BALANCE AND COORDINATION IN OLDER PEOPLE WITH MILD COGNITIVE IMPAIRMENT

BY

MISS SUPHANAN PUENGTANOM

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE

PHYSICAL THERAPY

FACULTY OF ALLIED HEALTH SCIENCES

THAMMASAT UNIVERSITY

ACADEMIC YEAR 2017

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THESIS

BY

MISS SUPHANAN PUENGTANOM

ENTITLED

BALANCE AND COORDINATION IN OLDER PEOPLE

WITH MILD COGNITIVE IMPAIRMENT

was approved as partial fulfillment of the requirements for

the degree of Master of Sciences

on April 30, 2018

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ABSTRACT

The aims of this study were: 1) to compare balance performance [Timed Up and Go (TUG) test, Timed Up and Go with Manual Task (TUG-Man), Timed Up and Go with Cognitive Task (TUG-Cog), Five Times Sit to Stand (FTSTS), Functional Reach Test (FRT), and Step Test (ST)], coordination performance [Nine Hole Peg Test (NHPT), Foot Tapping (FT)], and history of falls in twelve previous months between older people with and without mild cognitive impairment (MCI) and; 2) to determine the correlation between balance performance, coordination, and history of falls in older people with MCI.

Twenty-eight older people with MCI and 28 older people without MCI were recruited in the study. The study found that there were significant differences in all variables between the two groups. Older people with MCI have taken longer time of TUG with single and dual tasks, FTSTS, and NHPT, lower distance of FRT, lower number of steps performed in ST, and FT compared with older people without MCI. In addition, there was higher of number of fallers (have had at least 1 fall in the previous 12 months) in the group of older people with MCI than the other group. There were significant correlations between: 1) balance performance (measured by TUG, TUG-Man, FTSTS, and ST) and coordination (measured by FT); 2) balance performance (measured by TUG, TUG-Man, FTSTS, and ST) and falls history; 3) coordination (measured by FT) and falls history.

Older people with MCI have declined balance performance and coordination compared with older people without MCI. Assessment of balance and coordination as well as falls risk should be implemented as routine care for older people with MCI in order to prevent falls in this population. Findings of the correlations between balance performance, coordination and falls history of current study lead to clinical guide for evaluating falls risk which should include: balance measuring by FTSTS, TUG, TUG-Man, and ST; and coordination measuring by FT in older people with MCI.

Keywords: balance, coordination, falls, older people, mild cognitive impairment

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LIST OF ABBREVIATIONS

Symbols/Abbreviations	Terms
AD	Alzheimer’ s disease
CDR	Clinical dementia rating
CNS	Central nervous system
FT	Foot tapping
FTSTS	Five time sit to stand
FRT	Functional reach test
GDS	Geriatric depression scale
GDS	Global deterioration scale
LE	Lower extremity
MCI	Mild cognitive impairment
MMSE	Mini-Mental System Examination
MoCA	Montreal Cognition Assessment
MRI	Magnetic Resonance Imaging
NHPT	Nine Hole Peg Test
PD	Parkinson’s disease
PET	Positron emission tomography
ST	Step test
TGDS	Thai geriatric depression scale
TMT	Trial making test
TUG	Timed up and go test
TUG-Man	Timed up and go with manual task
TUG-Cog	Timed up and go with cognitive task

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CHAPTER 1
INTRODUCTION

1.1 Background

Nowadays, the growth of older population worldwide are increasing rapidly [1, 2]. By 2017, the number of Thai older people is projected to increase to 11 million (~17%) [3]. Increased amount of older population has raised awareness of its consequences. Due to the fact that older people's body systems generally get to stages of degenerations, several health conditions would occur and influence the population. Several common health conditions in older people caused by degeneration of nervous system which involves controlling movements of the body. Degenerative disorders of nervous system in older population generally caused on volume of brain, vasculature, and cognitive changes especially memory function [4]. One of the most recognized neuro-degenerative conditions in older people stated by World Alzheimer Report is dementia. In 2015, there were 46.8 million people worldwide diagnosed with the condition [5].

Mild cognitive impairment (MCI) is typically defined as pre-dementia or middle stage between older people with normally cognitive function and early dementia [6, 7]. Approximately 16.3% of older people aged greater than 65 years, diagnosed with MCI in which 15.8% of those would progress to dementia later [8], while there is only 1-2% of older people without MCI progress to dementia [9]. Diagnosis of MCI by Petersen's criteria has been recognized and widely used in both research and clinic. The criteria comprises of: 1) subjective memory complain, 2) objective memory impairment with adjustment of matching aged and education related healthy cognitive function, 3) expected general cognitive function, 4**)** able to perform activities of daily living, and 5) no dementia or Alzheimer disease [9]. Even though most symptoms of MCI present as cognitive impairments, older people with MCI have also been reported to have impaired physical performance including gait and balance changes which are factors increasing risk of falls in the population [10].

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Falls can happen in daily life. Falls in older people lead to more severe injuries than young faller [11]. Consequences of falls affect several aspects including: physical aspect (i.e. fractures, bruises, loss of functions, and morbidity) [12, 13]; and psychological aspect (i.e. depression, loss of self-confidence [13], and fear of falling [12]). Previous study reported that people with dementia had 7.58 higher risk of falls compared with healthy older people [14]. For people with MCI, previous study stated that people with MCI have 1.72 times higher chance of falls compared with general older people [15]. Although falls incidence in people with dementia is 4 times greater than those with MCI, falls prevention in people with dementia seems to be less effective than falls prevention implemented in healthy community-dwelling older people [16]. One of limitations that influencing effectiveness of falls prevention interventions is greatly impaired cognitive functions of people with dementia. If we could prescribe falls prevention program for people with early stage of cognitive impairment like MCI, greater effect of prevention program could be expected.

Previous systematic reviews have suggested that the most effective program for falls prevention is multifactorial intervention programs tailoring with results of falls risk assessment [16]. Most of the common falls risk factors in older people is balance deficit. Balance performance is abilities to maintain body or center of mass (CoM) over base of support (BOS) both static and dynamic movement [17]. Balance is complex task cooperation between sensory systems (afferent), motor systems (efferent), and central nervous system (CNS) integration processes [18-20].

There are some evidence of balance performance in older people with MCI compared healthy older people or dementia. Several studies founded balance impairment in older people with MCI [21-30]. Most of the previous studies assessed balance performance using only some functional balance tests such as siting to standing [23, 26, 29, 31-33], walking [21-24, 26, 27, 29, 31-36], turning [21-24, 26-29, 31-33, 36], standing on one foot [21, 23, 28, 32, 35, 37], and reaching [21] however, these did not cover all activities that commonly caused falls such as stepping. In addition, there are evidence suggested from previous studies that coordination abilities could be part of balance and falls risk factors in older adults [38, 39].

There are only a few evidence reported impaired coordination in people with MCI [37, 40-44] However, most of these studies assessed only fine hand coordination and not examined any falls or falls risk [40-42, 44]. A previous study was founded that interlimb coordination (wrists and elbows) task affected to postural sway [45]. Relationship between balance ability and arm coordination are associated with performance to correct posture or postural adjustment after external perturbations [46, 47].

Little is known about correlation between balance performance, coordination, and history of falls in older people with mild cognitive impairment. Effective prevention requires a better understanding of the causes of falls among older people with mild cognitive impairment. Therefore, empirical investigation is needed. The information would be beneficial for health care providers in order to plan an appropriate and effective intervention for falls prevention and management in older people with MCI.

1.2 Research Questions

1.2.1 Are there any differences in balance performance, coordination, and history of falls between older people with mild cognitive impairment and general healthy older people?

1.2.2 Are there any correlation between balance performance, coordination, and history of falls in older people with mild cognitive impairment?

1.3 Objectives

1.3.1 To compare balance performance, coordination, and history of falls between older people with mild cognitive impairment and general healthy older people.

1.3.2 To determine the correlation between balance performance, coordination, and history of falls in older people with mild cognitive impairment.

1.4 Hypotheses

1.4.1 There will be significant differences in balance performance, coordination, and history of falls between older people with mild cognitive impairment and healthy older people.

1.4.2 There will be significant correlation between balance performance, coordination, and history of falls in older people with mild cognitive impairment.

1.5 Benefits of the Study

1.5.1 Providing information regarding balance performance and coordination in older with mild cognitive impairment.

1.5.2 The comprehensive information of balance performance and coordination could assist in designing exercise or intervention program to decrease risk of falls in older people with mild cognitive impairment.

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CHAPTER 2
REVIEW OF LITERATURE

2.1 Ageing Population

2.1.1 Definition

The United Nations (UN) uses term "Older People" as people aged at least 60 years to refer to older people in developing countries, and for people aged at least 65 years to refer to older people in developed countries [(1)]. In level of community or countries, number of older people in the population has been used to define level of aged society as below: [(1)]

2.1.1.1 Aged Society

Aged society is referred to a proportion of older population aged ≥ 60 years (more than 10% of all populations) or aged ≥ 65 years (more than 7% of all populations).

2.1.1.2 Complete Aged Society

Complete aged society is referred to a proportion of older population aged ≥ 60 years (more than 20% of all populations) or aged ≥ 65 years (more than 10% of all populations).

2.1.1.3 Super Aged Society

Super aged society is referred to a proportion of older population aged ≥ 60 years (more than 28% of all populations) or aged ≥ 65 years (more than 20% of all populations).

Thailand became an 'aged society' since 2005. The country has been anticipated to be at stage of 'complete aged society' in 2021 and would become 'super aged society' in 2031 [(1)].

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2.1.2 Epidemiology

Nowadays, the growth of older population worldwide are increasing rapidly [1, 2]. In 1950, the older people worldwide (aged ≥ 60 years) had surpasses 205 million people. By 2012, the number of older people was nearly 810 million people and expected to reach 2 billion people by 2050 [2]. Similar trend of aging population has been shown in Thailand. There were 10.7 million older people in 2015 in which increased up to 16% of total population in Thailand. In 2015, older people in Singapore 18%, Thailand 16% and Vietnam 10%. The growth of older population in Thailand is second fast of Asian after only Singapore [1]. In addition, there has been predicted that in 2035, Thailand will have more than 20 million older people [48].

Life expectancy is defined as average number of years of populations to live [2]. Long life expectancy at present caused by the general reduction of birth rate and death rate. Thailand has been expected that in 2019, there would be first time that number of older people would be higher number of children population [1]. Average life expectancy for Thai population in 2017 is: 80.2 years for male and 83.5 years for female [3].

2.1.3 Consequence of Older People

Increased amount of older population has raised awareness of its consequences. Due to the fact that older people's body systems generally get to stages of degenerations, several health conditions have been occurred, in which affect to individuals, families, social, and government overall [49]. Increased age results in physiological changes, biological changes and cognitive/mental decline in which present as structural and functional degeneration. Some of these changes may effect on physical activity as well as quality of life [50]. Common ageing changes affecting health are listed below:

2.1.3.1 Musculoskeletal System

Musculoskeletal systems consists of the cartilage, ligament, bone, and muscle. Musculoskeletal changes in older people such as decrease bone mass (risk of osteoporosis), decrease muscle mass, decrease flexibility of muscle and joints. Therefore, the systems are clearly presented by physical changes (decrease physical activities, decrease muscle strength, and joint stiffness or limit range of motion) [51].

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2.1.3.2 Cardiovascular System

Cardiovascular system consists of the heart, arteries, vein, capillary, and blood. [52]. Result of this system changes is decreased maximum heart rate, decreased maximum oxygen consumption, reduce flexibility of capillary walls, and decreased heart rate [51].

2.1.3.3 Nervous System

Nervous system consists of central nervous system and peripheral nervous systems. Nervous system changes in older people are as follow:

1. Reduction in brain volume because of decrease cell body, and water/blood volume [51, 53].
2. Structure changes of some neuron types i.e. found neurotic plaque or neurofibrillary tangle [51, 53].
3. Increase reaction time or increase latency of sensory evoke potential which declines effectiveness of order from central nervous system (CNS) [51]. For example, increased reaction time detected from foot and hand coordination test [54].

2.1.3.4 Sensory System [51]

(1) Vision

Previous studies in older people founded eye lens thickness, eye lens is not clear, decrease elastic of eye lens, and color eye lens change to yellow. Effect to decrease visual performance all day, and especially at night.

(2) Vestibular

Vestibular system consists of semicircular canals (for angular acceleration), utriculosaccular system (for linear acceleration), vestibule-ocular reflex (maintain visual gaze during head movement), and vestibulospinal reflex (maintain head position while standing or upright position) [55]. Previous studies in older people founded hair cell loss and neuron loss in vestibular system which causes dizziness, vertigo, nystagmus, postural unstable, and increased falls risk [20, 55].

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(3) Somatosensory

Somatosensory inputs consist of cutaneous sense (touch and pressure) and proprioception sense (muscle spindle, golgi tendon, and joint capsule) [19].

Cutaneous sense impairment in older people founded neuron sensory receptor loss which perturb skin sensation (such as temperature, pain, pressure, etc.) and increase threshold of cutaneous sensations [56].

Proprioception sense receives data inputs from joint position sense (muscle fiber, golgi tendon, and joint capsule) during stand and movement. Proprioception impairment in older people commonly founded for example poor proprioception sense of ankle joint compared with younger adults [57]. In addition, proprioception impairment is one of factor contributing for postural instability or falls injuries [20].

(4) Balance

Balance impairment in older people are decline function between sensory systems (vision and vestibular), motor systems, and Central nervous system (CNS) integration processes [18-20]. This function deficit in older people shown by vertigo and dizziness (caused by postural hypotension) more than younger. Moreover, degeneration of sensory and motor functions are part of risk of falls in older.

2.2 Falls

2.2.1 Definition of Falls

World Health Organization (WHO) report defined ‘Fall’ as ‘an unexpected event in which the participant comes to rest on the ground, floor or lower level, excluding intentional change in position to rest in furniture, wall or other objects’ [58].

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2.2.2 Incidence and Prevalence Rates of Falls

The incidence rate of falls has been presented at approximately 28% in people aged 65 years and over [59]. Proportion of falls rate found 30% in older female (65 to 69 years), and increased to be over 50% in age of ≥ 85 years. While, proportion of falls in older men (aged 65-69 years) was at 13%, and increased to 30% in age ≥ 80 years [60]. Prevalence rates of falls increases with age: aged ≥ 55 years (24.3%) [61], aged ≥ 60 years (29.8%),[62] aged ≥ 65 years (35%) [63], in which female have higher rate of falls than male in all age [64]. The incidence rate of falls in Thailand during six months was founded at 10.4%, in which 45% of those have fallen two or more times [65].

2.2.3 Risk Factors of Falls

Falls risk factors cover characteristic, exposure or factors which increase falls occurrences or falls related injury when compared to no factors or exposure. Generally, falls risk factors could be classified into intrinsic and extrinsic factors [12].

2.2.3.1 Intrinsic Factors of Falls

Intrinsic factors mean factors which directly related to our bodies. Intrinsic factors of falls were summarized in four higher factors of falls: 1) demographic factors including age (older people increase reaction time in spatiotemporal variable and coordination time when compared to young people) [38, 39, 66], gender (older women fall more often than men), race; 2) systems factors including decrease gait, balance, and coordination performance [38, 66], decreased muscle strength, impaired vision, and cognitive decline; 3) symptoms/disease factors including dizziness or vertigo, cardiovascular disease, dementia, and depression, and 4) medications factors including psychotropic, diabetes medications, antiepileptic, and cardiovascular medications [12, 66]. A previous study summarized odd ratio for some falls risk factors as: women (odd ratio 3.10), aged more than 65 years (odd ratio =2.39), poor sleep ability (odd ratio =1.78) and lower power of grip strength (odd ratio =2.31) [61].

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2.2.3.2 Extrinsic Factors of Falls

Extrinsic factors could add to intrinsic factors, resulting in higher risk of falls. Summary and examples of extrinsic factors are: uneven ground surface, no fixation of carpets, inadequate light, lack or instability of handrail, irregular or high steps, high bed, low toilet seat, instability of chair and tables, pets, not fit in cloth and shoes, and obstacles. Additional socioeconomic factors (i.e. low level of education and low income, restricted access to health services, and no social supports) were also found to be risk factors of falls (12, 13).

2.2.4 Consequences of Falls in Older People

Consequences of falls upon severity of falls, shown in physiological or psychological effects. Falls consequences mostly resulted in physiological effects, i.e. bruises, abrasions, injuries in several segments, inactivity, loss of functions, and morbidity and fractures (12, 13). Falls consequences could also lead to psychological effect i.e., depression, loss of self-confidence, loss of self-efficacy (13), anxiety, social isolation, and fear of falling (12).

2.3 Balance

2.3.1 Principle of Balance

Balance is defined as an ability to maintain the body's center of mass (CoM) over base of support (BOS) during both static and dynamic movement (17). Balance is complex task cooperating between sensory systems (afferent), motor systems (efferent) and CNS integration processes (18-20).

2.3.1.1 The Sensory Systems

Sensory systems composed of vision from sight of eyes correlated CNS to image a spatial may around the environment. Vestibular about maintain and equilibrium during head movement relationship with vestibule-ocular reflex (maintain visual gaze during head movement) and vestibulospinal reflex (maintain head position while standing or upright position). Somatosensory including

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proprioception sense from body i.e. muscle spindles, Golgi tendon organs, and joint capsule as perception during contact as surface. The most important sensory systems influencing standing balance are vestibular, vision, and somatosensory systems [18-20]. Increased age lead to change or decline of sensory systems and that resulted in alteration in posture, balance, and gait performances (Table 2.1).

Table 2.1 Sensory systems effect to posture, balance, and gait

Sensory system	**Impact on sensorimotor system**	**Effect to posture, balance, and gait**
Visual	↓ Visual & depth perception ↓ Narrow of the visual field ↓ Adaptation in absence of light ↓ Dynamic visual performance	Postural instability, deviation Difficulty while walking Difficulty of gaze stabilization
Vestibular	↓ Hair cell ↓ Number of otoconia ↑ Otoconial fragments ↓ Neurons&cell bodies in vestibular ↓ Perception of head & body movement	↑ Postural instability ↓ Head & trunk stability ↓ Walk speed, stride length ↑ Stride time ↑ Energy for maintain unstable posture or walk
Somatosensory	↓ Proprioception sense (muscle spindles & golgi tendon organ) ↓ Perception of static and dynamic balance ↑ Threshold of joint sense	↑ Postural instability (especially on foam) ↑ Gait variability

Source: modified from Borel L and Alescio-Lautier B, 2014 [67]

2.3.1.2 The Motor Systems

The motor systems or motor movement of eyes, head, neck, trunk, and legs for maintain position during movement. Muscle power and reaction are ones of motor components that commonly measured in both clinic and research in areas of balance and postural control [18, 19]. Weakness of lower limbs and slower reaction time were found in older people [20]. Moreover previous studies also founded that delays of muscle latencies, increase joint stiffness or decrease range of motion, and delay of muscle responses can predict risk of falls [68].

2.3.1.3 Central Nervous System Integration

Central nervous system (CNS) is integration process by cerebral cortex, cerebellum cortex and brainstem as intermediate between afferent and efferent of body systems [18, 19]. Cerebellum have important role for body movements, posture, balance performance, and coordination [69]. This structure compares afferent of muscle action and order of brain in order to make movement occurred smoothly [53].Changes to older people of CNS detected by neuroimaging include white matter hyperdensity, decrease volumes of gray matter, decrease volumes of hippocampal volume, brain atrophy, cholinergic system dysfunction [70], or morphological changed (shrinking neuron pool and loss of myelin) [20] were found to be causes of cognitive decline in some or all cognitive function can predict to risk of fall [20, 70].

Maintain balance requires work together with all the three systems mentioned above (Figure 2.1).

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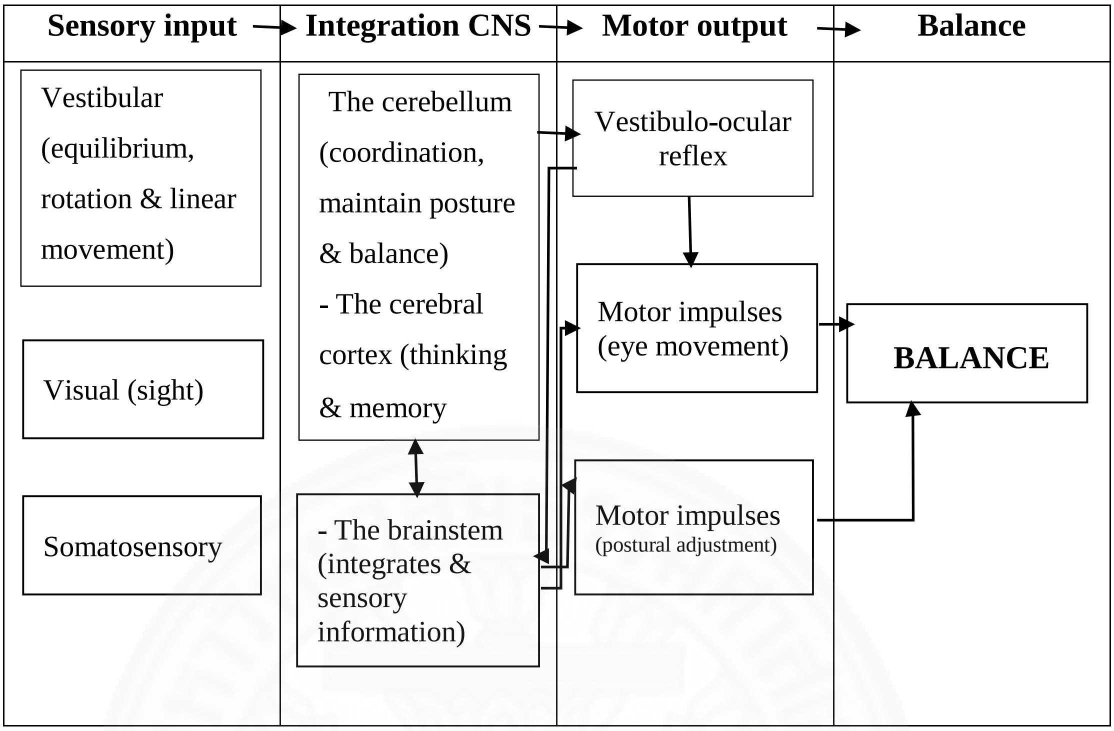

Figure 2.1 System of maintain balance

Source: modified from Watson MA and Black FO [18].

There are several balance measurement these days. Each measurement aims to measure different purposes and has been used in different populations. The benefits of balance measurements are baseline assessment, motivation tools, detect change in another time, and measure effective of treatment [71]. Show about common measurement as Table 2.2

Table 2.2 Summary of balance measurement in older people with and without cognitive impairment

Assessment Tests	Outcome Measurements	Descriptions	Cut-off score risk of falls (populations)	Sensitivity	Specificity
Timed Up and Go (TUG) test	Functional mobility, dynamic balance	Timed up and go (TUG) test will be used to measure mobility and dynamic balance. The participants will be instructed to rise from a chair, walk approximately three meters (9.86 foot), turn around at the line, walk back to the chair and sit down.	≥ 13.5 s (Older) (72)	31 %	74%
			≥ 15 s (Older) (73)	87%	87%
			≥ 11.5 s (PD) (74)	66%	62%
			≥ 13.5 s (MCI) (75)	20%	94.6%
Timed Up and Go with Cognitive task (TUG-Cog)	Functional mobility, dynamic balance combine other task	For the TUG with cognitive task, participant will be asked to rise from a chair while counting backward, walk approximately three meters, turn around at the line, walk back to the chair and sit down.	≥ 10 s (Older) (76)	70%	57%

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Table 2.2 Summary of balance assessment in older people with and without cognitive impairment (Cont.)

Assessment Tests	**Outcome Measurements**	**Descriptions**	**Cut-off score risk of falls (populations)**	**Sensitivity**	**Specificity**
Timed Up and Go with Manual tasks (TUG-Man)	Functional mobility, dynamic balance combine other task	For the TUG with manual task, participants will be ask to walk while holding a cup filled with water.	Score higher than TUG ≥ 4.5 s (PD) (77)	-	-
Step Test (ST)	Dynamic balance, Single leg stance	Step test will be used to measure dynamic single leg standing balance. The test will be performed with the participant in standing position. The participants will be instructed to step one foot fully on and off a 7.5 cm box as fast as possible in 15 seconds and repeat for the other side. Score is number of times the participant steps on and off in 15 seconds.	< 13 times (paretic side, chronic stroke) (78)	87%	87%
			< 11 times (non-paretic side, chronic stroke) (78)	100%	67%
			< 10 times (stroke)(79)	85%	95%

Table 2.2 Summary of balance assessment in older people with and without cognitive impairment (Cont.)

Assessment Tests	Outcome Measurements	Descriptions	Cut-off score risk of falls (populations)	Sensitivity	Specificity
Functional Reach Test (FRT)	Dynamic balance, maximum distance can reach forward	Functional reach test will be used to measure dynamic balance by measure the maximum distance that individual can reach forward. The test will be performed with the participant in standing position with arm at 90 degrees of shoulder flexion. Participants will perform three trials and then average the three trials.	< 20 cm (Older people) [80]	73%	88%
			< 25.4 cm (PD) [81]	30%	92%
			< 31.75 cm (PD) [82]	86%	52%
Five Times Sit to Stand (FTSTS)	Dynamic balance, strength of LE	Five time sit to stand test will be used to measure dynamic balance and functional muscle strength of lower extremity. The participants will be instructed to perform sit to stand for five times in a row, perform as quickly as possible with their arm crossed at their chest.	> 15 s.(Older people) [83]	55%	65%
			> 16 s. (PD) [84]	75%	68%
			≥ 15 s. (stroke)[79]	92%	69%

Table 2.2 Summary of balance assessment in older people with and without cognitive impairment (Cont.)

Assessment Tests	Outcome Measurements	Descriptions	Cut-off score risk of falls (populations)	Sensitivity	Specificity
Modified Clinical Test of Sensory Interaction and Balance (mCTSIB)	Static balance with sensory components	Participation are maintain standing balance in four conditions as firm surface (eye close, eye open) and form surface (eye close, eye open), hold 10 second/conditions. Participants will perform three trials and then average the three trials.	(Patient with balance disorder) (85)	95%	90%
Berg Balance Scale (BBS)	Static balance and fall risk	14 items: sitting to standing, sitting, standing, standing to sitting, transfers, standing with eye closed, standing with feet together, reaching forward, retrieving objet from floor, turning to look behind, turning 360 degrees, placing alternate foot, and standing one foot.	History of falls and BBS score ≤ 51/56 No history of falls and BBS score ≤ 42/56 (Older) (86)	91%	82%
			Score < 45/56 (87)	-	-

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Table 2.2 Summary of balance assessment in older people with and without cognitive impairment (Cont.)

Assessment Tests	Outcome Measurements	Descriptions	Cut-off score risk of falls (populations)	Sensitivity	Specificity
Tinetti Performance Oriented Mobility Assessment (Tinetti POMA)	Balance and gait ability related activities	16 items: 9 balance assessment (POMA-B); score is 16, 7 gait assessment (POMA-G); score is 12, and total score (POMA-T); score is 28.	POMA-B < 10/16, POMA-T score < 19/28 (older) [88]	-	-
			POMA-T score < 20 (PD) [89]	76%	66%
Fullerton Advanced Balance Scale (FAB)	Static and dynamic balance	10 items: standing with eye closed, reach forward to retrieve an object, turn 360 degrees in right and left directions, step up, tandem walk, stand on one leg, stand on form surface with eye closed, two foot jumping, walking with head turns, and reactive postural control	Score ≤ 25/40 (Older) [90]	74.6%	52.6%

Table 2.2 Summary of balance assessment in older people with and without cognitive impairment (Cont.)

Assessment Tests	**Outcome Measurements**	**Descriptions**	**Cut-off score risk of falls (populations)**	**Sensitivity**	**Specificity**
Mini Balance Evaluation Systems Test (Mini-BESTest)	Balance control systems	14 items about 4 domains anticipatory postural adjustments, reactive postural control, sensory orientation, and gait to consist	Score ≤ 17.5/32 (Older) [91]	64%	64%
			Score ≤ 20/32 (PD) [92]	88%	78%
Physiological Profile Approach (PPA)	Physiological functions and fall risk	PPA have two version: long form (comprehensive) and short form (screen) consist of postural sway, hand reaction time, strength of knee extensor muscle, leg proprioception, and visual edge contrast sensitivity.	Score < 0 (no risk of fall), 0-1 (mild risk of fall), 1-2 (moderate risk of fall), and > 2 (high risk of fall) (Older people) [93]	79%	-

Note: Mild cognitive impairment (MCI), Parkinson disease (PD), Lower extremity (LE)

2.3.2 Consequences of Poor Balance in Older People with Cognitive Impairment

Balance impairment in people with cognitive impairment or dementia affected to gait performance and increased risk of fall. The older people with cognitive impairment showed alterations both in gait (slower walking velocity, reduce step frequency, short step length, increase double support time, increase sway distance and increase trunk flexion) and balance [(94)]. A study found that another risk of fall in older people with cognitive impairment was slower reaction time and poor functional mobility [(31)].

2.4 Coordination

2.4.1 Principle of Coordination

Motor or limbs coordination is combination of body and limb segments. Coordination is an important component contributing activities or tasks performance. Effective balance control performance require intact coordination movement [(95)]. Brain map area in coordination tasks are common known cerebellum. Cerebellum has an important role in controlling movements, posture and balance [(69)]. This structure assists movement occur smoothly by comparing afferent of muscle action and order of brain [(53)]. Interlimbs coordination or coordination between hand and foot movement have found to be related with functions of several brain areas including: supplementary motor area (SMA), cingulate motor area (CMC), premotor cortex (PMC), primary sensorimotor cortex, and cerebellum respectively [(96)].

Increased age leads to physiological changes including limb coordination caused by sensorimotor impairments [(97)]. Impaired balance and coordination would lead to altered gait performance which most commonly found as slow walking [(98)]. Loss of balance in older people may increase arm or body swing in stance phase [(37)]. In young adult was founded that arm coordination task affected postural sway [(45)]. Relationship between balance ability and arm coordination are associated with performance to correct postural or postural adjustment after external perturbations [(46)].

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2.4.2 Reaction time

Reaction time is latency time from begin of external stimulus to response to the stimuli by muscle contraction. Generally older people response slower than younger [99]. Reaction time test determines sensorimotor performance in four processes: 1) mental processing time occur perception of stimulus, memory recognize; response selection and planning; 2) nerve conduction velocity or time; 3) movement time or action time of each movement; and 4) mechanical or tools response time [100]. Differences between hand and foot responses are that hand reaction time response quicker than foot as shorter distance of limbs from central nervous system [101, 102]. Previous studies have founded simple hand reaction time (SRT) increased with age. The reaction time is significant risk factor of falls [93]. Choice hand reaction time (CRT) found significant different between older people with and without history of falls [103]. A recently study has reported choice stepping reaction time (CSRT) significant predictor higher risk of falls in older people with MCI, but no significant in older people without MCI [104]. However, only study investigate CRST in older people has reported significant predictor falls [105].

2.5 Mild Cognitive Impairment

2.5.1 Definition

Mild cognitive impairment (MCI) is typically defined as pre-dementia or middle stage between older people with normally cognitive function and early dementia [6, 7]. Mild cognitive impairment has high progression to dementia or Alzheimer's disease (AD) [7]. Mild cognitive impairment (MCI) defines as a condition with subjective cognitive/ memory impairment, objective cognitive/ memory decline and memory complaints [106, 107]. General criteria for MCI are listed below [7, 108]:

1. Subjective cognitive complain/decline/deficits

2. Objective cognitive impairment at least one cognitive domain (memory, executive function and attention, language, or visuospatial skills)

3. Able to perform activities of daily living

4. No dementia or Alzheimer disease

Mild Cognitive Impairment (MCI) could also be classified specifically into Amnestic MCI in which the criteria presented below [6, 9, 109, 110]:

1. Subjective memory complain/decline/deficits

2. Objective memory impairment with adjustment of matching aged and education related healthy cognitive function

3. Expected general cognitive function

4. Able to perform activities of daily living

5. No dementia or Alzheimer disease.

2.5.2 Classifications

Classification of MCI divided by sign and symptom includes amnestic memory problems (aMCI), single domain (snMCI) and multiple domain (mdMCI). Patient with MCI symptom association with vascular disease (MCI with cerebrovascular disease (CVD), abnormal of movement strategies with parkinson disease (MCI with parkinsonism), abnormal of neuropsychiatric in mood or behavior (MCI with neuropsychiatric symptoms), irregular mood or change (MCI with depressive), abnormal of behavioral and psychotic (MCI with behavioral and psychotic symptoms) [111]. There are four common types of MCI [6, 9, 112, 113]:

1. Amnestic MCI, memory problems only (aMCI-sd),

2. Amnesic MCI, multiple domain with memory problems (aMCI-md),

3. Non-amnesic MCI, single domain but no memory problems including language, executive functions or visuospatial functions domains (non-aMCI-sd), and

4. Non-amnesic MCI, multiple domain but no memory problems including language, executive functions or visuospatial functions domains (non-aMCI-md).

Summary of subtype MCI according by memory complaint, etiology, pathology, and long terms effects are shown in the Table 2.3.

Table 2.3 Summary of subtype MCI according by memory complaint, etiology, pathology, and long terms effects

Variable	Amnestic MCI	Non-amnestic MCI
Memory complaint	Memory impairment/deficit	Non-memory impairment/deficit
Etiology	Neurological with degenerative disease APOE e4	Vascular disease Cerebrovascular disease
Pathophysiology	Neurological with degenerative disease Amyloid B plaques Neurofibrillary tangles Hippocampal atrophy	Cerebrovascular disease Cerebral infraction Subcortical infraction White matter hyperdensities
Long terms effects	Alzheimer disease (AD)	Vascular disease of dementia Dementia with lewy body Frontotemporal dementia

Source: modified from Robert et al in 2013 (7)

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2.5.3 Pathophysiology

Pathology for MCI is quite similar with older people who has normal cognition but involve gryrophilic grain disease, hippocampal disorder or abnormal of cerebrovascular [113]. Several methods could be used for diagnoses testing for MCI.

Neuroimaging could assess pathological brain changes. To investigate morphology and metabolism of the whole brain, Magnetic Resonance Imaging (MRI) and Positron Emission Tomography-scan (PET-scan) could be used. Magnetic resonance imaging (MRI) is a medical imaging technique used in radiology to picture anatomy and physiological processes of the body structure. In case of MCI, findings from MRI could include: lesion at the medial temporal lobe, entorhinal cortex, hippocampus, posterior cinguate gyrus [113] as well as in the middle frontal gyrus and superior frontal gyrus [35]. In case of non-specific MCI, MRI could find atrophy of the whole brain, hippocampal, entorhinal cortex. Additionally, several studies also found ventricular enlargement, gray/white matter atrophy, and cortical thickness [114, 115] in brain of older people with MCI.

Biomarkers have been used for diagnosis or predicting prognosis to dementia. Those commonly used are: apolipoprotein E (APOE), β amyloid 1-42, CSF total-T and phosphorylated tau 181 [106, 115].

Amyloid-PET scans; positron emission tomography (PET) brain scan, thereby MCI have revealing the presence of amyloid plaques in the brains indicating increased beta-amyloid (AB) in the lateral of frontal cortex, posterior cingulate gyrus cortex, both side of parietal lobes and the lateral of temporal lobe [113]. In early MCI, metabolic disorder found in temporal and parietal region. Shrinking of hippocampus has found to be related with progression from MCI to dementia [9]. Another indicator for progression of MCI to dementia is Apolipoprotein ε4 allele status [8, 115].

2.5.4 Incidence and Prevalence of MCI

Regarding prevalence and incidence of mild cognitive impairment (MCI), prevalence of MCI have twice of dementia. Several studies found correlation between MCI occurrence and age and education level. A study adjusted rate of MCI according to age and reported that incidence at 3% at age 60 year old and increase to 15% at age 75 years [111]. Additional risk factor of incidence MCI, included old age, APOE 4 allele, cardiovascular disease, diabetes type two, skin black, stroke or vascular disease [7], gene, social environment and activities in daily life [116]. As same as poor physical performance were affected with high risk from normal cognitive to dementia [117].

Incidence rate of MCI 1000 person per year were 47.9 (21.5 to 71.3), aMCI were 15.2 (8.5 to 25.9) [113]. A recent studies reported incidence rates of aMCI 96.9 in 1000 person per year [118]. A longitudinal study compared incidence of MCI between clinic and community settings founded that incident rate at clinic setting was 30 % (17% to 54%, mean years follow up 2.83±2.13) while at community setting was 5 % (3% to 6%, mean years follow up 4.60±2.29) [119] . From the same study, the incidence of MCI was 16.3% of older people (averaged follow up were 4.3 years) in which 15.8% of those would progress to dementia later [8].

Mild cognitive impairment (MCI) progress to dementia or Alzheimer disease (AD) at rate 10% to 15% per year, in which higher than those with normal cognition that has progression at rate 1% to 2% per year [9, 109].

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2.5.5 Diagnosis and Cognitive Measurements

Mild cognitive impairment diagnosis could be done with several assessment tools. Generally used criteria for MCI diagnostic cover three main aspects: 1) cognitive complaint, cognitive decline, or cognitive impairment (cognitive domains is memory, executive function and attention, language and visuospatial functions); 2) ability normally activities daily life; and 3) no dementia [7, 109, 112]. Another common MCI diagnostic criteria described by Petersen et al in 2001, 2004 [9, 108] covers five main points including:

1. Memory complaints assessed by self-report or information-report,
2. Normal cognitive function assessed by MMSE, CDR and GDS,
3. Memory declined assessed by neuropsychological test
4. Activities of daily living (ADL) assessed by interview, questionnaire about ADL or Instrumental activities of daily living (IADL),
5. Dementia diagnosis, exclusion criteria in these diagnosis assessed by MMSE, CDR, GDS score.

Assessment tools used in MCI diagnostic are detailed below:

2.5.5.1 Mini Mental State Examination (MMSE)

Mini Mental State Examination (MMSE) developed by Folstein et al in 1975 [120] consists of 30 items covering eleven cognitive domains: orientation, registration, attention and calculation, recall, naming, repetition, comprehensive, writing and construction. Cut-off score, most studies used scoring $\geq$ 24, but if score adjusted with education level for cut-off score $\geq$ 23 or $\geq$ 26 [6]. It has been shown to be the most common test for cognitive screening in older people with cognitive decline [121].

Mini Mental State Examination- Thai versions (MMSE-Thai 2002) has been developed specifically for Thai people by Thai Cognitive Test Development Committee 1999 [122]. The cut-off score divided into three levels according to education levels as shown in Table 2.4 [122].

Table 2.4 Cut-off score of MMSE-Thai 2002

Education level	Score	
	Cut-off	Full score
Older people did not study (Can't read and write)	≤ 14	23 (Did not do item 4, 9, 10)
Older people who studies in elementary school	≤ 17	30
Older people who completed elementary school	≤ 22	30

2.5.5.2 The Montreal Cognitive Assessment (MoCA)

The Montreal Cognitive Assessment (MoCA) was developed by Nasreddine Z., assessing cognitive function rapidly administration test about ten minutes with mild cognitive deficit. Total score is 30 points, 11 domains include visuospatial function, executive function, naming, memory recall, attention, orientation time or place, language, recall memory and abstraction task. Popular with patient cognitive decline i.e. Stroke, Dementia, Brain tumor, Parkinson disease, etc. MoCA score of 26 or higher is normal cognitive function. Examination of screening test between MoCA and MMSE in MCI founded, MoCA had a sensitivity to detect MCI 90% more sensitivity than MMSE had a sensitivity 18%. Whereas MoCA had a specificity to detected mild AD 100% more than MMSE 78%. Interpretation of applied MoCA had high sensitivity more than MMSE in clinical setting [(123)]. Moreover, these study have divided the severity level of cognitive impairment is score 22-30: no cognitive impairment, score 17-21: mild cognitive impairment and score 0-16: severe cognitive impairment or dementia [(124)].

The Montreal Cognitive Assessment-Thai (MoCA-T) was modified from the original MoCA to be suitable for Thai people by Solaphat Hemrungrojn in 2011. The Thai version has found to be good internal consistency and high correlation with MMSE-Thai. Cut-off score used as criteria for older people with MCI are: normal cognition ≥ 25, MCI < 25 (sensitivity 0.8, specificity 0.8), and dementia < 22 (sensitivity 1.0, specificity 0.98). Scoring differently form level educations low grade 6 by adding 1 point to achieved score (125).

2.5.5.3 The Clinical Dementia Rating (CDR)

The Clinical Dementia Rating (CDR) scale developed by Hughes in 1982, examines two domains: cognitive domain (memory, orientation, and problems solving) and function domains (community, home & hobbies and personal care). The evaluation scoring were 5.0 point rated by semi-structure interview (126). Interpretation of the score are: normal cognitive function (CDR 0), mild cognitive impairment (CDR 0.5), mild dementia (CDR 1), moderate dementia (CDR 2), and severe dementia (CDR 3) (9, 110).

2.5.5.4 The Global Deterioration Scale (GDS)

The Global Deterioration Scale (GDS) developed by Barry Reisberg in 1982 (also called the Reisberg scale). It assesses cognitive function by classification of primary degenerative dementia into seven stages: 1) normal cognitive function (GDS1) which is normally clinical, no complaints of memory decline; 2) lightly mild cognitive decline (GDS2) which is subject complaints in memory domain forgetting about person, place or time but would not present at the time of clinical interview; 3) mild cognitive deficit (GDS 3) which is a stage beginning of memory deficit, forget person, place and time, clinical assessment could detect the deficit, and these affect living in society; 4) moderate cognitive deficit (GDS 4) where more memory deficit stage 3 plus no longer perform complex tasks correctly and efficiently; 5) moderate to severe cognitive deficit (GDS5) which is early dementia where difficultly recalling in name of family, places, season, etc.; 6) severe cognitive deficit (GDS6) which is stage of middle dementia where more memory deficit presented,

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difficult counting number forward and backward, and changing in personality and emotionality; and 7) very severe cognitive deficit (GDS7) which is late stage of dementia where patient has inability to speak and communication with other people [9, 127]. Table 2.5 summarizes assessment tools using for diagnostic of MCI.

Table 2.5 Summary cognitive function assessment tools

<table>
<tr><th>Stage of Cognitive Functions</th><th>Mini Mental State Examination (MMSE) [120]</th><th>The Montreal Cognitive Assessment (MoCA) [124]</th><th>The Clinical Dementia Rating (CDR) [110]</th><th>The Global Deterioration Scale (GDS) [127]</th></tr>
<tr><td>Normal cognition</td><td>24-30</td><td>22-30</td><td>0</td><td>1</td></tr>
<tr><td>Mild cognitive impairment</td><td>18-23</td><td>17-21</td><td>0.5</td><td>2</td></tr>
<tr><td>Mild dementia</td><td rowspan="3">0-17</td><td rowspan="3">0-16</td><td>1</td><td>3-5</td></tr>
<tr><td>Moderate dementia</td><td>2</td><td>6</td></tr>
<tr><td>Severe dementia</td><td>3</td><td>7</td></tr>
<tr><td>Sensitivity (%)</td><td>18</td><td>90 [123]</td><td>-</td><td>-</td></tr>
<tr><td>Specificity (%)</td><td>78</td><td>100 [123]</td><td>-</td><td>-</td></tr>
</table>

2.5.6 Sign and Symptom in MCI

Cognitive dysfunction (attention and executive functions) has related to psychological functions including neuropsychiatric disturbances and physiological functions which comprise of poor physical performance, poor balance, gait changed affect to reduce quality of life, restriction of activities, and falls [10, 128].

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2.5.6.1 Psychological Aspects

Neuropsychiatric impact of mild cognitive impairment are behavior and mental symptoms. The most common sign and symptoms presenting in individual with MCI are; 1) depression (felling sad or having a depression mood) (129); 2) Sleep disorder (sleep problems; sleeping too much or not); and 3) apathy (lack of motivation in self-esteem and all activities). Other sign and symptoms are anxiety, delusions, hallucinations, aggressions and agitations (130). Having neuropsychiatric symptom in particular depression found to be a risk factor for progression from MCI to dementia. (115). Depression could also affect the reaction time (slower reaction time speed) in older people with MCI, in which could be one factor affecting activities of daily living or falls (131).

2.5.6.2 Physiological Aspects

Physical function is ability to perform functions (such as walking, running, climbing, etc.). Assessment of physical function includes functional ability, strength, agility, and endurance. Several studies have reported impaired physical function in older people with MCI assessed by senior fitness test which included strength of upper and lower extremity (chair stand test and arm curl test), flexibility of upper and lower extremity (back scratch and chair sit and reach), dynamic balance (eight foot up and go test) and aerobic capacity (two minute walk test) (26). Association of physical performance with quality of life has been reported. Poor physical function reduces quality of life. In addition, increased limitations of physical and mental functions lead to increased medical expenses (132).

(1) Balance in MCI

Balance is defined as an ability to maintain the body's center of mass (CoM) over base of support (BOS) during both static and dynamic movement (17). Alteration in balance results in gait disturbance and limit of the activities of daily life (55).

Controlling balance has found to be correlated with levels of cognitive impairment [28]. Older people with MCI reduced balance control while walking with cognitive tasks [133]. Previous studies have reported decreased motor performance when performing with cognitive task [27, 32]. Performing Timed up and go test while doing a cognitive task has shown to be challenged in people with MCI in which time taken to perform the tasks was longer than performing only TUG test or performing TUG with manual task [27]. Older people with MCI also presented to have impaired balance as shown as increased sway speed during standing on force platform [25, 134-136]. Some studies also reported that older people with MCI had greater maximum sway distance, average sway speed, and trajectory in condition with eye closed [25]. Balance dysfunction has been found to be one important risk factors of falls [137]. Summary of material and method in physical assessment were shown in Table 2.6.

(2) Coordination in MCI

Changed coordination in older people, disturbed interlimbs coordination of movement both upper and lower limbs. Moreover, initial center of mass stability has been reported to be related with upper limb coordination [47, 138].

Only few studies investigated coordination in older people with MCI. These studies assessed: 1) finger to nose, pronation to supination, mass grasp, finger opposition, heel on shin, and foot tapping [37, 43]; 2) nine hole peg test (fine movement or finger dexterity) [44]; and 3) fine movement or finger motor controls (handwriting) [40-42]. Results of the studies supported that older with MCI were slower, and less smooth [37, 40-44].

(3) Falls in MCI

Falls has been commonly defined as “an unexpected event in which the participant comes to rest on the ground, floor, or lower level” [139]. Consequences after falling including abrasions, bruises, fracture of the hip, forearm, arm, and pelvis regions [140]. Recent review reported a conceptual framework between cognitive impairments (older people with normal cognition, MCI, and dementia) and falls. The review concluded that cognitive impairment which would progress to

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dementia could have falls, fracture & immobility. At the same time impaired mobility & gait which would progress to falls, fracture & immobility could relate with cognitive decline (i.e. dementia) (Figure 2.2).

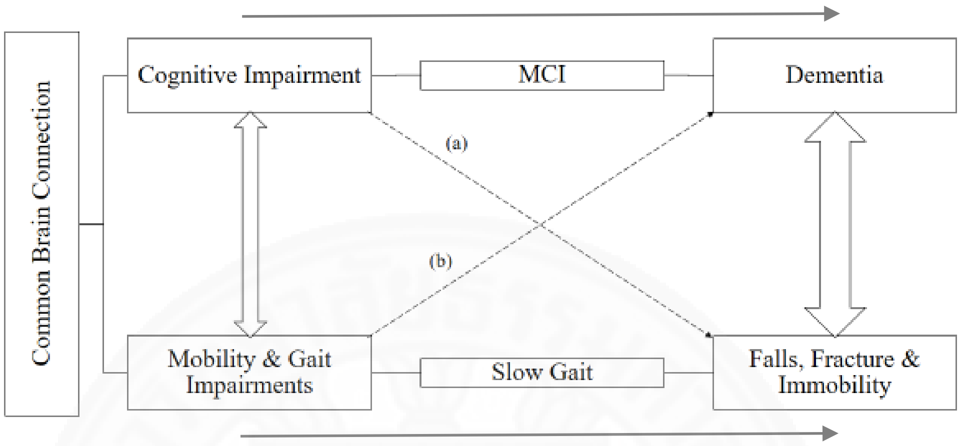

Figure 2.2 Common brain connection between cognitive impairment and falls
(a) Cognitive impairment predicts poor mobility and gait impairment, and falls,
(b) Mobility and gait impairments predict progression of cognitive decline to dementia.
Source: modified from Montero-Odasso et al [141].

Older people with MCI living in community have 1.72 times higher risk of falls compared with general community-dwelling older people. When focusing on older people with amnestic MCI (aMCI), there has been reported 1.98 times higher risk of falls than older people with non-amnestic MCI (non-aMCI), and 1.27 time greater risk of falls than general older people [15]. Risk of falls have related with the severity of cognitive impairment. [142, 143]. A study of older people in nursing home has reported risk of falls in normal cognition at 34%, in people with mild cognitive impairment (35%), moderate and severe cognitive decline (40% and 50% respectively) [144]. The systematic review about falls risk in older people with cognitive impairment has summarized risk factors of falls. These consist of: impaired motor or/and functions, impaired vision, abnormal of behavioral disturbances, stage and severity of cognitive decline, fall history, neuroleptics, and low bone density. The great risk of falls reported in older people with MCI are: motor impairment influencing balance, coordination and gait [137].

Table 2.6 Material and methods of cognitive & physical assessments in older people with mild cognitive impairment studies

Authors (years)	Participants	Cognitive assessments	Physical assessments	Results
Kluger A, et al. (1997)[43]	25 older people with MCI, 25 patient with AD, 41 older people with normal cognition (NC)	- MMSE - Global Deterioration Scale (GDS)	- Gross motor function -Gross motor speed (finger & foot tapping speed) -Steadiness (hand & head) -Strength - Fine motor function (Purdue and grooved pegboard) - Complex motor function	- MCI significant ↓ hand steadiness - MCI significant difference all outcome (fine motor function, complex motor function) compare NC
Franssen EH, et al. (1999) [37]	69 older people with MCI, 101 patients with mild AD, 195 normal cognition	- MMSE - Global Deterioration Scale (GDS)	- Single leg stance (SLS) - Tandem walk (TW) - Foot tapping (FT) - Alternate pronation and supination (PS) - Finger to thumb tapping (FTH)	- Mild AD and MCI significant different normal cognition in all test - MCI Vs normal cognition significant ↑ TW, FT, FTH, and specially PS

Table 2.6 Material and methods of cognitive & physical assessments in older people with mild cognitive impairment studies (Cont.)

Authors (years)	Participants	Cognitive assessments	Physical assessments	Results
Petterson AF et al. (2005) [32]	59 older people with MCI, 22 patients with AD, 26 patients with other dementia, and 33 with normal cognitive impairment	- MMSE	- The Frenchay Activities Index (FAI) - Berg Balance Scale (BBS) - Falls Efficacy Scale (FES) - TUG and TUG manual - Talking while walking (TWW) - Tinetti gait	- AD significant ↓ motor performance and ↓↓ dual tasks (TWW) but not in MCI
Liu-Ambrose T et al. (2008) [30]	72 older people with MCI, and 82 normal cognition	- MMSE cut off ≥ 24 - MoCA cut off < 26	- Physiological Profile Assessment (PPA): Postural sway Strength of quadriceps m. Reaction time Proprioception Edge contrast sensitivity	- MCI Vs Non-MCI significant ↑ composite of PPA scores, ↑ postural sway, and ↓ three executive function test

Table 2.6 Material and methods of cognitive & physical assessments in older people with mild cognitive impairment studies (Cont.)

Authors (years)	Participants	Cognitive assessments	Physical assessments	Results
Eggermont L H, et al. (2010) (33)	22 older people with MCI, 22 patient with AD, 22 older people with normal cognition	- MMSE - CDR	- 4 meter time walk test (4MWT) - TUG - Sit to stand test (STS)	- MCI & AD significant lower of 4MWT than controls - AD worse time score in TUG - No significant different all groups of STS
McGough EL et al. (2011) (24)	201 older people with aMCI	- MMSE, CDR Executive function (TMT-B, stroop word color test)	- Gait speed in 8 foot - TUG	aMCI correlation with executive function, ↓ gait speed & ↓ mobility (TUG)

Table 2.6 Material and methods of cognitive & physical assessments in older people with mild cognitive impairment studies (Cont.)

Authors (years)	Participants	Cognitive assessments	Physical assessments	Results
Makizako H et al. (2013) (35)	42 older people with MCI: faller (n=11), non-faller (n=31)	- MMSE - Clinical Dementia Rating (CDR)	- Knee extensor strength with HHD (peak torque) - One leg standing test (OLS) - Walking speed (5 m.) - Fall within 12 months	- Faller VS Non-fall significant ↓ OLS, ↑ history of falling - No significant difference in ↓ gait speed, ↓ knee extension strength
Tangen G et al. (2014) (28)	33 older people with MCI, 99 patients with mild AD, and 38 patients with moderate AD	- MMSE - TMT-A, TMT-B - The Clock Drawing Test (CDT)	- BESTest scales (6 domains, 36 items)	- ↓ BESTest significant difference of moderate AD > mild AD > MCI - TMT-B correlate with BESTest

Table 2.6 Material and methods of cognitive & physical assessments in older people with mild cognitive impairment studies (Cont.)

Authors (years)	Participants	Cognitive assessments	Physical assessments	Results
Lee SH et al. (2016) [26]	87 older people with MCI, and 356 with non-MCI	- MMSE	- Chair stand test - Arm curl test - Back stretch test - Chair sit and reach test - Eight foot up and go test - Six minute walk test	- MCI Vs non-MCI - significant of MMSE, back stretch test and eight foot up and go test
De Paula J, et al. (2016) [44]	34 older people with aMCI, 32 patient with MDaMCI, 38 patient with mild AD, 20 older people with normal cognition (NC)	- Mattis Dementia Rating Scale	- Nine-hole peg test (NHPT) General activities of daily living scale (GADL) and Instrumental ADLs	- No significant difference in NPHT between NC-aMCI, aMCI-MDaMCI, MDaMCI-AD - Significant difference in NPHT between control-MDaMCI, aMCI-AD - Correlate with NPHT and self-care ADLs

Table 2.6 Material and methods of cognitive & physical assessments in older people with mild cognitive impairment studies (Cont.)

Authors (years)	Participants	Cognitive assessments	Physical assessments	Results
Taylor M E, et al. (2014) [31]	174 cognitive impairment no specific	- MMSE - Boston naming test - Trail marking test (TMT)	- Sensorimotor function (visual contrast sensitivity, grip strength, proprioception, knee extension strength, and hand reaction time) - Standing balance (sway, tandem with eye close and eye open) - Functional mobility (coordination, TUG, FTSTS, gait velocity)	Higher fall rates correlate with slow reaction time, poor stand balance, and poor functional mobility
Blackwood J et al. (2016) [29]	26 older people with MCI, and 21 normal cognition	- MoCA cut off scores ≥ 26	- FTSTS - TUG test - Gait speed	- MCI: correlate with TUG & gait speeds

Table 2.6 Material and methods of cognitive & physical assessments in older people with mild cognitive impairment studies (Cont.)

Authors (years)	Participants	Cognitive assessments	Physical assessments	Results
Bortoli et al. (2015) [23]	9 older people with MCI, 12 patients with mild dementia (MID), 7 patients with moderate dementia (MOD) , 5 patients with severe dementia (SD)	- MMSE - CDR	- TUG – risk of falls - BBS – balance - Barthel index - functionality	- MCI correlate with balance (BBS) - Dementia correlate with balance (BBS), risk of falls (TUG), and functionality (Barthel index)
Borges S et al. (2015) [27]	42 older people with MCI, 26 patients with AD, and 36 normal cognition	- MMSE + CDR - Short Cognitive Test	- TUG single task - TUG cognitive - TUG manual - Triple TUG (manual plus cognition)	- TUG with cognitive tasks (Triple TUG & TUG cognitive) complicated task more than TUG without cognition in AD > MCI > control

Table 2.6 Material and methods of cognitive & physical assessments in older people with mild cognitive impairment studies (Cont.)

Authors (years)	Participants	Cognitive assessments	Physical assessments	Results
Borges S et al. (2015) [145]	42 older people with MCI, 26 patients with AD, and 36 normal cognition	- MMSE + CDR - Short Cognitive Test	- TUG single task - Falls history	- MCI Vs control Significance difference of TUG and falls history
Ansai JH, et al., (2017) [146]	40 older people with MCI, 38 patients with AD, and 40 normal cognition	- MMSE - GDS-15	- 10 meter walk test - TUG - TUG with manual task - Falls history at last year	- MCI Vs control no significance difference in TUG and TUG with manual task but significance in falls history - AD & control significance difference in TUG with manual and falls history

Table 2.6 Material and methods of cognitive & physical assessments in older people with mild cognitive impairment studies (Cont.)

Authors (years)	Participants	Cognitive assessments	Physical assessments	Results
Fujisawa C, et al. (2017) (21)	273 older people with aMCI, 181 patients with mild AD, 197 patients with moderate AD, and 210 normal cognition	- MMSE - FAB - GDS15	- Functional reach (FR) - One leg stance (OLS) - Timed up and go (TUG) - Tandem test (TG) - Grip strength (GS)	- aMCI Vs control significance difference of FR, OLS, TG - control Vs mild AD significance difference of FR, OLS, TG - control Vs moderate AD significance difference of FR, OLS, TG, TUG - aMCI Vs mild or moderate AD significance difference of FR, TUG, TG, GS - mild AD Vs moderate AD significance difference TUG

CHAPTER 3
RESEARCH METHODOLOGY

This chapter focuses on research methodology that was used to examine differences in balance performance, coordination, and history of falls between older people with mild cognitive impairment and healthy older people and to determine correlation between balance performance, coordination, and history of falls in older people with mild cognitive impairment. The details of participants, selection criteria, sample size, procedures, instrumentation, outcome measures, and statistical analysis were described in this chapter.

3.1 Study Design

This study was a cross sectional study.

3.2 Participants

3.2.1 Older people with mild cognitive impairment defined by Petersen's criteria [9]

3.2.2 Community-dwelling older people without mild cognitive impairment

The criteria for including participants in the study are as follows:

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3.3 Selection Criteria

3.3.1 Participants with MCI

3.3.1.1 Inclusion Criteria

1. Age 60 years and older.

2. Being diagnosed with mild cognitive impairment according to Petersen et al 2001 criteria defining Amnestic MCI [9].

3. Not being diagnosed with dementia or having Mini-Mental State Examination Thai (MMSE-Thai 2002) >14/23 (older people did not graduate any school), >17/30 (older people who studied in elementary school), and >22/30 (older people who completed elementary school)[122]; and Montreal Cognitive Assessment (MOCA-Thai version) score between 17-21/30 [124].

4. Being able to walk independently without any gait aids for at least 10 meters.

5. Not being diagnosed with cognitive dysfunction apart from MCI, or serious conditions (such as Parkinson's disease, history of cerebral disorder, significant cardiovascular disease, untreated significant hypertension, alcohol or drug abuse, untreated impaired vision and hearing, and significant muscle or joint disease, significant diabetic, significant abnormal alignment of knee and ankle) [37] that might affect balance and walking performance.

3.3.1.2 Exclusion Criteria

1. Having pain or discomfort during any assessment.

2. Potentially having depression condition classified by having score of Thai Geriatric Depression Scale (TGDS-15) >5/15 scores [147].

3. Having proprioception sense impairment.

Ref. code: 25605912030540QOI

3.3.2 Participants without MCI

3.3.2.1 Inclusion Criteria

1. Age 60 years and older.

2. Not being diagnosed with cognitive impairment or having Mini-Mental State Examination Thai (MMSE-Thai 2002) >14/23 (older people did not graduate any school), >17/30 (older people who studied in elementary school), and >22/30 (older people who completed elementary school)[122]; and Montreal Cognitive Assessment (MOCA-Thai version) between 22-30/30 [124].

3. Being able to walk independently without any gait aids for at least 10 meters.

4. No being diagnosed with cognitive dysfunction, or serious conditions (such as Parkinson's disease, history of cerebral disorder, significant cardiovascular disease, untreated significant hypertension, alcohol or drug abuse, untreated impaired vision and hearing, and significant muscle or joint disease, significant diabetic, significant abnormal alignment of knee and ankle) [37] that might affect balance and walking performance.

3.3.2.2 Exclusion Criteria

1. Having pain or discomfort during any assessment.

2. Potentially having depression condition classified by having score of Thai Geriatric Depression Scale (TGDS-15) > 5/15 score [147].

3. Having proprioception sense impairment.

Ref. code: 25605912030540QOI

3.4 Sample Size

The sample size was calculated using the following formula:

$$n = (\frac{r+1}{r})\frac{\sigma^2\ (Z_\beta + Z_{\frac{\alpha}{2}})^2}{(difference)^2}$$

n = Number of participants with mild cognitive impairment.

$(\frac{r+1}{r})$ = Ratio of older people without mild cognitive impairment to older people with mild cognitive impairment group. Equal number of case and control groups (r = 1)

σ^2 = Standard deviation of outcome measurements (σ^2= 2.1) (32)

Z_α = Z-value when set significance level at 0.05, 95% ($Z_\alpha 1.96, Z_{\frac{\alpha}{2}}$ = 0.98)

Z_β = Z-value when set the power of testing equal to 80% (Z_β = 0.84)

$(difference)^2$ = (Mean different of outcome variable between case and control groups)^2 ($difference$ = 0.5) (32)

$$n = (\frac{1+1}{1})\frac{2.1\ (0.84+0.98)^2}{(0.5)^2} = 27.82\text{/group}$$

The total number of participants in both groups were 56 (28 older people with MCI, and 28 older people without MCI).

3.5 Procedure of Study (Figure 3.1)

1. Potential participants were screened for exclusion of dementia and depression conditions by the following measurements **(Figure 3.2)**

- Thai Geriatric Depression Scale-15 (TGDS-15) **(Appendix B)**
- Mini Mental State Examination Thai (MMSE-Thai 2002) **(Appendix C)**
- Montreal Cognitive Assessment (MOCA-Thai version) **(Appendix D)**

2. Participants were screened of knee proprioception by Acumar™ digital inclinometer.
3. All procedures and details were explained to the participants. Participants were asked to sign an informed consent if they agree to participate in the study.
4. The demographic data of participants were collected by a researcher. The demographic details are as followed:

- Personal information: age (years), gender, marital status and family, education level, work status, hand dominant, caregiver, income per month, and residence. **(Appendix E)**
- Medical information: weight, height, body mass index (BMI), medical diagnosis, medicine history, walk abilities. **(Appendix E)**
- History of falls: amount of falls history in 12 months, causes of falls, falls pattern (direction of falls), and falls injury. **(Appendix F)**
- Physical activity level scale of elderly in one weeks. **(Appendix F)**

5. Participants will be tested with balance test (Timed Up and Go (TUG) test, TUG with dual task, Five Times Sit to Stand (FTSTS), Functional Reach Test (FRT), Step Test (ST)) **(Appendix G)** and coordination test (Foot Tapping (FT) and Nine-Hole Peg Test (NHPT) **(Appendix H)**.

3.6 Instrumentation

3.6.1 Thai Geriatric Depression Scale-15 (TGDS-15) data forms (Appendix B)

Thai Geriatric Depression Scale-15 (TGDS-15) was standard depression screening test. It's maximum score is 15 points with cut-off score > 5 in order to detect major depression disorder (MDD). This test was found sensitivity at 0.92 and specificity at 0.87 in older people in community (147).

3.6.2 Mini Mental State Examination Thai (MMSE-Thai 2002) (Appendix C)

Mini Mental State Examination assesses cognitive function covering: orientation for time and place, registration, attention and calculation, recall memory three words, and language (naming, speech according to the phrase, verbal command, writing command, writing, and visuo-construction) (120). Total score is 30 points. Mini Mental State Examination was translated to Thai language for screening older people with cognitive decline by Thai Cognitive Test Development Committee 1999 **(122)**. For Thai MMSE, cut-off scores were classified by level of education. Score for being classified as having cognitive impairment: older people did not study (Can't read and write) cut-off score ≤14/23; older people with graduated in elementary school cut-off ≤17/30; older people with graduated from elementary school ≤ 22/30 (148).

3.6.3 Montreal Cognitive Assessment (MOCA-Thai) (Appendix D)

Montreal Cognitive Assessment (MoCA) was developed by Nasreddine Z., to assess cognitive function. The tool could be rapidly to administration which generally approximately ten minutes (testing in people with mild cognitive deficit). Total score is 30 points in which 11 domains consist of: visuospatial function, executive function, naming, memory recall, attention, orientation time or place, language, recall memory and abstraction task. Examination of the screening test had a sensitivity to detect MCI at 90% and specificity 100%. The levels of cognitive impairment have been classified as: score 22-30 classified as no cognitive impairment, score 17-21 classified as mild cognitive impairment and score 0-16 classified as severe cognitive impairment or dementia (124).

3.6.4 Proprioception Sense

Proprioception was measured by Acumar^{TM} digital inclinometer. The participants were instructed to sit and lean against the backrest. The inclinometer was placed on the lower one third section part of lateral of tight and leg. The participants were instructed to close their eyes and fully extend knee, until the knee bend to the target 30°/80°, then return the leg to the starting position. Each participant was tested in same targeted angle (30° and 80°) holding for five seconds, three trials for each side. Error angles were recorded and error angles +/- five degrees classified as normal.

3.6.5 The Demographic Data Form (Appendix E)

- Personal information: age (years), gender, marital status & family, hand dominant, education level, work status, caregiver, income per month, and residence.
- Medical information: weight, height, body mass index (BMI), number of medical conditions, and number of medications.

3.6.6 The Falls History Data Form (Appendix F)

- History of falls: frequency of falls history in 12 months, causes of falls, falls pattern, and direction of falls.
- Physical activity level scale of elderly in one weeks.

3.6.7 Measurement of Balance and Coordination Assessment

3.6.7.1 Balance Assessment (Appendix G)

(1) Timed Up and Go (TUG) test

Timed up and go (TUG) test was used to measure mobility and dynamic balance. The participants were instructed to rise from a chair, walk approximately three meters (9.86 foot), turn around at the line, walk back to the chair and sit down.

Ref. code: 25605912030540QOI

(2) Timed Up and Go with Dual Task

Timed up and go with dual task test was used to measure dynamic balance in dual task conditions (TUG with cognitive task or manual task). For the TUG with cognitive task, participants were asked to rise from a chair while counting backward by one, from the number 98, walk approximately three meters, turn around at the line, walk back to the chair and sit down. In the TUG with manual task, participants were ask to walk while holding a cup filled with water.

(3) Functional Reach Test (FRT)

Functional reach test was used to measure forward limit of stability (dynamic balance) by measuring the maximum distance that individual can reach forward. The test was performed while participants being in standing position with arm at 90 degrees of shoulder flexion.

(4) Step Test (ST)

Step test was used to measure dynamic single leg standing balance. The test was performed with the participant in standing position. The participants will be instructed to step one foot fully on and off a 7.5 cm box as fast as possible in 15 seconds and repeat for the other side. Score is number of times the participant steps on and off in 15 seconds.

(5) Five Times Sit to Stand (FTSTS) Test

Five time sit to stand test was used to measure dynamic balance and functional muscle strength of lower extremity. The participants were instructed to perform sit to stand for five times in a row, perform as quickly as possible with their arm crossed at their chest. The total time were recorded.

3.6.7.2 Coordination Assessment (Appendix H)

(1) Foot Tapping (FT)

Foot tapping test was used to measure foot coordination. The participants were instructed to seat on a chair without armrest, leaning against the backrest and taps their foot with barefoot within five seconds/each foot. Participants

Ref. code: 25605912030540QOI

performed three trials for each foot and average number of taps of both sides were recorded. The recorded average number of taps were then rated in seven levels as: 1 = twenty taps, 2 = 16 to 19 taps, 3 = 13 to 15 taps, 4 = 9 to 12 taps, 5 = 5 to 8 taps, 6 = 1 to 4 taps, and 7 = unable to performs (37).

(2) Nine-Hole Peg Test (NHPT)

Nine-Hole Peg test was used to measure fine motor dexterity or fine coordination tasks. The participants were instructed to seat on a chair, leaning against backrest and place their forearm on the table. The examiner asked the participants to pick up the pegs and put them into the holes until the holes are all filled. Then remove the pegs out of pegs board and return to container as fast as possible. Participants performed two time with each hand. The total time (dominant hand for two times and non-dominant hand for two times) were recorded (44, 149).

3.8 Outcomes Measures

3.8.1 Balance Performance Data (Appendix G)

3.7.1.1 Timed Up and Go (TUG) test

3.7.1.2 Timed Up and Go with Manual and Cognitive task

3.7.1.3 Functional Reach Test (FRT)

3.7.1.4 Step Test (ST) in worst side (150)

3.7.1.5 Five Times Sit to Stand (FTSTS)

3.8.2 Coordination Performance Data (Appendix H)

3.7.2.1 Foot tapping of average both sides (37)

3.7.2.2 Nine-Hole Peg Test of total times (dominant 2 times and non-dominant 2 times) (44)

3.8.3 History of Falls: data collection of history of falls **(Appendix F)**

3.9 Statistical Analysis

All data will be analyzed using the SPSS version 20.

3.9.1 Descriptions of the participants was used report by using descriptive statistics: frequencies, percentages, means, and standard deviations.

3.9.2 The normal distributions of all data was determined by Shapiro-Wilk test.

3.9.3 Normal distribution data (case of numerical data)

3.9.3.1 Independent t-test was used to determine the statistical difference between the MCI and control groups.

3.9.3.2 Pearson's product moment correlation coefficient was used to measure the correlation between balance performance, coordination, and history of falls in older people with MCI.

3.9.4 Non-normal distribution data (case of numerical data)

3.9.4.1 Mann-Whitney U test was used to determine the statistical difference between the MCI and control groups.

3.9.4.2 Spearman correlation coefficient was used to measure the correlation between balance performance, coordination, and history of falls in older people with MCI.

3.9.5 Categorical data

Chi-square test and Fisher's exact test (small sample size) were used to determine the statistical difference between the MCI and control groups.

3.9.6 Point-biserial correlation was used to measure the correlation between balance performance and coordination (case of numerical data), and history of falls (case of categorical data) in older people with MCI.

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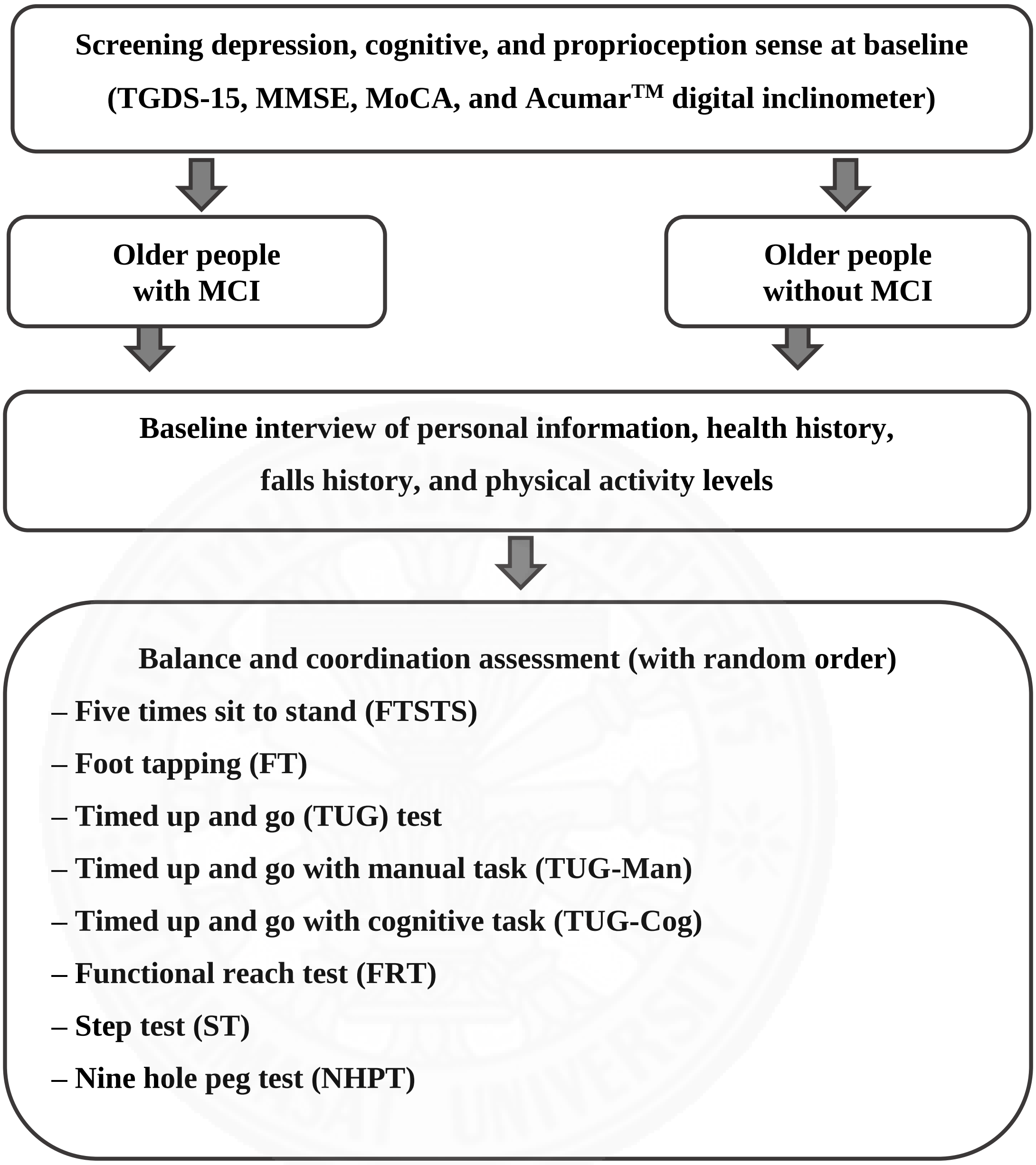

Figure 3.1 Procedure flow chart

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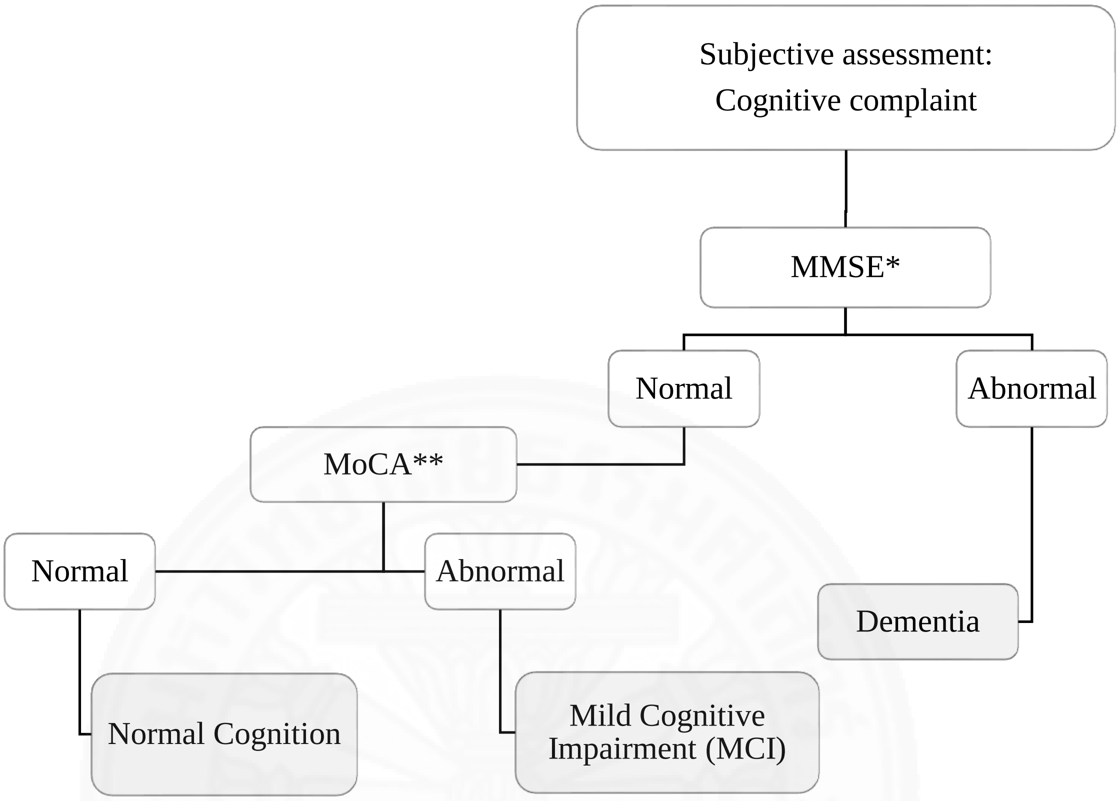

Figure 3.2 Screening criteria of participants

Adapted from Weerasak Muangpaisan (2013) [151]

Table 3.1 Cut of score of Mini Mental State Examination (MMSE)

Education level	**Score**	
	Cut-off	**Full score**
Older people did not study (Can't read and write)	≤ 14	23 (Did not do item 4, 9, 10)
Older people who studied in elementary school	≤ 17	30
Older people who completed elementary school	≤ 22	30

* The Mini Mental State Examination (MMSE) [122]
**The Montreal Cognitive Assessment (MoCA): score 22-30: no cognitive impairment, score 17-21: mild cognitive impairment and score 0-16: severe cognitive impairment or dementia [124].

CHAPTER 4
RESULTS

4.1 Participant Characteristics

Twenty-eight older people with mild cognitive impairment (MCI) and 28 older people without MCI (age ranged 60-80 years) were recruited in the study. Participants in both groups were matched aged, gender, and education level. Sixty-one percent of participants were female, and 82.1% were graduated in Elementary school (grade 4-6). Table 4.1 shows the participants' characteristics which is divided into two parts: personal information and health information. There were no significant differences between two groups on most of the characteristics recorded. However, work status, number of medical conditions, Mini-mental state examination-Thai version, Montreal cognition assessment-Thai version, and Thai geriatric depression scale were significant difference between two groups ($p \leq 0.05$).

Table 4.1 Comparisons of participant characteristics between older people with and without mild cognitive impairment

Characteristics	Older People with MCI (n=28)	Older People without MCI (n=28)	*p*-value
Personal information			
Age (mean ± SD)	67.71 ± 5.97	67.39 ± 5.80	0.84[c]
Gender, n (%)			
- Male	11 (39.3)	11 (39.3)	1.00[a]
- Female	17 (60.7)	17 (60.7)	

Ref. code: 25605912030540QOI

Table 4.1 Comparisons of participant characteristics between older people with and without mild cognitive impairment (Cont.)

Characteristics	Older People with MCI (n=28)	Older People without MCI (n=28)	*p*-value
Marital status & family, n (%)			
- Single	1 (3.6)	1 (3.6)	
- Married	17 (60.7)	21 (75)	0.70[a]
- Devoted	2 (7.1)	1 (3.6)	
- Widow	8 (28.6)	5 (17.9)	
Education level, n (%)			
- No education	1 (3.6)	1 (3.6)	
- Elementary school (grade 1-3)	0 (0)	0 (0)	
- Elementary school (grade 4-6)	23 (82.1)	23 (82.1)	1.00[a]
- Junior high school	0 (0)	0 (0)	
- Senior high school	1 (3.6)	1 (3.6)	
- Bachelor's degree	2 (7.1)	2 (7.1)	
- Master's degree or Doctor of Philosophy	0 (0)	0 (0)	
Work status, n (%)			
- Working	2 (7.1)	8 (28.6)	**0.04[a]***
- Non-working	26 (92.9)	20 (71.4)	
Hand dominant, n (%)			
- Right side	24 (85.7)	26 (92.9)	0.34[b]
- Left side	4 (14.3)	2 (7.1)	

Table 4.1 Comparisons of participant characteristics between older people with and without mild cognitive impairment (Cont.)

Characteristics	Older People with MCI (n=28)	Older People without MCI (n=28)	*p*-value
Caregiver, n (%)			
- Parents	0 (0)	0 (0)	
- Brethren	1 (3.6)	1 (3.6)	
- Husband and wife	17 (60.7)	18 (64.3)	0.99[a]
- Relative	8 (28.6)	7 (25)	
- Another	2 (7.1)	2 (7.1)	
Income per month, n (%)			
- < 5,000 Baht	22 (78.6)	21 (75)	
- 5001 – 10,000 Baht	6 (21.4)	4 (14.3)	
- 10,001-15,000 Baht	0 (0)	2 (7.1)	0.33[a]
- 15,001-20,000 Baht	0 (0)	0 (0)	
- 20,001-25,000 Baht	0 (0)	0 (0)	
- > 25,000 Baht	0 (0)	1 (3.6)	
Residence, n (%)			
- Own home	25 (89.3)	25 (89.3)	
- Living with other house	2 (7.1)	2 (7.1)	
- Rental house	1 (3.6)	1 (3.6)	1.00[a]
- Living with an employer	0 (0)	0 (0)	
- Homeless	0 (0)	0 (0)	
Medical Information			
Weight (kilogram)	62.72 ± 14.03	61.25 ± 10.66	0.95[c]
Height (centimeter)	159.42±10.33	159.04± 7.91	0.84[c]
Body mass index (BMI) (kilogram/meter^2)	24.68 ± 5.25	24.39 ± 4.98	0.96[c]

Table 4.1 Comparisons of participant characteristics between older people with and without mild cognitive impairment (Cont.)

Characteristics	**Older People with MCI (n=28)**	**Older People without MCI (n=28)**	***p*-value**
Number of medical conditions, Median (range)	1 (0-2)	1 (0-3)	0.16[c]
Number of medications, Median (range)	1 (0-4)	1 (0-5)	0.10[c]
Physical activity scale of elderly (hour/week)	39.83 ± 16.99	45.03 ± 22.38	0.43[c]
Mini mental state examination - Thai version (MMSE)	25.79 ± 2.27	27.61 ±1.69	**<0.01[c**]**
Montreal cognition assessment -Thai version (MoCA)	18.82 ± 1.34	24.82 ± 2.29	**<0.01[c**]**
Thai geriatric depression scale (TGDS-15)	2.82 ± 1.34	2.07 ± 1.61	**0.04[c*]**

Note: Mini mental state examination – Thai version (MMSE) and Montreal cognition assessment-Thai version (MoCA) have maximum score = 30, Thai geriatric depression scale (TGDS-15) has maximum score = 15. Statically Analysis: [a] = Pearson Chi-square test, [b] = Fisher's Exact test, [c] = Mann Whitney U test. Significant difference between two groups at ** $p \leq 0.01$, * $p \leq 0.05$.

4.2 Comparison of Balance Performance, Coordination and Falls History between Older People with and without Mild Cognitive Impairment

4.2.1 Balance Performance

Balance performance were compared between older people with and without MCI. Table 4.2 presents mean and standard deviation of all balance measures. The results shows significant difference of Timed Up and Go (TUG) test (TUG), Timed Up and Go with Manual Task (TUG-Man), Timed Up and Go with Cognitive Task (TUG-Cog), Five Times Sit to Stand (FTSTS), Functional Reach Test (FRT), and Step Test (ST).

Table 4.2 Comparisons of balance performance between older people with and without mild cognitive impairment

Balance Performance	**Older People with MCI (n=28)**	**Older People without MCI (n=28)**	***p*-value**
Timed Up and Go (TUG) test (seconds)	9.90 ± 1.41	8.97 ± 1.22	**0.01**^{a**}
Timed Up and Go with Manual Task (TUG-Man) (seconds)	11.13 ± 1.74	9.72 ± 1.44	**<0.01**^{a**}
Timed Up and Go with Cognitive Task (TUG-Cog) (seconds)	12.97 ± 1.82	10.97 ± 1.94	**0.02**^{b*}
Five Times Sit to Stand (FTSTS) (seconds)	9.83 ± 2.14	8.48 ± 1.50	**0.01**^{a**}
Functional Reach Test (FRT) (centimeters)	23.46 ± 7.49	29.04 ± 6.67	**0.01**^{a**}
Step Test in worst side (ST) (times)	12.32 ± 2.74	14.07 ± 3.02	**0.03**^{a*}

Note: Statically analysis: ^{a} = Independent t-test, ^{b} = Mann Whitney U test.
Significant difference between two groups at ** $p \leq 0.01$, * $p \leq 0.05$.

4.2.2 Coordination Performance

Table 4.2 presents comparison mean and standard deviation) of coordination measures between the two groups. The results showed that there were significant differences of both Nine Hole Peg Test (NHPT) and Foot Tapping (FT) ($p \leq 0.01$).

Table 4.3 Comparisons of coordination performance between older people with and without mild cognitive impairment

Coordination Performance	Older People with MCI (n=28)	Older People without MCI (n=28)	*p*-value
Nine Hole Peg Test (NHPT) (seconds)	93.37 ± 11.87	85.09 ± 9.87	**<0.01****
Foot Tapping (FT) (scores)	4.17 ± 0.56	3.59 ± 1.02	**0.02***

Note: Statically analysis: Mann Whitney U test.
Significant difference between two groups at ** $p \leq 0.01$, * $p \leq 0.05$.

4.2.3 Falls History

Falls history including number of faller, number of falls, cause of falls, direction of falls, injuries of falls, and area of falls were compared between two groups. There were significance difference of number of faller and number of falls ($p \leq 0.05$) as shown in Table 4.4.

Table 4.4 Comparisons of falls history between older people with and without mild cognitive impairment

Falls History	Older People with MCI (n=28)	Older People without MCI (n=28)	*p*-value
Number of faller, n (%) - Faller - Non-faller	 9 (32.2) 19 (67.8)	 2 (7.1) 26 (92.9)	**0.02**^{a*}
Number of falls, Median (range)	0 (0-4)	0 (0-1)	**0.02**^{b*}

Ref. code: 25605912030540QOI

Table 4.4 Comparisons of falls history between older people with and without mild cognitive impairment (Cont.)

Falls History	**Older People with MCI (n=9)**	**Older People without MCI (n=2)**	***p*-value**
Cause of recent falls, n (%)			
- Collapse	0 (0)	0 (0)	
- Stumble	4 (45)	1 (50)	
- Dizzy or loss of conscious	0 (0)	0 (0)	0.89[a]
- Falls down	0 (0)	0 (0)	
- Slip	5 (55)	1 (50)	
Direction of recent falls, n (%)			
- Left direction	2 (22)	1 (50)	
- Right direction	2 (22)	0 (0)	0.17[a]
- Front direction	3 (34)	1 (50)	
- Back direction	2 (22)	0 (0)	
Injuries of falls, n (%)			
- No injuries	3 (33)	1 (50)	
- Bruises	4 (45)	1 (50)	0.12[a]
- Bone fracture	2 (22)	0 (0)	
Area of falls, n (%)			
- Indoor	4 (45)	2 (100)	0.06[a]
- Outdoor	5 (55)	0 (0)	

Note: Statically analysis: [a] = Pearson Chi-square test, [b] = Mann Whitney U test. Significant difference between two groups at * $p \leq 0.05$.

4.3 Correlation of Balance Performance, Coordination, and Falls History in Older People with Mild Cognitive Impairment

4.3.1 Correlation between Balance Performance and Coordination

Table 4.5 shows correlation between balance performance and coordination in older people with MCI. There were significant correlation (moderate level) between FT and TUG (r=0.524, $p \leq .01$), significant correlation (moderate level) between FT and FTSTS (r=0.662, $p \leq 0.01$), significant correlation (low level) between FT and FRT (r=-0.408, $p \leq 0.05$), and significant correlation (low level) between FT and TUG–Man (r=0.390, $p \leq .05$), In addition, there were no correlation between balance and NHPT in all balance measures.

Table 4.5 Correlation of balance performance and coordination of older people with mild cognitive impairment

Correlation of Balance Performance and Coordination of Mild Cognitive Impairment	**Nine Hole Peg Test (NHPT) (n=28)**	**Foot Tapping (FT) (n=28)**
Timed Up and Go (TUG) test	0.330	**0.524******
Timed Up and Go with Manual Task (TUG-Man)	0.237	**0.390***
Timed Up and Go with Cognitive Task (TUG-Cog)	0.190	0.285
Five Times Sit to Stand (FTSTS)	0.022	**0.662****
Functional Reach Test (FRT)	-0.090	-0.096
Step Test (ST)	-0.172	**-0.446***

Note: Statically Analysis: Spearman's rank correlation.

Significant difference between two groups at ** $p \leq 0.01$, * $p \leq 0.05$.

4.3.2 Correlation between Balance Performance and Falls History

Correlation between balance performance and falls history in older people with MCI are shown in Table 4.6. There were significant correlation (high level) between falls history and FTSTS (r = 0.718, $p \leq 0.01$), significant correlation (moderate level) between falls history and TUG with manual task (r = 0.589, $p \leq 0.01$), significant correlation (low level) between falls history and TUG (r = -0.405, $p \leq 0.05$), significant correlation (low level) between falls history and ST (r = -0.481, $p \leq 0.05$). However, there were no correlation between falls history and TUG-Cog, and FRT.

Table 4.6 Correlation of balance performance and falls history of older people with mild cognitive impairment

Correlation of Balance Performance and Falls History of Mild Cognitive Impairment	**Falls History (Faller & non-faller) (n=28)**
Timed Up and Go (TUG) test	**0.405***
Timed Up and Go with Manual Task (TUG-Man)	**0.589****
Timed Up and Go with Cognitive Task (TUG-Cog)	0.338
Five Times Sit to Stand (FTSTS)	**0.718****
Functional Reach Test (FRT)	-0.064
Step Test (ST)	**-0.481****

Note: Statically analysis: point-biserial correlation.
Significant difference between two groups at ** $p \leq 0.01$, * $p \leq 0.05$.

Ref. code: 25605912030540QOI

4.3.3 Correlation between Coordination and Falls History

Correlation between coordination performance and falls history in older people with MCI are shown in Table 4.7. There was significant correlation (low level) between falls history and FT (r= 0.399, $p \leq 0.05$), but no correlation between falls history and NHPT.

Table 4.7 Correlation of coordination and falls history of older people with mild cognitive impairment

Correlation of coordination and falls history of mild cognitive impairment	**Falls History (Faller & non-faller) (n=28)**
Nine Hole Peg Test (NHPT)	0.231
Foot Tapping (FT)	**0.399***

Note: Statically analysis: point-biserial correlation.

Significant difference between two groups at * $p \leq 0.05$.

Ref. code: 25605912030540QOI

CHAPTER 5
DISCUSSIONS

This chapter is divided into 3 main sections: 1. comparison of participants' characteristics (personal information and health information) between two groups (older people with and without mild cognitive impairment), 2. comparison of balance performance, coordination, and history of falls between the two groups, and 3. correlation of balance performance and coordination, and history of falls of older people with mild cognitive impairment.

5.1 Participant Characteristics

In the present study, fifty-six older people were recruited with and without mild cognitive impairment (MCI). There were no significant differences in all variables of participants' characteristic except work status, Mini-mental state examination (MMSE), Montreal cognition assessment (MoCA), and Thai geriatric depression scale-15 (TGDS-15). However, both groups are classified as normal (i.e. no depression).

There was significant difference in Thai geriatric depression scale -15 (TGDS-15) between the two groups in which MCI group higher than non-MCI group. However, both groups were score less than six points which indicated that neither groups had indication of depression [147]. The higher score of TGDS-15 in MCI group may be due to one category of the test perception, is related with MCI's sign and symptoms. In addition, the higher score of depression in MCI might also be explained with their working status. Participants with MCI reported non-working status more than those without MCI. Staying at home or being at the same place may cause routine activities which could contribute to increase risk of depression in the older people [152].

5.2 Comparison of Balance performance, Coordination, and Falls History between Older People with and without Mild Cognitive Impairment

5.2.1 Comparison of Balance Performance between Older People with and without Mild Cognitive Impairment

Older people with MCI showed decreased balance performance in all balance measures [Timed Up and Go (TUG) test, Timed Up and Go with Manual Task (TUG-Man), Timed Up and Go with Cognitive Task (TUG-Cog), Five Times Sit to Stand (FTSTS), Functional Reach Test (FRT), and Step Test (ST)] compared with older people without MCI. As balance performance requires cognitive function especially attention, and executive function (24, 128), therefore, balance performance in older people with MCI could be affected and this could lead an increased falls risk in people with MCI as found in several previous studies (15, 35, 137, 144-146).

There were several studies previously assessed balance performance using Timed Up and Go (TUG) test in people with MCI (21, 27, 32, 33, 145). The results of the present study showed significant differences of balance performance measured by TUG between older people with and without MCI. These results were accordingly with results from two studies by Borges et al. (2015) (27, 145), which reported significant difference between two groups. This similar results might be due to the similar criteria for inclusion and exclusion of participants with MCI. In addition, the results from study by Borges et al (145) also reported significant higher incidence of falls (previous 12 months) in MCI group compared with control group. However, there were also some previous studies reported no decreased balance performance measured by TUG in some previous studies (21, 32, 33). One possible explanation of the different results could be the difference of inclusion criteria in which the study did not include older people with MCI but also include people with MCI who aged less than 60 years old (32). Moreover, no cognitive impairment group and MCI groups of the study reported slightly higher score of MMSE (MCI: 28, non-MCI: 29) compared with the participants in MCI group in the current study (32). This less severity of impaired cognitive function of participants with MCI may lead to less affect to balance performance in the MCI groups therefore no significant difference were found when compared with healthy group.

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Fujisawa et al. (2017) [21] reported no significant difference of score of TUG between aMCI and normal cognition group. Participants in both groups could use assistive gait devices (cane and walker) during TUG that might influence results of the study. Other studies reported no significant difference of score of TUG between MCI and cognitively normal older adults is study by Eggermont et al. (2010) [33]. Including participants with comorbid conditions (i.e. peripheral neuropathy) might influence results of the study. When focusing on balance under dual task conditions testing by TUG with manual or cognitive task, MCI group took more time than older people without MCI. These results were consistent with the study by Borges et al. (2015) [27]. TUG-Cog is more difficult and more complex than original TUG. TUG-Cog has required challenged cognitive function in particular attention [153]. This could cause altered balance and walking performance influence and could be presented in older people with cognitive decline [21, 27, 32, 145, 150].

Five Times Sit to Stand (FTSTS) test was used to measure dynamic balance and functional muscle strength of lower extremity by changing siting to standing position for five times perform as quickly as possible. There were significant differences between older people with and without MCI in this study. There was no previous study reported result of FTSTS in older people with MCI. However, there were two previous studies measuring Sit to Stand Test (STS) [33] and Chair Stand Test (CST) [26] which were the same test measuring maximum number of times of performing sit to stand in 30 seconds in people with MCI. The two studies reported no significant difference of CST between MCI and non-MCI groups. The non-significant differences found in the two studies could be partly explained by the fact that: 1) in the study by Eggermont et al. (2010) [33], there were some participants with low MMSE who could not perform sit to stand function consequently would not being assessed with the STS; 2) CST or STS used in the two studies [26, 33] is a test mainly measures functional lower extremity endurance in which differ from FTSTS that measures functional lower extremity strength as well as balance [154]. Decreased CST / STS could also be found in general older people which were the control groups of the two studies.

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Step Test (ST) was used for measuring dynamic single standing balance. Older people with MCI group showed a significant lower times in step test (worst side) compared with non-MCI group. There was no studies previously reported result of ST in older people with MCI. However, there was one previous study by Fujisawa et al. (2017) [21] measuring one leg stance (OLS) (static single leg stance) in people with aMCI. The study reported significant difference of result of OLS between MCI and normal cognition group. This similar results might be due to the similar range of MMSE score of participants of the two studies. The results of current study consistent with previous study clearly shown that older people with aMCI was not only poor single standing balance, but also dynamic single standing balance, which results in decreased performance in single and dynamic single balance when compared with normal cognition group.

Functional Reach Test (FRT) was used for measuring dynamic balance as well as limit of stability during standing. Comparing with other tests used in this study, FRT is one of the most simple dynamic balance test as it does not required changing base of support (BOS) during testing. This could imply that FRT requires less executive function than dynamic balance tests (TUG) [155]. However, the current study also found significant decreased in FRT in MCI group compared with non-MCI group. The results is consistent with results from a study by Fujisawa et al. (2017) [21]. The study reported that higher distance in FRT in normal cognition group compared with MCI group in which indicated lower functional balance in MCI group.

5.2.2 Comparison of Coordination Performance between Older People with and without Mild Cognitive Impairment

Older people with MCI showed decreased coordination performance in both measures: Nine Hole Peg Test (NHPT) and Foot Tapping (FT) compared with older people without MCI.

Nine Hole Peg Test (NHPT) was used for measuring fine movement as well as upper limbs coordination. There were significant differences between the two groups. MCI group took longer time to perform the test than older people without MCI. There was one study previously assessed fine coordination performance by nine hole peg test in people with MCI by De Paula et al. (2016) (44). Their results were accordingly with current study. The study by De Paula et al. (2016) (44) showed that multiple domains amnestic MCI (MDaMCI) group were slower compared with healthy control group (44). The reason could partly explained by the fact that multiple brain regions are linkage for great performance of coordination time tasks. And that the connection could be interrupted in people with cognitive impairment (156) in which could be presented with poor coordination performance in terms speed and accuracy (157). Moreover, the study by De Paula et al. (2016) (44) also showed that participants with AD were significantly slower than aMCI and healthy control groups. These would support that fine movement would decline in older people with MCI and higher tendency in dementia.

Foot Tapping (FT) was used for measuring lower limbs coordination. In this study, older people with MCI have slower time to perform the test compared with older people without MCI. There were few studies previously assessed coordination using FT in people with MCI (37, 43). The current study's results were accordingly with results from one study by Franssen et al. (1999) (37), which reported significant difference between MCI group and non-cognitive impairment group. The similar results (mean value of non-cognitive impairment group and % change decrease performance with older people without MCI) might be due to the similar criteria for inclusion and exclusion of participants with MCI group as well as the similar way of measure FT (number of steps in 5 seconds). Cai et al. (2014) (158) explained that participants with MCI have decreased general plasticity which delay of center nervous system (CNS) process effect to decline limbs coordination and balance performance. However, there was one previous study measuring foot tapping speed test by Kluger et al. (1997) [43] and found non-significant differences between cognitively normal elderly and mild cognitive impairment group. One possible explanation of the different results could be the difference of measurement i.e. the study measured foot tapping speed within 15 second, whereas the current study measure number of step during 5 seconds.

5.2.3 Comparison of Falls History between Older People with and without Mild Cognitive Impairment

Finding of the current study, older people with MCI have higher of number of faller and number of falls in previous 12 months compared with older people without MCI. The results consistent with the study on incidence of falls in MCI groups which reported that MCI group had 1.72 times higher risk of falls compared with older people without MCI [15]. These results were also accordingly with results from other two previous studies by Ansai et al. (2017) [146] and Borges et al. (2015) [145]. Ansai et al. (2017) [146] reported significant difference of number of fallers between elderly people with preserved cognition and MCI. Borges et al. (2015) [145] reported significant difference between older adults with cognitively healthy and MCI. The increased number of faller and number of falls in older people with MCI in the study by Borges et al. (2015) [145] and the current study might be due to the decreased balance performance (TUG in single and dual task) in older adults in MCI found in the study, which consequently could lead to higher prevalence of falls [27, 145]. Montero-Odasso (2017) [141] explained that older people with cognitive impairment was declined of attention and executive function [24, 128] which required for maintaining balance and performing normal gait. Accordingly, older people with cognitive impairment was related with dementia, gait changed, and risk of falls [128] as that cognitive impairment could progress to dementia as well as could have falls, fracture & immobility [141]. Previous studies also support that the incidence of falls in MCI group was consistency with severity of cognitive impairment as dementia [144, 145].

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The results of current study together with previous studies [21, 27, 37, 44, 145, 146] supported that older people with MCI was not only declining in memory domain, but also attention, and executive function [24, 128], which results in decreased performance in balance and coordination, and these could contribute to higher risk of falls in the population.

However, the study did not assess impairments related with balance and falls (muscle strength, range of motion (ROM), and flexibility of lower extremity), therefore, the study could not definitely point out what changes in the impairments that maybe resulted in decreased balance and coordination, and high falls risk in the MCI group. Further study should assess muscle strength, range of motion (ROM), and flexibility of lower extremity in order to identify possible impairments causing falls in older people with MCI.

5.3 Correlation between Balance Performance, Coordination, and Falls History in Older People with Mild Cognitive Impairment

In the present study aimed to determine the correlation between balance performance, coordination, and falls history in older people with Mild cognitive impairment (MCI). Previous study was reported result of correlation only between balance performance and falls risk in.

Finding of the study found correlation between balance performance [Five Times Sit to Stand (FTSTS), Timed Up and Go (TUG) test, Timed Up and Go with Manual Task (TUG-Man), and Step Test (ST)], and falls history in older people with MCI. However, there were no significance correlation between balance performance measured by Functional Reach Test (FRT) and Timed Up and Go with Cognitive Task (TUG-Cog), and falls history. There was a study previously reported result of correlation between balance performance and falls history in older people with MCI [29]. Blackwood et al. (2016) [29] reported significant correlation between balance measured by falls risk (measured by TMT-B) and TUG, but no significant correlation between falls risk and FTSTS**.** One possible explanation of the different results could be the difference level of cognitive impairment between the two studies in which the study by Blackwood et al. (2016) recruited people with MCI who had MoCA score: < 26 while the current study included only MoCA score: 17-22 which is slightly lower than the previous study. This might influence results of the study. Regarding not significant correlation of the result of FRT and falls history in older people with MCI, could be partly from the nature of FRT which is one of simple dynamic balance tasks as it does not required changing base of support (BOS) during testing. Whereas, TUG-Cog which was used to measuring dynamic balance with cognitive task (count backwards) required challenged cognitive function (in particular attention function) [153]. However, the current study found no significance correlation between TUG-Cog and falls history of people with MCI. Looking at cause of falls reported from people with MCI in this study, falls occurred due to stumble 45% and slip 55%. However, the current study did not record activity or circumstance during falls therefore could not definitely pin point whether falls in the people with MCI in this study would related with circumstance required high attention. Another possible explanation might be the fact that people with MCI might perform TUG-Cog by paying attention with cognitive task more than the balance or walking task [153].

Results of this study presented significant correlation between Foot Tapping (FT) and falls history as well as FT and balance performance (FTSTS, TUG, TUG-Man, and ST) in older people with MCI. FT was used to measuring coordination performance of lower extremity which suggests from previous studies that coordination abilities could be part of balance and falls risk factors in older adults [38, 39]. Accordingly, loss of balance performance could leads to increasing attention of leg movement to compensation [128]. This could imply that coordination measuring by FT is direct relationship with between balance performance and consequently risk of falls. However, the current study found no significance correlation between FT and a couple balance measures, FRT and TUG-Cog. Possible explanation of the no correlation results might be the low challenge of FRT and the possible higher required in cognitive task than balance task in TUG-Cog for older people with MCI.

There was no significance correlation between Nine Hole Peg Test (NHPT) and balance measures as well as NHPT and falls history. One possible explanation could be the fact that NHPT are test measuring fine movement as well as coordination of upper extremity while the balance measures in the study and falls would more related with lower extremity function. However, previous study supported that arm coordination could have relationship with balance due to arm coordination could be associated with performance to correct posture or postural adjustment in circumstance with external perturbations [159]. De Paula et al. (2016) [44] reported correlation between NHPT and self-care ADLs in people with MCI. These could imply that NHPT could have indirect relationship with balance performance in particular in situations required postural adjustment and that NHPT could have relationship with tasks involving with upper extremity.

5.4 Limitation and Further Study

This study was recruited participants into MCI group by Petersen's criteria which defined of amnestic MCI (aMCI) but not cover all subtype of MCI (amnestic MCI: single or multiple domains and non-amnestic MCI: single or multiple domains) [44]. Differential groups might be different results from this study.

This study did not assess fear of falling which could happen after falling. The decreased balance or coordination ability could be from either decreased physical performance or fear of falling. Further study should assess fear of falling in order to identify possible causes of impairments.

Finally, this study is cross sectional study design. The present study aimed to compare balance performance, coordination**,** and history of falls between two groups at one moment in time. Further study should be longitudinal study design to provide information of impact of the changes in older people with and without MCI.

5.5 Clinical Implications

In current study, older people with MCI have declined of balance performance and coordination compared with older people without MCI. In addition, in the group of older people with MCI have had higher number of people who had fallen in the past year. Therefore, balance performance, coordination and falls history should be issues being aware and focused in this group of people. Assessment of balance and coordination as well as falls risk should be implemented as routine care for people with MCI in order to prevent falls in this population. Findings of the correlations between falls history and balance / coordination of this study lead to clinical guide for evaluating risk of falls in older people with MCI which should include: balance measuring by Timed Up and Go (TUG) test, Timed Up and Go with Manual Task (TUG-Man), Five Times Sit to Stand (FTSTS), and Step Test (ST); and coordination measuring by Foot Tapping (FT).

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CHAPTER 6
CONCLUSION

Results of this study presented significant differences in all measures between older people with and without Mild cognitive impairment (MCI). Older people with MCI took longer time to perform Timed Up and Go (TUG) with single and dual tasks, Five Times Sit to Stand (FTSTS), and Nine Hole Peg Test (NHPT), lower distance of Functional Reach Test (FRT), lower number of Step Test (ST), and Foot Tapping (FT) compared with older people without MCI. Additionally, current study showed higher of number of fallers in the group of older people with MCI. There were significant correlations between: 1) balance performance (measured by TUG, TUG-Man, FTSTS, and ST) and coordination (measured by FT); 2) balance performance (measured by TUG, TUG-Man, FTSTS, and ST) and falls history; 3) coordination (measured by FT) and falls history.

Older people with MCI have declined balance performance and coordination compared with older people without MCI. Assessment of balance and coordination as well as falls risk should be implemented as routine care for people with MCI in order to prevent falls in this group. This study lead to clinical guide for evaluating risk of falls in older people with MCI which should include: balance measuring by FTSTS, TUG, TUG-Man, and ST; and coordination measuring by FT.

Ref. code: 25605912030540QOI

REFERENCES

1. Foundation of Thai Gerontology Research and Development Institute. Situation of the thai elderly. 2015.
2. UNFPA and HelpAge International. Ageing in the Twenty-First Century: A Celebration and A Challenge: UNFPA and HelpAge International. 2012.
3. Gazette MP. Population of thailand, 2017. Mahidol Population Gazette. January 2017.
4. Peters R. Ageing and the brain. Postgraduate Medical Journal. 2006;82(964):84-8.
5. Martin P, Adelina Comas-herrera, Martin Knapp, Maelenn Guerchet, Maria Karagiannidou. World Alzheimer Report 2015: The Global Impact of Dementia. An Analysis of Prevalence, Incidence, Cost and Trends. 2015.
6. Stephan B, Minett T, Pagett E, Siervo M, Brayne C, McKeith I. Diagnosing Mild Cognitive Impairment (MCI) in clinical trials: a systematic review. BMJ Open. 2013;3(2).
7. Roberts R, Knopman DS. Classification and epidemiology of MCI. Clin Geriatr Med. 2013;29(4):753-72.
8. Michaud TL, Su D, Siahpush M, Murman DL. The Risk of Incident Mild Cognitive Impairment and Progression to Dementia Considering Mild Cognitive Impairment Subtypes. Dementia and Geriatric Cognitive Disorders EXTRA. 2017;7(1):15-29.
9. Petersen RC, Doody R, Kurz A, Mohs RC, Morris JC, Rabins PV, et al. Current concepts in mild cognitive impairment. Arch Neurol. 2001;58(12):1985-92.
10. Johansson MM, Marcusson J, Wressle E. Cognitive impairment and its consequences in everyday life: experiences of people with mild cognitive impairment or mild dementia and their relatives. Int Psychogeriatr. 2015;27(6):949-58.
11. Talbot LA, Musiol RJ, Witham EK, Metter EJ. Falls in young, middle-aged and older community dwelling adults: perceived cause, environmental factors and injury. BMC Public Health. 2005;5:86.

Ref. code: 25605912030540QOI

12. Wagner Fabrício L. Taets Silva, Roberta L. Rica, Bianca Ramalho, Alexandre F. Machado, Fabio Ceschini, Francisco Luciano Pontes Júnior, et al. Fall Determinants and Associated Factors in Older People. Int J Sports Sci. 2016;6(4):146-52.

13. Terroso M, Rosa N, Torres Marques A, Simoes R. Physical consequences of falls in the elderly: a literature review from 1995 to 2010. Eur Rev Aging Phys Act. 2014;11(1):51-9.

14. Allan LM, Ballard CG, Rowan EN, Kenny RA. Incidence and prediction of falls in dementia: a prospective study in older people. PLoS One. 2009;4(5):e5521.

15. Delbaere K, Kochan NA, Close JC, Menant JC, Sturnieks DL, Brodaty H, et al. Mild cognitive impairment as a predictor of falls in community-dwelling older people. Am J Geriatr Psychiatry. 2012;20(10):845-53.

16. Soriano TA, DeCherrie LV, Thomas DC. Falls in the community-dwelling older adult: A review for primary-care providers. Clin Interv Aging. 2007;2(4):545-53.

17. Pollock AS, Durward BR, Rowe PJ, Paul JP. What is balance? Clin Rehabil. 2000;14(4):402-6.

18. Watson M A, Black F. The Human Balance System-A Complex Coordination of central and Peripheral Systems. Vestibular disorders association [Internet]. Available from: http://www.vestibular.org/.

19. Susan B. O'Sullivan , Thomas J. Schmitz. Examintion of Motor Function. Phy Rehabil. 5th ed. 2007.p. 245-64.

20. L. Sturnieks D, St George R, R. Lord S. Balance disorders in the elderly. Clin Neurophysiol. 2008;38(6):467-78.

21. Fujisawa C, Umegaki H, Okamoto K, Nakashima H, Kuzuya M, Toba K, et al. Physical Function Differences Between the Stages From Normal Cognition to Moderate Alzheimer Disease. J Am Med Dir Assoc. 2017;18(4):368.e9-.e15.

22. Mirelman A, Weiss A, Buchman AS, Bennett DA, Giladi N, Hausdorff JM. Association between performance on Timed Up and Go subtasks and mild cognitive impairment: further insights into the links between cognitive and motor function. J Am Geriatr Soc. 2014;62(4):673-8.

23. Bortoli CG, Piovezan MR, Piovesan EJ, Zonta MB. Balance, falls and functionality among elderly persons with cognitive function impairment. Revista Brasileira de Geriatria e Gerontologia. 2015;18:587-97.

Ref. code: 25605912030540QOI

24. McGough EL, Kelly VE, Logsdon RG, McCurry SM, Cochrane BB, Engel JM, et al. Associations between physical performance and executive function in older adults with mild cognitive impairment: gait speed and the timed "up & go" test. Phys Ther. 2011;91(8):1198-207.

25. Borges AP, Carneiro JA, Zaia JE, Carneiro AA, Takayanagui OM. Evaluation of postural balance in mild cognitive impairment through a three-dimensional electromagnetic system. Braz J Otorhinolaryngol. 2016;82(4):433-41.

26. Lee SH, Han JH, Jin YY, Lee IH, Hong HR, Kang HS. Poor physical fitness is independently associated with mild cognitive impairment in elderly Koreans. Biol Sport. 2016;33(1):57-62.

27. Borges Sde M, Radanovic M, Forlenza OV. Functional mobility in a divided attention task in older adults with cognitive impairment. J Mot Behav. 2015;47(5):378-85.

28. Tangen GG, Engedal K, Bergland A, Moger TA, Mengshoel AM. Relationships between balance and cognition in patients with subjective cognitive impairment, mild cognitive impairment, and Alzheimer disease. Phys Ther. 2014;94(8):1123-34.

29. Blackwood J, Shubert T, Forgarty K, Chase C. Relationships Between Performance on Assessments of Executive Function and Fall Risk Screening Measures in Community-Dwelling Older Adults. J Geriatr Phys Ther. 2016;39(2):89-96.

30. Liu-Ambrose TY, Ashe MC, Graf P, Beattie BL, Khan KM. Increased risk of falling in older community-dwelling women with mild cognitive impairment. Phys Ther. 2008;88(12):1482-91.

31. Taylor ME, Delbaere K, Lord SR, Mikolaizak AS, Brodaty H, Close JC. Neuropsychological, physical, and functional mobility measures associated with falls in cognitively impaired older adults. J Gerontol A Biol Sci Med Sci. 2014;69(8):987-95.

32. Pettersson AF, Olsson E, Wahlund LO. Motor function in subjects with mild cognitive impairment and early Alzheimer's disease. Dement Geriatr Cogn Disord. 2005;19(5-6):299-304.

Ref. code: 25605912030540QOI

33. Eggermont LH, Gavett BE, Volkers KM, Blankevoort CG, Scherder EJ, Jefferson AL, et al. Lower-Extremity Function in Cognitively Healthy Aging, Mild Cognitive Impairment, and Alzheimer’s Disease. Arch Phys Med Rehabil. 2010;91(4):584-8.

34. Quadri P, Merlo A, Zanda E, Ronchi S, Meroni F, Zemp D, et al. Balance, gait, postural stability, and falls in mild cognitive impairment: The Canton ticino study. Alzheimer's & Dementia: The Journal of the Alzheimer's Association. 2011;7(4):S544.

35. Makizako H, Shimada H, Doi T, Park H, Yoshida D, Uemura K, et al. Poor balance and lower gray matter volume predict falls in older adults with mild cognitive impairment. BMC Neurol. 2013;13:102.

36. Beauchet O, Launay CP, Sejdic E, Allali G, Annweiler C. Motor imagery of gait: a new way to detect mild cognitive impairment? J Neuroeng Rehabil. 2014;11:66.

37. Franssen EH, Souren LE, Torossian CL, Reisberg B. Equilibrium and limb coordination in mild cognitive impairment and mild Alzheimer's disease. J Am Geriatr Soc. 1999;47(4):463-9.

38. Dionyssiotis Y. Analyzing the problem of falls among older people. Int J Gen Med. 2012;5:805-13.

39. Biolgical, Medical and Behavioral Risk Factors on Falls [Internet]. Available from:http://www.who.int/ageing/projects/2.Biological,%20medical%20and%20behavioural%20risk%20factors%20on%20falls.pdf.

40. Kawa J, Bednorz A, Stepien P, Derejczyk J, Bugdol M. Spatial and Dynamical Handwriting Analysis in Mild Cognitive Impairment. 2017;82(4):21-8.

41. Schroter A, Mergl R, Burger K, Hampel H, Moller HJ, Hegerl U. Kinematic analysis of handwriting movements in patients with Alzheimer's disease, mild cognitive impairment, depression and healthy subjects. Dement Geriatr Cogn Disord. 2003;15(3):132-42.

42. Yan JH, Rountree S, Massman P, Doody RS, Li H. Alzheimer's disease and mild cognitive impairment deteriorate fine movement control. J Psychiatr Res. 2008;42(14):1203-12.

43. Kluger A, Gianutsos JG, Golomb J, Ferris SH, George AE, Franssen E, et al. Patterns of motor impairement in normal aging, mild cognitive decline, and early Alzheimer's disease. J Gerontol B Psychol Sci Soc Sci. 1997;52b(1):P28-39.

Ref. code: 25605912030540QOI

44. De Paula JJ, Albuquerque MR, Lage GM, Bicalho MA, Romano-Silva MA, Malloy-Diniz LF. Impairment of fine motor dexterity in mild cognitive impairment and Alzheimer's disease dementia: association with activities of daily living. Rev Bras Psiquiatr. 2016;38(3):235-8.

45. Li Y, Levin O, Forner-Cordero A, Swinnen SP. Interactions between interlimb and intralimb coordination during the performance of bimanual multijoint movements. Exp Brain Res. 2005;163(4):515-26.

46. Belen'kii VY, Gurfinkel V, Pal'tsev YI. Control elements of voluntary movements. 1967;12(1):135-41.

47. Zehr EP, Duysens J. Regulation of arm and leg movement during human locomotion. Neuroscientist. 2004;10(4):347-61.

48. John Knodel, Bussarawan Teerawichitchainan, Vipan Prachuabmoh, Wiraporn Pothisiri. The situation of Thailand's older population: An update based on the 2014 Survey of Older Persons in Thailand. Research Collection School of Social Sciences. 2015.

49. Knodel J, Chayovan N. Older Persons in Thailand: A Demographic, Social and Economic Profile. Ageing International. 2008;33(1):3-14.

50. Charles ST, Carstensen LL. Social and emotional aging. Annu Rev Psychol. 2010;61:383-409.

51. ไพลวรรณ สัทธานนท์. กายภาพบำบัดในผู้สูงอายุ. กรุงเทพฯ; สำนักพิมพ์มหาวิทยาลัยธรรมศาสตร์, 2559.

52. Strait JB, Lakatta EG. Aging-associated cardiovascular changes and their relationship to heart failure. Heart failure clinics. 2012;8(1):143-64.

53. ราตรี สุดทรวง. ประสาทวิทยา. กรุงเทพฯ; ศูนย์หนังสือแห่งจุฬาลงกรณ์มหาวิทยาลัย: สำนักพิมพ์แห่งจุฬาลงกรณ์มหาวิทยาลัย, 2550.

54. Adelsberg S, Pitman M, Alexander H. Lower extremity fractures: relationship to reaction time and coordination time. Arch Phys Med Rehabil. 1989;70(10):737-9.

55. Nnodim JO, Yung RL. Balance and its Clinical Assessment in Older Adults - A Review. J Geriatr Med Gerontol. 2015;1(1):1-19.

56. Gupta MA, Gupta AK. Cutaneous sensory disorder. Semin Cutan Med Surg. 2013;32(2):110-8.

Ref. code: 25605912030540QOI

57. Thelen DG, Brockmiller C, Ashton-Miller JA, Schultz AB, Alexander NB. Thresholds for sensing foot dorsi- and plantarflexion during upright stance: effects of age and velocity. J Gerontol A Biol Sci Med Sci. 1998;53(1):M33-8.

58. World Health Organization. WHo Global report on falls Prevention in older Age. 2007.

59. Prudham D, Evans JG. Factors associated with falls in the elderly: a community study. Age Ageing. 1981;10(3):141-6.

60. Stepehn R. Load, Catherine Sherrington, hylton Menz, Jacqueline Close. Falls in older people: risk factors and strategies for prevention. 2nd ed. 2013.

61. Prato SCF, Andrade SM, Cabrera MAS, Dip RM, Santos HGD, Dellaroza MSG, et al. Frequency and factors associated with falls in adults aged 55 years or more. Rev Saude Publica. 2017;51(0):37.

62. Patil S, Suryanarayana S, Dinesh R, Shivraj N, Murthy N. Risk factors for falls among elderly: A community-based study. Int J Health Allied Sci. 2015;4(3):135-40.

63. Blake AJ, Morgan K, Bendall MJ, Dallosso H, Ebrahim SB, Arie TH, et al. Falls by elderly people at home: prevalence and associated factors. Age Ageing. 1988;17(6):365-72.

64. Overstall PW, Exton-Smith AN, Imms FJ, Johnson AL. Falls in the elderly related to postural imbalance. Br Med J. 1977;1(6056):261-4.

65. Sophonratanapokin B, Sawangdee Y, Soonthorndhada K. Effect of the living environment on falls among the elderly in Thailand. Southeast Asian J Trop Med Public Health. 2012;43(6):1537-47.

66. Ambrose AF, Paul G, Hausdorff JM. Risk factors for falls among older adults: a review of the literature. Maturitas. 2013;75(1):51-61.

67. Borel L, Alescio-Lautier B. Posture and cognition in the elderly: interaction and contribution to the rehabilitation strategies. Neurophysiol Clin. 2014;44(1):95-107.

68. Woollacott MH. Systems contributing to balance disorders in older adults. J Gerontol A Biol Sci Med Sci. 2000;55(8):M424-8.

69. Miall RC, Reckess GZ. The Cerebellum and the Timing of Coordinated Eye and Hand Tracking. Brain and Cognition. 2002;48(1):212-26.

70. Amboni M, Barone P, Hausdorff JM. Cognitive contributions to gait and falls: evidence and implications. Mov Disord. 2013;28(11):1520-33.

Ref. code: 25605912030540QOI

71. Langley FA, Mackintosh SFH. Functional Balance Assessment of Older Community Dwelling Adults: A Systematic Review of the Literature. The Internet Journal of Allied Healh Sciences and Practice (JAHSP). 2007;5(4):1-11.

72. Barry E, Galvin R, Keogh C, Horgan F, Fahey T. Is the Timed Up and Go test a useful predictor of risk of falls in community dwelling older adults: a systematic review and meta-analysis. BMC Geriatr. 2014;14:14.

73. Shumway-Cook A, Brauer S, Woollacott M. Predicting the probability for falls in community-dwelling older adults using the Timed Up & Go Test. Phys Ther. 2000;80(9):896-903.

74. Nocera JR, Stegemöller EL, Malaty IA, Okun MS, Marsiske M, Hass CJ, et al. Using the Timed Up & Go Test in a Clinical Setting to Predict Falling in Parkinson's Disease. Arch Phys Med Rehabil. 2013;94(7):1300-5.

75. Rolenz E, Reneker JC. Validity of the 8-Foot Up and Go, Timed Up and Go, and Activities-Specific Balance Confidence Scale in older adults with and without cognitive impairment. J Rehabil Res Dev. 2016;53(4):511-8.

76. Hofheinz M, Mibs M. The Prognostic Validity of the Timed Up and Go Test With a Dual Task for Predicting the Risk of Falls in the Elderly. Gerontology and geriatric medicine. 2016;2:1-5.

77. Maranhao-Filho PA, Maranhao ET, Lima MA, Silva MM. Rethinking the neurological examination II: dynamic balance assessment. Arq Neuropsiquiatr. 2011;69(6):959-63.

78. Hong SJ, Goh EY, Chua SY, Ng SS. Reliability and validity of step test scores in subjects with chronic stroke. Arch Phys Med Rehabil. 2012;93(6):1065-71.

79. Blennerhassett JM, Dite W, Ramage ER, Richmond ME. Changes in balance and walking from stroke rehabilitation to the community: a follow-up observational study. Arch Phys Med Rehabil. 2012;93(10):1782-7.

80. Duncan PW, Studenski S, Chandler J, Prescott B. Functional reach: predictive validity in a sample of elderly male veterans. J Gerontol. 1992;47(3):M93-8.

81. Behrman AL, Light KE, Flynn SM, Thigpen MT. Is the functional reach test useful for identifying falls risk among individuals with Parkinson's disease? Arch Phys Med Rehabil. 2002;83(4):538-42.

Ref. code: 25605912030540QOI

82. Dibble LE, Lange M. Predicting falls in individuals with Parkinson disease: a reconsideration of clinical balance measures. J Neurol Phys Ther. 2006;30(2):60-7.

83. Buatois S, Miljkovic D, Manckoundia P, Gueguen R, Miget P, Vancon G, et al. Five times sit to stand test is a predictor of recurrent falls in healthy community-living subjects aged 65 and older. J Am Geriatr Soc. 2008;56(8):1575-7.

84. Duncan RP, Leddy AL, Earhart GM. Five Times Sit to Stand Test Performance in Parkinson Disease. Arch Phys Med Rehabil. 2011;92(9):1431-6.

85. Weber PC, Cass SP. Clinical assessment of postural stability. Am J Otol. 1993;14(6):566-9.

86. Shumway-Cook A, Baldwin M, Polissar NL, Gruber W. Predicting the probability for falls in community-dwelling older adults. Phys Ther. 1997;77(8):812-9.

87. Berg KO, Wood-Dauphinee SL, Williams JI, Maki B. Measuring balance in the elderly: validation of an instrument. Can J Public Health. 1992;83 Suppl 2:S7-11.

88. Faber MJ, Bosscher RJ, van Wieringen PC. Clinimetric properties of the performance-oriented mobility assessment. Phys Ther. 2006;86(7):944-54.

89. Kegelmeyer DA, Kloos AD, Thomas KM, Kostyk SK. Reliability and validity of the Tinetti Mobility Test for individuals with Parkinson disease. Phys Ther. 2007;87(10):1369-78.

90. Hernandez D, Rose DJ. Predicting which older adults will or will not fall using the Fullerton Advanced Balance scale. Arch Phys Med Rehabil. 2008;89(12):2309-15.

91. Tsang CS, Liao LR, Chung RC, Pang MY. Psychometric properties of the Mini-Balance Evaluation Systems Test (Mini-BESTest) in community-dwelling individuals with chronic stroke. Phys Ther. 2013;93(8):1102-15.

92. Leddy AL, Crowner BE, Earhart GM. Utility of the Mini-BESTest, BESTest, and BESTest Sections for Balance Assessments in Individuals with Parkinson Disease. J Neurol Phys Ther. 2011;35(2):90-7.

93. Lord SR, Clark RD, Webster IW. Physiological factors associated with falls in an elderly population. J Am Geriatr Soc. 1991;39(12):1194-200.

94. Shaw FE. Prevention of falls in older people with dementia. J Neural Transm (Vienna). 2007;114(10):1259-64.

95. Horak FB. Clinical assessment of balance disorders. Gait & Posture. 1997;6(1):76-84.

Ref. code: 25605912030540QOI

96. Debaere F, Swinnen SP, Beatse E, Sunaert S, Van Hecke P, Duysens J. Brain areas involved in interlimb coordination: a distributed network. Neuroimage. 2001;14(5):947-58.

97. Desrosiers J, Hebert R, Bravo G, Dutil E. Upper-extremity motor co-ordination of healthy elderly people. Age Ageing. 1995;24(2):108-12.

98. Nutt JG, Marsden CD, Thompson PD. Human walking and higher-level gait disorders, particularly in the elderly. Neurology. 1993;43(2):268-79.

99. Misra N, Mahajan KK, Maini BK. Comparative study of visual and auditory reaction time of hands and feet in males and females. Indian J Physiol Pharmacol. 1985;29(4):213-8.

100. Green M. "How Long Does It Take to Stop?" Methodological Analysis of Driver Perception-Brake Times. Transportation Human Factors. 2000;2(3):195-216.

101. Dhavalikar M, Narkeesh A, Gupta N. Effect of skin temperature on nerve conduction velocity and reliability ofteperature correction formula in Indian females. Exercise Science and Physiotherapy. 2009;5(1):24-9.

102. Pal GK, Pal P. Nerve conduction study. Textbook of practical physiology. 3rd ed. Universities press, Orient Longman Private Ltd; 2011.p.215-22.

103. Woolley SM, Czaja SJ, Drury CG. An assessment of falls in elderly men and women. J Gerontol A Biol Sci Med Sci. 1997;52(2):M80-7.

104. Bunce D, Haynes BI, Lord SR, Gschwind YJ, Kochan NA, Reppermund S, et al. Intraindividual Stepping Reaction Time Variability Predicts Falls in Older Adults With Mild Cognitive Impairment. J Gerontol A Biol Sci Med Sci. 2017;72(6):832-7.

105. Lord SR, Fitzpatrick RC. Choice stepping reaction time: a composite measure of falls risk in older people. J Gerontol A Biol Sci Med Sci. 2001;56(10):M627-32.

106. Cheng Y-W, Chen T-F, Chiu M-J. From mild cognitive impairment to subjective cognitive decline: conceptual and methodological evolution. Neuropsychiatric Disease and Treatment. 2017;13:491-8.

107. Abdulrab K, Heun R. Subjective Memory Impairment. A review of its definitions indicates the need for a comprehensive set of standardised and validated criteria. Eur Psychiatry. 2008;23(5):321-30.

108. Petersen RC. Mild cognitive impairment as a diagnostic entity. J Intern Med. 2004;256(3):183-94.

Ref. code: 25605912030540QOI

109. Gauthier S, Reisberg B, Zaudig M, Petersen RC, Ritchie K, Broich K, et al. Mild cognitive impairment. The Lancet. 2006;367(9518):1262-70.

110. Petersen RC. Mild cognitive impairment or questionable dementia? Arch Neurol. 2000;57(5):643-4.

111. Panza F, D'Introno A, Colacicco AM, Capurso C, Del Parigi A, Caselli RJ, et al. Current epidemiology of mild cognitive impairment and other predementia syndromes. Am J Geriatr Psychiatry. 2005;13(8):633-44.

112. Busse A, Angermeyer MC, Riedel-Heller SG. Progression of mild cognitive impairment to dementia: a challenge to current thinking. Br J Psychiatry. 2006;189:399-404.

113. Rajesh R. Tampi, Deena J. Tampi, Silpa Chandran, Ambreen Ghori, Megan Durning. Mild cognitive impairment: A comprehensive review. Healthy Aging Research. 2015;4:39.

114. Tabatabaei-Jafari H, Shaw ME, Cherbuin N. Cerebral atrophy in mild cognitive impairment: A systematic review with meta-analysis. Alzheimers Dement (Amst). 2015;1(4):487-504.

115. Li JQ, Tan L, Wang HF, Tan MS, Tan L, Xu W, et al. Risk factors for predicting progression from mild cognitive impairment to Alzheimer's disease: a systematic review and meta-analysis of cohort studies. J Neurol Neurosurg Psychiatry. 2016;87(5):476-84.

116. Buscemi S, Di Pasquale V, Buscemi C, Piccoli T, Giordano C. Factors associated with mild cognitive impairment in a population-based cohort. Eur J Intern Med. 2017;43(9):e20-1.

117. Wang L, Larson EB, Bowen JD, van Belle G. Performance-based physical function and future dementia in older people. Arch Intern Med. 2006;166(10):1115-20.

118. Wang T, Xiao S, Chen K, Yang C, Dong S, Cheng Y, et al. Prevalence, Incidence, Risk and Protective Factors of Amnestic Mild Cognitive Impairment in the Elderly in Shanghai. Curr Alzheimer Res. 2017;14(4):460-6.

119. Chen Y, Denny KG, Harvey D, Farias ST, Mungas D, DeCarli C, et al. Progression from normal cognition to mild cognitive impairment in a diverse clinic-based and community-based elderly cohort. Alzheimers Dement. 2017;13(4):399-405.

Ref. code: 25605912030540QOI

120. Folstein MF, Folstein SE, McHugh PR. "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res. 1975;12(3):189-98.

121. Bossers WJR, van der Woude LHV, Boersma F, Scherder EJA, van Heuvelen MJG. Recommended Measures for the Assessment of Cognitive and Physical Performance in Older Patients with Dementia: A Systematic Review. Dementia and Geriatric Cognitive Disorders EXTRA. 2012;2(1):589-609.

122. Thai Cognitive Test Development Committee 1999. Mini-Mental State Examination-Thai 2002. Bangkok: Institute of Geriatric Medicine, Department of Medicine Services, Ministry of Public Health, Thailand. 2002.

123. Nasreddine ZS, Phillips NA, Bedirian V, Charbonneau S, Whitehead V, Collin I, et al. The Montreal Cognitive Assessment, MoCA: a brief screening tool for mild cognitive impairment. J Am Geriatr Soc. 2005;53(4):695-9.

124. Freitas S, Simoes MR, Alves L, Santana I. Montreal cognitive assessment: validation study for mild cognitive impairment and Alzheimer disease. Alzheimer Dis Assoc Disord. 2013;27(1):37-43.

125. Tangwongchai S, Thammanard C, Muthiata P. The validity of thai version of the montreal cognitive assessment (MoCA-T). Dement Neuropsychol. 2009;3(2):136-78.

126. Woolf C, Slavin MJ, Draper B, Thomassen F, Kochan NA, Reppermund S, et al. Can the Clinical Dementia Rating Scale Identify Mild Cognitive Impairment and Predict Cognitive and Functional Decline? Dement Geriatr Cogn Disord. 2016;41(5-6):292-302.

127. Reisberg B, Ferris SH, de Leon MJ, Crook T. The Global Deterioration Scale for assessment of primary degenerative dementia. Am J Psychiatry. 1982;139(9):1136-9.

128. Yogev-Seligmann G, Hausdorff JM, Giladi N. The role of executive function and attention in gait. Mov Disord. 2008;23(3):329-42; quiz 472.

129. Panza F, D'Introno A, Colacicco AM, Capurso C, Del Parigi A, Caselli RJ, et al. Depressive symptoms, vascular risk factors and mild cognitive impairment. The Italian longitudinal study on aging. Dement Geriatr Cogn Disord. 2008;25(4):336-46.

Ref. code: 25605912030540QOI

130. Kohler CA, Magalhaes TF, Oliveira JM, Alves GS, Knochel C, Oertel-Knochel V, et al. Neuropsychiatric Disturbances in Mild Cognitive Impairment (MCI): A Systematic Review of Population-Based Studies. Curr Alzheimer Res. 2016;13(10):1066-82.

131. Phillips M, Rogers P, Haworth J, Bayer A, Tales A. Intra-individual reaction time variability in mild cognitive impairment and Alzheimer's disease: gender, processing load and speed factors. PLoS One. 2013;8(6):e65712.

132. Ervin RB. Prevalence of functional limitations among adults 60 years of age and over: United States, 1999-2002. Adv Data. 2006(375):1-7.

133. Boripuntakul S, Lord SR, Brodie MA, Smith ST, Methapatara P, Wongpakaran N, et al. Spatial variability during gait initiation while dual tasking is increased in individuals with mild cognitive impairment. J Nutr Health Aging. 2014;18(3):307-12.

134. Mignardot JB, Beauchet O, Annweiler C, Cornu C, Deschamps T. Postural sway, falls, and cognitive status: a cross-sectional study among older adults. J Alzheimers Dis. 2014;41(2):431-9.

135. Bahureksa L, Najafi B, Saleh A, Sabbagh M, Coon D, Mohler MJ, et al. The Impact of Mild Cognitive Impairment on Gait and Balance: A Systematic Review and Meta-Analysis of Studies Using Instrumented Assessment. Gerontology. 2016.

136. Shin BM, Han SJ, Jung JH, Kim JE, Fregni F. Effect of mild cognitive impairment on balance. J Neurol Sci. 2011;305(1-2):121-5.

137. Harlein J, Dassen T, Halfens RJ, Heinze C. Fall risk factors in older people with dementia or cognitive impairment: a systematic review. J Adv Nurs. 2009;65(5):922-33.

138. Swinnen SP, Wenderoth N. Two hands, one brain: cognitive neuroscience of bimanual skill. Trends Cogn Sci. 2004;8(1):18-25.

139. Lamb SE, Jørstad EC, Hauer K, Becker C. Development of a common outcome data set for fall injury prevention trials. J Am Geriatr Soc. 2005;53(9):1618-22.

140. Institute of Medicine (US) Division of Health Promotion and Disease Prevention., Robert L. Berg, Cassells. JS. Falls in Older Persons: Risk Factors and Prevention. The Second Fifty Years: Promoting Health and Preventing Disability1992.

Ref. code: 25605912030540QOI

141. Montero-Odasso M. Cognition, Gait Disorders, and Fall Risk in Healthy Neurological Older Individuals. In: Barbieri FA, Vitório R, editors. Locomotion and Posture in Older Adults: The Role of Aging and Movement Disorders. Cham: Springer International Publishing; 2017.p. 91-114.

142. Tinetti ME, Speechley M, Ginter SF. Risk factors for falls among elderly persons living in the community. N Engl J Med. 1988;319(26):1701-7.

143. Muir SW, Gopaul K, Montero Odasso MM. The role of cognitive impairment in fall risk among older adults: a systematic review and meta-analysis. Age Ageing. 2012;41(3):299-308.

144. Seijo-Martinez M, Cancela JM, Ayan C, Varela S, Vila H. Influence of cognitive impairment on fall risk among elderly nursing home residents. Int Psychogeriatr. 2016;28(12):1975-87.

145. Borges Sde M, Radanovic M, Forlenza OV. Fear of falling and falls in older adults with mild cognitive impairment and Alzheimer's disease. Neuropsychol Dev Cogn B Aging Neuropsychol Cogn. 2015;22(3):312-21.

146. Ansai JH, Andrade LP, Rossi PG, Takahashi ACM, Vale FAC, Rebelatto JR. Gait, dual task and history of falls in elderly with preserved cognition, mild cognitive impairment, and mild Alzheimer's disease. Braz J Phys Ther. 2017;21(2):144-51.

147. Wongpakaran N, Wongpakaran T, Van Reekum R. The Use of GDS-15 in Detecting MDD: A Comparison Between Residents in a Thai Long-Term Care Home and Geriatric Outpatients. J Clin Med Res. 2013;5(2):101-11.

148. อรวรรณ์ คูหา, บูริณี บุญมีพิพิธ, จิตนภา วณิชวโรตฒ์, นันทศักดิ์ ธรรมานวัตร์. การเปรียบเทียบความสัมพันธ์แบบทดสอบสภาพสมองเสื่อมเบื้องต้น (ฉบับภาษาไทย) (MMSE-Thai) 2002 และแบบทดสอบสมรรถภาพสมองไทย (TMSE) ในการคัดกรองผู้สูงอายุภาวะสมองเสื่อม. กรุงเทพฯ; วารสารพฤฒาวิทยาและเวชศาสตร์ผู้สูงอายุ. 2552;10(1):19-24.

149. Oxford Grice K, Vogel KA, Le V, Mitchell A, Muniz S, Vollmer MA. Adult norms for a commercially available Nine Hole Peg Test for finger dexterity. Am J Occup Ther. 2003;57(5):570-3.

150. Suttanon P, Hill KD, Said CM, Logiudice D, Lautenschlager NT, Dodd KJ. Balance and mobility dysfunction and falls risk in older people with mild to moderate Alzheimer disease. Am J Phys Med Rehabil. 2012;91(1):12-23.

151. วีรศักดิ์ เมืองไพศาล. การป้องกัน การประเมินและการดูแลผู้ป่วยสมองเสื่อม. กรุงเทพฯ; ภาควิชาเวชศาสตร์ป้องกันและสังคม คณะแพทยศาสตร์ศิริราชพยาบาล มหาวิทยาลัยมหิดล, 2556.

152. Pilania M, Bairwa M, Khurana H, Kumar N. Prevalence and Predictors of Depression in Community-Dwelling Elderly in Rural Haryana, India. Indian J Community Med. 2017;42(1):13-8.

153. Chen HY, Tang PF. Factors Contributing to Single- and Dual-Task Timed "Up & Go" Test Performance in Middle-Aged and Older Adults Who Are Active and Dwell in the Community. Phys Ther. 2016;96(3):284-92.

154. McCarthy EK, Horvat MA, Holtsberg PA, Wisenbaker JM. Repeated chair stands as a measure of lower limb strength in sexagenarian women. J Gerontol A Biol Sci Med Sci. 2004;59(11):1207-12.

155. Xu D, Cole MH, Mengersen K, Silburn PA, Qiu F, Graepel C, et al. Executive function and postural instability in people with Parkinson's disease. Parkinsons Dis. 2014;2014:8.

156. Sun Y, Yin Q, Fang R, Yan X, Wang Y, Bezerianos A, et al. Disrupted functional brain connectivity and its association to structural connectivity in amnestic mild cognitive impairment and Alzheimer's disease. PLoS One. 2014;9(5):e96505.

157. Scheller E, Abdulkadir A, Peter J, Tabrizi SJ, Frackowiak RS, Kloppel S. Interregional compensatory mechanisms of motor functioning in progressing preclinical neurodegeneration. Neuroimage. 2013;75:146-54.

158. Cai L, Chan JS, Yan JH, Peng K. Brain plasticity and motor practice in cognitive aging. Front Aging Neurosci. 2014;6:31.

159. Fasano A, Plotnik M, Bove F, Berardelli A. The neurobiology of falls. Neurol Sci. 2012;33(6):1215-23.

Ref. code: 25605912030540QOI

APPENDICES

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APPENDIX A

THE HUMAN RESEARCH ETHICS COMMITTEE OF THAMMASAT UNIVERSITY NO.3

AF 01_12

คณะอนุกรรมการจริยธรรมการวิจัยในคน มหาวิทยาลัยธรรมศาสตร์ ชุดที่ 3 สาขาวิทยาศาสตร์
อาคารราชสุดา ชั้น 1 ภายในศูนย์วิจัยฯ คณะพยาบาลศาสตร์ ต.คลองหนึ่ง อ.คลองหลวง จ.ปทุมธานี 12121
โทรศัพท์: 0-2986-9213 ต่อ 7373 โทรสาร: 0-2516-5381 E-mail: ecsctu3@nurse.tu.ac.th

COA No. 179/2559

ใบรับรองโครงการวิจัย

โครงการวิจัยที่ : 120/2559

ชื่อโครงการวิจัย : ความบกพร่องด้านความสามารถทางกายและปัญหาการล้มในผู้สูงอายุที่มีการรับรู้ความเข้าใจบกพร่องเล็กน้อย: ความชุก ปัจจัยเสี่ยง การจัดการและการป้องกัน

: PHYSICAL IMPAIRMENT AND FALLS IN OLDER PEOPLE WITH MILD COGNITIVE IMPAIRMENT: PREVALENCE, RISK FACTORS, MANAGEMENT AND PREVENTION

ผู้วิจัยหลัก : ผู้ช่วยศาสตราจารย์ ดร.ไพลวรรณ สัทธานนท์

หน่วยงาน : คณะสหเวชศาสตร์ มหาวิทยาลัยธรรมศาสตร์

คณะอนุกรรมการพิจารณาจริยธรรมการวิจัยในคน มหาวิทยาลัยธรรมศาสตร์ ชุดที่ 3 ได้พิจารณาโดยใช้หลัก ของ The International Conference on Harmonization – Good Clinical Practice (ICH-GCP) อนุมัติให้ดำเนินการศึกษาวิจัยเรื่องดังกล่าวได้

ลงนาม..	ลงนาม..
(ศาสตราจารย์ ดร.ประนอม โอทกานนท์)	(อาจารย์ ดร.ศารีรัตน์ วุฒิอาภา)
ประธานคณะอนุกรรมการ	อนุกรรมการและเลขานุการ
วันที่รับรอง : 23 พฤศจิกายน 2559	**วันหมดอายุ** : 22 พฤศจิกายน 2560

กำหนดส่งรายงานความก้าวหน้า: ครั้งที่ 1: 23 พฤษภาคม 2560

เอกสารที่คณะอนุกรรมการรับรอง

1) โครงการวิจัย
2) ข้อมูลสำหรับประชากร/กลุ่มตัวอย่างหรือผู้มีส่วนร่วมในการวิจัยและใบยินยอมของประชากร/กลุ่มตัวอย่างหรือผู้มีส่วนร่วมในการวิจัย
3) ประวัติผู้วิจัย
4) เอกสารเครื่องมือต่างๆ ที่ใช้ในการวิจัย เป็นต้นว่า แบบสอบถาม
5) เอกสารอื่นๆ ที่เกี่ยวข้อง เช่น เอกสารประชาสัมพันธ์ เป็นต้น

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APPENDIX B

Thai Geriatric Depression Scale -15: TGDS-15

(แบบวัดความเศร้าในผู้สูงอายุไทย 15 ข้อ)

คำชี้แจง โปรดอ่านข้อความในแต่ละข้ออย่างละเอียด และประเมินความรู้สึกของท่านในช่วง 1 สัปดาห์ที่ผ่านมา ใช้ขีด / ลงในช่องที่ตรงกับ "ใช่" ถ้าคำในข้อความนั้นตรงกับความรู้สึกของท่าน ให้ขีดเครื่องหมาย / ลงในช่องที่ตรงกับ "ไม่ใช่" ถ้าคำในข้อความนั้นไม่ตรงกับความรู้สึกของท่าน

หัวข้อ	คำตอบ	
	ใช่	ไม่ใช่
1. โดยทั่วไปแล้วคุณพึงพอใจกับชีวิตตัวเองหรือไม่		
2. คุณลดกิจกรรมหรือความสนใจในสิ่งต่างๆลงหรือไม่		
3. คุณรู้สึกว่าชีวิตคุณว่างเปล่าหรือไม่		
4. คุณรู้สึกเบื่อๆ อยู่บ่อยครั้งหรือไม่		
5. คุณอารมณ์ดีเป็นส่วนใหญ่หรือไม่		
6. คุณกลัวว่าอะไรร้ายๆ จะเกิดขึ้นกับคุณหรือไม่		
7. คุณรู้สึกมีความสุขเป็นส่วนใหญ่หรือไม่		
8. คุณรู้สึกหมดหนทางอยู่บ่อยครั้ง		
9. คุณชอบอยู่กับบ้านมากกว่าออกไปหาอะไรทำนอกบ้านหรือไม่		
10. คุณรู้สึกว่าคุณมีปัญหาความจำมากกว่าใครๆ หรือไม่		
11. คุณคิดว่าการที่มีชีวิตอยู่มาได้จนถึงทุกวันนี้มันช่างแสนวิเศษใช่หรือไม่		
12. คุณรู้สึกหรือไม่ว่าชีวิตที่กำลังเป็นอยู่ตอนนี้ช่างไร้ค่าเหลือเกิน		
13. คุณรู้สึกมีกำลังเต็มที่หรือไม่		
14. คุณรู้สึกหมดหวังกับสิ่งที่คุณกำลังเผชิญอยู่หรือไม่		
15. คุณคิดว่าคนอื่นๆ ดีกว่าคุณหรือไม่		

คะแนนรวม ....../ 15

APPENDIX C

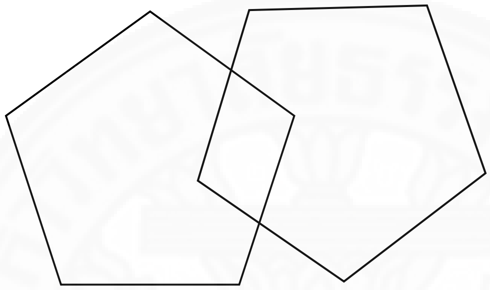
Mini-Mental State Examination-Thai 2002: MMSE-Thai 2002

(แบบทดสอบสภาพสมองเบื้องต้นฉบับภาษาไทย)

** ในกรณีที่ผู้ถูกทดสอบอ่านไม่ออก เขียนไม่ได้ ไม่ต้องทำข้อ 4, 9 และ 10

หัวข้อ	บันทึกคำตอบทุกครั้ง	คะแนน
1.Orientation for Time (5 คะแนน) 1.1 วันนี้ วันที่เท่าไร 1.2 วันนี้ วันอะไร 1.3 เดือนนี้ เดือนอะไร 1.4 ปีนี้ ปีอะไร 1.5 ฤดูนี้ ฤดูอะไร		
2.Orientation for Place (5 คะแนน) (ให้เลือกทำข้อใดข้อหนึ่ง) กรณีอยู่สถานพยาบาล 2.1 สถานที่ตรงนี้ เรียกว่าอะไร และ......ชื่อว่าอะไร 2.2 ขณะนี้ อยู่ที่ชั้นเท่าไรของตัวอาคาร 2.3 ที่นี่อยู่ในอำเภอ 2.4 ที่นี่จังหวัดอะไร 2.5 ที่นี่ภาคอะไร กรณีอยู่บ้านของผู้ทดสอบ 2.1 สถานที่ตรงนี้เรียกว่าอะไร และบ้านเลขที่เท่าไหร่ 2.2 ที่นี้หมู่บ้าน หรือละแวก/คุ้ม/ย่าน/ถนนอะไร 2.3 ที่นี่อยู่ในอำเภอ 2.4 ที่นี่จังหวัดอะไร 2.5 ที่นี่ภาคอะไร		
3. Registration (3 คะแนน) บอกชื่อของ 3 อย่างแล้วให้ผู้ทดสอบพูดตาม ( ) ดอกไม้ ( ) แม่น้ำ ( ) รถไฟ ในกรณีที่ทำแบบทดสอบซ้ำภายใน 2 เดือน ( ) ต้นไม้ ( ) ทะเล ( ) รถยนต์		

4. Attention /Calculation (5 คะแนน) * ถ้าตอบคิดเป็นให้ตอบข้อ 4.1 * ถ้าตอบคิดไม่เป็นหรือไม่ตอบ ให้ตอบข้อ 4.2 4.1 "คิดในใจ เอา 100 ตั้ง ลบออกทีละ 7 ไปเรื่อยๆได้ผลลัพธ์เท่าไร ………… …………. …………. …………. …………. 4.2 สะกดคำว่ามะนาวให้ฟัง แล้วให้ผู้ทดสอบสะกดถอยหลัง .... …..... .... …..... .... ว า น ะ ม		
5. Recall (3 คะแนน) เมื่อสักครู่ที่ให้จำของ 3 อย่าง จำได้ไหม มีอะไรบ้าง ( ) ดอกไม้ ( ) แม่น้ำ ( ) รถไฟ ( ) ต้นไม้ ( ) ทะเล ( ) รถยนต์		
6. Naming (2 คะแนน) 6.1 ยื่นดินสอให้ผู้สูงอายุแล้วถามว่า"ของสิ่งนี้เรียกว่าอะไร" 6.2 ชี้นาฬิกาข้อมือให้ผู้สูงอายุดูแล้วถามว่า "ของสิ่งนี้เรียกว่าอะไร"		
7. Repetition (1 คะแนน) พูดข้อความแล้วให้พูดตาม โดยบอกเพียงหนึ่งครั้ง " ใคร ใคร่ ขาย ไก่ ไข่"		
8. Verbal command (3 คะแนน) บอกผู้ทดสอบว่าจะส่งกระดาษให้ แล้วให้รับด้วยมือขวา พับครึ่งด้วยมือ 2 ข้าง แล้ววางไว้ที่ ….. (พื้น, โต๊ะ, เตียง) ( ) รับด้วยมือขวา ( ) พับครึ่ง ( ) แล้ววางที่.... (พื้น,โต๊ะ,เตียง)		
9. Written command (3 คะแนน) ให้ผู้ทดสอบอ่านข้อความที่กำหนด แล้วให้ทำตามจะอ่านออกเสียงหรืออ่านในใจก็ได้ ผู้ทดสอบแสดงกระดาษที่เขียนว่า **"หลับตา"** ( ) หลับตาได้		

10. Writing (1 คะแนน) ให้ผู้ทดสอบเขียนข้อความอะไรก็ได้ ที่อ่านแล้วรู้เรื่อง หรือมีความหมายมา 1 ประโยค		
11. Visuo-construction (1 คะแนน) ข้อนี้เป็นคำสั่ง "จงวาดให้เหมือนภาพตัวอย่าง"ในที่ว่างด้านข้างของภาพตัวอย่าง 		
รวม		

จุดตัด Cut-off สำหรับคะแนนที่สงสัยภาวะสมองเสื่อม (Cognitive impairment) ระดับการศึกษา	**คะแนน**	
	จุดตัด	**เต็ม**
- ผู้สูงอายุปกติ ไม่ได้เรียนหนังสือ (อ่านไม่ออกเขียนไม่ได้)	≤ 14	23 (ต้องไม่ทำข้อ 4,9,10)
- ผู้สูงอายุปกติ เรียนระดับประถมศึกษา	≤ 17	30
- ผู้สูงอายุปกติ เรียนระดับสูงกว่าประถมศึกษา	≤ 22	30

Ref. code: 25605912030540QOI

APPENDIX D

Montreal Cognitive Assessment- Thai version

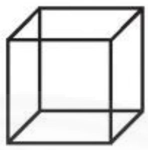
(แบบประเมินพุทธิปัญญา)

MONTREAL COGNITIVE ASSESSMENT (MOCA)

ชื่อ :
ระดับการศึกษา : วันเดือนปีเกิด:
เพศ : วันที่ทำการทดสอบ :

VISUOSPATIAL / EXECUTIVE — คะแนน

[ ]

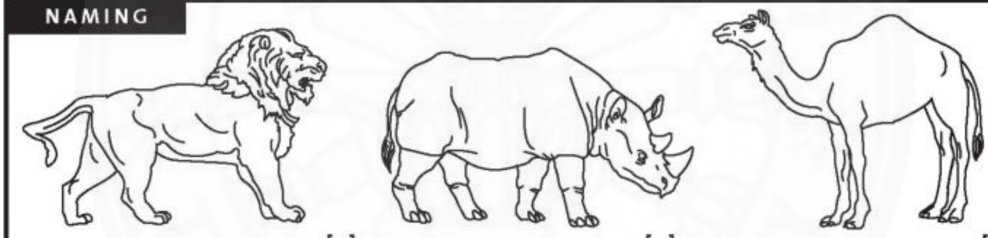


คัดลอก ลูกบาศก์ [ ]

วาดหน้าปัดนาฬิกา บอกเวลาที่ 11.10 น. (3 คะแนน)

[ ] รูปร่าง [ ] ตัวเลข [ ] เข็ม __/5

NAMING



[ ] [ ] [ ] __/3

MEMORY

อ่านชุดคำเหล่านี้แล้วให้ผู้ทดสอบทวนซ้ำ ทดสอบ 2 ครั้ง และถามซ้ำอีกครั้งหลัง 5 นาที

	หน้า	ผ้าไหม	วัด	มะลิ	สีแดง
ทวนครั้งที่ 1					
ทวนครั้งที่ 2					

ATTENTION

อ่านตัวเลขต่อไปนี้ตามลำดับ (1 ตัว/วินาที) ให้ผู้ทดสอบทวนซ้ำตามลำดับ [ ] 2 1 8 5 4
ผู้ทดสอบทวนซ้ำแบบย้อนลำดับ [ ] 7 4 2 __/2

อ่านออกเสียงตัวเลขต่อไปนี้ แล้วให้ผู้ทดสอบเคาะโต๊ะเมื่อได้ยินเสียงอ่านเลข " 1 " (ไม่มีคะแนนถ้าผิดเกิน 2 ครั้ง)
[ ] 5 2 1 3 9 4 1 1 8 0 6 2 1 5 1 9 4 5 1 1 1 4 1 9 0 5 1 1 2 __/1

เริ่มจาก 100 ลบไปเรื่อยๆทีละ 7 [ ] 93 [ ] 86 [ ] 79 [ ] 72 [ ] 65 __/3
ลบถูก 4 หรือ 5 ตัว ได้ 3 คะแนน , 2 หรือ 3 ตัว ได้ 2 คะแนน , 1 ตัวได้ 1 คะแนน , 0 ตัว ไม่ได้คะแนน

LANGUAGE

Repeat : ฉันรู้ว่าจอมเป็นคนเดียวที่มาช่วยงานวันนี้ [ ]
แมวมักซ่อนตัวอยู่หลังเก้าอี้เมื่อมีหมาอยู่ในห้อง [ ] __/2

Fluency / บอกคำที่ขึ้นต้นด้วยตัวอักษร " ก " ให้มากที่สุดใน 1 นาที ก [ ] _____ (N ≥ 11 words) __/1

ABSTRACTION

บอกความเหมือนระหว่าง 2 สิ่ง เช่น กล้วย-ส้ม : เป็นผลไม้ [ ] รถไฟ - จักรยาน [ ] นาฬิกา - ไม้บรรทัด __/2

DELAYED RECALL

ให้ทวนชุดคำที่จำไว้ก่อนหน้านี้ โดยไม่มีการให้ตัวช่วย	หน้า	ผ้าไหม	วัด	มะลิ	สีแดง	ให้คะแนนเฉพาะคำที่ทวนได้โดยไม่ให้ตัวช่วย	__/5
	[ ]	[ ]	[ ]	[ ]	[ ]		
Optional: Category cue							
Optional: Multiple choice cue							

ORIENTATION

[ ] วันที่ [ ] เดือน [ ] ปี [ ] วัน [ ] สถานที่ [ ] จังหวัด __/6

Translated by Solaphat Hemrungrojn MD
Trial version 01 Updated August 31, 2011
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www.mocatest.org

ค่าปกติ ≥ 25/30

คะแนนรวม __/30
เพิ่ม 1 คะแนน ถ้าจำนวนปีการศึกษา ≤ 6

APPENDIX E

The Demographic Data Form

Personal Information and Medical Information

(แบบบันทึกประวัติส่วนตัว และประวัติทางสุขภาพ)

<u>ประวัติส่วนตัว (Personal Information)</u>

ผู้สูงอายุ ☐ MCI …..……… ☐ Non-MCI……..…….. **อายุ** ……… **ปี วัน/เดือน/ปีเกิด** …../..…/……..…

เพศ ☐ หญิง ☐ ชาย

สถานภาพ ☐ โสด ☐ คู่ ☐ หย่า ☐ หม้าย

การศึกษา ☐ ไม่ได้ศึกษา ☐ ประถมต้น ☐ประถมปลาย ☐มัธยมต้น ☐ มัธยมปลาย

☐ ปริญญาตรี ☐ สูงกว่าปริญญาตรี

ปัจจุบัน ☐ ทำงาน (ระบุ ……………………………………………………………….…………………..)

☐ ไม่ได้ทำงาน (หน้าที่รับผิดชอบปัจจุบัน …………………………..……………………)

ที่อยู่: บ้านเลขที่ ……….. ตรอก/ซอย……..………… ตำบล……….……………..อำเภอ……..……..…..…..

จังหวัด ………………… เบอร์โทรศัพท์……..…………………..

ถนัดมือข้าง ☐ ขวา ☐ ซ้าย

ผู้ดูแล ☐ พ่อ/แม่ ☐ พี่/น้อง ☐ สามี/ภรรยา ☐ ลูกหลาน ☐ ญาติ

☐ อื่นๆ ………………………………….…...

รายได้/เดือน ☐ ต่ำกว่าหรือเท่ากับ 5,000 บาท ☐ 5,001 – 10,000 บาท

☐ 10,001 – 15,000 บาท ☐ 15,001 – 20,000 บาท

☐ 20,001 – 25,000 บาท ☐ มากกว่า 25,000 บาท

ลักษณะที่อยู่อาศัย ☐ บ้านตนเอง ☐ อาศัยผู้อื่นอยู่ ☐ บ้านเช่า ☐ อยู่กับผู้จ้าง ☐ ไม่มีที่อยู่เป็นหลักแหล่ง

Ref. code: 25605912030540QOI

<u>ประวัติทางสุขภาพ (Medical Information)</u>

ลักษณะทั่วไป

ส่วนสูง ……………..… เซนติเมตร น้ำหนัก ……………..….กก. BMI ……………….. กก./ม.^{2}

การวินิจฉัยทางการแพทย์

☐ ไม่มีโรคประจำตัว

☐ ภาวะการรับรู้บกพร่องเล็กน้อย (คะแนน: MMSE ……..… /30, MoCA ………. /30)

☐ โรคประจำตัวอื่นๆ

……………………………………………… ……………………..………………..….

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ยาที่รับประทานประจำ (หมายถึง ยาแผนปัจจุบัน ยาแผนไทย วิตามิน อาหารเสริม)

……………………………………………… ……………………..………………..….

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Ref. code: 25605912030540QOI

เลขที่ ....
วันที่ ....

APPENDIX F

The Falls History Data Form

(แบบบันทึกประวัติการล้ม)

<u>ประวัติการหกล้ม</u>

1. คุณเคยล้มหรือไม่ ☐ เคย .... ครั้ง

   ☐ ไม่เคย (ข้ามไปหัวข้อระดับการทำกิจวัตรประจำวัน)

2. คุณบอกได้ไหมอะไรเป็นสาเหตุให้คุณล้ม (ถ้าล้มรุนแรงที่สุดเป็นครั้งเดียวกับที่ล้มล่าสุดใส่ในล้มล่าสุด)

   - **การล้มครั้งล่าสุด**

     ☐ เข่าทรุดไม่มีแรง ☐ สะดุดสิ่งที่กีดขวาง ☐ วิงเวียนหรือวูบหมดสติ

     ☐ ก้าวพลาด ตกบันไดหรือตกหลุม ☐ อื่นๆ ระบุ ……………...บอกไม่ได้ เพราะ ……………..

   - **การล้มครั้งรุนแรงที่สุด**

     ☐ เข่าทรุดไม่มีแรง ☐ สะดุดสิ่งที่กีดขวาง ☐ วิงเวียนหรือวูบหมดสติ

     ☐ ก้าวพลาด ตกบันไดหรือตกหลุม ☐ อื่นๆ ระบุ ……………...บอกไม่ได้ เพราะ ……………..

3. คุณจำได้ไหมว่าคุณล้มไปด้านไหน

   - การล้มครั้งล่าสุด ☐ ด้านซ้าย ☐ ด้านขวา ☐ ด้านหน้า ☐ ด้านหลัง
   - การล้มครั้งรุนแรงที่สุด ☐ ด้านซ้าย ☐ ด้านขวา ☐ ด้านหน้า ☐ ด้านหลัง

Ref. code: 25605912030540QOI

4. คุณมีอาการบาดเจ็บจากการล้มครั้งดังกล่าวหรือไม่

- **การล้มครั้งล่าสุด** ☐ ไม่มีอาการบาดเจ็บ ☐ มีรอยฟกช้ำถลอก บริเวณ ……..

  ☐ มีแผลฉีกขาด บริเวณ …………

  ☐ มีกระดูกหัก บริเวณ ……..… ☐ มีการบาดเจ็บที่ศีรษะ

- **การล้มครั้งที่รุนแรงที่สุด** ☐ ไม่มีอาการบาดเจ็บ ☐ มีรอยฟกช้ำถลอก บริเวณ ……..

  ☐ มีแผลฉีกขาด บริเวณ …………

  ☐ มีกระดูกหัก บริเวณ ……..… ☐ มีการบาดเจ็บที่ศีรษะ

5. คุณจำได้ไหมคุณล้มที่ไหน

- การล้มครั้งล่าสุด ………………………………………………………

- การล้มครั้งรุนแรงที่สุด ………………………………………………………

ระดับการทำกิจวัตรประจำวัน (ดัดแปลงมาจาก Physical activity scale for the elderly)

1. ในช่วงเวลา 7 วันที่ผ่านมา คุณทำกิจกรรมลักษณะนั่ง เช่น อ่านหนังสือ, ดูทีวี หรือ งานฝีมือ
   ……วัน เฉลี่ย ….ชั่วโมง/ สัปดาห์
2. ในช่วงเวลา 7 วันที่ผ่านมา คุณทำกิจกรรมที่ต้องออกเดินนอกบ้าน เช่น เดินไปทำงาน, เดินเล่น, เดินซื้อของ ……วัน เฉลี่ย ….ชั่วโมง/ สัปดาห์
3. ในช่วงเวลา 7 วันที่ผ่านมา คุณทำกิจกรรมลักษณะกีฬาเบาๆ หรือกิจกรรมนันทนาการลักษณะออกกำลังกาย เช่น ไทเก็ก, โยนโบว์ลิ่ง, ตกปลา, เล่นกอล์ฟ ……วัน เฉลี่ย ….ชั่วโมง/ สัปดาห์
4. ในช่วงเวลา 7 วันที่ผ่านมา คุณทำกิจกรรมลักษณะกีฬาค่อนข้างหนัก หรือกิจกรรมนันทนาการลักษณะออกกำลังกายค่อนข้างหนัก เช่น แอโรบิก, เทนนิส, วิ่งจ๊อกกิ้ง, ว่ายน้ำ, ปั่นจักรยาน
   ……วัน เฉลี่ย ….ชั่วโมง/ สัปดาห์
5. ในช่วงเวลา 7 วันที่ผ่านมา คุณทำงานบ้าน เช่น กวาดบ้าน, ล้างจาน, ซักผ้า, รีดผ้า

   ……วัน เฉลี่ย ….ชั่วโมง/ สัปดาห์

รวมคะแนน ……...ชั่วโมง/ สัปดาห์

APPENDIX G

Balance Assessment

(แบบประเมินด้านการทรงตัว)

แบบประเมินด้านการทรงตัว

<u>คำชี้แจงการทดสอบ</u>

- อธิบายขั้นตอนการทดสอบแก่ผู้ทดสอบ หากเกิดความไม่เข้าใจอาจสาธิตท่าทางประกอบ
- ให้ผู้ทดสอบถอดรองเท้าก่อนการทดสอบทุกการทดสอบ
- ให้ผู้ถูกทดสอบซ้อมทำความเข้าใจก่อการทดสอบจริง 1 รอบ
- ให้ผู้ถูกทดสอบยืนในทิศทางเดียวกับผู้ประเมิน เพื่อระวังอุบัติเหตุระหว่างการทดสอบ
- ให้บันทึกเหตุการณ์หรืออุบัติเหตุทั้งหมดระหว่างการทดสอบ อย่างละเอียด

1. Five Times Sit to Stand (FTSTS)

เพื่อประเมินการทรงตัวขณะเคลื่อนไหลและทดสอบกำลังกล้ามเนื้อขาทั้งสองข้าง

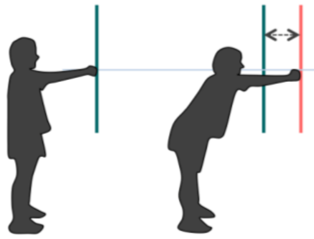
<u>ขั้นตอนการทดสอบ</u>

- นั่งบนเก้าอี้, เท้าวางราบบนพื้น โดยนั่งในท่าที่สะดวกต่อการลุกขึ้นยืน
- มือกอดอกทั้งสองข้าง
- ลุกขึ้นยืน โดยให้เข่าเหยียดเต็มที่และนั่งลง
- ลุกขึ้นยืนจำนวน 5 ครั้งติดต่อกัน ทำอย่างรวดเร็วและปลอดภัย
- เริ่มจับเวลาการทดสอบ ตั้งแต่เริ่มลุกขึ้นยืน จนยืนเต็มที่ครั้งที่ 5

<u>ผลการทดสอบ</u>

ระยะเวลาในการลุกนั่งติดต่อกัน 5 ครั้ง ....วินาที

2. Functional Reach Test (FRT)



เพื่อประเมินการทรงตัวขณะเคลื่อนที่ไปทิศทางด้านหน้า

<u>ขั้นตอนการทดสอบ</u>

- ยืนหันข้างเข้ากำแพง ใกล้กำแพงมากที่สุดโดยไม่สัมผัสกำแพง ยืนเท้าห่างประมาณ 10 เซนติเมตร
- ยกแขน 90 องศาและกำมือ โดยบันทึกตัวเลขตั้งแต่เทปวัดเริ่มต้น
- พยายามรักษาแขนให้อยู่ในระดับเดิม โน้มตัวไปทางด้านหน้าให้ไกลสุด โดยบันทึกระยะที่เปลี่ยนแปลงไปได้ (ดูตำแหน่งของนิ้วกลางขณะกำมือ) โดยไม่ล้มหรือก้าว

<u>ผลการทดสอบ</u>

ระยะเริ่มต้น …………………..เซนติเมตร, ระยะสิ้นสุด ………………… เซนติเมตร

ระยะทางที่เปลี่ยนแปลงไป ……………………………………….…… เซนติเมตร

3. Step Test (ST)

เพื่อประเมินการทรงตัวขณะเคลื่อนที่ ขณะยืนขาเดียว

<u>ขั้นตอนการทดสอบ</u>

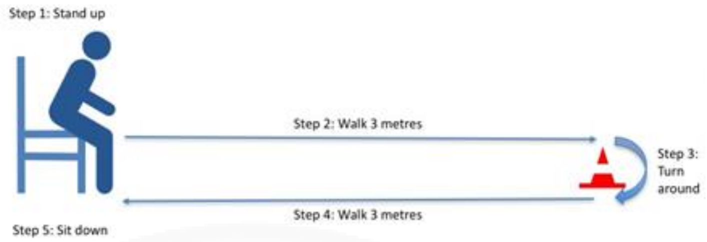
- ยืนหันหน้าเข้ากล่องห่างประมาณ 5 เซนติเมตร เท้าแยกจากกันประมาณ 10 เซนติเมตร
- ให้ผู้ทดสอบใช้เท้าข้างหนึ่งวางเท้าให้เต็มเท้าบนกล่อง แล้วกลับมาวางที่เดิม
- ทำซ้ำเร็วที่สุด โดยปลอดภัยและไม่เสี่ยงในการล้ม จำนวนครั้งมากที่สุดภายในเวลา 15 วินาที
- ผู้ทดสอบจับเวลาและจำนวนครั้งที่ผู้ทดสอบทำได้ และคอยระวังการล้ม
- ทำการทดสอบทีละข้าง ทำทั้ง 2 ข้าง

<u>ผลการทดสอบ</u>

- ข้างขวา …………………………. ครั้ง
- ข้างซ้าย …………………………. ครั้ง

4. Timed Up and Go Test (TUG)

เพื่อประเมินการทรงตัวขณะเคลื่อนที่



<u>ขั้นตอนการทดสอบ</u>

- ผู้ทดสอบนั่งพิงผนักพิงเก้าอี้ เท้าวางราบกับพื้น
- ลุกขึ้นยืนโดยใช้หรือไม่ใช้มือพยุงตัวขณะลุกขึ้นยืน เดินด้วยความเร็วปกติไปยังจุดหมาย (กรวย) ระยะทาง 3 เมตร หมุนตัวและกลับมานั่งที่เก้าอี้หลังพิงผนักเก้าอี้
- จับเวลาตั้งแต่ผู้ประเมินบิกว่า เริ่ม จนกระทั่งผู้ทดสอบกลับมานั่งเก้าอี้และหลังพิงผนักเก้าอี้

<u>ผลการทดสอบ</u>

- ระยะเวลาการทดสอบ TUG …………วินาที
- ระยะเวลาการทดสอบ TUG ขณะถือแก้วน้ำบรรจุอยู่ 80% (เดินไม่ให้น้ำหก)

  ……..…. วินาที
- ระยะเวลาการทดสอบ TUG ขณะนับเลขถอยหลัง (จากเลข 98) …………วินาที

APPENDIX H
Coordination Assessment
(แบบประเมินด้านการประสานสัมพันธ์)

แบบทดสอบด้านการประสานสัมพันธ์

คำชี้แจงการทดสอบ

- อธิบายขั้นตอนการทดสอบแก่ผู้ทดสอบ หากเกิดความไม่เข้าใจอาจสาธิตท่าทางประกอบ
- ให้ผู้ทดสอบถอดรองเท้าก่อนการทดสอบทุกการทดสอบ
- ให้ผู้ถูกทดสอบซ้อมทำความเข้าใจก่อการทดสอบจริง 1 รอบ
- ให้ผู้ถูกทดสอบยืนในทิศทางเดียวกับผู้ประเมิน เพื่อระวังอุบัติเหตุระหว่างการทดสอบ
- ให้บันทึกเหตุการณ์หรืออุบัติเหตุทั้งหมดระหว่างการทดสอบ อย่างละเอียด

1. **Foot Tapping (FT)**

- ผู้ทดสอบนั่งพิงผนักเก้าอี้ ถอดรองเท้า และเท้าวางราบกับพื้นทั้งสองข้าง
- ให้ผู้ทดสอบวางส้นเท้ากับพื้น ปลายเท้าสัมผัสพื้น เร็วที่สุดเท่าที่ทำได้ ภายในเวลา 5 วินาที ทำทีละข้าง, ข้างละ 3 ครั้ง และทำทั้งสองข้าง
- เริ่มจับเวลาเมื่อบอก "เริ่ม" และหมดเวลา 5 วินาทีจะบอก "หยุด"
- ผู้ประเมินจับเวลาการทดสอบ 5 วินาที, นับจำนวนครั้งที่ได้เท้าสัมผัสพื้นและยกขึ้นสมบูรณ์

ผลการทดสอบ

- ข้างขวา 1. ……., 2………, 3……….. ครั้ง = ……..ครั้ง, …...….คะแนน
- ข้างซ้าย 1. ……., 2………, 3……….. ครั้ง = ……..ครั้ง, …...….คะแนน

การให้คะแนนภายใน 5 วินาที

1 คะแนน = เท้าสัมผัสพื้น 20 ครั้ง, 2 คะแนน = เท้าสัมผัสพื้น 16-19 ครั้ง, 3 คะแนน = เท้าสัมผัสพื้น 13-15 ครั้ง, 4 คะแนน = เท้าตีสัมผัสพื้น 9-12 ครั้ง, 5 คะแนน = เท้าตีสัมผัสพื้น 5-8 ครั้ง, 6 คะแนน = เท้าตีสัมผัสพื้น 4-5 ครั้ง, 7 คะแนน = ไม่สามารถเท้าตีสัมผัสพื้นได้สมบูรณ์

Ref. code: 25605912030540QOI

2. Nine Hole Peg Test (NHPT)

- ผู้ทดสอบนั่งบนหลังพิงพนักเก้าอี้ เท้าวางราบกับพื้นทั้งสองข้าง
- วางอุปกรณ์ด้านหน้าผู้ทดสอบ ให้ผู้ทดสอบนำแท่งพลาสติกใส่หลุมทั้ง 9 หลุมและเอาออกจากหลุมทั้งหมด
- เริ่มจับเวลาเมื่อบอก “เริ่ม” และหมดเวลาเมื่อนำพลาสติกเข้าและออกจากอุปกรณ์เรียบร้อยแล้ว ทำทั้งสองข้าง (ข้างละ 2 รอบ)

<u>ผลการทดสอบ</u>

- ข้างขวา …………………..…, ………………….. วินาที
- ข้างซ้าย …………………..…, ………………….. วินาที

รวมเวลาทั้งหมด ………………..……………….. วินาที

BIOGRAPHY

Name	Miss Suphanan Puengtanom
Date of Birth	September 29, 1990
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Work Experiences	2011-Nowaday: Physical therapist at Thammasat University Hospital

Ref. code: 25605912030540QOI