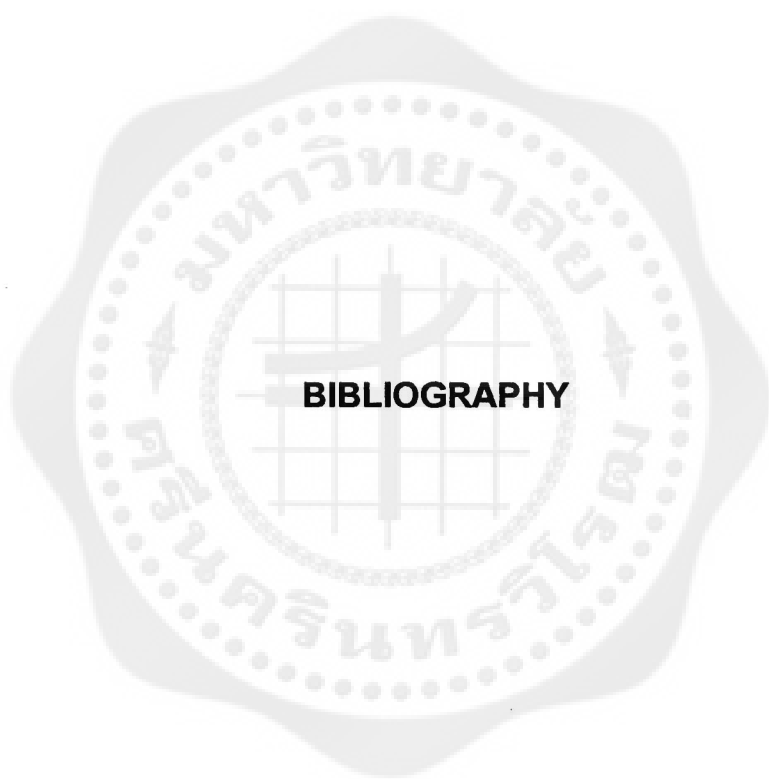
However, a recent study in fall prediction demonstrated that the 6-month retrospective fall data gathered from persons with PD (H &Y stage 2-3) led to similar fall predicted values as the 6-month prospective fall data (118).

Limitation

This study suggested the Mini-BESTest could be used to correctly identify young elderly who have high risks of falls based on their functional balance. Other fall risk factors such as psychological aspects, medications and co-morbidity were not covered in this study. With regard to the age of participants, the results should be carefully interpreted in light of the healthy and young elderly. In addition, the majority of fallers in this study had only single fall, thus another group of elderly subjects with the history of several falls should be examined in the future study.

Conclusion

The Mini-BESTest was the most accurate scale in identifying risk of falls in the active young elderly compared to the BBS and TUG.



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คณะสหเวชศาสตร์ มหาวิทยาลัยศรีนครินทรวิโรฒ

แบบสอบถามคัดกรองข้อมูลทั่วไปของผู้สูงอายุ

- วัตถุประสงค์ 1. เพื่อศึกษาว่าแบบประเมิน Mini-BESTest สามารถทำนายความเสี่ยงในการหกล้มในผู้สูงอายุได้หรือไม่ โดยดูค่าของความไว, ความจำเพาะและระดับของความถูกต้องในการระบุผู้ที่มีประวัติการหกล้ม
2. เพื่อเปรียบเทียบความแตกต่างของคะแนนในผู้สูงอายุ ระหว่าง กลุ่มหกล้มและไม่หกล้ม

คำอธิบาย : โปรดกรอกข้อมูลลงในช่องว่าง หรือทำเครื่องหมาย ✓ ลงใน ☐

1. ข้อมูลทั่วไป

- ชื่อ นาย/นาง/นางสาว..... อายุ..... ปี
- ที่อยู่ บ้านเลขที่..... หมู่ที่..... ซอย..... ถนน.....
- ตำบล/แขวง..... อำเภอ/เขต.....
- จังหวัด..... รหัสไปรษณีย์.....
- หมายเลขโทรศัพท์..... E-mail.....
- สถานภาพ ☐ โสด ☐ สมรส
- ☐ หย่าร้าง/แยกกันอยู่ ☐ คู่สมรสเสียชีวิตแล้ว
- การศึกษา ☐ ประถมศึกษา ☐ มัธยมศึกษาตอนต้น
- ☐ มัธยมศึกษาตอนปลาย/ปวช. ☐ อนุปริญญาหรือเทียบเท่า
- ☐ ปริญญาตรีหรือเทียบเท่า ☐ สูงกว่าปริญญาตรี
- อาชีพ ☐ ค้าขาย ☐ เกษตรกร
- ☐ ข้าราชการ/พนักงานรัฐวิสาหกิจ/เจ้าหน้าที่ในหน่วยงานของรัฐ
- ☐ พนักงานเอกชน ☐ อื่น ๆ (โปรดระบุ).....
- ☐ ไม่ได้ประกอบอาชีพ

2. ข้อมูลด้านสุขภาพ

- น้ำหนัก..... กิโลกรัม ส่วนสูง..... เซนติเมตร
- ความดันโลหิต..... มิลลิเมตรปรอท อัตราการเต้นของหัวใจ..... ครั้ง/นาที

3. ท่านมีโรคประจำตัวหรือไม่

☐ ไม่มี

☐ มี โรคประจำตัว ได้แก่

- ☐ โรคความดันโลหิตสูง ☐ โรคเบาหวาน
- ☐ โรคหัวใจ ☐ โรคข้อเข่าเสื่อม
- ☐ โรคเกาต์ ☐ อื่น ๆ (โปรดระบุ).....

ท่านได้รับการรักษา.....

4. ท่านเคยได้รับการผ่าตัดหรือไม่

☐ ไม่เคย

☐ เคย สาเหตุที่ต้องผ่าตัด เนื่องจาก.....
 อวัยวะที่ถูกผ่าตัด คือ.....

5. ลักษณะสายตา

☐ ปกติ☐ สายตาสั้น☐ สายตายาว☐ สายตาเอียง

และได้รับการแก้ไขหรือไม่

☐ ไม่ได้รับการแก้ไข☐ ได้รับการแก้ไข (โปรดระบุ).....

6. ปัญหาทางสายตา

☐ ไม่มี☐ มี ได้แก่☐ ต้อลม☐ ต้อกระจก☐ ต้อหิน☐ จอประสาทตาเสื่อม☐ อื่น ๆ (โปรดระบุ).....

และได้รับการแก้ไขหรือไม่

☐ ไม่ได้รับการแก้ไข☐ ได้รับการแก้ไข (โปรดระบุ).....

7. ปัจจุบันมียาที่ต้องรับประทานหรือไม่

☐ ไม่มี☐ มี มีทั้งหมด☐ 1 ชนิด☐ 2 ชนิด☐ 3 ชนิด☐ 4 ชนิด☐ มากกว่า 4 ชนิด

8. ในช่วงระยะเวลา 6 เดือน ที่ผ่านมา ท่านเคยหกล้มหรือไม่

พ.ศ. 2555						
เมษายน	พฤษภาคม	มิถุนายน	กรกฎาคม	สิงหาคม	กันยายน	ตุลาคม

☐ ไม่เคย (ไม่ต้องทำข้อ 6)☐ เคย จำนวน.....ครั้ง (กรุณาทำข้อ 6)9. ท่านเคยหกล้มที่ไหน (สามารถทำเครื่องหมาย ✓ ลงใน ☐ ได้มากกว่า 1 ช่อง)☐ ภายในบริเวณบ้านของตนเอง☐ ขณะขึ้นหรือลงบันได☐ ขณะก้าวขึ้นหรือลงพื้นต่างระดับ☐ ขณะก้าวข้ามสิ่งกีดขวาง☐ ขณะลุกจากเตียง☐ ขณะลุกจากเก้าอี้☐ ขณะอาบน้ำ☐ ขณะเข้าห้องน้ำ/สุขา☐ ขณะเดินในสนามหญ้า☐ ขณะเดินบนทางเท้า☐ อื่น ๆ (โปรดระบุ).....

☐ ภายในบริเวณบ้าน/อาคารของผู้อื่น

- | | |
|---|---|
| ☐ ขณะขึ้นหรือลงบันได | ☐ ขณะก้าวขึ้นหรือลงพื้นต่างระดับ |
| ☐ ขณะก้าวข้ามสิ่งกีดขวาง | ☐ ขณะลุกจากเตียง |
| ☐ ขณะลุกจากเก้าอี้ | ☐ ขณะอาบน้ำ |
| ☐ ขณะเข้าห้องน้ำ/สุขา | ☐ ขณะเดินในสนามหญ้า |
| ☐ ขณะเดินบนทางเท้า | ☐ อื่น ๆ (โปรดระบุ)..... |

☐ สถานที่สาธารณะ

- | | |
|---|--|
| ☐ ขณะเดินบนทางเท้า/บาทวิถี | ☐ ขณะขึ้นลงรถยนต์/รถโดยสาร |
| ☐ ขณะเดินบนทางลาด | ☐ ขณะเดินบริเวณขอบถนน/ท่อระบายน้ำ |
| ☐ อื่น ๆ (โปรดระบุ)..... | |

☐ ล้มได้อย่างไร

- | | |
|---|--|
| ☐ สะดุด | ☐ ลื่น |
| ☐ สูญเสียการทรงตัว | ☐ เข่าอ่อน |
| ☐ เป็นลม | ☐ วิงเวียนศีรษะ/มึนงง |
| ☐ อื่น ๆ (โปรดระบุ)..... | |

☐ ได้รับบาดเจ็บหรือไม่

- | | |
|--|---|
| ☐ ไม่ได้รับการบาดเจ็บ | |
| ☐ ได้รับการบาดเจ็บ ได้แก่ | |
| ☐ ฟกช้ำ | ☐ ถลอก |
| ☐ ข้อมือสั่น | ☐ กระดูกหัก (โปรดระบุตำแหน่ง)..... |
| ☐ ปวดหลัง/สะโพก | ☐ อื่น ๆ (โปรดระบุ)..... |

การตรวจร่างกาย

1. Sensory test (Ankle)

	Right side	Left side
Light touch		
Pinprick		
Proprioception		

2. Vestibular disorders

Vertigo	.....
Nystagmus	.....

3. Muscle power (Lower extremity)

Hip flexion/extension	.....	Knee flexion/extension	.....
Hip abduction/adduction	.....	Ankle dorsiflexion/plantarflexion	.....



APPENDIX B

List of medications affect to balance

- Antidepressant
 - Sedative
 - Amitriptyline
 - Benzodiazepines
 - Barbiturates
 - Alcohol derivative
- Antianxiety
 - Valium
 - Ativan
- Mood stabilize
 - Carbamazepine
- Antipsychotic drug
 - Chlorpromazine
 - Hadol
 - Phenthiazine
- Antihypertension
 - Digoxin
 - Diuretic
- Cardiovascular drugs
 - Antihypertensives
 - Nitrates
 - Anti-arrhythmics
 - Nicotinic acid
 - adrenoceptor blocker eye drops
- Other drugs
 - Analgesics
 - Antivertigo preparations
 - Hypoglycaemics
 - Urinary antispasmodics

van der Velde N, Stricker BHC, Pols HAP, van der Cammen TJM. Risk of falls after withdrawal of fall-risk-increasing drugs: a prospective cohort study. *Br J Clin Pharmacol* 2006; 63(2): 232-7.



APPENDIX C

MMSE – Thai 2002 Mini – Mental State Examination:

สถาบันเวชศาสตร์ผู้สูงอายุกรมการแพทย์กระทรวงสาธารณสุข แบบทดสอบสภาพสมองเสื่อมเบื้องต้นฉบับภาษาไทย

1. Orientation for time (5 คะแนน) (ตอบถูกข้อละ 1 คะแนน)	บันทึกคำตอบไว้ทุกครั้ง (ทั้งคำตอบที่ถูกและผิด)	คะแนน
1.1 วันนี่วันที่เท่าไร	.....	☐
1.2 วันนี่วันอะไร	.....	☐
1.3 เดือนนี่เดือนอะไร	.....	☐
1.4 ปีนี้ปีอะไร	.....	☐
1.5 ฤดูนี้ฤดูอะไร	.....	☐
2. Orientation for place (5 คะแนน) (ให้เลือกข้อใดข้อหนึ่ง) (ตอบถูกข้อละ 1 คะแนน)		
2.1 กรณีอยู่ที่สถานพยาบาล		
2.1.1 สถานที่ตรงนี้เรียกว่า อะไร และ.....ชื่อว่าอะไร	.....	☐
2.1.2 ขณะนี้ท่านอยู่ที่ชั้นที่เท่าไรของตัวอาคาร	.....	☐
2.1.3 ที่อยู่ในอำเภอ - เขตอะไร	.....	☐
2.1.4 ที่นี้จังหวัดอะไร	.....	☐
2.1.5 ที่นี้ภาคอะไร	.....	☐
2.2 กรณีที่อยู่ที่บ้านของผู้ทดสอบ		
2.2.1 สถานที่ตรงนี้เรียกว่าอะไร และบ้านเลขที่อะไร	.....	☐
2.2.2 ที่นี้หมู่บ้าน หรือละแวก/คุ้ม/ย่าน/ถนนอะไร	.....	☐
2.2.3 ที่นี้อำเภอเขต / อะไร	.....	☐
2.2.4 ที่นี้จังหวัดอะไร	.....	☐
2.2.5 ที่นี้ภาคอะไร	.....	☐

3. Registraion (3 คะแนน)

ต่อไปนี้เป็นารทดสอบความจำ ดิฉันจำบอกชื่อของ 3 อย่าง คุณ (ตา , ยาย....) ตั้งใจฟังให้ดิฉัน

เพราะจะบอกเพียงครั้งเดียว ไม่มีการบอกซ้ำอีก เมื่อ ผม (ดิฉัน) พูดจบ ให้ คุณ(ตา,ยาย....)

พูดทบทวนตามที่ได้ยิน ให้ครบ ทั้ง 3 ชื่อ แล้วพยายามจำไว้ให้ดี เดี๋ยวดิฉันจะถามซ้ำ

* การบอกชื่อแต่ละคำให้ห่างกันประมาณหนึ่งวินาที ต้องไม่ช้าหรือเร็วเกินไป

(ตอบถูก 1 คำได้ 1 คะแนน)

☐ ดอกไม้ ☐ แม่น้ำ ☐ รถไฟ

☐

ในกรณีที่ทำแบบทดสอบซ้ำภายใน 2 เดือน ให้ใช้คำว่า

☐ ดันไม้ ☐ ทะเล ☐ รยยนต์

☐

4. Attention/Calculation (5 คะแนน) (ให้เลือกข้อใดข้อหนึ่ง)

ข้อนี้เป็นการคิดเลขในใจเพื่อทดสอบสมาธิ คุณ (ตา,ยาย....) คิดเลขในใจเป็นไหม ?

ถ้าตอบคิดเป็นทำข้อ 4.1 ถ้าตอบคิดไม่เป็นหรือไม่ตอบให้ทำข้อ 4.2

4.1 "ข้อนี้คิดในใจเอา 100 ตั้ง ลบออกทีละ 7

ไปเรื่อยๆ ได้ผลเท่าไรบอกมา

☐

บันทึกคำตอบตัวเลขไว้ทุกครั้ง (ทั้งคำตอบที่ถูกต้องและผิด) ทำทั้งหมด 5 ครั้ง

ถ้าลบได้ 1,2,หรือ3 แล้วตอบไม่ได้ ก็คิดคะแนนเท่าที่ทำได้ ไม่ต้องย้ายไปทำข้อ 4.2

4.2 "ผม (ดิฉัน) จะสะกดคำว่า มะนาว ให้คุณ (ตา , ยาย....) ฟังแล้วให้คุณ (ตา , ยาย....) สะกดถอยหลังจากพยัญชนะ
หลังไปตัวแรก คำว่ามะนาวสะกดว่า มอม้า-สระ อะ-นอหนู-สระอา-วอแหวน ไหนคุณ(ตา,ยาย....)สะกดถอยหลัง ให้ฟังซิ

.....

ว า น ะ ม

5. Recall (3 คะแนน)

เมื่อสักครู่นี้ให้จำของ 3 อย่างจำได้ไหมมีอะไรบ้าง" (ตอบถูก 1 คำได้ 1คะแนน)

☐ ดอกไม้ ☐ แม่น้ำ ☐ รถไฟ

☐

ในกรณีที่ทำแบบทดสอบซ้ำภายใน 2 เดือน ให้ใช้คำว่า

☐ ดันไม้ ☐ ทะเล ☐ รยยนต์

☐

6. Naming (2 คะแนน)

6.1 ยื่นดินสอให้ผู้ถูกทดสอบดูแล้วถามว่า

“ของสิ่งนี้เรียกว่าอะไร”

.....

☐

6.2 ชื่นาฬิกาข้อมือให้ผู้ถูกทดสอบดูแล้วถามว่า

“ของสิ่งนี้เรียกว่าอะไร”

.....

☐

7. Repetition (1 คะแนน)

(พูดตามได้ถูกต้องได้ 1 คะแนน)

ตั้งใจฟังผม (ดิฉัน) เมื่อผม (ดิฉัน) พูดข้อความนี้ แล้วให้คุณ (ตา, ยาย) พูดตาม ผม (ดิฉัน) จะบอกเพียงครั้งเดียว

“ใครใคร่ขายไก่ไข่”

.....

☐

8. Verbal command (3 คะแนน)

ข้อนี้ฟังคำสั่ง “ฟังดิจ นะเตียผม (ดิฉัน) จะส่งกระดาษให้คุณ แล้วให้คุณ (ตา, ยาย....)

รับด้วยมือขวา พับครึ่งกระดาษ แล้ววางไว้ที่.....”(พื้น, โต๊ะ, เติง)

ผู้ทดสอบแสดงกระดาษเปล่าขนาดประมาณ เอ-4 ไม่มีรอยพับ ให้ผู้ถูกทดสอบ

☐ รับด้วยมือขวา ☐ พับครึ่ง ☐ วางไว้ที่” (พื้น, โต๊ะ, เติง)

☐

9. Written command (1 คะแนน)

ต่อไปเป็นคำสั่งที่เขียนเป็นตัวหนังสือ ต้องการให้คุณ (ตา, ยาย....) อ่านแล้วทำตาม (ตา, ยาย....) จะอ่านออกเสียง

หรืออ่านในใจ ผู้ทดสอบแสดงกระดาษที่เขียนว่า “หลับตาได้” ☐ หลับตาได้.....

☐

10. Writing (1 คะแนน)

ข้อนี้จะเป็นคำสั่งให้ “คุณ (ตา, ยาย....) เขียนข้อความอะไรก็ได้ที่อ่านแล้วรู้เรื่องหรือมีความหมายมา 1 ประโยค”

.....

☐ ประโยคมีความหมาย

.....

☐

11. Visuoconstruction (1 คะแนน)

ข้อนี้เป็นคำสั่ง “จงวาดภาพให้เหมือนภาพตัวอย่าง”

(ในช่องว่างด้านขวาของภาพตัวอย่าง)

.....

☐






The Activities-specific Balance Confidence (ABC) Scale

For each of the following activities, please indicate your level of self-confidence by choosing a corresponding number from the following rating scale:

0% 10 20 30 40 50 60 70 80 90 100%

no confidence

completely confident

	How confident are you that you will <u>not</u> lose your balance or become unsteady when you...	%	ระดับความมั่นใจในการทำกิจกรรม
1	walk around the house?		เดินรอบบ้าน
2	walk up or down stairs?		เดินขึ้นและลงบันได
3	bend over and pick up a slipper from the front of a closet floor		หยิบรองเท้าแตะจากพื้นด้านหน้า
4	reach for a small can off a shelf at eye level?		เอื้อมมือหยิบของทางข้างหน้า
5	stand on your tiptoes and reach for something above your head?		เขย่งปลายเท้าเพื่อเอื้อมมือหยิบของเหนือศีรษะ
6	stand on a chair and reach for something?		ยืนบนเก้าอี้และหยิบของ
7	sweep the floor?		กวาดบ้าน
8	walk outside the house to a car parked in the driveway?		เดินไปยังรถที่จอดอยู่
9	get into or out of a car?		ขึ้นและลงรถ
10	walk across a parking lot to the mall?		เดินข้ามลานจอดรถกว้างๆ
11	walk up or down a ramp?		เดินขึ้นและลงทางลาดชัน
12	walk in a crowded mall where people rapidly walk past you?		เดินในห้างที่คนพลุกพล่าน
13	are bumped into by people as you walk through the mall?		เดินในที่คนพลุกพล่านและถูกกระแทก
14	step onto or off an escalator while you are holding onto a railing?		ขึ้นบันไดเลื่อนแบบจับราวจับ
15	step onto or off an escalator while holding onto parcels such that you cannot hold onto the railing?		ขึ้นบันไดเลื่อนแบบไม่จับราวจับ
16	walk outside on icy sidewalks?		เดินบนพื้นลื่น



APPENDIX E

Mini-BESTest

Item	Score	Scoring criteria
III. Transitions-anticipatory postural adjustment		
1. Sit to stand		(2) Normal: Comes to stand without use of hands and stabilizes independently. (1) Moderate: Comes to stand WITH use of hands on first attempt. (0) Severe: Impossible to stand up from chair without assistance –OR- several attempts with use of hands.
2. Rise to toes		(2) Normal: Stable for 3 sec with maximum height (1) Moderate: Heels up, but not full range (smaller than when holding hands)-OR-noticeable instability for 3 s (0) Severe: < 3 sec
3. Stand on one leg		<u>Left</u> Time in sec Trial 1: _____ Trial 2: _____ (2) Normal: 20 s (1) Moderate: < 20 sec (0) Severe: Unable <u>Right</u> Time in sec Trial 1: _____ Trial 2: _____ (2) Normal: 20 s (1) Moderate: < 20 sec (0) Severe: Unable
IV. Reactive postural response		
4. Compensatory stepping correction - Forward		(2) Normal: Recovers independently a single, large step (second realignment step is allowed) (1) Moderate: More than one step used to recover equilibrium (0) Severe: No step, OR would fall if not caught, OR falls spontaneously
5. Compensatory stepping correction - Backward		(2) Normal: Recovers independently a single, large step (1) Moderate: More than one step used to recover equilibrium (0) Severe: No step, OR would fall if not caught, OR falls spontaneously
6. Compensatory stepping correction - Lateral		<u>Left</u> (2) Normal: Recovers independently with 1 step (crossover or lateral OK) (1) Moderate: Several steps to recovers equilibrium (0) Severe: Falls, or cannot step <u>Right</u> (2) Normal: Recovers independently with 1 step (crossover or lateral OK) (1) Moderate: Several steps to recovers equilibrium (0) Severe: Falls, or cannot step

V. Sensory orientation		
7. Eyes open, Firm surface (feet together)		Time in sec: _____ (2) Normal: 30s (1) Moderate: < 30s (0) Severs: Unable
8. Eyes close, Foam surface (feet together)		Time in sec: _____ (2) Normal: 30s (1) Moderate: < 30s (0) Severe: Unable
9. Incline – eyes close		Time in sec: _____ (2) Normal: Stands independently 30 sec and aligns with gravity (1) Moderate: Stands independently <30 SEC -OR- aligns with surface (0) Severe: Unable to stand >10 sec -OR- will not attempt independent stance
VI. Stability on gait		
10. Change gait speed		(2) Normal: Significantly changes walking speed without imbalance (1) Moderate: Unable to change walking speed or imbalance (0) Severe: Unable to achieve significant change in speed AND signs of imbalance
11.Walk with head turns- Horizontal		(2) Normal: performs head turns with no change in gait speed and good balance (1) Moderate: performs head turns with reduction in gait speed (0) Severe: performs head turns with imbalance
12.Walk with pivot turn		(2) Normal: Turns with feet close, FAST (< 3 steps) with good balance (1) Moderate: Turns with feet close SLOW (>4 steps) with good balance (0) Severe: Cannot turn with feet close at any speed without imbalance
13.Strep over obstacles		(2) Normal: able to step over box with minimal change of speed and with good balance (1) Moderate: steps over shoe boxes but touches box OR display cautious behavior by slowing gait. (0) Severe: cannot step over shoe boxes OR hesitates OR steps around box
14.Timed up and go with dual task TUG: _____sec; Dual Task TUG: _____sec		(2) Normal: No noticeable change between sitting & standing in backward counting & no change in gait speed for TUG. (1) Moderate: Dual task affects either counting OR

		walking. (0) Severe: Stops counting while walking OR stops walking while counting.
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Manual instruction

Item	Instruction	Command in Thai language
III. Transitions-anticipatory postural adjustment		
1. Sit to stand	Note the initiation of the movement, and the use of hands on the arms of the chair or their thighs or thrusts arms forward.	มือกดดอกเอาไว้ พยายามที่จะไม่ใช้มือช่วยยันเพื่อลุกขึ้นยืน ถ้าจำเป็นจะต้องใช้มือช่วยยันสามารถใช้ได้ กรุณาลุกขึ้นยืน
2. Rise to toes	Allow the patient to try it twice. Record the best score. (If you suspect that subject is using less than their full height, ask them to rise up while holding the examiners' hands.) Make sure subjects look at a nonmoving target 4-12 feet away.	กางขาเท่ากับความกว้างของไหล่ มือจับสะโพก ให้เขย่งปลายเท้าให้สูงเท่าที่สามารถทำได้ หน้ามองตรงไปข้างหน้า ค้างไว้ 3 วินาที
3. Stand on one leg	Allow the patient two attempts and record the best. Record the no. of seconds they can hold posture up to a maximum of 30sec. Stop timing when subject moves their hand off hips or puts a foot down. Make sure subjects look at a non-moving target 4-12 feet ahead.	มือจับที่สะโพก หน้ามองตรงให้ยืนขาเดียวโดยให้งอขาไปข้างหลังและไม่สัมผัสกับขาอีกข้าง ยืนให้นานเท่าที่ทำได้ (เปลี่ยนข้าง)
IV. Reactive postural response		
4. Compensatory stepping correction - Forward	Stand in front to the side of patient with one hand on each shoulder and ask them to push forward. (Make sure there is room for them to step forward). Require them to lean until their shoulders and hips are in front of their toes. Suddenly release your push when the subject is in place and providing constant pressure to a level just before the heels lift off. The test must elicit a step.	ยืนกว้างเท่าขนาดไหล่ ให้ผู้ตรวจในทิศทางข้างหน้า และเมื่อผู้ตรวจปล่อยมือ ทำยังงี้ก็ได้ จะก้าวก็ได้ ทำให้ตัวเองล้มลง
5. Compensatory stepping correction - Backward	Stand in back to the side of the patient with one hand on each scapula and ask them to push backward. (Make sure there is room for them to step backward.) Require them to lean until their shoulders and hips are in back of their heels. Release your push when the subject is in	ยืนกว้างเท่าขนาดไหล่ ให้ผู้ตรวจในทิศทางข้างหลัง และเมื่อผู้ตรวจปล่อยมือ ทำยังงี้ก็ได้ จะก้าวก็ได้ ทำให้ตัวเองล้มลง

	place, and providing constant pressure to a level just before the heels lift off. Test must elicit a step.	
6. Compensatory stepping correction - Lateral	Stand behind the patient, place one hand on either the right (or left) side of the pelvis, and get them to lean their whole body into your hand. Require them to lean until the midline of pelvis is over the right (or left) foot and then suddenly release your hold.	ผู้ตรวจมือผู้ตรวจในทิศทางด้านข้าง (ซ้าย/ขวา) และเมื่อผู้ตรวจปล่อยมือ จะก้าวก็ได้ถ้าต้องการ ทำให้ตัวเองล้มลง (ตรวจอีกข้างที่เหลือ)
V. Sensory orientation		
7. Eyes open, Firm surface (feet together)	Record the time the patient was able to stand to a maximum of 30 seconds.	มือจับที่สะโพก ยืนเท้าชิด มองตรงไปข้างหน้า ยืนลืมตา ยืนให้มั่นคงจนกว่าจะบอกว่าหยุด
8. Eyes close, Foam surface (feet together)	Use medium density Temper® foam, 4 inches thick. Assist subject in stepping onto foam. Tell patient to "Close Eyes" Record the time the patient was able to stand in each condition to a maximum of 30 seconds. Have the subject step off the foam between trials. Include leaning or hip strategy during a trial as "instability."	มือจับที่สะโพก ยืนเท้าชิด มองตรงไปข้างหน้า หลับตา ยืนให้มั่นคงจนกว่าจะบอกว่าหยุด
9. Incline – eyes close	Aid the patient onto the ramp. Once the patient closes their eyes, begin timing and record and average both times. Note if sway is greater than when standing on firm, level, surface with eyes closed or if there is poor alignment to vertical. Assist includes a cane or light touch any time during the trial.	ยืนทรงตัวบนทางลาด ยืนกว้างเท่าขนาดใหญ่ มือจับที่สะโพก และจะเริ่มจับเวลาเมื่อคุณหลับตา
VI. Stability on gait		
10. Change gait speed	Allow the patient to take 3-5 steps at their normal speed, and then say "fast", after 3-5 fast steps once say "slow". Allow 3-5 slow steps before they stop walking.	เริ่มจากเดินด้วยความเร็วตามปกติของคุณ เมื่อบอกว่าเดินเร็วให้คุณเดินเร็วที่สุด และเมื่อบอกว่าเดินช้า ให้คุณเดินช้ามาก
11. Walk with head turns- Horizontal	Allow the patient to reach their normal speed, and give the commands "right, left" every 3-5 steps. Score if you see a problem in either direction. If patient has severe cervical restrictions allow combined	เริ่มจากเดินด้วยความเร็วปกติของคุณ เมื่อบอกว่าขวา ให้คุณหันศีรษะมองและไปทางขวา และเมื่อบอกว่าซ้าย ให้คุณหันศีรษะมองและไป

	head and trunk movements (enbloc).	ทางซ้าย พยายามเดินให้เป็นเส้นตรง
12. Walk with pivot turn	Demonstrate a pivot turn. Once the patient is walking at normal speed, say "turn and stop." Count the steps from turn" until the subject is stable. Instability may be indicated by wide stance width, extra stepping or trunk motion.	เริ่มจากเดินด้วยความเร็วปกติของคุณ เมื่อบอกให้หมุนและหยุด คุณจะต้องหมุนหมุนกลับหลังหันอย่างรวดเร็วและหยุดอยู่กับที่ ให้เท้าชิดกัน
13. Step over obstacles	Place the box (9" or 22.9 cm height) 10 ft. away from where the patient will begin walking. Use a stopwatch to time gait duration to calculate average velocity by dividing the number of seconds into 20 feet.	เริ่มจากเดินด้วยความเร็วปกติของคุณ ให้เดินก้าวข้ามกล่องแล้วเดินต่อไปเรื่อย โดยไม่อ้อมกล่อง
14. Timed up and go with dual task TUG: _____ sec; Dual Task TUG: _____ sec	Have the patient sit with their back against the chair. Time the patient from the time you say "Go" until they return to sitting in chair. Stop timing when the patient's buttocks hit the chair bottom. The chair should be firm with arms to push from if necessary. While sitting, determine how fast and accurately the patient can count backwards by 3's from a number between 90-100. Then, ask them to count from a different number and after a few numbers say "go". Time the patient from the time you say "go" until they return to the sitting position.	เมื่อบอกว่า ไป ให้คุณลุกจากเก้าอี้ เดินไปด้วยความเร็วปกติ เลี้ยวกลับตรงจุดเทพ เดินกลับมานั่งที่เก้าอี้หลังพิงพนัก ซ้อมนับถอยหลังทีละ 3 โดยเริ่มจาก 100 ลดลงทีละ 3 ไปเรื่อยๆ นับถอยหลังทีละ 3 โดยเริ่มจาก (80, 70, 60 เลือกเลขใดเลขหนึ่ง หรือถ้าไม่สามารถคิดเลขได้ใช้ภาษาไทย ให้ใช้คำขึ้นต้นว่า กระ, มะ หรือ ก. ไก่ นำหน้า) เมื่อบอกว่า ไป ให้คุณลุกจากเก้าอี้ เดินไปด้วยความเร็วปกติ เลี้ยวกลับตรงจุดเทพ เดินกลับมานั่งที่เก้าอี้หลังพิงพนัก ขณะเดินให้นับต่อไปเรื่อยๆ จนกว่าจะบอกว่าพอ



APPENDIX F

The Berg Balance Scale

Item	Instructions	Score	Scoring criteria
1. Sitting to standing	Please stand up. Try not to use your hand for support. ลุกขึ้นยืน โดยพยายามที่จะไม่ใช้มือช่วย		(4) able to stand without using hands and stabilize independently (3) able to stand independently using hands (2) able to stand using hands after several tries (1) needs minimal aid to stand or stabilize (0) needs moderate or maximal assist to stand
2. Standing unsupported	Please stand for two minutes without holding on. ยืนตรงทรงตัวนิ่ง 2 นาที		(4) able to stand safely for 2 minutes (3) able to stand 2 minutes with supervision (2) able to stand 30 seconds unsupported (1) needs several tries to stand 30 seconds unsupported (0) unable to stand 30 seconds unsupported
3. Sitting unsupported	Please sit with arms folded for 2 minutes. นั่งกอดอก 2 นาที		(4) able to sit safely and securely for 2 minutes (3) able to sit 2 minutes under supervision (2) able to sit 30 seconds (1) able to sit 10 seconds (0) unable to sit without support 10 seconds
4. Standing to sitting	Please sit down. นั่งลง		(4) sits safely with minimal use of hands (3) controls descent by using hands (2) uses back of legs against chair to control descent (1) sits independently but has uncontrolled descent (0) needs assist to sit
5. Transfers	You may use two chairs (one with and one without armrests) or a bed and a chair. เคลื่อนย้ายตัวจากเก้าอี้ที่นั่งอยู่ไปยังอีกตัวแล้วกลับมาที่นั่งที่เก้าอี้ตัวเดิม		(4) able to transfer safely with minor use of hands (3) able to transfer safely definite need of hands (2) able to transfer with verbal cuing and/or supervision (1) needs one person to assist (0) needs two people to assist or supervise to be safe
6. Standing with eyes closed	Please close your eyes and stand still for 10 seconds.		(4) able to stand 10 seconds safely (3) able to stand 10 seconds with

	ยืนหลับตา 10 วินาที		supervision (2) able to stand 3 seconds (1) unable to keep eyes closed 3 seconds but stays safely (0) needs help to keep from falling
7. Standing with feet together	Place your feet together and stand without holding on. ยืนเท้าชิดกันโดยไม่มีการจับ		(4) able to place feet together independently and stand 1 minute safely (3) able to place feet together independently and stand 1 minute with supervision (2) able to place feet together independently but unable to hold for 30 seconds (1) needs help to attain position but able to stand 15 seconds feet together (0) needs help to attain position and unable to hold for 15 seconds
8. Reaching forward with outstretched arm	Lift arm to 90 degrees. Stretch out your fingers and reach forward as far as you can. ยืนเท้าชิดกัน ยกแขนตั้งฉากเหยียดนิ้วไปข้างหน้าให้ได้มากที่สุด โดยไม่ขยับเท้า		(4) can reach forward confidently 25 cm (10 inches) (3) can reach forward 12 cm (5 inches) (2) can reach forward 5 cm (2 inches) (1) reaches forward but needs supervision (0) loses balance while trying/requires external support
9. Retrieving object from floor	Pick up the shoe/slipper, which is place in front of your feet. ก้มเก็บของที่อยู่หน้าเท้า		(4) able to pick up slipper safely and easily (3) able to pick up slipper but needs supervision (2) unable to pick up but reaches 2-5 cm(1-2 inches) from slipper and keeps balance independently (1) unable to pick up and needs supervision while trying (0) unable to try/needs assist to keep from losing balance or falling
10. Turning to look behind	Turn to look directly behind you over toward the left shoulder. Repeat to the right. Examiner may pick an object to look at directly behind the subject to encourage a better twist turn. หันไปมองข้างหลังผ่านทางไหล่ซ้าย ทำอีกด้าน หันไปมองข้างหลังผ่านทางไหล่ขวา		(4) looks behind from both sides and weight shifts well (3) looks behind one side only other side shows less weight shift (2) turns sideways only but maintains balance (1) needs supervision when turning (0) needs assist to keep from losing balance or falling
11. Turning 360 degrees	Turn completely around in a full circle. Pause. Then turn a full		(4) able to turn 360 degrees safely in 4 seconds or less

	circle in the other direction. หมุนรอบตัวเอง 1 รอบและหมุนตัวกลับอีกทาง		(3) able to turn 360 degrees safely one side only 4 seconds or less (2) able to turn 360 degrees safely but slowly (1) needs close supervision or verbal cuing (0) needs assistance while turning
12. Placing alternate foot on stool	Place each foot alternately on the step/stool. Continue until each foot has touched the step/stool four times. ยกขาแต่ละสลับบนกล่องสลับทีละข้าง โดยทำจนเท้าแตะพื้นทั้ง 4 ครั้งทั้ง 2 ข้าง		(4) able to stand independently and safely and complete 8 steps in 20 seconds (3) able to stand independently and complete 8 steps in > 20 seconds (2) able to complete 4 steps without aid with supervision (1) able to complete > 2 steps needs minimal assist (0) needs assistance to keep from falling/unable to try
13. Standing with one foot in front	An examiner demonstrates to a subject. Place one foot directly in front of the other. If you feel that you cannot place your foot directly in front, try to step far enough ahead that the heel of your forward foot is ahead of the toes of the other foot. ยืนต่อเท้า 30 วินาที		(4) able to place foot tandem independently and hold 30 seconds (3) able to place foot ahead independently and hold 30 seconds (2) able to take small step independently and hold 30 seconds (1) needs help to step but can hold 15 seconds (0) loses balance while stepping or standing
14. Standing on one foot	Stand on one leg as long as you can without holding on. ยืนขาเดียวโดยไม่มีการจับ		(4) able to lift leg independently and hold > 10 seconds (3) able to lift leg independently and hold 5-10 seconds (2) able to lift leg independently and hold 3 seconds (1) tries to lift leg unable to hold 3 seconds but remains standing independently. (0) unable to try or needs assist to prevent fall
Total score	Maximum 56 points		



APPENDIX G

Timed Up and Go Testing

Name: _____

Assistive Device and/or Bracing Used: _____

Instructions (derived from Podsiadlo and Richardson, 1991):

1. Instruct the patient to sit on the chair and place his/her back against the chair and rest his/her arms chair's arms.
2. The upper extremities should not be on the assistive device (if used for walking), but it should be nearby.
3. Demonstrate the test to the patient.
4. When the patient is ready, say "Go"
5. The stopwatch should start when you say go, and should be stopped with the patient's buttocks touch the seat.

Date: _____

TUG Time: _____

TUG Time: _____

TUG Time: _____

Average: _____

Reference:

Podsiadlo, D. and Richardson, S. (1991). "The timed "Up & Go": a test of basic functional mobility for frail elderly persons." J Am Geriatr Soc 39(2): 142-148.



APPENDIX H

หนังสือให้ความยินยอมเข้าร่วมในโครงการวิจัย

วันที่

ข้าพเจ้า.....อายุ.....ปี อยู่บ้านเลขที่.....
ถนน.....หมู่ที่.....แขวง/ตำบล.....เขต/อำเภอ.....
จังหวัด โทรศัพท์

ขอทำหนังสือนี้ให้ไว้ต่อหัวหน้าโครงการวิจัยเพื่อเป็นหลักฐานแสดงว่า

- ข้อ 1. ข้าพเจ้า ได้รับทราบโครงการวิจัยของนางสาวอัญมณี ยิ่งยงยุทธ เรื่อง การใช้แบบประเมิน Mini-BESTest เพื่อพยากรณ์การหกล้มในผู้สูงอายุ
- ข้อ 2. ข้าพเจ้า ยินยอมเข้าร่วมโครงการวิจัยนี้ ด้วยความสมัครใจ โดยมีได้มีการบังคับขู่เข็ญ หลอกลวงแต่ประการใด และจะให้ความร่วมมือในการวิจัยทุกประการ
- ข้อ 3. ข้าพเจ้า ได้รับการอธิบายจากผู้วิจัยเกี่ยวกับวัตถุประสงค์ของการวิจัย วิธีการวิจัย ประสิทธิภาพ ความปลอดภัย อาการหรืออันตรายที่อาจเกิดขึ้น รวมทั้งแนวทางป้องกันและแก้ไข หากเกิดอันตราย ค่าตอบแทนที่จะได้รับ ค่าใช้จ่ายที่ข้าพเจ้าจะต้องรับผิดชอบจ่ายเอง โดยได้อ่าน ข้อความ ที่มีรายละเอียดอยู่ในเอกสารชี้แจงผู้เข้าร่วมโครงการวิจัยโดยตลอด อีกทั้งยังได้รับ คำอธิบายและ ตอบข้อสงสัยจากหัวหน้าโครงการวิจัยเป็นที่เรียบร้อยแล้ว และตกลงรับผิดชอบตาม คำรับรองใน ข้อ 5 ทุกประการ
- ข้อ 4. ข้าพเจ้า ได้รับการรับรองจากผู้วิจัยว่าจะเก็บข้อมูลส่วนตัวของข้าพเจ้าเป็นความลับ จะเปิดเผย เฉพาะผลสรุปการวิจัยเท่านั้น
- ข้อ 5. ข้าพเจ้า ได้รับทราบจากผู้วิจัยแล้วว่า หากมีอันตรายใด ๆ อันเกิดขึ้นจากการวิจัยดังกล่าว ข้าพเจ้า จะได้รับการรักษาพยาบาลจากคณะผู้วิจัย โดยไม่คิดค่าใช้จ่ายและจะได้รับค่าชดเชย รายได้ที่สูญเสียไปในระหว่างการรักษาพยาบาลดังกล่าว ตลอดจน มีสิทธิได้รับค่าทดแทน ความ พิกarที่อาจเกิดขึ้นจากการวิจัยตามสมควร
- ข้อ 6. ข้าพเจ้า ได้รับทราบแล้วว่าข้าพเจ้ามีสิทธิจะบอกเลิกการร่วมโครงการวิจัยนี้ และการบอกเลิก การ ร่วมโครงการวิจัย จะไม่มีผลกระทบต่อกรดูแลรักษาโรคที่ข้าพเจ้าจะพึงได้รับต่อไป
- ข้อ 7. หากข้าพเจ้ามีข้อข้องใจเกี่ยวกับขั้นตอนของการวิจัย หรือหากเกิดผลข้างเคียงที่ไม่พึงประสงค์ จากการวิจัย สามารถติดต่อกับนางสาวอัญมณี ยิ่งยงยุทธ ที่อยู่คณะสหเวชศาสตร์ มหาวิทยาลัยศรีนครินทรวิโรฒ หมายเลขโทรศัพท์ 081-143-2892
- ข้อ 8. หากข้าพเจ้า ได้รับการปฏิบัติไม่ตรงตามที่ระบุไว้ในเอกสารชี้แจงผู้เข้าร่วมการวิจัย ข้าพเจ้าจะ สามารถติดต่อกับประธานคณะกรรมการจริยธรรมสำหรับการพิจารณาโครงการวิจัยที่ทำใน มนุษย์หรือผู้แทน ได้ที่ อาจารย์ชัชฎา ชินกุลประเสริฐ โทร 02-649-5000 ต่อ 2252-3

/ ข้าพเจ้า.....

ข้าพเจ้าได้อ่านและเข้าใจข้อความตามหนังสือนี้โดยตลอดแล้ว เห็นว่าถูกต้องตามเจตนา
ของข้าพเจ้า จึงได้ลงลายมือชื่อไว้เป็นสำคัญพร้อมกับหัวหน้าโครงการวิจัยและต่อหน้าพยาน

ลงชื่อ

ลงชื่อ

(.....)

(.....)

ผู้ยินยอม

ผู้ให้ข้อมูลและขอความยินยอม/หัวหน้าโครงการวิจัย

ลงชื่อพยาน

ลงชื่อ

พยาน

(.....)

(.....)

ในกรณีที่ผู้เข้าร่วมการวิจัย อ่านหนังสือไม่ออก ผู้ที่อ่านข้อความทั้งหมดแทนผู้เข้าร่วมการวิจัยคือ

.....

จึงได้ลงลายมือชื่อไว้เป็นพยาน

ลงชื่อพยาน

(.....)

หมายเหตุ

1. กรณีผู้ยินยอมตนให้ทำวิจัย ไม่สามารถอ่านหนังสือได้ ให้ผู้วิจัยอ่านข้อความในหนังสือให้ความ
ยินยอมนี้ให้แก่ผู้ยินยอมตนให้ทำวิจัยฟังจนเข้าใจแล้ว และให้ผู้ยินยอมตนให้ทำวิจัยลงนาม หรือ
พิมพ์ลายนิ้วหัวแม่มือรับทราบ ในการให้ความยินยอมดังกล่าวด้วย



ใบแนะนำการเขียนแบบคำชี้แจงอาสาสมัคร (Information sheet) ควรประกอบด้วยหัวข้อดังต่อไปนี้

1. ชื่อโครงการ

การใช้แบบประเมิน Mini-BESTest เพื่อพยากรณ์การหกล้มในผู้สูงอายุ

2. ชื่อผู้รับผิดชอบโครงการ

นางสาวอัญมณี ยิ่งยงยุทธ ผู้ทำโครงการวิจัย คณะสหเวชศาสตร์ มหาวิทยาลัยศรีนครินทรวิโรฒ

หมายเลขโทรศัพท์ 081-143-2892 อีเมลล์ fongfinez@hotmail.com

3. เหตุที่ต้องทำวิจัยและเหตุผลที่ต้องการศึกษาในคน รวมทั้งเหตุผลที่อาสาสมัครที่ได้รับเชิญเข้าร่วมโครงการ

การหกล้มเป็นหนึ่งในปัญหาสุขภาพที่สำคัญและได้รับการยอมรับเป็นสาเหตุที่สำคัญที่ห้าของการบาดเจ็บและการเสียชีวิตในสูงอายุ การมีแบบประเมินเพื่อที่จะช่วยประเมินและระบุความเสี่ยงที่จะเกิดการหกล้ม และจะช่วยป้องกันการล้มและช่วยออกแบบโปรแกรมที่ควรปฏิบัติให้เหมาะสม แบบประเมิน Mini-BESTest ได้รับการออกแบบมาเพื่อประเมินความสามารถในการทรงตัวในผู้ป่วยทางระบบประสาท จึงจำเป็นต้องทำการศึกษาศาสมารถในการทำนายการล้มของแบบประเมิน Mini-BESTest ในผู้สูงอายุ

4. วัตถุประสงค์ของโครงการ

- 1) เพื่อศึกษาว่าแบบประเมิน Mini-BESTest สามารถทำนายความเสี่ยงในการหกล้มในผู้สูงอายุได้หรือไม่ โดยดูจากค่าของความไว, ความจำเพาะและระดับของความถูกต้องในการระบุผู้ที่มีประวัติการหกล้ม
- 2) เพื่อเปรียบเทียบความแตกต่างของคะแนนในผู้สูงอายุ ระหว่างกลุ่มหกล้มและไม่หกล้ม

5. ขั้นตอนและกระบวนการทำวิจัย

ผู้สูงอายุทั้งชายและหญิงที่มีสุขภาพดีที่ได้รับการคัดเลือกจากชุมชน ที่มีอายุอายุ 60 ปีหรือมากกว่านั้น และผู้เข้าร่วมต้องลงชื่อยินยอมในหนังสือให้ความยินยอมเข้าร่วมโครงการ (R02/1) โดยผู้เข้าร่วมมีคุณสมบัติดังต่อไปนี้

เกณฑ์การรับอาสาสมัครเข้าร่วมโครงการ (Inclusion criteria)

- (1) อายุ 60 ปีหรือมากกว่านั้น
- (2) สามารถเดินโดยไม่ต้องใช้เครื่องช่วยเดิน
- (3) สามารถที่จะดำเนินกิจกรรมในชีวิตประจำวันขั้นพื้นฐานได้โดยอิสระ
- (4) ไม่มีประวัติการเป็นโรคทางระบบประสาท

(5) ไม่มีอาการปวดเข่ารุนแรงที่รบกวนเดินในวันของการประเมิน

เกณฑ์การไม่รับอาสาสมัครเข้าร่วมโครงการ (Exclusion criteria)

(1) ได้รับยาที่มีผลต่อการทรงท่า

(2) ไม่สามารถปฏิบัติตามคำแนะนำ

(3) มีภาวะโรคหลอดเลือดและหัวใจ เช่น โรคหัวใจ ความดันโลหิตสูง หรือประจำตัว เช่น โรคเบาหวานที่ไม่ได้รับการรักษาและควบคุมโดยแพทย์

ขั้นตอนการทำวิจัย

- 1) ผู้สูงอายุที่ผ่านเกณฑ์คัดเข้าและเกณฑ์คัดออกแล้ว แสดงความยินยอมก่อนเข้าร่วมการวิจัย
- 2) ข้อมูลส่วนตัวถูกรวบรวมโดยใช้แบบสอบถามโดยผู้ประเมินคนที่ 1 และได้รับการทดสอบการรับรู้สิ่งที่ทำ ความเชื่อมั่นในการทำกิจกรรม ความแข็งแรงของกล้ามเนื้อ และความจำ
- 3) ผู้เข้าร่วมงานวิจัยจะได้รับการประเมินสัญญาณชีพและความดันโลหิตก่อนและหลังการทดสอบ จากนั้นจะได้รับการทดสอบความสามารถในการทรงตัว 2 แบบ โดยใช้เวลาในการประเมินทั้งหมด 35 นาที หากผู้เข้าร่วมวิจัยมีอาการเหนื่อยหรือล้า จะได้รับการพัก จนกว่าจะสามารถทำกิจกรรมในการประเมินต่อไปได้

6. ประโยชน์ที่คาดว่าจะเกิดขึ้นจากการทำวิจัย

1) ได้แบบประเมินที่ช่วยในการทำนายภาวะความเสี่ยงที่จะเกิดการหกล้มที่ครอบคลุมทุกกลไกที่ทำให้เกิดการหกล้มในผู้สูงอายุ

2) เพื่อช่วยลดความเสี่ยงที่ลดลงจะนำไปสู่การหกล้ม และเป็นแนวทางในการหาโปรแกรมป้องกันลดการบาดเจ็บที่เกี่ยวข้องกับการหกล้มและภาวะแทรกซ้อนในผู้สูงอายุ

7. สิ่งที่อาสาสมัครจะต้องปฏิบัติและไม่ปฏิบัติระหว่างการฝึก และระยะเวลาของการวิจัย

ต้องให้ความร่วมมือในการประเมิน

8. ความเสี่ยงหรืออันตรายที่จะเกิดขึ้นและหรือความไม่สะดวกสบายของอาสาสมัครที่อาจได้รับและมาตรการที่ผู้วิจัยเตรียมไว้ป้องกัน

ให้นักกายภาพบำบัด 1 คนคอยอยู่ด้านข้างของผู้เข้าร่วมวิจัย เพื่อระวังความปลอดภัย

9. กรณีเกิดภาวะแทรกซ้อนที่เกี่ยวข้องกับการวิจัยผู้วิจัยจะให้การดูแลรักษาพยาบาลหรือชดเชยอาสาสมัครอย่างไร

หากเกิดปัญหา ผู้วิจัยจะให้การปฐมพยาบาลเบื้องต้นและการดูแลโดยทันที

10. การให้ค่าตอบแทนเป็นเงิน ควรระบุจำนวนและจำนวนครั้งที่ให้อาสาสมัคร

ผู้เข้าร่วมวิจัยจะได้รับของตอบแทนการเข้าร่วมการวิจัย

11. การรักษาความลับเกี่ยวกับอาสาสมัคร

ข้อมูลของผู้เข้าร่วมงานวิจัยที่ได้ให้ไว้จะไม่ถูกนำมาเผยแพร่ต่อสาธารณะชน

12. สิทธิของอาสาสมัครในการถอนตัวออกจากโครงการเมื่อไรก็ได้ โดยไม่กระทบต่อการรักษาพยาบาลของอาสาสมัครที่เป็นผู้ป่วย

ผู้เข้าร่วมวิจัยสามารถถอนตัวออกจากโครงการเมื่อไรก็ได้

13. โครงการวิจัยได้รับความเห็นชอบจากคณะกรรมการจริยธรรมการวิจัยในมนุษย์ จากคณะสหเวชศาสตร์มหาวิทยาลัยศรีนครินทรวิโรฒ



APPENDIX J

ข้อมูลที่มาของผู้สูงอายุ

ตำบล	จังหวัด	จำนวน
ต.หนองเต็ง อ.กะสัง	บุรีรัมย์	26
ต.กระสัง อ.กะสัง	บุรีรัมย์	35
ต. จันทบเพชร อ.บ้านกรวด	บุรีรัมย์	19
ต.แกใหญ่ อ.เมือง	สุรินทร์	11
บ้านปรือ ต.ปรือ อ.ปราสาท	สุรินทร์	8
แสงพันธ์ อ.เมือง	สุรินทร์	38
ต.เขวาสินรินทร์ อ.เขวาสินรินทร์	สุรินทร์	2
ต.เจนีง อ.เมือง	สุรินทร์	3
ต.โคกสะอาด อ.ปราสาท	สุรินทร์	14
บ้านสำโรง ต.สำโรง อ.เมือง	สุรินทร์	10
บ้านจะบก ต.แกใหญ่ อ.เมือง	สุรินทร์	7
บ้านโคกจ๊ะ ต.สมุด อ.ปราสาท	สุรินทร์	21
ต.กังแอน อ.ปราสาท	สุรินทร์	5
บ้านแถม ต.ปรือ อ.ปราสาท	สุรินทร์	1

	ข้อมูลสุขภาพอื่นๆ	กลุ่มไม่หกล้ม(n=100)	กลุ่มหกล้ม(n=100)
สถานะ	โสด	0	3
	สมรส	66	57
	หย่าร้าง/แยกกันอยู่	2	2
	คู่สมรสเสียชีวิต	32	38
การศึกษา	ประถมศึกษา	97	98
	มัธยมศึกษาตอนต้น	2	0
	ปริญญาตรีหรือเทียบเท่า	1	2
อาชีพ	ค้าขาย	4	9
	เกษตรกร	68	66
	ข้าราชการบำนาญ/รัฐวิสาหกิจ	1	2
	ไม่ได้ประกอบอาชีพ	22	21
	อื่นๆ	5	2
โรคประจำตัว	ความดันโลหิต	19	29
	เบาหวาน	6	12
	หัวใจ	-	5
	เก๊าท์	2	3
	เข่าเสื่อม	2	2
	อื่นๆ	18	12
	ไม่มี	59	54
ปัญหาสายตา	ปกติ	43	53
	สายตาสั้น	12	14
	สายตายาว	45	33
ปัญหาทางสายตา	ไม่มี	74	77
	ต้อลม	6	5
	ต้อกระจก	14	15
	ต้อหิน	3	1
	ต้อเนื้อ	1	1
	จอประสาทตาเสื่อม	1	1
ยาที่ต้องรับประทาน	ไม่มี	54	50
	1 ชนิด	30	24
	2 ชนิด	6	14
	3 ชนิด	10	12



APPENDIX L

Random Sequence

A	BBS 1-7 , BBS 8-14, Mini-BESTEst 1-7, Mini-BESTEst 8-14
B	BBS 8-14, BBS 1-7, Mini-BESTEst 8- 14, Mini-BESTEst 1-7
C	Mini-BESTEst 1-7, Mini-BESTEst 8-14, BBS 1-7 , BBS 8-14
D	Mini-BESTEst 8- 14, Mini-BESTEst 1-7, BBS 8-14, BBS 1-7

Random Sequence

Random Sequence	A				B				C				D			
Subject Number	1	3	6	9	2	10	14	21	4	11	15	18	5	7	8	13
	12	17	19	25	22	23	26	31	27	28	30	32	16	20	24	29
	33	35	38	42	37	40	44	47	39	43	45	46	48	34	36	41
	49	52	54	58	50	55	57	60	53	56	62	66	51	59	64	65
	61	70	72	75	63	67	71	76	69	73	80	82	68	74	78	81
	77	83	88	92	79	86	90	93	84	87	91	94	85	89	95	96
	100	105	108	112	99	101	104	107	97	98	103	109	102	106	110	111
	116	119	125	128	113	117	120	126	114	122	123	124	115	118	121	127
	130	133	134	138	131	137	140	143	129	136	139	141	132	135	142	144
	145	150	152	156	147	151	155	157	146	148	153	158	149	154	159	160
	163	165	169	171	161	164	168	170	162	167	173	176	166	172	174	175
	179	183	184	187	177	180	188	190	181	185	189	192	178	182	186	191
	193	195			196	200			198	199			194	197		



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