RELATIONSHIP BETWEEN COGNITIVE DOMAINS, DYNAMIC POSTURAL STABILITY AND FALL RISK IN ELDERLY INDIVIDUALS WITH MILD COGNITIVE IMPAIRMENT: A PILOT STUDY

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By

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ABSTRACT

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Background: Malaysia is approaching the status of an aging nation leading to balance deficits and falls risk increase, particularly in population of MCI. Fall contributed to 44% of minor injuries among elderly. While the relationship between the cognitive domains __visuospatial skills, and attention __ dynamic postural stability and fall risk remains unclear, particularly in those with MCI.

Objective: The aim of the study is to investigate the relationship between the cognitive domains, dynamic postural instability and fall risk and compare which cognitive domains will have a greater impact on dynamic postural stability and fall risk in elderly with MCI. It is hypothesized that both cognitive domains are related to dynamic postural stability and fall risk in this population.

Methods: The study design is pilot cross-sectional study. The targeted population was the community-dwelling older and elderly at nursing home, who are aged 60 and above living within Klang Valley, Selangor. 32 participants were included in this study as identified through the MoCA with a score between 18-25. The participants were divided into two groups, 15 people with attention deficit (TMT-A) and 17 people with visuospatial deficit (CDT). Both groups performed TUG to evaluate the dynamic postural stability and fall risk.

Results: The total number of participants recruited were 32 elderly with MCI. The elderly consist of 53.1% male and 46.9% female which have the mean age of 72.78±6.973. No significant association was found for attention domain (p=0.444), while a significant association for visuospatial domain (p=0.038) between dynamic postural stability and fall risk. The visuospatial domain had a greater impact on dynamic postural stability and fall risk among elderly with MCI compared to the attention domain with the Cramer’s V value of 0.498 and 0.170 respectively.

Conclusion: In general, the study found no significant association for attention domain, but there was a statistically significant association for visuospatial domain between dynamic postural stability and fall risk among elderly with MCI. Furthermore, the study found that visuospatial domain was the key domain to maintain dynamic postural stability and fall risk among elderly with MCI.

Keywords: cognitive impairment, cognitive domains, fall risk, postural stability, elderly

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APPROVAL SHEET

This Research project entitled "**RELATIONSHIP BETWEEN COGNITIVE DOMAINS, DYNAMIC POSTURAL STABILITY AND FALL RISK IN ELDERLY INDIVIDUALS WITH MILD COGNITIVE IMPAIRMENT: A PILOT STUDY**" was prepared by **CHONG YI XIAN** and submitted as partial fulfilment of the requirements for the degree of Bachelor of Physiotherapy (HONOURS) at Universiti Tunku Abdul Rahman.

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Date: 23/09/2024

PERMISSION SHEET

It is hereby certified that **CHAW JADE WERN** (ID No: **21UMB05270**) has completed this Research Project entitled "RELATIONSHIP BETWEEN COGNITIVE DOMAINS, DYNAMIC POSTURAL STABILITY AND FALL RISK IN ELDERLY INDIVIDUALS WITH MILD COGNITIVE IMPAIRMENT: A PILOT STUDY"

under the supervision of **Ms. Premala a/p Krishnan** (Supervisor) from the Department of Physiotherapy, M. Kandiah Faculty of Medicine and Health sciences.

Yours truly,

(CHAW JADE WERN)

DECLARATION

I hereby declare that the Research Project is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UTAR or other institutions.

Name: CHAW JADE WERN

Date: 23/09/2024

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LIST OF ABBREVIATIONS

MCI	Mild Cognitive Impairment
MoCA	Montreal Cognitive Assessment
TMT-A&B	Trail Making Test, Part A and Part B
CDT	Clock Drawing Test
TUG	Timed Up and Go
ACE-R	Addenbrooke’s Cognitive Examination-Revised
ACE-III	Addenbrooke’s Cognitive Examination-III
AD	Alzheimer’s Disease
EF	Executive Function
WHO	The World Health Organization

CHAPTER 1

1.0 INTRODUCTION

1.1 Chapter overview

This chapter will first discuss the background of the study. Cognitive domains--attention and visuospatial skill, dynamic postural stability, fall risk, elderly, mild cognitive impairment (MCI) and relevance of present study were introduced in brief to provide a background overview. The chapter was then continued with the research questions followed by the research objectives, hypothesis as well as the operational definition of terms.

1.2 Background of the study

1.2.1 Cognitive domains __ attention and visuospatial skill

Cognitive performance is typically characterized and classified in clinical neuropsychology using concepts called domains of cognitive performance. Cognitive ability domains can be conceptualized in a variety of ways. These include classification based on the general process, such as memory or attention, language, or executive functioning. Alternative approaches rely on regional brain functions, which are determined by lesion studies and attribute functions to the hippocampus, frontal lobe, temporal lobe, parietal lobe, or other regions. A further organizational structure is based on the operations' complexity and is hierarchical (Harvey, 2019). A good ability to adjust to changing environments is aided by cognition (Ni et al., 2022). Among the cognitive domains linked with information processing are attention, memory, visuospatial, and executive skills. Information is processed, and then a response is made to maintain balance and avoid falls (Nazrien M.D Nazrien et al., 2024).

Attention, which is classified as a specific subset of executive function, operates as a dynamic mechanism that is fuelled by sensory perception and the necessity to select a preferred stimulus for a particular action while simultaneously disregarding stimuli that are unnecessary or irrelevant. Selective attention manages on sensory input, and any alterations to this sensory input, such as diminished visual acuity, may adversely impact gait, necessitating a greater reliance on executive function and attention to maintain stability during movement (Zhang et al., 2019).

The phrase "visuospatial ability" refers to the way the mind arranges and interprets two to three dimensions of space. It encompasses a wide range of abilities, such as mental imagery, rotation, navigation, distance and depth perception, and visuospatial construction (Bigelow & Agrawal, 2015; Redfern et al., 2018). The intricate process of spatial navigation represents a multifaceted cognitive task that necessitates the creation, maintenance, and continual updating of internal cognitive maps that represent one's surroundings, along with the spatial relationships existing within that environment, which also includes the individual's own position and orientation within it (Wolbers and Hegarty, 2010; as cited by Agathos et al., 2020). Being able to navigate through space daily is crucial for independency, ensuring safety and enhancing overall quality of life in individuals. To navigate successfully in space, a multitude of perceptual and cognitive faculties must be engaged, including the utilization of optic flow, the processing of various sensory cues, working memory, the allocation of attention, and the mental manipulation of spatial information (Agathos et al., 2020).

1.2.2 Dynamic postural stability

Posture balance control is a complex activity that is influenced by multiple factors and relies on the integration of motor, sensory, visual, cognitive, and vestibular neural networks (Appeadu & Gupta, 2021). Several domains of cognition collaborate to process information when doing tasks like balancing. In fact, a decline in gait speed has been linked to cognitive decline in late adulthood. It has been suggested that cognitive impairment in older adults' results in slower gait, higher gait variability and fall risk, and decreased gait stability (Fastame et al., 2022). In order to maintain postural stability, one must be able to receive proprioceptive information from muscle spindles, cutaneous and joint sensors, and cognitive perception of passive or active motion and movement direction. Postural instability may be caused by the interruption of any one of these circuit (Appeadu & Gupta, 2021). Reduced visual input and attentional demand were strongly correlated with postural instability (Mesbah et al., 2017).

1.2.3 Fall risk

The heightened risk of falls in older adults exhibiting Mild Cognitive Impairment (MCI) and dementia is hypothesized to stem from neurocognitive alterations. In particular, deterioration in attention, cognitive processing speed, visuospatial capabilities, and executive functions (i.e., advanced cognitive skills such as cognitive flexibility, planning, and behavioral inhibition) is linked to an increased likelihood of subsequent falls, even after controlling for additional risk factors, including demographic characteristics and previous fall incidents (Liu et al., 2020).

1.2.4 Elderly

The World Health Organization (WHO) states that the majority of developed nations recognize 65 as the official age at which someone is considered "elderly." However, by referring to the elderly population, the United Nations (UN) suggested a 60+ year old cut-off (Naja et al., 2017). Important concerns regarding global aging were brought up in the most recent United Nations World Population Aging Reports. The number of people over 60 in the world has increased by over twofold since 1980. It is expected to double again by 2050, surpassing two billion and exceeding the number of children and teenagers aged between 10 and 24 (Petersen, 2016). It is estimated that approximately 13% of the 7 billion people worldwide are older adults aged 60 years and above. This number is expected to increase in proportion to 21% in the year 2050. Malaysia faces a similar phenomenon with an estimated 7% out of 28 million population consisting of older adults aged 60 years and above. By year 2035, this number is expected to rise to 15%, and this is likely to gain Malaysia the status of an aging nation (Singh et al., 2015).

1.2.5 Mild cognitive impairment

The decline in cognitive function is often considered an intermediary state that lies between normal cognitive function and the manifestation of clinical symptoms of dementia, it is known as mild cognitive impairment (MCI) (Lim et al., 2020). Older adults with MCI have a conversion rate of 14.9% to dementia and the prevalence of MCI tends to increase steadily with age, ranging from 8.4% in adults aged 65 to 69 years to 25.2% in those aged 80 to 84 years (Petersen et al., 2017, as cited in Liu et al., 2020). It typically involves difficulties with memory, planning, attention, and visuospatial abilities, affecting a range of 3% to 19% of individuals aged 65 and older (Gauthier et al., 2006; Booth et al., 2016a; IsordiaMartinez et al., 2014; Pieruccini-Faria et al., 2018, as cited in Baydan et al., 2020). For older individuals, cognitive issues pose an independent risk for serious falls and injuries like hip fractures and head trauma, with about 70% of those with cognitive problems experiencing falls annually (Booth et al., 2016a; Harvey et al., 2016, as cited in Baydan et al., 2020).

1.2.6 Importance and relevance of study

As the elderly population continues to grow, particularly in countries like Malaysia, where the percentage of individuals aged 60 and above is rapidly increasing, the health challenges associated with aging, such as cognitive decline and fall risk, become more pressing. MCI is a condition often considered a transitional stage between normal cognitive aging and dementia, is associated with increased susceptibility to falls, which can lead to severe injuries and diminished quality of life.

While prior research has recognized the strong correlation between dynamic postural instability and cognitive domains including executive function, data pertaining to visuospatial skills have been inconsistent in elderly with MCI. Besides, the previous studies are mainly focus on the relationship between attention domains, balance and fall in elderly with neurodegenerative disease (Parkinson's disease, Alzheimer's disease). Hence, there is lack of literature to address the relationship between attention domain, dynamic postural stability and fall risk in elderly with MCI.

Furthermore, there is still insufficient knowledge on balance issues in elderly people with cognitive disabilities. Further research in the cognitive realm is necessary to clarify the relationships between balance and cognitive impairment. Fall prevention strategies designed for people with cognitive impairments will be more effective if these mechanisms are thoroughly understood (Szczepańska-Gieracha et al., 2015). In order to achieve it, identifying which cognitive domains are strong fall risk factors through analysis in older adults with cognitive impairment would help target and customize cognitive assessment and therapies to predict and to preserve the cognitive function of elderly (Chantanachai et al., 2021).

In order to give a thorough knowledge of the interaction between cognitive domains, dynamic postural stability, and fall risk, this study will use comprehensive neuropsychological examinations to examine each cognitive domains (attention and visuospatial skills) at the same time. Understanding the specific cognitive deficits that contribute to dynamic postural instability and fall risk in elderly individuals with MCI is crucial for developing effective rehabilitation and prevention strategies. Current approaches to fall prevention often emphasize physical training without adequately addressing the cognitive aspects that underlie postural stability. By identifying the cognitive domains that are most closely related to dynamic postural stability and fall risk, this study aims to inform the design of more comprehensive interventions that incorporate both cognitive and physical components, ultimately improving the safety and well-being of elderly individuals with MCI.

1.2.7 Concluding remark

This study is aimed to investigate the relationship between cognitive domains (attention and visuospatial) between dynamic postural stability and fall risk in elderly individuals with MCI. Besides, this study also aimed to assess which cognitive domain poses a greater impact on dynamic postural stability and fall risk in the same population.

1.3 Research questions

1. What is the relationship between attention domain with dynamic postural stability and fall risk in elderly individuals with MCI?
2. What is the relationship between visuospatial skills domain with dynamic postural stability and fall risk in elderly individuals with MCI?
3. Which cognitive domains will have a greater impact on dynamic postural stability and fall risk in elderly individuals with MCI?

1.4 Problem statement

The increasing prevalence of cognitive impairment among the elderly, particularly mild cognitive impairment (MCI), presents significant challenges for healthcare systems worldwide. In Malaysia, where the elderly population is rapidly growing, this issue is of particular concern. Cognitive decline in older adults is strongly associated with an increased risk of falls, which are the leading cause of injury and hospitalization in this age group. Despite the well-established link between executive function, and dynamic postural stability, the relationship between other cognitive domains—such as, attention, and visuospatial skills—and fall risk remains poorly understood.

The previous studies have reported a significant association between visuospatial skill, balance (Taylor et al., 2021), and fall (Taylor et al., 2014, 2012a; Taylor et al., 2017; as cited by Chantanachai et al., 2021). however, there are conflicting results showing that there are no significant association between the visuospatial domain, balance performance, and fall in elderly with cognitive impairment (Ansai et al., 2017; Bruce-Keller et al., 2012; Tangen, 2014).

Besides, the significant association between attention domain and balance have reported in elderly with Parkinson's Disease and Alzheimer's Disease (Dana et al., 2021; Ansai et al., 2017). Hence, there may be lacking literature review to address a significant association between attention domains, balance, and fall risk in elderly with MCI. Even while earlier research has examined the connection between the cognitive domains of attention and visuospatial skill, dynamic balance, and gait performance, and fall risk in older people with MCI, the results are still conflicting and unclear. There is limited evidence that exercise interventions can improve balance in people with cognitive impairment in mixed settings (Lam et al., 2018, as cited in Chantanachai et al., 2021).

Current rehabilitation programs often focus on improving physical strength and balance in the elderly, but they may not adequately address the cognitive components that contribute to postural instability. Without a clear understanding of how specific cognitive deficits impact dynamic postural stability, these interventions may fail to effectively reduce fall risk in elderly individuals with MCI. This gap in knowledge underscores the need for research that explores the connection between cognitive domains and postural stability, with the goal of developing more comprehensive and effective fall prevention strategies for this vulnerable population. Hence, I wish to conduct a pilot study to explore the specific cognitive domains that are related to dynamic postural stability and fall risk among elderly with mild cognitive impairment.

1.5 Research objectives

1. To assess the relationship between attention domain with dynamic postural stability and fall risk in elderly individuals with MCI.
2. To assess the relationship between visuospatial skills domain with dynamic postural stability and fall risk in elderly individuals with MCI.
3. To determine which cognitive domains will have a greater impact on dynamic postural stability and fall risk in elderly individuals with MCI.

1.6 Hypothesis

Null hypothesis (H_0)

i. There is no relationship between attention domain with dynamic postural stability and fall risk in elderly individuals with MCI.
ii. There is no relationship between visuospatial skills domain with dynamic postural stability and fall risk in elderly individuals with MCI.
iii. There is no specific cognitive domain show a greater impact on dynamic postural stability and fall risk in elderly individuals with MCI.

Alternate hypothesis (HA)

i. There is a relationship between attention domain with dynamic postural stability and fall risk in elderly individuals with MCI.
ii. There is a relationship between visuospatial skills domain with dynamic postural stability and fall risk in elderly individuals with MCI.
iii. There is a specific cognitive domain show a greater impact on dynamic postural stability and fall risk in elderly individuals with MCI.

1.7 Operational definition

1. Cognitive domains

Cognitive impairment is a term used to describe the decline or impairment of one or more cognitive domains, including orientation, memory, calculations, attention, language, executive function, reasoning, and visuospatial function (Ni et al., 2022). Based on the current study, there are various neuropsychological test to assess the cognitive domains such as attention, and visuospatial skill. The tests included are Trail Making Test (TMT- A), and Clock Drawing Test (CDT).

2. Mild Cognitive Impairment

The decline in cognitive functions is often considered an intermediary state that lies between normal cognitive function and the manifestation of clinical symptoms of dementia, it is known as mild cognitive impairment (MCI) (Lim et al., 2020). Based on the current study, the participants with the scored 18-25 on the Montreal Cognitive Assessment (MoCA) will be classified as MCI (Nagamatsu et al., 2013).

3. Dynamic Postural stability

The ability to move and regulate one's centre of mass projection across a support base while switching from a dynamic to a static position is known as dynamic postural stability (Heebner et al., 2015). Based on the current study, the assessment tool such as Timed Up and Go (TUG) test will be used to assess the dynamic postural stability, the participants with ≥13.5 seconds will be classified as dynamic postural instability and high fall risk population respectively.

4. Elderly

The people with 60 years of age and above are defined as elderly (Mohammad & Abbas, 2012). Based on the current study, there are 12 participants with the aged 60 and above, and currently live in nursing home or community-dwelling within Klang Valley will be recruited.

5. Fall Risk

The falls risk is defined as "the likelihood of a fall occurring." Clinical evaluation of falls risk can be conducted utilizing specialized assessment instruments or by employing mobility metrics like gait velocity (Hsu et al., 2012). Based on the current study, the fall risk is assessed by the TUG test, the participants with ≥13.5 seconds will be classified as high fall risk population respectively.

1.8 Structure of research project

In this research paper, the background of the study comprises the research questions, research objectives, importance and relevance were introduced in Chapter 1. The literature review on pertinent topics from prior studies was then discussed in Chapter 2. The methodology for this study was included in Chapter 3, which also included the research design, sample design, research instrument, and data collecting process data analysis strategies. In Chapter 4, the findings from the data gathered after descriptive and inferential analysis as well as the hypothesis testing are presented. Last but not least, Chapter 5 covers the review of the study's findings, its limitations, and recommendations for further research.

Chapter 2

2.0 REVIEW OF LITERATURE

2.1 Chapter overview

This chapter presents a review of past journals and literature from different topics, providing the blueprints for this research project.

2.2 Prevalence of MCI among elderly

A comprehensive meta-analysis of 34 studies conducted in the United States revealed that the prevalence of mild cognitive impairment (MCI) among the elderly population ranged from 6.7% for those aged 60-64 years to 25.2% for individuals aged 80-84 years. In a large-scale study conducted in China from 2015 to 2018, data revealed that the prevalence of MCI among the elderly population aged 60 years and above was 15.5%. Further analysis of the data showed that the prevalence varied across different age groups, with 11.9% for individuals aged 60-69 years, 19.3% for those aged 70-79 years, 24.4% for individuals aged 80-89 years, and 33.1% for individuals aged 90 years and above (Ni et al., 2022). Research from other nations has shown that the percentage of older people with cognitive impairment is significantly greater, which is between 7.5–22.5% (Sharma et al., 2013). The estimated number of elderly people with MCI varies between 12 and 18% worldwide, with some studies finding numbers as high as 42% in specific nations (Ni et al., 2022).

In Malaysia, the percentage of people with cognitive impairment varied from 11.4% to 22.4%, which was corresponding to other populations. The prevalence of cognitive impairment varied between publications because of the variations in terminology, diagnostic criteria, sample techniques, and evaluation protocols. However, it is anticipated that the percentage of people with cognitive impairment in Malaysia would increase as the total number and proportion of the elderly increase in Malaysia. Studies shows that older Malaysian males may actually be more likely than women to acquire MCI. This increased risk is thought to be caused by the emotional discomfort that comes with shifting social roles, such as divorce, losing a spouse, retiring, and having little social support (Lim et al., 2020).

The prevalence of MCI exhibits variability based on the geographical location, age, research methods and the criteria employed for its recognition. Certain local studies conducted in Malaysia have suggested that the risk factors for MCI may vary among elderly individuals from different Asian ethnic groups. The following factors are associated with an increased risk of MCI in older males in Malaysia: being overweight, not exercising, being married, and having high cholesterol. An elevated risk of MCI was linked to a number of variables, including high fasting blood sugar, hyperlipidaemia, diabetes, high blood pressure, smoking, low education, and a lack of physical activity. Moreover, a lack of calorie restriction and a decreased intake of fruits and fresh fruit juices were found to be risk factors for MCI in older persons in Malaysia (Hussin et al., 2019).

The majority of patients initially experience mild cognitive impairment (MCI), which is characterized as a syndrome of cognitive complaints, measurable mild cognitive declines, and no change in functional abilities, such as the ability to perform instrumental activities of daily living. The patient would be diagnosed with dementia if the cognitive deficits worsen and there is evidence of functional impairment brought on by the cognitive abnormalities. According to longitudinal research, there is an approximate annual conversion rate of 15% from amnestic MCI to probable AD (Murman, 2015). The higher prevalence of mild cognitive impairment in elderly indicated that the cognitive function of the elderly is decrease as aging; thus it can lead to a negative impact on the mental and physical health, physical performance and quality of life.

2.3 Effect of attention domain on dynamic postural stability

An emerging area of research on falls explores the impact of cognition on postural control, a multifaceted process that involves coordinating motor and sensory systems through higher-level neurological processes, specifically executive function (EF) (Muir-Hunter et al., 2014). Attention, which is classified as a specific subset of executive function, operates as a dynamic mechanism that is fueled by sensory perception and the necessity to select a preferred stimulus for a particular action while simultaneously disregarding stimuli that are unnecessary or irrelevant.

Selective attention enables the discernment of which information to process and the corresponding response, as it is infeasible to process all presented information simultaneously. A limited subset of information is filtered and processed to prevent mental overload. Selective attention encompasses both the centralization of the attention object (attentional focus) and the active suppression of distracting elements that could disrupt this focus (Borel & Alescio-Lautier, 2014). It manage sensory input, and any alterations to this sensory input, such as diminished visual acuity, may adversely impact gait, necessitating a greater reliance on executive function and attention to maintain stability during movement (Zhang et al., 2019).

Divided attention allocates cognitive resources towards dual sources concurrently. Given the finite nature of available attentional resources, effectively executing two tasks concurrently is unattainable beyond a certain complexity threshold (Borel & Alescio-Lautier, 2014). Specifically, if the demands of doing two tasks concurrently exceed an individual's cognitive capacity, their performance on one or both tasks may suffer. It is thought that this competition for attentional resources makes it more difficult to produce a suitable postural response, which in turn increases the risk of falls (Muir-Hunter et al., 2014). Reduced capacity to pay attention to surroundings limits access to the sensory inputs that control posture and balance, which raises the chance of falling. It was proposed that falls that occur outside in unfamiliar settings are mostly caused by attention and concentration problems but falls that happen inside the home more obviously indicate the physical frailty of the elderly.

The capacity for quick reaction times is importance for the maintenance of balance and the successful avoidance of falls, especially during postural challenges or various threats that may arise in everyday situations. The deterioration of attention and the slowing of reaction times among older adults can often be attributed to significant changes occurring within both the central and peripheral nervous systems as they age. This instability, which may stem from cognitive deterioration or age-related changes within the nervous system, can consequently lead to a multitude of problems that are directly related to functioning in daily life and overall health. Among the most significant hazards associated with this instability are falls and various postural disorders, both of which are acknowledged as critical geriatric syndromes and present serious risks to both health and life (Malik et al., 2024).

2.4 Effect of visuospatial domain on dynamic postural stability

The frontal-visuospatial network, which plays a crucial role in the functioning of the brain, may indeed be one of the key neural substrates that are responsible for regulating both the velocity at which individuals move and the variability in their gait patterns, which collectively serve as vital measures of dynamic postural stability. This specific network is actively involved in the flexible and adaptable modulation of motor behavior, particularly in situations where the environmental context undergoes changes that require swift adjustments in movement (Amboni et al., 2013).

Visuospatial function, or visual memory, may be connected to postural instability (Jong Moon Lee et al., 2012). An increased risk of falls is linked to poor visuospatial abilities in older persons (Naslund, 2010; as cited in Shao et al., 2022). Studies revealed that, particularly in older persons, visual/spatial cognitive tasks more severely impair postural control than other types of cognitive tasks (Maylor and Wing, 1996; Bock, 2008; Menant et al., 2014; as cited in Agathos et al., 2020). A vision impairment can decrease in visual perception response, elevate oscillations, and hinder flexibility, all of which can impact the ability to maintain dynamic balance and lower gait velocity. Vision is one of the elements responsible for maintaining static and dynamic balances as well as postural stability (Xia et al., 2023).

Reduced visual input and attentional demand were strongly correlated with postural instability (Mesbah et al., 2017). A greater correlation was seen between somatosensory dysfunction and dynamic balance as well as postural stability. Integration of vestibular, proprioceptive, and visual systems was necessary for efficient spatial orientation and balance. As aging progressed, sensorimotor degradation emerged, which was accompanied by a rise in the degree of body sway, a reduction in ankle-hip head axis flexibility, an increase in frailty, a decline in functional ability, thus it may cause a higher risk of fall (Xia et al., 2023).

2.5 Dynamic postural stability and its role in fall risk

The ability to regulate one's posture while moving was frequently measured by postural stability (Kang and Dingwell, 2006; as cited in Shao et al., 2022). Ambulation constitutes a highly repetitive human activity. While the preservation of postural stability during walking has traditionally been viewed as an automatic function, emerging evidence indicates that it necessitates both advanced cognitive functions and sensorimotor processes (Hsu et al., 2012). To regain the body's stability when necessary, an appropriate postural control technique was required. Increased postural stability improved resistance to disturbances, hence fall risk can be reduced (Latash et al., 2010; as cited in Shao et al., 2022).

Dynamic postural stability can be significantly undermined by a range of factors, including both internal disturbances within the body as well as external disruptions that may arise from the surrounding environment (Remaud et al. in 2016).Among the wide range of intrinsic risk factors that can play a role in this instability are historical falls, cognitive impairments, limitations in function, inadequate vision, reaching the age of 80 years or older, the presence of knee osteoarthritis, balance deficits, multiple comorbidities, reliance on assistive devices, diminished handgrip strength, gait irregularities, and the consequences of polypharmacy. On the other hand, extrinsic risk factors encompass environmental conditions that are closely related to the living situations experienced by elderly individuals. The cumulative presence of these risk factors can significantly elevate the likelihood of experiencing falls among the elderly population (Chantanachai et al., 2021).

The dynamic postural stability is more difficult and challenges as it places high demands on various cognitive processes (Nahid Divandari et al., 2023). It is thought that a variety of factors, such as emotional state, visual feedback, cerebellar activity, and cognitive processing, affect postural stability. Any issues with the mechanisms of driving postural control can affect balance, cause postural sway, and increase the likelihood of unintentional falls and injuries. An individual's capacity to sustain postural control diminishes with advancing age, and the degeneration of postural control abilities correlates with a heightened incidence of falls, which represent a significant cause of morbidity, disability, and mortality among the elderly population (Liang et al., 2022).

Postural control depends on attention and executive function, which can contribute to the instability seen in some age-related disorders. The deterioration of balancing abilities is also influenced by cognitive aging, particularly the slower rate of information processing, attentional abilities, and inhibitory abilities (Borel & Alescio-Lautier, 2014). Since MCI has been shown to alter some gait metrics and static balance, abnormalities in balance and postural control are widespread in older adults with MCI (Redlicka et al., 2021). The preceding investigations have established that instability is the predominant factor contributing to falls, as routine activities like domestic cleaning necessitate the simultaneous functioning of both visual and muscular systems. Specifically, the visuospatial-motor system and the motor system are engaged concurrently (Koppelaar et al., 2021).

2.6 Prevalence of fall among elderly, fall risk factor and its consequences

The World Health Organization (WHO) characterizes a fall as "accidentally coming to rest on the ground, floor, or another lower level, excluding a deliberate adjustment in position to rest on furniture, a wall, or other objects" (Fallaci et al., 2022). Falls are quantified by tallying the number of fall within a designated timeframe—either retrospectively by recalling events over a defined duration, or prospectively (Hsu et al., 2012). Falls frequently occur during intricate motor tasks (such as turning, transitioning from sitting to standing or vice versa, and most commonly while ambulating) (Szczepańska-Gieracha et al., 2015).

Studies conducted globally have indicated that falls affect older adults at a rate of over 30%. Regarding Asian nations, earlier studies from Japan, Taiwan, and Thailand indicated that falls were common among their senior populations, with the rates of fall of 15.8%, 17.0%, and 26.1% respectively (Sahril et al., 2020). In China, the incidence of falls among male and female citizens 65 years of age and older is 21%–23% and 43%–44%, respectively. A number of previous China studies have indicated incidences of falls among the elderly within a year that range from 14.7% to 34.0%. An incidence of 18.8% was observed in a population-based longitudinal research on falls among Taiwanese community-dwelling individuals aged 60 or above (Shi et al., 2014). The prevalence of fall found in Brazil, England, and USA is 27.6%, 28.4% and 28.7% respectively.

Prevalence in Malaysia has been observed to range from 4.07% to 32.8% in earlier studies. Among those included in the NHMS 2018 who were

60 years of age and above, the frequency of falls was 14.1%. A different survey of 1086 senior citizens who lived in communities throughout four states that encompassed Malaysia's central, south, north, and east revealed a prevalence of falls of 14.8% among participants, which was comparable to the NHMS data. 30% to 40% of elderly people are predicted to fall at least once within a year. One in five of the people who have fallen will hurt themselves more than once. Among Malaysians who are aged 60 and above, one in six reported having fallen at least once within the past 12 months (Sahril et al., 2020).

The burden of falls is anticipated to rise with the elderly population, as falls may be linked to changes in physical, sensory, and cognitive abilities caused by aging. Aging, a history of falls, a fear of falling, and multiple types of medical diseases, such as muscular weakness, joint disorders, vision problems, abnormalities of gait, and balance issues, have all been linked to an increased fall risk (Sahril et al., 2020). Cognitive decline, specifically regarding short-term or immediate memory, is recognized as an independent risk factor for recurrent falls in individuals aged 75 and older (Koppelaar et al., 2021).

Falls are the leading cause of trauma-related hospital visits among the elderly, and they have been implicated in a significant proportion of injuries and injury-related mortality for more than ten years. The Centers for Disease Control and Prevention report that among US individuals who are 65 years of age and above, fall-related injuries resulted in over 19,700 mortality in 2008, 2.2 million emergency department visits, and over 581,000 hospitalizations in 2009. According to US data, falls caused injuries that resulted in the deaths of 15,802 people who were 65 years of age or older in 2005. Research has indicated that common minor injuries like sprains, abrasions, lacerations, and bruises make up a significant portion, which 44% of all injuries caused by falls, while fractures of the wrist and hip are much less common, occurring only 4% to 5% of the time (Shi et al., 2014).

Fall risks are most closely related to complex attention (sustained attention, divided attention, selective attention, and processing speed), executive function (working memory, planning, decision-making, responding to feedback, inhibition, and flexibility), and perceptual motor function (visual perception, visuoconstructional reasoning, and perceptual-motor coordination) (Zhang et al., 2019).

About half of the individuals in the high-risk fall group had experienced falls in the past (Lord et al., 2003). An increased risk of falling is one of the main issues that come with age. Fall risks are much higher among the elderly residing in intermediate and nursing home care facilities, with one out of three individuals likely to experience a fall at least once a year (Lord et al., 2003). Researchers report that every elderly person in a nursing home has experienced a fall, and due to the influence of multiple factors, the frequency of falls reaches 1.5 times per year, ranging from 0.2 to 3.6 times (Mesbah et al., 2017).

2.7 The level of knowledge

A previous study has indicated that there is a notable and significant association between visuospatial abilities and the occurrence of falls, while concurrently noting that there appears to be no such association between attention deficits and the incidence of falls (Taylor et al., 2014, 2012a; Taylor et al., 2017; as cited by Chantanachai et al., 2021). Both executive function and visuospatial abilities exhibit a much stronger association with balance control and gait speed as compared to the broader category of global cognition in older individuals who are cognitively impaired (Taylor et al., 2021a; Toots et al., 2019; as cited in Chantanachai et al., 2021).

A previous study also found similar results, indicating that executive function and visuospatial ability were strongly and independently linked to balance with MCI (Taylor et al., 2021), gait and dual task was independently associated with visuospatial domains within the population with MCI (Ansai et al., 2017). Nevertheless, it is important to highlight that there are conflicting results emerging from the investigation conducted by Ansai et al. in 2019, where they reported finding no significant association between falls and the visuospatial domain in individuals suffering from MCI. Even though these 3 studies had utilised the subdomain score of ACE-R to assess the individual domains only 2 out of 3 studies had found there was a significant association between visuospatial skill with balance and gait.

A previous study found that there was no significant association between global cognition, memory, processing speed, visuospatial skill, and verbal fluency with balance performance in elderly individuals with cognitive impairment (Bruce-Keller et al., 2012; Tangen, 2014). According to StevanJovanović et al. (2022), there was no correlation found between dynamic balance and agility with any cognitive domain (working memory, attention, concentration, and temporal and spatial domains). This study did not measure the cognitive status of the elderly, and the individual domains was assessed by MoCA test. Hence, the results may be varied as MoCA test had a low variability to assess individual domain (Stevan Jovanović et al., 2022). Hence, there were conflicting results about the relationship between visuospatial skill domain with dynamic balance and fall risk, especially in population with MCI.

According to Taylor et al. (2014), as cited in Chantanachai et al., 2021, it discovered that an increased gait speed was significantly associated with a reduced rate of falls in a large cohort of older adults who were experiencing mild to moderate cognitive impairment, with an incident rate ratio of 0.77 and a 95% confidence interval ranging from 0.63 to 0.96. This finding implies that while increased gait speed may suggest improved mobility, it might simultaneously compromise postural control, which could potentially elevate the risk of falls among this population. On the other hand, in two separate studies that utilized the same sample and included a follow-up period of six months, noted that individuals with MCI who had experienced falls exhibited significantly slower walking speeds when compared to those who did not experience falls (Ansai et al., 2018, Ansai et al., 2019, as cited in Chantanachai et al., 2021).

Moreover, the previous study has reported that attention deficits may indeed be among the contributing factors to balance disturbances observed in patients diagnosed with Parkinson's Disease, as it is suggested that both attention deficits and balance issues might share a common underlying cause rooted in brain circuitry (Dana et al., 2021). However, there appears to be a lack of prior research addressing a significant relationship specifically between the attention domain, balance difficulties, and fall risk among elderly individuals suffering from MCI.

Nevertheless, we hypothesize that there exists a significant relationship between the attention domains, balance, and the risk of falls. This hypothesis is premised on the understanding that safe and effective navigation for older adults necessitates larger attentional demands during ambulation, as well as spatial learning and reorientation. It is essential for individuals to intentionally focus on their environment to effectively encode spatial relationships; while the learning of landmarks and boundaries may demand minimal attention, the process of associating this information with specific actions or locations within the environment is markedly more demanding (Chrastil and Warren, 2012; as cited in Agathos et al., 2020).

2.8 Gaps of the current knowledge

The previous studies have acknowledged that deficit in cognitive domains of executive function, are associated with impairment in either dynamic or static postural instability. However, the relationship between other cognitive domains—such as attention, and visuospatial skills—dynamic postural stability and fall risk remains poorly understood in elderly with MCI. Even through the attention domain has only been reported to be significantly associated with elderly with neurodegenerative disease, there remain a gap in understanding the impact of attention domain deficit on dynamic postural stability and fall risk in elderly with MCI. As to be safe and effectively navigation for the elderly, they required larger attentional demands during ambulation, as well as spatial learning and reorientation to maintain dynamic postural stability and prevent fall (Chrastil and Warren, 2012; as cited in Agathos et al., 2020).

According to Chantanachai et al. (2021), they had reported that among older adults with cognitive impairment who live in the community, balance and gait speed are risk factors for falls. Based on their findings, they had suggested that the further study is required to determine whether certain cognitive domains may be more sensitive to predict falls in older adults with cognitive impairments, as global cognitive evaluation is not sensitive to fall risk. The systematic review done by Nahid Divandari and his colleague (2023) has reported a significant association of EF and processing speed with dynamic balance in healthy elderly. However, it is advisable to explore the correlation between cognitive domains and dynamic balance in various cognitive disorders, such as MCI to generalise the results to larger population

According to Yan et al. (2022), the study reported that good standing balance was significantly associated with higher cognitive function. However, the study did not measure the level of cognitive impairment of the participants as they are using Cognitive Status test. It is advisable that the future studies are required to investigate the relationship between the level of cognitive function and dynamic postural stability (Yan et al., 2022). Hence, the Montreal Cognitive Assessment (MoCA) will be utilised in our study as it is believed to be much more effective to diagnose the level of cognitive impairment especially mild cognitive impairment compared to Mini-Mental State Examination (MMSE) (Cieślik et al., 2019).

CHAPTER 3

3.0 METHODS

3.1 Chapter overview

This chapter will cover the research methodology used, including the research design, ethical approval, sampling design, research instrument and study procedures and data analysis strategies.

3.2 Research design

This pilot study employed a cross-sectional exploratory design to investigate preliminary relationships between various cognitive domains and dynamic postural stability and fall risk in elderly individuals with mild cognitive impairment (MCI). The primary aim of this pilot study was to assess the feasibility of the study design, data collection methods, and instruments, and to gather preliminary data to inform the design of a larger, more definitive study (Viechtbauer et al., 2015).

3.3 Ethical approval

All participants were required to sign and read the consent form and provided demographic data after being thoroughly explained the study procedures. The results and data were computerized and recorded in Microsoft

Excel. This study was performed after obtaining the ethical approval by the Scientific and Ethical Review Committee (SERC) of Universiti Tunku Abdul Rahman (refer to Appendix A).

3.4 Sampling design

The samples were selected using a convenient sampling method in which the samples were selected according to the accessible population at Klang Valley. Convenient sampling method is a cost-effective sampling technique, as no extensive resources or time are required to recruit participants. It is particularly practical when the researcher has time and resource constraint. Convenience sampling has the drawback of being prone to bias due to the high likelihood of self-selection in non-probability sampling. Therefore, it is not appropriate to assume that the convenience sampling is representative of the population (Ilker Etikan et al., 2016).

3.5 Sample size

The targeted participants were community-dwelling olders, and the elderly at nursing home within Klang Valley and have MCI. By using G*Power version 3.1.9.4, the test family selected is ‘exact’ while the type of statistical test selected is ‘Correlation: Bivariate normal model’. Then, the input parameters used are ‘two tails’, effect size dz of 0.5, alpha error problem of 0.05 and power of 0.8. The calculated total sample size is 29 participants. 10% of participants is added to prevent drop out. Thus, the finalized sample size will be 32 participants.

3.6 Inclusion and Exclusion Criteria

The targeted participants for this study were community-dwelling olders, and the elderly at nursing home within Klang Valley, Selangor. A total of 32 participants were recruited regardless of gender and race instead, they were recruited based on the inclusion and exclusion criteria as shown below.

The participants who met the inclusion criteria for this study area were recruited:

a) Elderly who are age 60 and above,

b) Subjects who scored between 18 -25 on the Montreal Cognitive Assessment (MoCA),

c) Subjects can walk independently with or without walking aids (except wheelchair users).

On the other hand, the participants who met the exclusion criteria were excluded:

a) Subjects with recent stroke (within 18- months),

b) progressive neurodegenerative disorders (eg. Parkinson's or Huntington's disease),

c) diagnosis of dementia of any type,

d) orthopaedic surgery within the last two years in the lower limb,

e) unable to understand the instructions due to language barrier

f) Subject who exceed 78seconds in TMT-A, and score between 0-4 in CDT

3.7 Research Instrument

This study involves 4 outcomes measures. They are Montreal Cognitive Assessment (MoCA), Trail Making Test (TMT) Parts A, Clock Drawing Test (CDT) and Timed Up and Go test (TUG).

3.7.1 Montreal Cognitive Assessment (MoCA)

Medical professionals around the world have taken a keen interest in the MoCA, a relatively new cognitive assessment tool that is intended to differentiate between MCI and normal cognitive aging (Nasreddine et al., 2005, as cited in Carson et al., 2018).It comprises a total of thirty distinct items that are systematically utilized to evaluate a diverse array of cognitive domains, which include orientation, memory, visuospatial skills, executive function, language, and attention. The scoring system for this assessment operates within the range of 0 to 30, wherein higher scores are indicative of superior cognitive functioning (Lee et al., 2021). Preliminary analyses have demonstrated that individuals possessing 12 years of formal education or fewer typically exhibit poorer performance results on the MoCA compared to their more educated counterparts. To address the potential confounding effects of educational attainment on test scores, a correctional measure is implemented wherein 1 additional point is added to the total MoCA score of participants with twelve years of education or less, provided that their raw score is less than 30 (Nasreddine et al., 2005). Furthermore, the administration time for the MoCA has been observed to average approximately 15 minutes (Lee et al., 2021).

According to Hodges and Larner (2017), it has a good sensitivity (0.77) and good specificity (0.83) with a cut-off point of 25/30 to detect mild cognitive impairment. According to Jaywant et al. (2020), the original developers of the MoCA suggest that scores between 18 and 25 represent mild cognitive impairment, scores between 10 and 17 represent moderate impairment, and scores between 0 and 10 represent severe impairment. The internal consistency of the MoCA has been found to be commendable, yielding a Cronbach alpha coefficient of 0.83 on the standardized items, which reflects a strong correlation among the various components of the test. Additionally, the test-retest reliability of the MoCA is notably high, with an ICC value of 0.92, indicating that the assessment yields consistent results over repeated administrations (Nasreddine et al., 2005).

The MoCA assessment involve, the short-term memory recall task, which is worth a total of 5 points, entails two separate learning trials involving the memorization of five nouns, followed by a delayed recall period that spans approximately 5 minutes. The evaluation of visuospatial abilities is conducted through a clock-drawing task, which is allocated a total of 3 points, in addition to a three-dimensional cube copying task that is assigned 1 point. A range of executive functions is assessed through various tasks, including an alternation task that is adapted from the TMT-B, which is worth 1 point, a phonemic fluency task that also carries a value of 1 point, and a two-item verbal abstraction task that is assigned 2 points. Attention, concentration, and working memory are evaluated through a sustained attention task that involves target detection via tapping, which is worth 1 point, a serial subtraction task that is allocated 3 points, and a forward and backward digit span task, each of which is assigned 1 point. Language capabilities are assessed through a three-item confrontation naming task that includes low-familiarity animals, specifically a lion, a camel, and a rhinoceros, which collectively account for 3 points, as well as the repetition of two syntactically complex sentences that are worth 2 points, in addition to the previously mentioned fluency task. Lastly, the assessment of orientation to both time and place is also conducted, which is valued at a total of 6 points (Nasreddine et al., 2005).

3.7.2 Trail Making Test (TMT) Parts A

The TMT-A is extensively recognized as a reliable metric for evaluating psychomotor speed, as well as visual attention, requiring individuals to draw a continuous line that connects the 25 digits, which are haphazardly arranged across a single sheet of paper, in an ascending numerical order, while striving to complete the task in the shortest amount of time possible (Wei et al., 2017). Within this segment, participants engage in tasks that necessitate perceptual tracking alongside simple sequencing, thereby testing their ability to maintain focus and coordinate visual inputs effectively (Kim et al., 2014). The attention domain of the subject can be evaluated using the TMT-A (Ni et al., 2022). Previous studies have shown that the Cronbach's alpha coefficient for

TMT- A ranges from 0.76 to 0.89, showing high to exceptional TMT reliability (Poreh, Miller, Dines, & Levin, 2012, as cited in Jia et al., 2023). Specificity and sensitivity values for TMT-A are 0.90 and 0.69 (Freund & Gravenstein, 2004).

The TMT-A has 25 circles with numbers (1-25), the test requires the participants to draw a line between 24 consecutive circles in ascending order. Without taking the pen or pencil off the page, the patient should be told to join the circles as soon as possible. It is important to note that the recorded time encompasses any corrections of errors that are prompted by the examiner during the assessment process. Should the participant find themselves unable to complete the test within a 5 minute time frame, the assessment will be terminated. Statistically, the average score for TMT-A is typically around 29 seconds, while scores that exceed 78 seconds are considered indicative of significant deficiencies in performance (Ciosek, 2020). According to Bowie and Harvey (2006), the procedures to conduct the TMT-A are:

1. The participants were given a Part A sheet with the practice side facing upwards and lying flat upon the table.
2. They were given a pencil and a clear instruction: "On this page (while pointing to the number 1), there's a series of numbers. You can draw a continuous line connecting the numbers in ascending order by starting from the number 1 until the circle marked with 'END'. Do not lift the pencil from the paper during the process. Ready. Start."

3. Throughout the task, it is crucial to provide any necessary instructions and constructive feedback to the subject to facilitate optimal performance outcomes. If a participant commits an error, promptly instruct them to ‘‘stop’’ to allow for correction.
4. Upon the successful completion of the practice trial, flip the page over and present the actual test to the participant.
5. A clear instruction was given to the participants again: “On this page, there will be 25 circles with number (1-25). You are required to do as you did the practice by starting at the number 1 and end with the number 25. Remember to do as quickly as you can and do not lift the pencil throughout the test. Ready? Start.”
6. Start to record the time and ensure that the timing continues uninterrupted, even in cases where the subject makes errors, until the participant successfully reaches the end of the sequence.

3.7.3 Clock Drawing Test (CDT)

The CDT serves as a comprehensive assessment tool that evaluates a diverse array of cognitive skills, which encompass critical areas such as reading comprehension, strategic planning, visual memory, and the ability to reconstruct visual information, as well as the essential visuospatial skills that are required for navigating and interpreting spatial relationships in the environment (Hazan et al., 2017). Its primary advantage lies in its straightforward application and the minimal time required for administration, as well as its remarkable resilience against the influences of linguistic proficiency, educational attainment, or varying cultural experiences, which often complicate other cognitive assessments (Park et al., 2018). The sensitivity and specificity of the CDT using the Shulman 5-point scoring system are 82% and 75.7% respectively, and the inter-rater reliability is 0.96 (Park et al., 2018; Shulman, 2000). The elderly who score 5 was classified as normal visuospatial function; the score of 4 was minor visuospatial deficit and score below 3 was classified as moderate-severe deficit (Raksasat et al., 2023).

Currently, the scoring system awards a total of 5 points for a 'perfect' clock representation, while a score of 4 is allocated for minor visuospatial inaccuracies that do not significantly detract from the overall integrity of the clock; a score of 3 is given for an incorrect portrayal of '10 after 11' accompanied by a well-structured visuospatial layout, whereas a score of 2 is designated for a moderate level of visuospatial disorganization that renders it impossible to accurately depict '10 after 11'. A score of 1 is assigned in instances of severe visuospatial disorganization, while a score of 0 is recorded if the participant fails to produce any reasonable semblance of a clock representation (Shulman et al., 1993, as cited in Shulman, 2000). The procedures to conduct the CDT are:

1. The participants were given a sheet of paper that features a pre-drawn circle, which serves as a clock face.
2. The participants were instructed to place the numbers on the clock face.
3. The participants were instructed to set the time to indicate “10 after 11”, or 10 minutes past 11 o’clock.

A range of times, such as 8:05, 3:00, and 2:45, have been employed across different evaluative contexts; however, the specific task of representing the time as 11:10 proves particularly beneficial, as it not only engages both visual fields effectively but also concurrently challenges the participant to suppress the instinctive tendency to position the minute hand towards the numeral 10, a common mistake frequently observed among individuals who might exhibit subtle cognitive deficits (Shulman, 2000).

3.7.4 Timed Up and Go test (TUG)

TUG test is used to assess the functional mobility of elderly. It is a clinical assessment of dynamic balance in elderly. According to Singh et al. (2015), the TUG test has an ICC value of 0.98. This demonstrated the high test-retest reliability of the TUG test among older adults. TUG has a sensitivity (76.2%) and specificity (91.1%) (Sakthivadivel et al., 2022). As a result, the TUG test is valid and dependable for use in this study to evaluate dynamic postural stability of elderly.

According to Singh et al. (2015), the equipment required for the TUG test are a chair with 46 cm in height and 65cm in arm rest height, stopwatch, measuring tape or ruler, tape and walking aid. The therapist or healthcare practitioner does not offer the participants with any physical assistance; nevertheless, they are allowed to use walking aids. There is no limited time to perform TUG test. According to Barry et al. (2014), the TUG test cut-off score of ≥13.5 seconds is used to identify elderly who have a high fall risk. The TUG test score will be calculated by taking the mean of three data (Singh et al., 2015).

The measurement will be carried out through the following steps:

1. The participant is given instruction to sit on a chair against a wall, and with the arm resting at the handrail or resting at their sides of body.
2. When therapist says “Go”, the participant is instructed to stand, walk on a 3m pathway, turn at the end point, walk back to the seat, and sit on the chair again.
3. The stopwatch will start once the participant get up from the chair and the time will being recorded in second when the participant sits back on the chair.
4. The test is required to attempt 3 times, with sufficient rest interval between each test.

3.8 Procedure

3.8.1 Recruitment process

This pivot study involved 32 participants who were seniors aged 60 years and older, able to walk independently with or without walking aids, except the wheelchair users and residing in nursing homes or the community in Klang Valley. Convenience sampling was used to recruit participants through face-to-face method. The participants were asked to fill up the forms before they proceeded to the next step.

The informed consent form (see Appendix B) offers a succinct introduction and elaboration regarding the study's purpose, methodology, duration, as well as the anticipated benefits and associated risks. The researcher’s contact details were supplied to facilitate inquiries pertaining to the study and to provide additional clarification as necessary. The concluding section of the consent form required participants to affix their signature and personal identification as verification of their consent to engage in the study.

The demographic data collection and screening form (see Appendix C) encompassed initial questions regarding name, age, gender, year of study, history of falls, and prior medical conditions. The subsequent section incorporated several queries designed to assess exclusion criteria, including diagnoses of any neurodegenerative disorders (such as Parkinson's disease, Huntington's disease, or dementia), and physical disabilities (such as the use of a wheelchair).

The Personal Data Protection notice (see Appendix D) necessitated that participants indicate their acknowledgment of the notice by expressing agreement, consent, and understanding of its contents.

After that, they underwent a screening test, called as MoCA, to screen the cognitive levels. Participants who scored between 18 -25 were recruited in the study.

3.8.2 Data collection

The eligible participants went through 2 neurophysiological assessments, such as TMT-A and CDT, to assess the attention and visuospatial skill domains.

The participants who exceeded 78seconds with a score of 5 in TMT-A and CDT were categorized as “attention deficit”; while the participants who did not exceeded 78 seconds and score between 0 to 4 in TMT-A and CDT were categorized as “visuospatial skill deficit. All the participants were asked to performed TUG test to evaluate the dynamic postural stability and fall risk. The procedures to performed MoCA, TMT-A, CDT and TUG were explained above. A total of 32 participants were completed the assessments, 15 of them were categorized as attention deficit, 17 of them were categorized as visuospatial skill deficit.

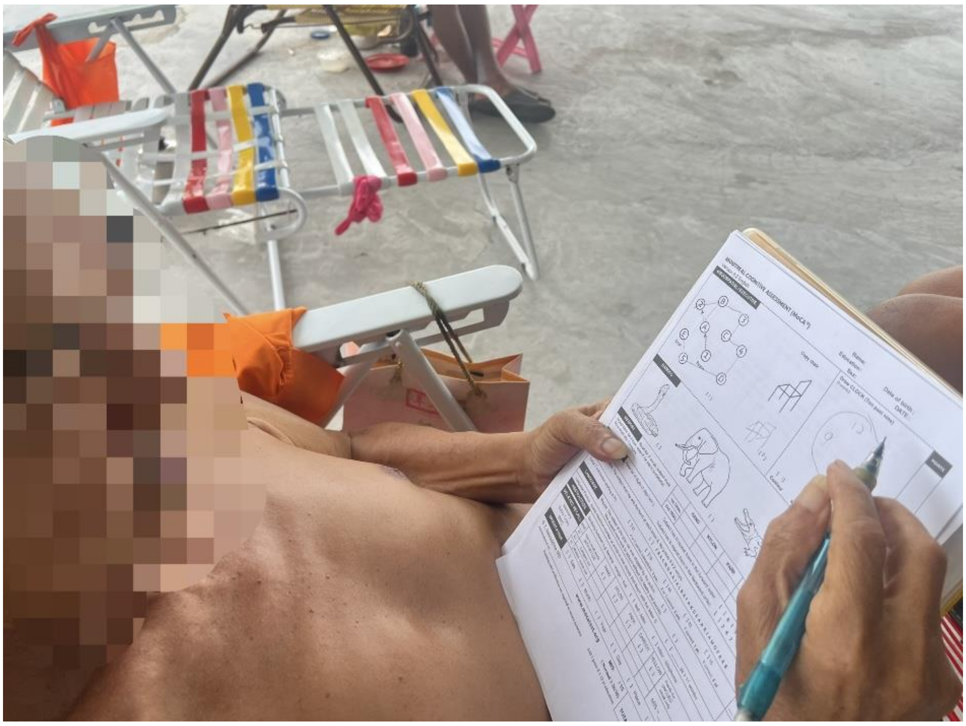

Figure 3.1 Participant performing MoCA test

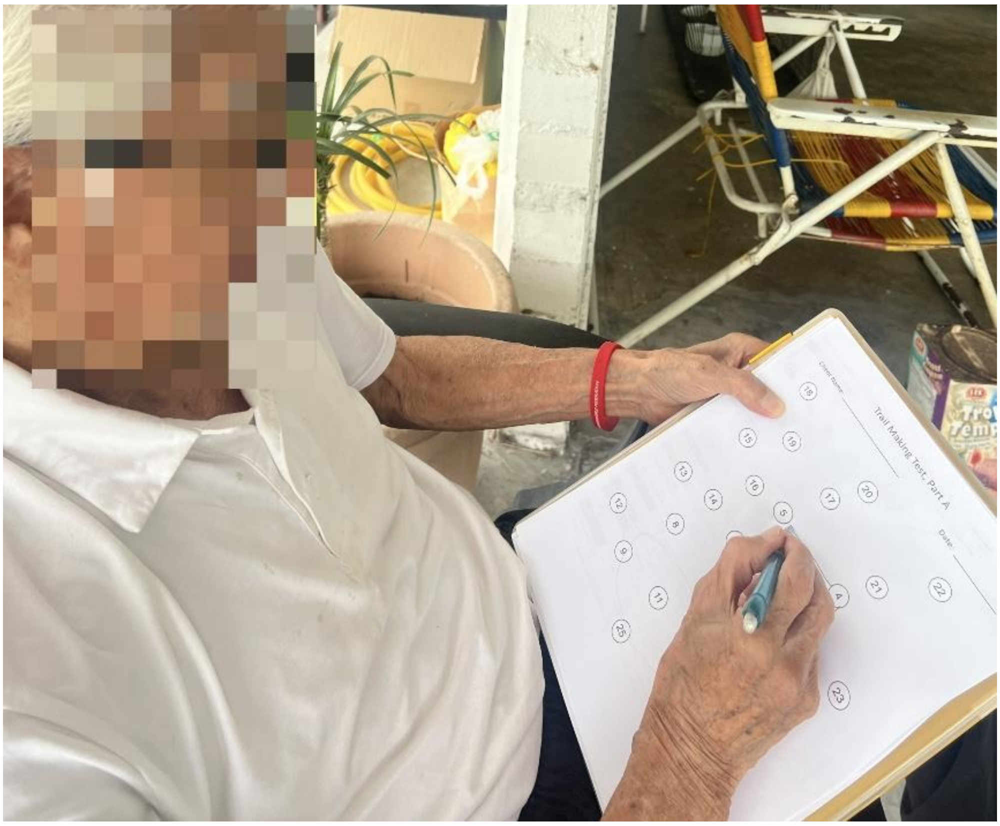

Figure 3.2 Participant performing TMT-A test

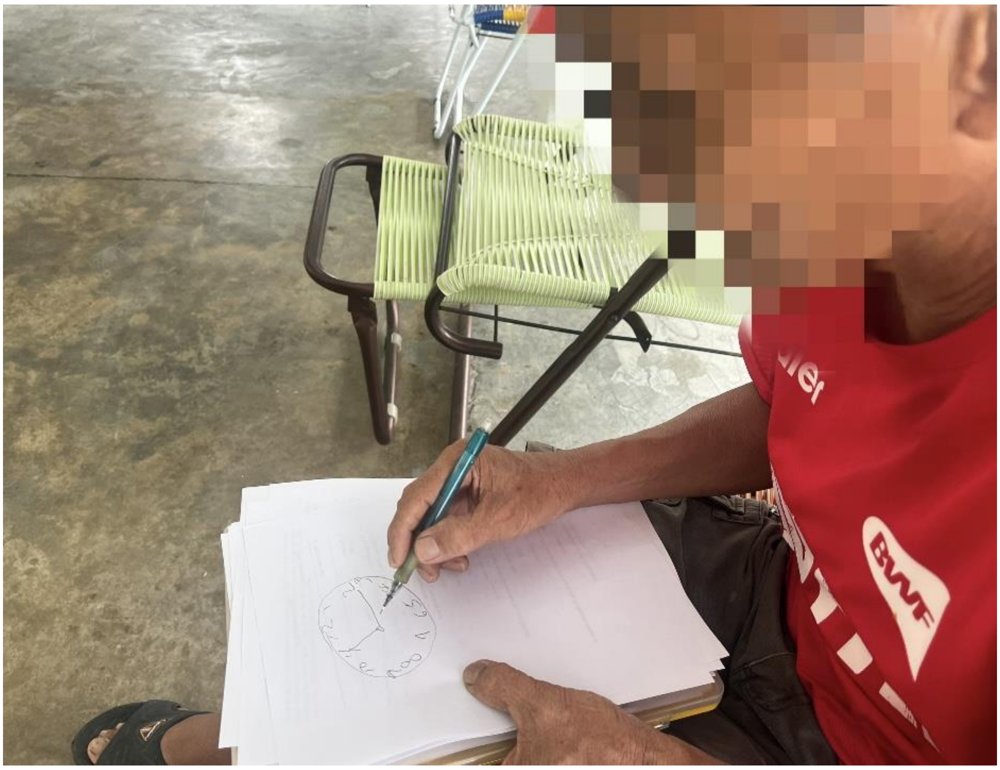

Figure 3.3 Participant performing CDT

Figure 3.4 Participant performing TUG test

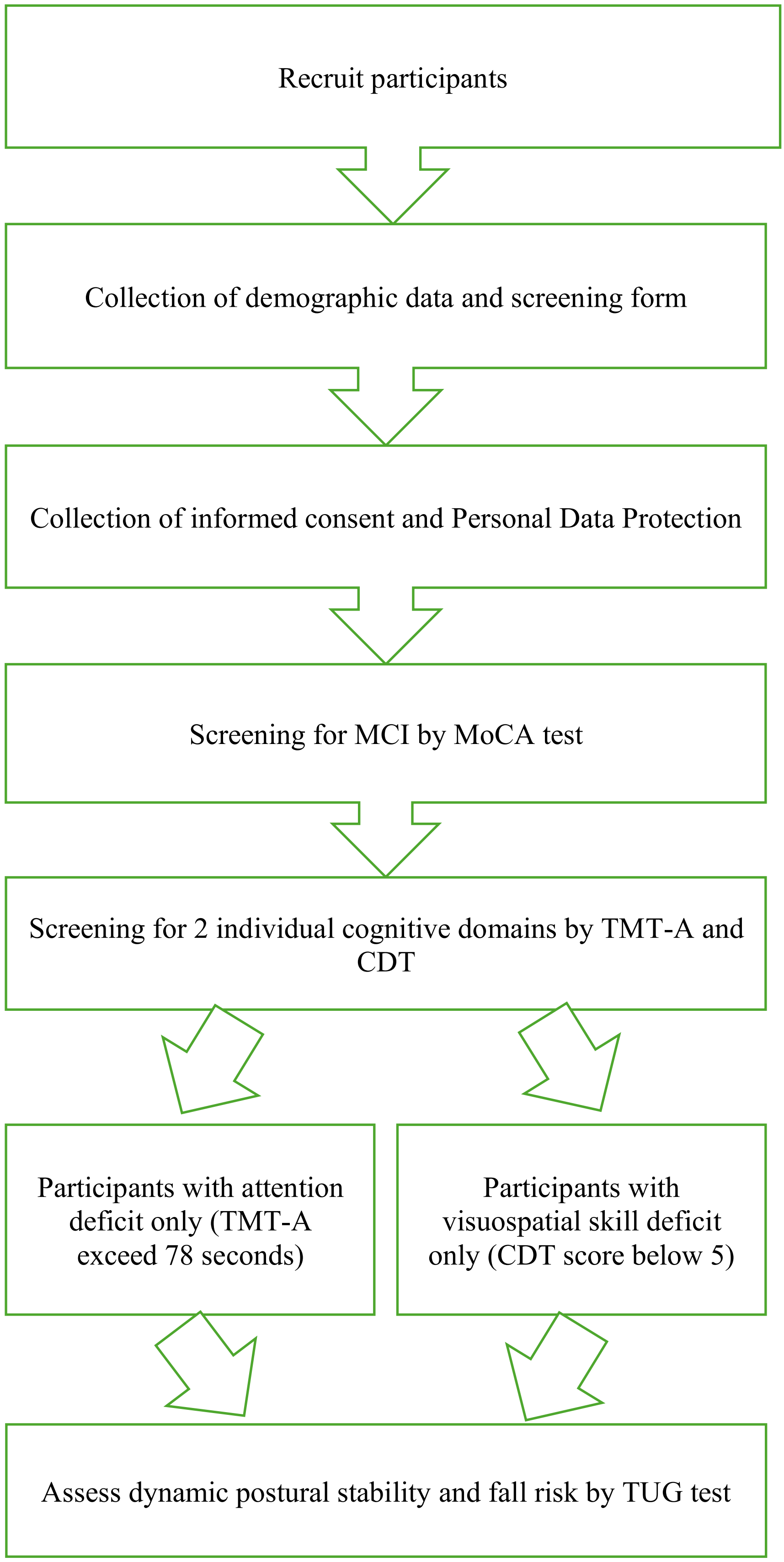

Figure 3.5 Study Flowchart

3.9 Data analysis strategies

The data collected was analysed using IBM SPSS Statistics software version 29 and Microsoft Excel. Descriptive statistics was used to analyse demographic data of participants. Distribution of gender, age, years of education, and number of falls were visualised using pie chart and histogram, the results provided as frequency, percentage and mean (M) and standard deviation (SD). A table of summary of demographic data of participants was presented. For inferential analysis, the first test conducted is the test of normality, which was used to assess the normality of dependent variables (TUG) at the baseline using the Shapiro-Wilk test. Furthermore, the relationship between cognitive domains (attention and visuospatial), dynamic postural stability and fall risk, and to compare which domain has a greater impact on dynamic postural stability and fall risk, Chi-square test of independent was conducted. The significant value was reported with a p-value set with 95% of confidential level ($p<0.05$).

CHAPTER 4

4.0 RESULTS

4.1 Chapter overview

This chapter presents the findings from the data collected throughout this research project. The demographic information of the participants was presented in the beginning, followed by the descriptive statistics and outcomes of the inferential tests. The chapter then proceeds with hypothesis testing. The findings were provided in the following order: a brief description of statistical test used, a summary of test result and followed by graph or tabulation at the end of that component.

4.2 Demographic data of the participants

4.2.1 Gender

This study involved 32 participants, where 17 males and 15 females were participated. Figure 4.1 showed the gender distribution of participants in this study, the pie chart consists of 53.1% males and 46.9% females.

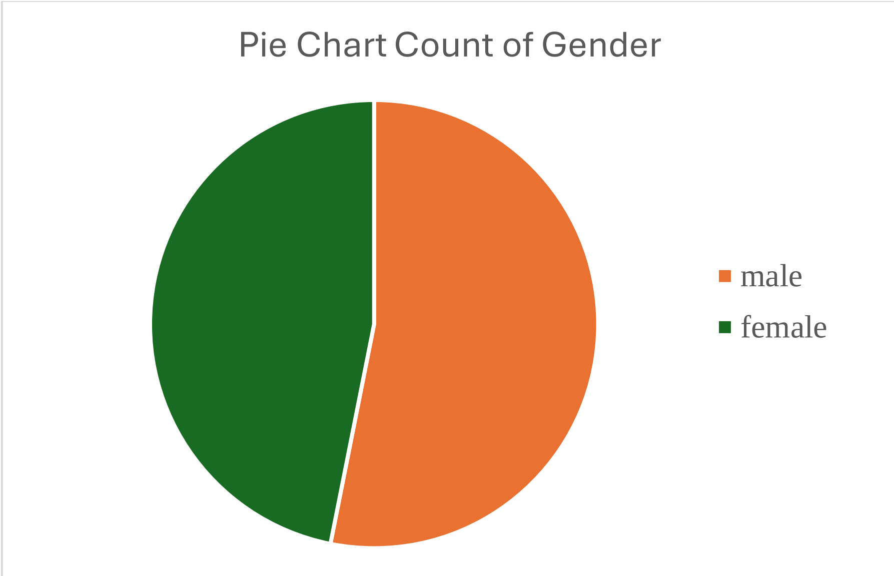

Figure 4.1 Gender distribution among participants

4.2.2 Age

Figure 4.2 showed the age distribution among the participants. The mean (M) and standard deviation (SD) were 72.78 and 6.973 respectively. The age ranged from 62 years old to 90 years old. The mode of age was 70 years old (n=4, 12.5%). There are 14 participants under the age groups of 60 -70 years old (43.8%) and 71-80 years old (43.8%) respectively, while there are 4 participants under the age groups of 81-90 years old (12.5%)

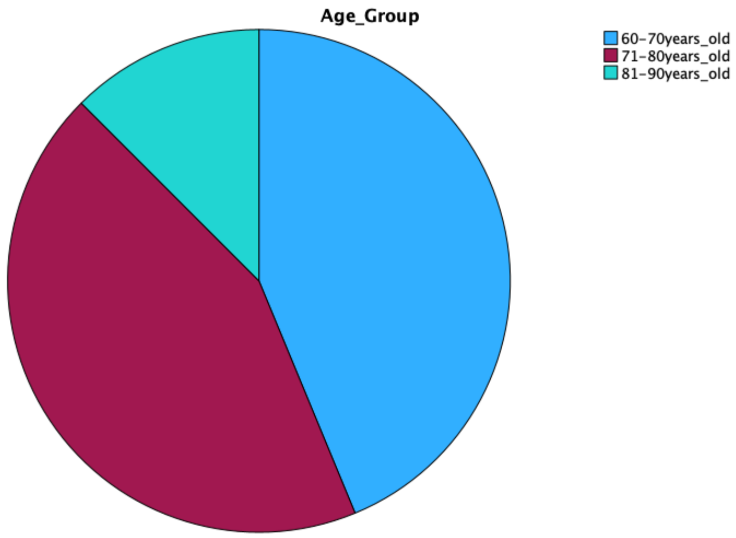

Figure 4.2 Age distribution among participants

4.2.3 Years of Education

Figure 4.3 showed the education years distribution among the participants. The M and SD were 6.25 and 3.233 respectively. The years of education ranged from 0 to 11 years. The mode of the years of education was 9 (n=10, 31.3%), followed by 6 (n=7, 21.9%), 0 and 7 (n=4, 12.5%) respectively, 2 5 and 11 (n=2, 6.3%) respectively, and 4 (=1, 3.1%).

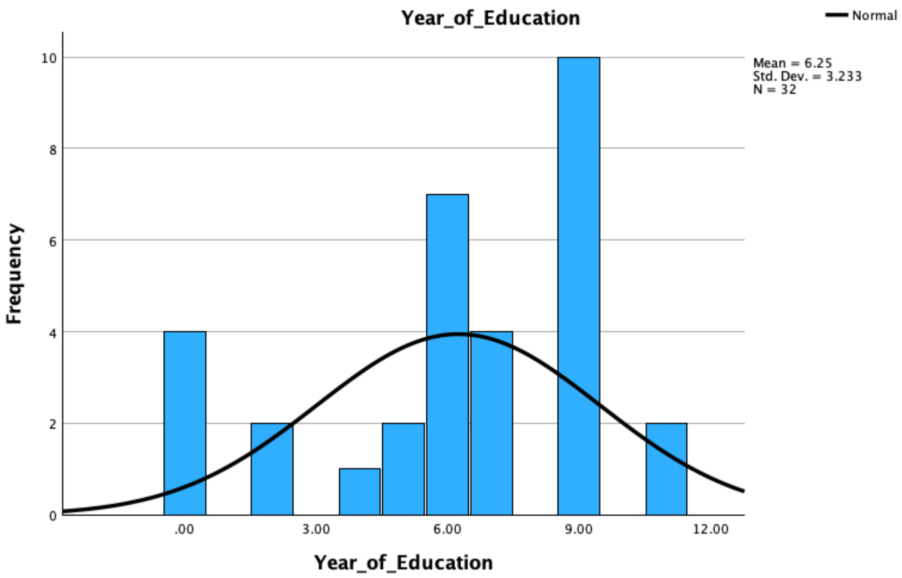

Figure 4.3 Years of education among participants

4.2.4 Number of Falls

Figure 4.4 showed the fall numbers distribution among the participants. The M and SD were 0.97 and 1.87 respectively. The number of falls ranged from 0 to 9. The mode of the fall number was 0 times (n=19, 59.4%), followed by 1times (n=8, 25%), 3 and 4 times (n=2, 6.3%) respectively and 9 times (n=1, 3.1%).

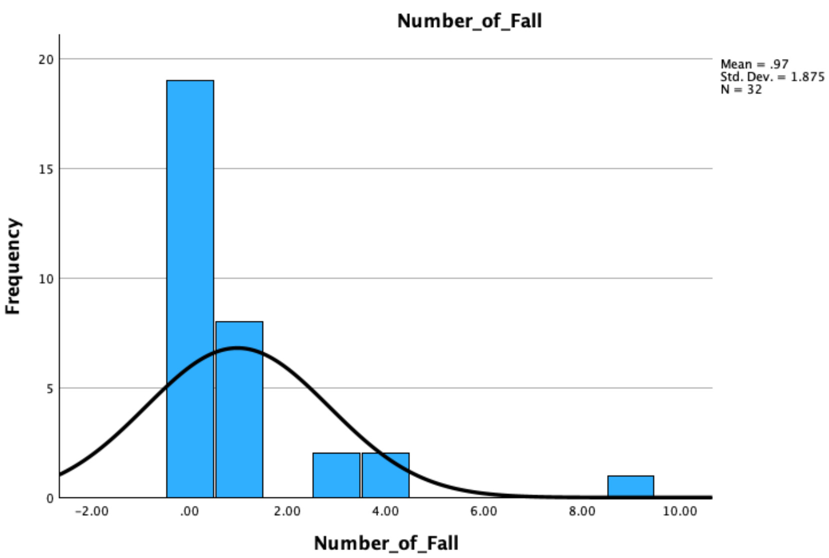

Figure 4.4 Number of falls among participants

4.2.3 Summary of the demographic data

Table 4.1 shows the summary of the demographic data of the participants who were selected through convenience sampling from the nursing home and community-dwelling in Klang Valley, Selangor. There are more male participants than female participants (n=17, 53.1%) as stated in Table 4.1. For the age subcategory, most of the participants were in the age group of 60-70 (n=14, 4.8%) and 71-80 (n=14, 43.8%). Furthermore, majority of the participants were not using walking aids during the TUG test (n=21, 65.6%). There are majority of the participants reported they had taken medicine (n=26, 81.3%). Besides, the number of non-fallers was larger than the number of fallers (n=19, 59.4%), and the mean number of the fall was 0.969 with SD 1.875.

Demographic Variables	Subcategory	Mean ± SD	Frequency(n)	Percentage (%)
Gender	**Male**		17	53.1
	Female		15	46.9
Age		72.78 ± 6.973		
	60-70		14	43.8
	71-80		14	43.8
	81-90		4	12.5
Years of Education		6.250± 3.233		
	0		4	12.5
	1-6		12	37.5
	7-11		16	50.0
	≥ 12		0	0.0
Usage of walking aids	**Yes**		11	34.4
	No		21	65.6
Personal Medical History	**Taken Medicine**		26	81.3
	Non-Taken Medicine		6	18.8
Number of falls		0.969 ± 1.875		
	Faller		13	40.6
	Non-faller		19	59.4

Table 4.1 Demographic data of the participants

4.3 Summary of characteristics of participants according to baseline TUG test results

Table 4.2 shows the summary of characteristics of participants according to baseline TUG test results using chi-square test. The data were grouped and presented as number and percentage. The usage of walking aid was the only characteristic of participants showed significant association between dynamic postural stability with the $p<0.05$ ($p=0.013$). While the other characteristics had been found no significant association between dynamic postural stability and fall risk as the $p>0.05$. the percentage of male was higher in the high fall risk group than female (52.2% vs 47.8%). Besides, the age group between 71 to 80 years old (52.2%) was found to have a higher risk of fall than the age groups of 60-70 years old (30.4%) and 81-90 years old (17.4%). The higher year of education, 7 to 11 years, had been found to have a higher risk of fall (43.5%) compared to the other 2 groups. Furthermore, the participants who did not utilised a walking aid (52.2% vs 47.8%), taken medicine (73.9% vs 26.1%), did not have a history of fall (52.2% vs 47.8%) were found to have a higher fall risk.

Characteristics	TUG results		p-value (χ2)
	Low fall risk	High fall risk	
Gender			1.000
Male	5(55.6)	12(52.2)	
Female	4(44.4)	11(47.8)	
Age			0.072
60-70	7(77.8)	7(30.4)	
71-80	2(22.2)	12(52.2)	
81-90	0(0.0)	4(17.4)	
Years of education			0.433
0	0(0.0)	4(17.4)	
1-6	3(33.3)	9(39.1)	
7-11	6(66.7)	10(43.5)	
Usage of walking aid			0.013
Yes	0 (0.0)	11(47.8)	
No	9 (100.0)	12 (52.2)	
Personal Medical History			0.150
Taken Medicine	9(100.0)	17(73.9)	
Non-Taken Medicine	0(0.0)	6(26.1)	
History of fall			0.249
Faller	2(22.2)	11 (47.8)	
Non-faller	7(77.8)	12 (52.2)	

Table 4.2 Characteristics of participants according to baseline TUG test results

4.4 Research Instrument

4.4.1 Montreal Cognitive Assessment

Figure 4.3 showed the MoCA score of the participants in this study, which had a M and SD of 22.03 and 1.959 respectively. All participants had received additional 1 mark to their total score to address the potential confounding effects of educational attainment on test scores. The score was ranging from 19 to 25, the higher the score indicated the higher the cognitive function. The mode of

MoCA score was 20 /30 (n=7, 21.9%), followed by 21/30 and 25/30 (n=6, 18.8%) respectively, 23/30 (n=5, 15.6%), 22/30 (n=4, 12.5%), 24/30 and 19/30 (n=2, 6.3%) respectively.

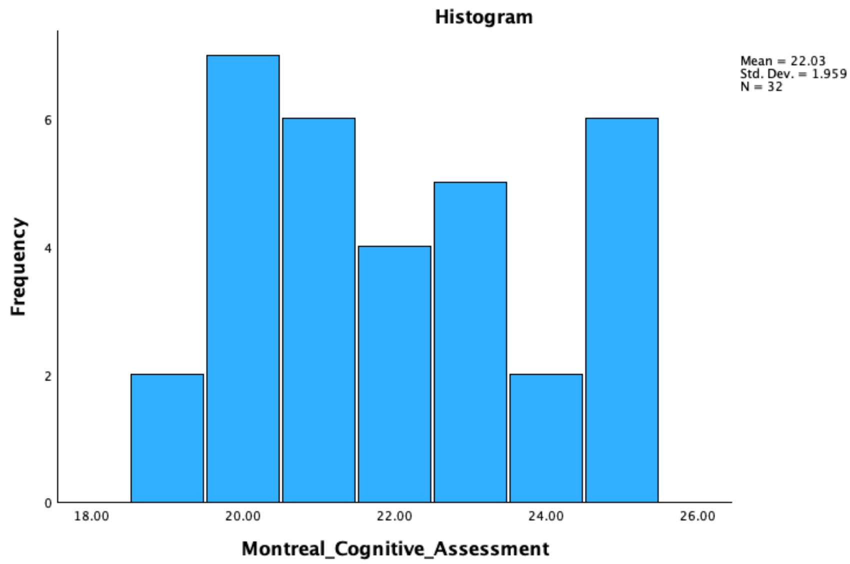

Figure 4.5 MoCA score

4.4.2 Trail Making Test Part A

Figure 4.4 showed the TMT-A score of the participants in this study. The M and SD were 77.57and 35.37respectively. The TMT-A score ranged from 22 seconds to 197 seconds.

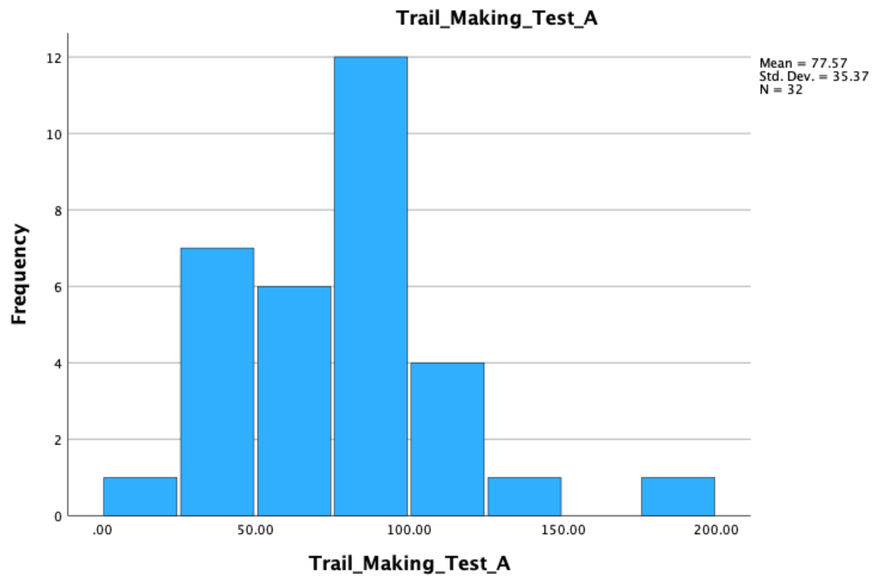

Figure 4.6 TMT-A score

4.4.3 Clock Drawing Test

Figure 4.5 showed the CDT score of the participants in this study which had a M and SD of 3.88 and 1.24respectively. The scores ranged from 2 to 5. The mode of the score was 5 (n=15, 46.9%), followed by the score of 7 (n=7, 21.9%), the score of 3 and 4 (n=5, 15.6%) respectively.

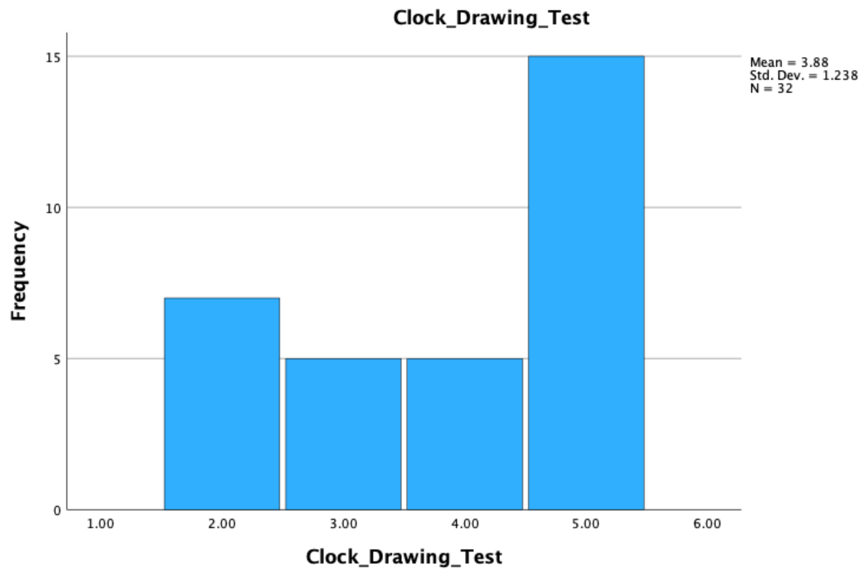

Figure 4.7 CDT score

4.4.4 Timed Up and Go Test

Figure 4.6 showed the TUG score of the participants in this study which had a M and SD of 18.53 and 8.79 respectively. The score ranged from 10.8 seconds to 47.58 seconds.

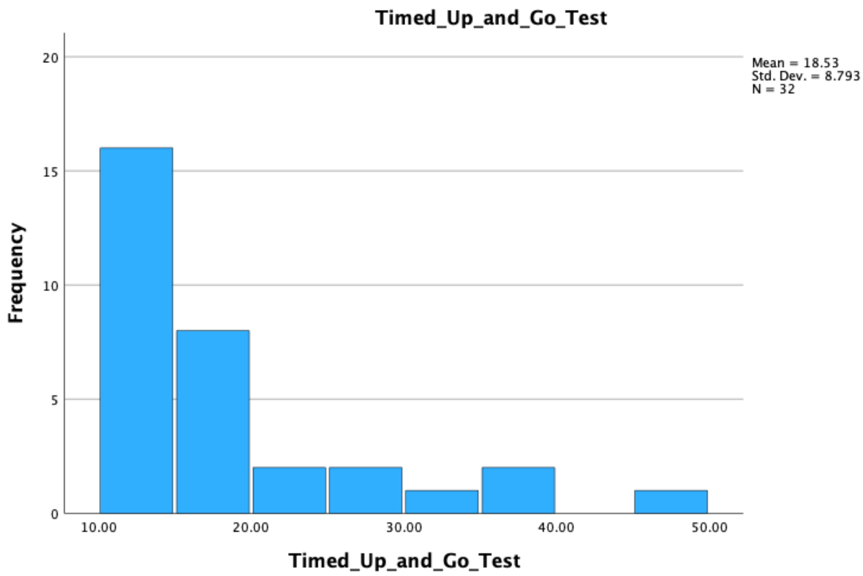

Figure 4.8 TUG score

4.5 Inferential Analysis

4.5.1 Normality Test

Tests of Normality using Shapiro-Wilk was conducted to assess the data distribution of all independent and dependent variables at baseline, including MoCA, TMT-A, CDT, TUG. The data is normally distributed when the p >0.05, indicated that the null hypothesis is failed to be rejected. The data is non-normally distributed when the p <0.05, indicated that the null hypothesis is rejected. Based on the normality test results showed in Table 4.2, it shows that all variables were non-normally distributed.

Variable	Shapiro-Wilk (p-value)	Skewness	Kurtosis
TMT-A	0.029	1.030	2.881
CDT	<0.001	-0.510	-1.421
TUG	<0.001	1.865	3.184

Table 4.3 Test of normality for baseline data

4.5.2 Relationship between attention domain, dynamic postural stability and fall risk

In table 4.2, a Chi-square test was performed between the score of TMT-A and TUG, to determine the relationship between attention domain, dynamic postural stability and fall risk. The observed frequency revealed that among those participants with attention domain deficit (n=15), 3 of them were low fall risk and 12 of them were high fall risk. Besides, among the participants with no attention deficit (n=17), 6 of them were low fall risk and 11 of them were high fall risk. There was 2 cell (50%) had expected count less than 5 in the contingency table with the minimum expected count of 4.33. Therefore, Fisher's Exact Test will be more appropriated to observe the significant value. The table showed that X2/FET is not calculable and sig- $\chi 2$ (p-value) =0.444. Since p-value more than 0.05, the H0 was failed to reject, hence there was no significant association between attention domain, dynamic postural stability and fall risk.

	Value	df	Exact Significance (2-sided)
Fisher's Exact Test			0.444

Table 4.4 Relationship between attention domain, dynamic postural stability and fall risk

4.5.3 Relationship between visuospatial skill domain, dynamic postural stability and fall risk

In table 4.3, a Chi-square test was performed between the score of CDT and TUG, determine the relationship between visuospatial domain, dynamic postural stability and fall risk. The observed frequency revealed that there were 17 participants with visuospatial domain deficits. Among the participants with visuospatial domain deficit (n=17), there were 5 participants with minor deficits, 1 was fall under category of high fall risk and 4 were fall under category of low fall risk; while among 16 participants with moderate to severe deficit, 2 of them were low fall risk and 10 of them were high fall risk. Besides, among the participants with no visuospatial domain deficit (n=15), 3 of them were low fall risk and 12 of them were high fall risk. There was 4 cell (66.7%) had expected count less than 5 in the contingency table with the minimum expected count of 1.41. Therefore, Fisher-Freeman-Halton Exact Test will be more appropriated to observe the significant value. The table showed that X2/FFH = 6.645 and sig-$\chi 2$ (p-value) =0.038. Since p-value less than 0.05, the H0 was rejected, hence there was a significant association between visuospatial domain, dynamic postural stability and fall risk.

	Value	df	Exact Significance (2-sided)
Fisher-Freeman-Halton Exact Test	6.645		0.038

Table 4.5 Relationship between visuospatial skill domain, dynamic postural stability and fall risk

4.5.4 Relationship between attention and visuospatial skill domains on dynamic postural stability and fall risk

In the table 4.4, the effect size was calculated using Cramer's V to assess the strength of the association between attention domain, and visuospatial skill domain on dynamic postural stability and fall risk respectively. The effect size between TMT-A and TUG was 0.170, indicated the result was weak in association; the effect size between CDT and TUG was 0.498, indicated the result was moderate in association.

	Cramer's V	Exact Significance (2-sided)
TMT-A and TUG	0.170	0.444
CDT and TUG	0.498	0.027

Table 4.6 Relationship between attention domain and visuospatial skill domain on dynamic postural stability and fall risk

5.0 RESULTS

5.1 Chapter Overview

This chapter provides a summary of key findings from the results of this study, an overview and interpretation of the findings in accordance with the research objectives was presented, followed by comparison with previous studies and justification. The chapter was continued with discussion of limitation of the present study, recommendation for future study and conclusion.

5.2 Discussion

5.2.1 Characteristics of participants according to baseline TUG test

The current study evaluated risk variables for dynamic postural stability and fall risk in older adults with MCI by comparing participant characteristics with the TUG results. Analysis using the Chi-square test showed that, with a p-value of 0.013, the usage of walking aids—was the only characteristics had a significant association with fall risk. The results specifically showed that older adults who did not use a walking aid on a daily basis were more likely to fall (52.2%). According to Chantanachai et al. (2021), the previous studies had noted variable results regarding the usage of walking aid to become a predictor of fall risk (Ansai et al., 2019; Taylor et al., 2014, 2013; Taylor et al., 2012a, b).

Other demographic factors, including gender, age category, year of education, medical history, and the distinction between fallers and non-fallers, did not demonstrate significant association with dynamic postural stability and fall risk, as their p-values exceeded 0.05. This result is consistent with earlier studies that found no link between fall risk and gender (Ansai et al., 2019, 2018; Bunce et al., 2017; Goncalves et al., 2018; Taylor et al., 2014, 2013; Taylor et al., 2012a, 2017; Taylor et al., 2012b, as cited by Chantanachai et al., 2021).

Those between the ages of 71 and 80 had the highest fall risk (52.2%), followed by those between the ages of 60 and 70 (30.4%) and 81 and 90 (17.4%). However, bias may have been introduced into the results due to the unequal distribution of individuals among age groups. Furthermore, this study found no significant association between years of education and fall risk ($p = 0.433$), in contrast to earlier studies that found a link between falls and higher education levels. It is noteworthy that the current study classified educational levels within the range of 0–11 years, a divergence from previous research which utilized higher educational benchmarks. The contradictory results might be explained by this disparity. Regardless, participants possessing 7–11 years of education exhibited a heightened fall risk (43.5%) relative to those with fewer than 6 years of education and those with no formal education (39.1%, 17.4%) respectively.

Pharmaceutical usage emerged as another significant factor, with participants on medication displaying an increased risk of falls (73.9%). Prior research has identified polypharmacy as a contributory risk factor for falls among individuals experiencing mild to moderate cognitive impairment (Taylor et al., 2014, 2013; Taylor et al., 2012a, b). Additionally, vascular health issues such as hypertension, cardiac conditions, and arrhythmias have been associated with a heightened incidence of multiple falls within this demographic (Taylor et al., 2013, 2012a; Taylor et al., 2012b, as cited by Chantanachai et al., 2021).

Notably, this study observed that non-fallers had a higher fall risk (52.2%) in comparison to fallers (47.8%). This finding contradicts earlier studies, which indicated that elderly individuals with cognitive impairment who had fallen exhibited significantly reduced gait velocity and shorter stride lengths relative to those who had not fallen or had only fallen once (Taylor et al., 2013).

5.2.2 Relationship between attention domains on dynamic postural stability and fall risk among elderly with MCI

In the present study, the outcomes derived from the analysis illustrate that there exists no statistically significant relationship between the attention domain, dynamic postural stability, and the risk of falls among elderly individuals with MCI, with a p-value calculated at 0.444. These results lead to the inference that dynamic postural instability, along with an increased risk of falls, does not linked with deficits observed in the attention domain within this population.

The findings of in this study has contradicted to the previous study that had established an association between deficits in attention, postural instability along with an elevated risk of falls among older adults. Nonetheless, it is also noteworthy that a limited number of studies have documented a lack of significant relationship between the attention domain, postural stability, and risk of falling. For instance, various prospective studies have identified critical executive function domains such as processing speed, verbal memory, set-shifting, reaction inhibition, and attention as being intrinsically linked to the risk of falls (Herman et al., 2010; Watson et al., 2010; Pijnappels et al., 2010, as cited by Hsu et al., 2012), correlation between selective attention, reaction inhibition and fall risk was found in older woman (Liu-Ambrose et al., 2010, as cited by Hsu et al., 2012).

Moreover, a cross-sectional analysis had found a significant relationship between diminishing levels of attention, processing speed, reaction inhibition, and set-shifting, all of which were linked to an increased risk of falls within elderly populations with MCI (McGough et al., 2011, as cited by Hsu et al., 2012). A cross-sectional study conducted by Taylor et al. (2021), reported that attention domain was associated with balance in the elderly with cognitive impairment, and reduction in attention was highly likely to increase the risk of falls (Ambrose et al., 2015, as cited by Oki et al., 2021).

The notable inconsistencies that have been identified between the results of the current research and those derived from earlier investigations can be primarily ascribed to the different outcome measures employed, as well as the variations in the demographic characteristics of the populations studied across the respective investigations. First, the studies conducted by Watson et al. (2010) and Pijnappels et al. (2010) did not evaluate the cognitive status of their participants whereas Liu-Ambrose et al. (2010) introduced a significant gender bias by concentrating solely on elderly females and similarly failed to provide any information regarding the cognitive status of the individuals involved in their research. As a direct consequence of these methodological shortcomings, it becomes abundantly clear that the findings generated by these studies are not suitable for making generalizations regarding elderly individuals who are afflicted with mild cognitive impairment (MCI), thereby limiting their applicability to this specific population.

Besides, McGough et al. (2011) was the only studies focused on the elderly population with MCI however, this study utilised different outcome measures, such as Stroop Word Colour Test and TMT-B. These two tests are widely used to assess the executive function, and encompasses various domain such as processing speed, response inhibition, cognitive flexibility and set-switching(Emek-Savas et al., 2019; and Niina Lähde et al., 2024). The executive function have been found to correlate strongly with the risk of future falls, not only in elderly individuals suffering from MCI but also in those who are cognitively intact (Nahid Divandari et al., 2023; and Liu et al., 2020). The outcome measure utilised in the study conducted by Taylor et al. (2021), measured the static balance by measuring postural sway on floor and foam, which is a measurement of static balance.

Furthermore, a systematic review conducted by Chantanachai et al. (2021) presented findings from three separate studies that investigated the relationship between the attention domain and fall risk in the elderly individuals with MCI, and these studies collectively found no significant associations (Ansai et al., 2019; Taylor et al., 2014; and Taylor et al., 2012a); This observation is further corroborated by another investigation that similarly reported no significant association between attention and gait performance, as measured by the widely utilized TUG test, in elderly individuals who are afflicted with MCI (Ansai et al., 2017).

Despite the fact that the results from these studies align with the present study, a number of reasons might account for the absence of a significant association between attention and the risk of falls. A plausible explanation for attention domain showed no association between fall risk may be due to the outcome measures utilized in each study were difference. For example, the research conducted by Ansai et al. (2019), Ansai et al. (2017), and Taylor et al. (2012a) relied on subdomain scores that were derived from the ACE-R to evaluate various cognitive domains. According to Mioshi et al. (2006), the attention subdomain scores obtained from the ACE-R lack the necessary sensitivity to reliably differentiate between individuals diagnosed with MCI and those who are considered to be healthy elderly individuals. Consequently, studies that utilize ACE-R subdomain scores as a means of assessing attention may yield results that are fundamentally unreliable and ultimately inconclusive. Besides, TMT-B was used to assess attention domain in the study conducted by Taylor et al., 2014.

5.2.3 Relationship between visuospatial skill domain, dynamic postural stability and fall risk among elderly with MCI

In the present study, the results derived from the analysis indicate that there exists a statistically significant association between the domain of visuospatial skills, dynamic postural stability, and the associated risk of falls among elderly individuals with MCI, with a p-value calculated at 0.038, which underscores the robustness of these findings. These findings suggest that deficit of visuospatial skill domain is intricately linked to a notable degree of dynamic postural instability, thereby elevating the overall risk of falling within this population. The conclusions drawn from the current research are in consistent with a multitude of prior studies that have explored similar themes; nevertheless, it is important to acknowledge that conflicting results have also emerged in the literature.

In older people with cognitive impairment, visuospatial skills have been shown to be independently associated with balance performance (Taylor et al., 2021). Even after adjusting for factors including age, sex, and years of formal education, poor visuospatial skills were associated with a higher risk of falls (Taylor et al., 2017, as referenced by Chantanachai et al., 2021). This conclusion was further supported by research that, after controlling for age and educational background, showed that older adults with superior visuospatial abilities had a significantly lower incidence of falls among those with mild to moderate cognitive impairment (Taylor et al., 2014, as cited by Chantanachai et al., 2021).

Furthermore, some research had shown that falls in older people with dementia are more closely linked to diminished visuospatial abilities than to gait abnormalities (Yamada et al., 2012, as citedc by Oki et al., 2021). Prior study has also revealed balance and visuospatial abilities as important risk factors for falls in people with Alzheimer's disease (Oki et al., 2021). Notably, two studies found that processing speed, executive functions, and visuospatial ability all strongly predict fall events (Herman et al., 2010; Fallaci et al., 2022). Additionally, studies showed that, especially in older individuals, visual and spatial cognitive activities impair postural control more than other cognitive tasks (Menant et al., 2014, as cited by Agathos et al., 2020).

While the results of the current study were consistent with those of earlier research, it was important to highlight the variations in outcome measures employed in the various investigations. For example, Taylor et al. (2021) used the ACE-III to examine visuospatial ability and postural sway on foam and floor surfaces to measure balance, which is indicative of static equilibrium. However, there are no discernible variations in visuospatial task performance between healthy older persons and those with moderate cognitive impairment (MCI) according to the ACE-III (Potts et al., 2021). This indicates that individuals diagnosed with MCI might not demonstrate significant deficits in this cognitive domain when compared to cognitive-intact elderly, thereby complicating the task of distinguishing visuospatial impairments as a cognitive variable.

Besides, Taylor et al. (2014) employed the ACE-R subscore to evaluate visuospatial capabilities, incorporating the cube drawing assessment, which exhibited a notable correlation with falls ($p = 0.008$) among elderly individuals experiencing cognitive deficits. Conversely, the clock drawing evaluation failed to reveal a significant association ($p = 0.2853$), while this finding had showed a different result from the current study, as the CDT is subject to some variation. The findings of previous research are limited in their generalizability since they mostly examined older adults with cognitive impairment without elucidating the extent of their deficiencies.

It's also critical to recognize that some research has shown no link between fall risk and visuospatial skill. Among older people with MCI, 2 studies had reported no significant association for visuospatial skill (Taylor et al., 2012a; and Ansai et al., 2019, as cited by Chantanachai et al., 2021). Likewise, Tangen et al. (2014) found no correlation between balance and visuospatial skills in those with Alzheimer's disease, MCI, and subjective cognitive impairment. However, the study conducted by Ansai et al. (2019) had found a significant association in the elderly with mild Alzheimer's and absence of significant association in the elderly with MCI.

5.2.4 Compare the impact of attention domain and visuospatial skill domains on dynamic postural stability and fall risk among elderly with MCI

In the present study, the results derived from the analysis indicate that there exists a statistically significant association between the domain of visuospatial skills, dynamic postural stability, and fall risk among elderly individuals with MCI, with a p-value of 0.038 and Cramer’s V value of 0.498; while there is no statistically significant association between the domain of attention skills, dynamic postural stability, and fall risk among elderly individuals with MCI, with a p-value of 0.444 and Cramer’s V value of 0.170. The present study concluded that visuospatial domain has a greater impact on dynamic postural stability and fall risk as it shows a moderate significant association with dynamic postural stability and fall risk among elderly with MCI.

Surprisingly, the attention domain did not demonstrate a significant correlation with dynamic postural stability and fall risk, despite the existence of an extensive body of literature that underscores the critical role that attention plays in the processes of walking and maintaining postural stability. Previous study had reported that both walking and the maintenance of postural stability encompass not just motor tasks but also critically involve higher-order executive functions and various attentional processes that are essential for successful execution (Malik et al., 2024). It has been established that both static and dynamic postural control possess a cognitive component that tends to become increasingly demanding in terms of attention as individuals advance in age (Woollacott and Shumway-Cook, 2002, as cited by Agathos et al., 2020).

Even tasks that may appear to be straightforward, such as the act of walking, can transform into cognitively challenging activities for older adults, requiring greater attentional demand (Woollacott and Shumway-Cook, 2002; Holtzer et al., 2011; Zwergal et al., 2012, as cited by Agathos et al., 2020). Supporting this notion, the research conducted by Remaud et al. (2016) revealed that engaging in dynamic standing tasks significantly elevated the attentional demands associated with the maintenance of postural control, with the effect being notably more pronounced in healthy elderly populations when compared to the younger adults.

Furthermore, spatial learning, which is recognized as a fundamental component of visuospatial functioning, is known to be particularly demanding in terms of the allocation of attentional resources, as it necessitates a considerable degree of cognitive engagement in order to effectively process and interpret spatial information (Rand et al., 2015; as cited by Agathos et al., 2020). This evidence has explained the importance of attention within the context of visuospatial tasks, as well as the elevated cognitive demands that are required to uphold dynamic postural stability.

The absence of a notable relationship between the attention domain, dynamic postural stability and fall risk observed in the present study can be due to the single-task paradigm that was employed in this study, TUG test, which is a widely utilized measure of mobility. In contrast, dual-task challenges that necessitate the simultaneous execution of both cognitive and motor tasks have been demonstrated to elevate the demands of attention, thereby serving as effective indicators of fall risk within various populations with neurodegenerative diseases, such as MCI, and dementia (RE et al., 2022; Makizako, Shimada, & Park, 2013, as cited by Ansai et al., 2017).

According to a study conducted by Ansai and his college (2019),they had reported that dual-task test was the independent predictor of fall in the elderly with MCI. In scenarios characterized by dual-task conditions, the increased attentional load is capable of pushing elderly individuals to the limits of their capacity for shared attention, thereby complicating their ability to perform both tasks effectively. This often results in a phenomenon known as task prioritization, in which postural performance may experience a decline if attentional resources are redirected towards the completion of cognitive tasks, illustrating a significant interplay between cognitive and motor functions. Typically, elderly individuals tend to adopt a strategy referred to as "posture first," which is aimed at mitigating the risk of falls (Borel & Alescio-Lautier, 2014). Fall risk can be enhanced by complex dual-task scenarios, which can result in diminished walking speeds, a reduction in the number of steps taken, and an increase in the variability of stride times (Hunter et al., 2020, as cited by Minta et al., 2023).

In conclusion, the study shows that the visuospatial domain has a stronger impact on dynamic postural stability and fall risk in older adults with MCI, but the function of attention is less evident in situations involving a single task. Dual-task paradigms should be used in future studies to provide a more thorough evaluation of fall predictors in this group and to better understand how cognitive domains interact with postural stability and fall risk.

5.3 Limitation of study

This study has several limitations that should be acknowledged. First, a pilot study employed a small sample size in this study may not enough to detect the subtle changes among the participants with individual cognitive domain deficit. Besides, a small sample size may increase the probability of Type II error, in which the researcher fails to reject a null hypothesis that is actually incorrect in the population (Banerjee et al., 2019), thereby compromising the reliability of the data. More strong statistical power would result from a larger sample size, which might produce more statistically significant findings.

Second, it's possible that the instruments employed to evaluate the cognitive domains affected the results and made it more difficult to find significant association. The attention domain, for instance, was evaluated in this study using the TMT-A; nevertheless, the results may have been distorted by the test's overlap with other domains, such as visual attention (Kim et al., 2014). The lack of a significant association between the attention domain, dynamic postural stability and fall risk in this study may be explained by this overlap.

The study was also limited by funding restrictions, which made it difficult to use more accurate evaluation instruments. For example, the CDT was used to evaluate the visuospatial domain in this study, however, the JLO test would be a more reliable instrument as it was designed to be "as pure a measure of one aspect of spatial thinking, as could be conceived," according to Arthur Benton (Calamia et al., 2011). However, because of financial constraints, the JLO was not utilized in this study.

This study's approach of assessing fall risk had drawbacks. The lack of significant correlation in this study may have been caused by the TUG test's failure to adequately capture the role of attention in fall risk in the absence of the additional cognitive burden of a dual-task arrangement.

5.4 Recommendation for future research

The sample size should be increased in future research to improve statistical power and lower the possibility of Type II errors. This would enable the detection of subtle changes and produce more accurate results that can be generalized to a broader population. Furthermore, more specialized cognitive evaluation measures should be employed to isolate distinct domains. In contrast to the CDT, the JLO test would be a more reliable assessment tool to assess the visuospatial domain. Moreover, incorporating dual-task paradigms that integrate cognitive and motor tasks into the evaluation process is crucial, as these methodologies serve as a more accurate reflection of fall risk and postural instability in individuals.

Lastly, the future study is recommended to conduct in a longitudinal study design as it is able to monitor changes over time and identify causal links between fall risk, postural stability, and cognitive domain in older adults with MCI. In order to achieve precise outcomes and foster a deeper understanding of how cognitive function impacts dynamic postural stability and fall risk in the elderly population suffering from MCI, it is also advised to use more sophisticated tools, such as wearable sensors, force plate measurements, or gait analysis. By implementing these enhancements, future research would not only significantly bolster the reliability of the findings, but also deepen the insights gained and expand the practical applications that can arise from such studies. Ultimately, these improvements would contribute to a more comprehensive understanding of the intricate relationships between cognitive function and physical stability, thereby informing interventions aimed at reducing fall risks among vulnerable populations.

5.5 Conclusion

In summary, the findings of this study revealed that among elderly with MCI, there is no statistically significant relationship between attention domain, dynamic postural stability and fall risk, as evidenced by the significant value greater than 0.05 ($p = 0.444$). Besides, the findings revealed that there is a statistically significant relationship between visuospatial domain, dynamic postural stability and fall risk among elderly with MCI, as evidenced by the significant value lesser than 0.05 ($p = 0.038$). Hence, it is indicated that visuospatial domain is the key domain that affect dynamic postural stability and fall risk among elderly with MCI. Furthermore, the visuospatial domain has a greater impact on dynamic postural stability and fall risk among elderly with MCI compared to the attention domain. This is evidenced by the Cramer' s V value, which visuospatial domain showed a moderate significant association (Cramer's V = 0.498). These results indicated that visuospatial domain plays a vital role in the maintenance of postural stability and the mitigation of fall risk.

Fall risk, dynamic postural stability, and the attention domain do not significantly associate, which is contrary to the results of the majority of earlier research. Thus, there is a necessitating further exploration and rigorous investigation as the influence of attention on postural stability and fall risk remains complex. Hence, the future study is needed to fully understand the underlying mechanism of effect of attention deficit on postural stability and fall risk among elderly with MCI.

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Appendix

Appendix A – ETHICAL FORM

UTAR UNIVERSITI TUNKU ABDUL RAHMAN
Wholly Owned by UTAR Education Foundation (Company No. 578227-M)

Re: U/SERC/78-363/2024

23 September 2024

Mr Muhammad Noh Zulfikri bin Mohd Jamali
Head, Department of Physiotherapy
M. Kandiah Faculty of Medicine and Health Sciences
Universiti Tunku Abdul Rahman
Jalan Sungai Long
Bandar Sungai Long
43000 Kajang, Selangor

Dear Mr Muhammad Noh,

Ethical Approval For Research Project/Protocol

We refer to your application for ethical approval for your students' research project from Bachelor of Physiotherapy (Honours) programme enrolled in course UMFD3026. We are pleased to inform you that the application has been approved under Expedited Review.

The details of the research projects are as follows:

No	Research Title	Student's Name	Supervisor's Name	Approval Validity
1.	The Effect of Diaphragm Muscle Exercise on Dynamic Balance among Post-COVID-19 Older Adults in Klang Valley, Malaysi	Goh Le Yi	Ms Premala a/p Krishnan	23 September 2024 – 22 September 2025
2.	Relationship Between Cognitive Domains, Dynamic Postural Stability and Fall Risk in Elderly Individuals with Mild Cognitive Impairment: A Pilot Study	Chaw Jade Wern		
3.	Smartphone Addiction and Its Relationship with Forward Head Posture and Grip Strength Among University Students in Klang Valley	Chuar Yu Cheng	Mr Chew Wai Hoong	
4.	Dynamic Balance and Life-Space Mobility Among Community Dwelling Older Adults: A Correlation Study	Grace Wong Mui Kar		
5.	Relationship Between Neck Disability, Sleep Quality, and Perceived Stress Among University Students in Klang Valley	Low Jun Kai		
6.	Association Between Medial Longitudinal Arch and Body Mass Index Among Young Adults in Klang Valley and Selangor, Malaysia	Mahaasiri a/p Kamalavallo	Ms Ambusam a/p Subramaniam	
7.	Effectiveness of Mulligan's Traction Straight Leg Raise Technique on Young University Students with Symptoms of Restless Leg Syndrome	Lim Chun Qi	Mr Tarun Amalnerkar Ms Swapneela Jacob	
8.	Effect of 4-week Inspiratory Muscle Training (IMT) Program on Young Adult with Mild Obstructive Sleep Apnea (OSA)	Sia Cai Ni	Mr Tarun Amalnerkar Ms Swapneela Jacob Mr Sathish Kumar Sadagobane	

The conduct of this research is subject to the following:

(1) The participants' informed consent be obtained prior to the commencement of the research;

(2) Confidentiality of participants' personal data must be maintained; and

(3) Compliance with procedures set out in related policies of UTAR such as the UTAR Research Ethics and Code of Conduct, Code of Practice for Research Involving Humans and other related policies/guidelines.

(4) Written consent be obtained from the institution(s)/company(ies) in which the physical or/and online survey will be carried out, prior to the commencement of the research.

Kampar Campus : Jalan Universiti, Bandar Barat, 31900 Kampar, Perak Darul Ridzuan, Malaysia
Tel: (605) 468 8888 **Fax**: (605) 466 1313
Sungai Long Campus : Jalan Sungai Long, Bandar Sungai Long, Cheras, 43000 Kajang, Selangor Darul Ehsan, Malaysia
Tel: (603) 9086 0288 **Fax**: (603) 9019 8868
Website: www.utar.edu.my

Should the students collect personal data of participants in their studies, please have the participants sign the attached Personal Data Protection Statement for records.

Thank you.

Yours sincerely,

Professor Ts Dr Faidz bin Abd Rahman
Chairman
UTAR Scientific and Ethical Review Committee

c.c Dean, M. Kandiah Faculty of Medicine and Health Sciences
Director, Institute of Postgraduate Studies and Research

Appendix B – INFORMED CONSENT FORM

Research Participant Information Sheet

Universiti Tunku Abdul Rahman Faculty of Medicine and Health Sciences
Department of Physiotherapy
Bachelor of Physiotherapy (Honours)

Information Sheet to Participate in the Study
"Relationship Between Cognitive Domains, Dynamic Postural Stability And Fall Risk In Elderly Individuals With Mild Cognitive Impairment: A Pilot Study"

Student Investigator: Chaw Jade Wern
Department: Department of Physiotherapy
Course Name and Course Code: UMFD2013 RESEARCH PROJECT
Year and Semester: Year 3 Semester 1
Research Supervisor: Ms Premala Krishnan

You are being asked to volunteer for this research study that is being conducted as part of the requirement to complete the above-mentioned Course.

Please read this information sheet and contact me to ask any questions that you may have before agreeing to take part in this study.

Purpose of the Research Study

The purpose of this study is to investigate the relationship between cognitive domains, dynamic postural stability and fall risk in elderly individuals with mild cognitive impairment

Approximately 32 individuals will participate in this study.

Procedures
If you agree to be in this study, you will be asked to perform a MoCA test that take 10 minutes to complete. TMT-A, CDT will be used to assess the cognitive domains. TUG test will be used to assess dynamic postural stability and fall risk. The relevant data will then be collected and analysed.

Length of participation One time participation only

Risks and Benefits No risk will be involved throughout in the current study.

The benefits of participating in this study include increased the understanding about the relationship of cognitive impairment, dynamic postural stability and fall risk to develop an effective rehabilitation program to prevent fall among elderly.

Confidentiality
No information that will make it possible to identify you, will be included in any reports to the University or in any publications.
Research records will be stored securely, and only approved researchers will have access to the records.

Voluntary Nature of the Study
Participation in this study is voluntary. If you withdraw or decline participation, you will not be penalized or lose benefits or services unrelated to the study. If you decide to participate, you may decline to answer any question and may choose to withdraw at any time.

Contacts and Questions
If you have any questions, clarifications, concerns or complaints, about the research, the researcher conducting this study can be contacted at 016-4487453, or by email with archerteh@1utar.my.

My Research Supervisor, Ms Premala Krishnan, can be contacted at 010-373 6373, or by email with premala@utar.edu.my if there are any inquiries, concerns or complaints about the research and there is a wish to talk to someone other than individuals on the research team.

Please keep this information sheet for your records.

Research Participant Consent Form

Universiti Tunku Abdul Rahman Faculty of Medicine and Health Sciences
Department of Physiotherapy
Bachelor of Physiotherapy (Honours)

Consent Form to Participate in the Study
"Relationship Between Cognitive Domains, Dynamic Postural Stability And Fall Risk In Elderly Individuals With Mild Cognitive Impairment: A Pilot Study"

Student Investigator: Chaw Jade Wern
Department: Department of Physiotherapy
Course Name and Course Code: UMFD3026 RESEARCH PROJECT
Year and Semester: Year 3 Semester 1
Research Supervisor: Ms Premala Krishnan

I have read the provided information, or it has been read to me. I have had the opportunity to ask questions about it and any questions I have, has been answered to my satisfaction. I understand that I will be given a copy of this form, and the researcher will keep another copy on file. I consent voluntarily to be a participant in this study.

Appendix C – DEMOGRAPHIC DATA AND SCREENING FORM

DEMOGRAPHIC DATA

1. What is your name?

____

2. What is your age?

____

3. Gender?

   () Male () Female () Others

4. What race are you?

   ( ) Chinese ( ) Malay ( ) Indian ( ) Others

5. What is your highest education level attained?

   ( ) Never been to school ( ) Primary level ( ) Secondary/ pre-university level ( ) University level

6. Do you have any physical disabilities?

   () No () if Yes, please state: ________

7. Have you had any recent surgeries?

   () No () if Yes, please state: _________

8. Do you have any chronic disease (such as diabetes mellitus, heart failure)?

   () No () if Yes, please state: _________

9. Does your have a history of fall?

   () No () Yes, please state: _________

10. Do you have any progressive neurodegenerative disease (eg. Parkinson's disease or Huntington's disease)?

    () No () Yes, please state: _________

11. Do you have been diagnosed with any type of dementia?

    () No () Yes, please state: _________

Appendix D – PERSONAL DATA PROTECTION NOTICE

PERSONAL DATA PROTECTION NOTICE

Please be informed that in accordance with Personal Data Protection Act 2010 ("PDPA") which came into force on 15 November 2013, Universiti Tunku Abdul Rahman ("UTAR") is hereby bound to make notice and require consent in relation to collection, recording, storage, usage and retention of personal information.

1. Personal data refers to any information which may directly or indirectly identify a person which could include sensitive personal data and expression of opinion. Among others it includes:

   a) Name
   b) Identity card
   c) Place of Birth
   d) Address
   e) Education History
   f) Employment History
   g) Medical History
   h) Blood type
   i) Race
   j) Religion
   k) Photo
   l) Personal Information and Associated Research Data

2. The purposes for which your personal data may be used are inclusive but not limited to:

   a) For assessment of any application to UTAR
   b) For processing any benefits and services
   c) For communication purposes
   d) For advertorial and news
   e) For general administration and record purposes
   f) For enhancing the value of education
   g) For educational and related purposes consequential to UTAR
   h) For replying any responds to complaints and enquiries
   i) For the purpose of our corporate governance
   j) For the purposes of conducting research/ collaboration

3. Your personal data may be transferred and/or disclosed to third party and/or UTAR collaborative partners including but not limited to the respective and appointed outsourcing agents for purpose of fulfilling our obligations to you in respect of the purposes and all such other purposes that are related to the purposes and also in providing integrated services, maintaining and storing records. Your data may be shared when required by laws and when disclosure is necessary to comply with applicable laws.

4. Any personal information retained by UTAR shall be destroyed and/or deleted in accordance with our retention policy applicable for us in the event such information is no longer required.

5. UTAR is committed in ensuring the confidentiality, protection, security and accuracy of your personal information made available to us and it has been our ongoing strict policy to ensure that your personal information is accurate, complete, not misleading and updated. UTAR would also ensure that your personal data shall not be used for political and commercial purposes.

Consent:

6. By submitting or providing your personal data to UTAR, you had consented and agreed for your personal data to be used in accordance to the terms and conditions in the Notice and our relevant policy.

7. If you do not consent or subsequently withdraw your consent to the processing and disclosure of your personal data, UTAR will not be able to fulfill our obligations or to contact you or to assist you in respect of the purposes and/or for any other purposes related to the purpose.

8. You may access and update your personal data by writing to us at______________.

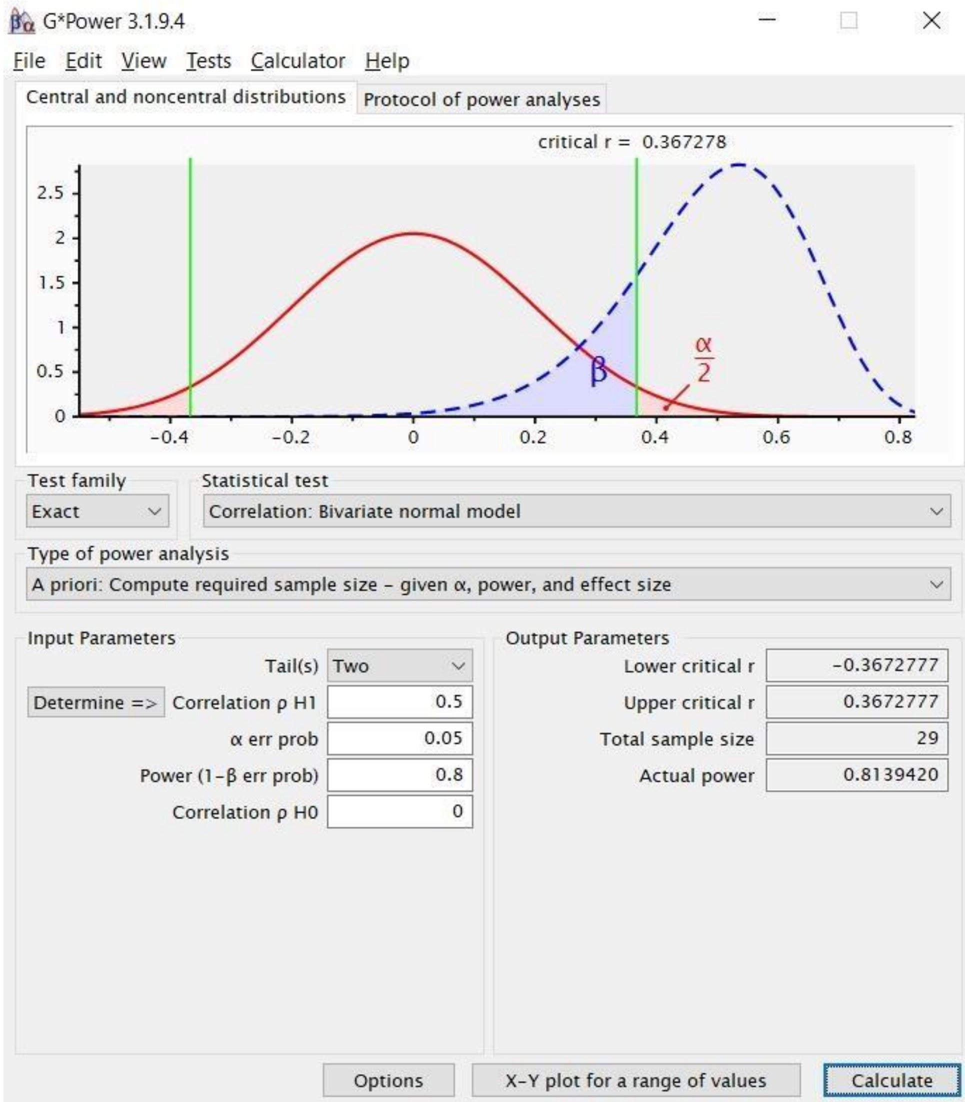
Acknowledgment of Notice

[ ] I have been notified and that I hereby understood, consented and agreed per UTAR above notice.

[ ] I disagree, my personal data will not be processed.

…………………………
Name:
Date:

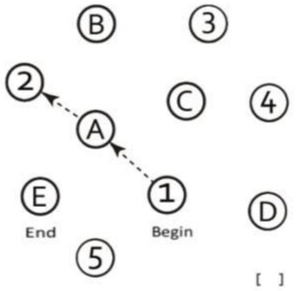
Appendix E – Sample Size Calculation

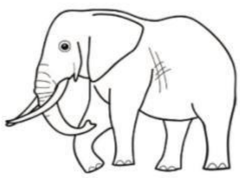
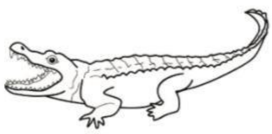


Appendix F – MoCA SCORE SHEET

MONTREAL COGNITIVE ASSESSMENT (MoCA®)
Version 8.2 English

Name:
Education:
Sex:
Date of birth:
DATE:

VISUOSPATIAL / EXECUTIVE			POINTS
 [ ]	Copy chair  [ ]	Draw CLOCK (Ten past nine) (3 points) [ ] Contour [ ] Numbers [ ] Hands	__/5

NAMING			
 [ ]	 [ ]	 [ ]	__/3

MEMORY		HAND	NYLON	PARK	CARROT	YELLOW	
Read list of words, subject must repeat them. Do 2 trials, even if 1st trial is successful. Do a recall after 5 minutes.	1st TRIAL						NO POINTS
	2nd TRIAL						

ATTENTION Read list of digits (1 digit / sec.).	Subject has to repeat them in the forward order. [ ] 8 1 5 2 4 Subject has to repeat them in the backward order. [ ] 2 4 7	__/2
Read list of letters. The subject must tap with his hand at each letter A. No points if ≥ 2 errors.	[ ] F B A C M N A A J K L B A F A K D E A A A J A M O F A A B	__/1
Serial 7 subtraction starting at 70.	[ ] 63 [ ] 56 [ ] 49 [ ] 42 [ ] 35 4 or 5 correct subtractions: **3 pts**, 2 or 3 correct: **2 pts**, 1 correct: **1 pt**, 0 correct: **0 pt**	__/3
LANGUAGE Repeat:	The robber of the gray car was stopped by the police. [ ] The student went back to school without his books and pencils. [ ]	__/2
Language Fluency.	Name maximum number of words in one minute that begin with the letter S. [ ] ____ (N ≥ 11 words)	__/1
ABSTRACTION	Similarity between e.g. banana - orange = fruit [ ] bed - table [ ] letter - telephone	__/2

DELAYED RECALL	(MIS)	Has to recall words WITH NO CUE	HAND [ ]	NYLON [ ]	PARK [ ]	CARROT [ ]	YELLOW [ ]	Points for UNCUED recall only	__/5
Memory Index Score (MIS)	X3								
	X2	Category cue						MIS = ____/15	
	X1	Multiple choice cue							

ORIENTATION	[ ] Date	[ ] Month	[ ] Year	[ ] Day	[ ] Place	[ ] City	__/6

 www.mocatest.org

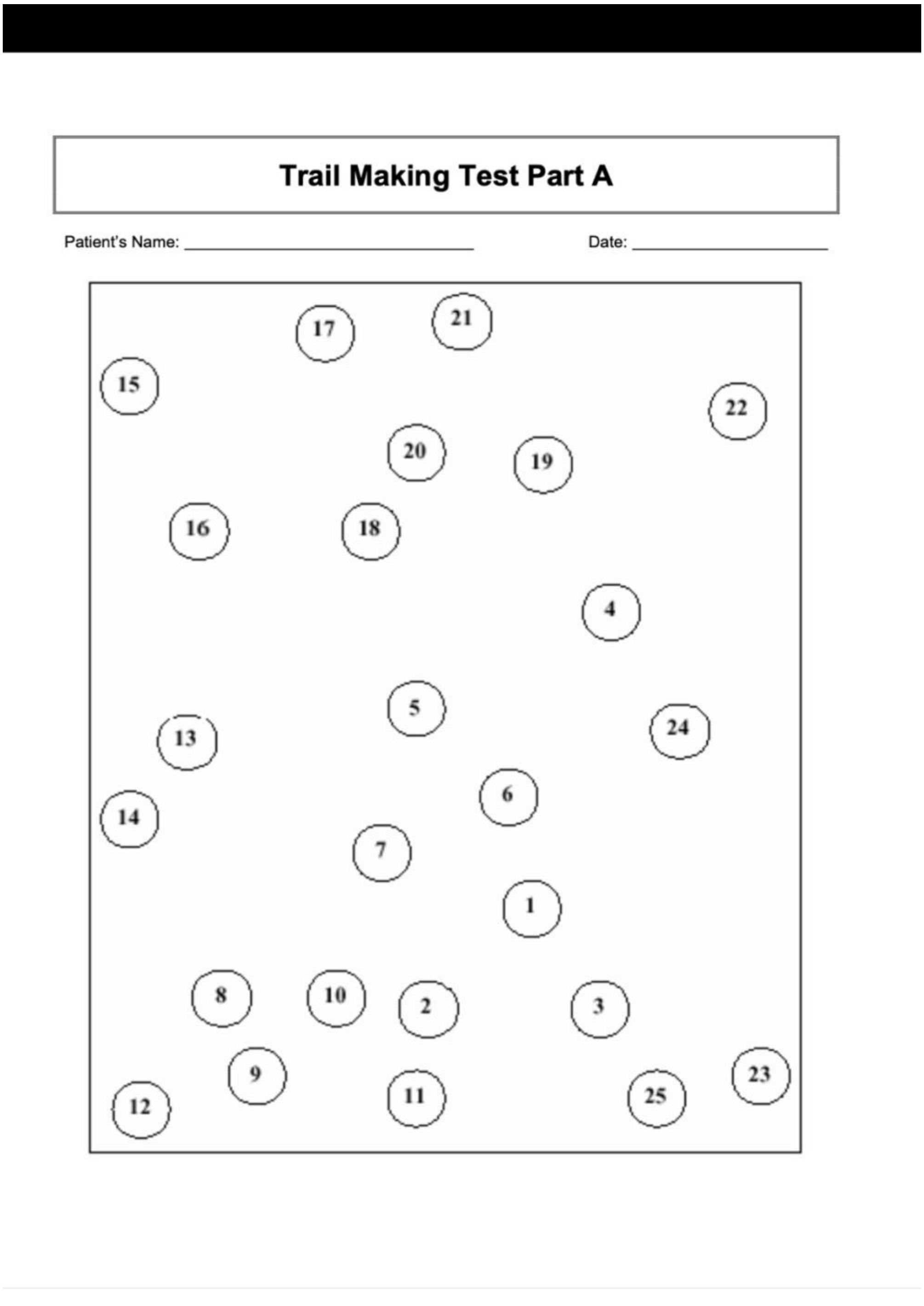
Administered by: ______________________

Training and Certification are required to ensure accuracy.

MIS: /15
(Normal ≥ 26/30)
Add 1 point if ≤ 12 yr education

TOTAL __/30

Appendix G– TMT-A SCORE SHEET


Trail Making Test Part A

Patient's Name: ______________________ Date: ________________

Appendix H – TURNITIN REPORT

RELATIONSHIP BETWEEN COGNTIVE DOMAINS, DYNAMIC POSTURAL STABILITY AND FALL RISK IN ELDERLY INDIVIDUALS WITH MILD COGNITVE IMPAIRMENT: A PILOT STUDY

by Chaw Jade Wern

Submission date: 20-Dec-2024 11:40AM (UTC+0800)
Submission ID: 2556401978
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RELATIONSHIP BETWEEN COGNTIVE DOMAINS, DYNAMIC POSTURAL STABILITY AND FALL RISK IN ELDERLY INDIVIDUALS WITH MILD COGNITVE IMPAIRMENT: A PILOT STUDY

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