THE EFFECTS OF PHYSICAL EXERCISE AND COGNITIVE ACTIVITIES ON DEMENTIA RISK REDUCTION AMONG ELDERLY INDIVIDUALS WITH MILD COGNITIVE IMPAIRMENT

BY

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A dissertation submitted in fulfillment of the requirement for the degree of Master of Health Sciences (Biobehavioral)

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ABSTRACT

Introduction: The elderly population in the world is increasing, not excluding Malaysia. This phenomenon is a significant concern as the rise of dementia cases is anticipated in the subsequent decades. Undoubtedly, the disease will have a detrimental effect on economics, society, and individuals. Physical exercise and cognitive interventions have been proven as potential risk reduction strategies in targeting high-risk groups known as mild cognitive impairment (MCI). Nevertheless, movement limitations among elderly have highlighted the necessity of remote delivery interventions, particularly in rural areas. This study aims to measure the effect of Aerobic exercise and Cognitive activities for Elderly (ACE) programme on the cognitive performance of elderly with MCI. Material and methods: A total of 87 participants completed the study, consisting of an experimental group (n = 43) and a control (n = 44) group. Participants in the experimental group received the ACE programme three times weekly over 12 weeks, whereas the control group received no intervention. The validated Mini-Cog instrument assessed the participants' cognitive performance at three intervals: baseline, week 4, and week 12 post-intervention. Chi-square and independent t-tests were performed for univariate analysis, whereas generalised estimating equations were used for multivariate analysis to measure the score changes between baseline and post-intervention within and between the two study groups. Results: The results demonstrated that the memory and clock drawing test scores were not significantly different between the experimental and control groups after four weeks ($p > 0.05$ for both groups). Interestingly, after 12 weeks, a significant difference in memory scores and clock drawing test scores between the experimental and control groups were observed ($p = 0.003$) and ($p = 0.045$), respectively. After adjusting the confounders, multivariate analyses showed that the experimental group was significantly improved in both memory ($p = 0.036$) and clock drawing test ($p = 0.041$) scores compared to the control group, with 2.322 and 2.360 times more likely to improve the scores, respectively. A significant association between assessment time and cognitive performance was also observed, showing that 12 weeks of intervention significantly improved memory ($p < 0.001$) and clock drawing test ($p = 0.035$) scores compared to four weeks. Conclusion: The ACE programme had improved cognitive performance among the elderly with MCI, showing that implementation of physical and cognitive leisure activities at the community level may help to delay the progression of dementia among the FELDA elderly. Simultaneously, the selection of activities that can be performed at home may be a practical, inexpensive, safe, and convenient option for the elderly population in rural areas.

ملخص البحث

مقدمة: عدد السكان المسنين في العالم آخذ في الازدياد، ولا يستثنى من ذلك ماليزيا. وتشكل هذه الظاهرة مصدر قلق كبير حيث من المتوقع أن ترتفع حالات الخرف في العقود اللاحقة. ومما لا شك فيه أن المرض سيكون له تأثير ضار على الاقتصاد والمجتمع والأفراد. لقد ثبت أن التمارين البدنية والتدخلات المعرفية هي استراتيجيات محتملة للحد من المخاطر في استهداف المجموعات المعرضة للخطر الشديد والمعروفة باسم الضعف الإدراكي المعتدل (MCI). ومع ذلك، فإن القيود المفروضة على الحركة بين كبار السن سلطت الضوء على ضرورة تدخلات الولادة عن بعد، وخاصة في المناطق الريفية. تهدف هذه الدراسة إلى قياس تأثير برنامج التمرينات الهوائية والأنشطة المعرفية لكبار السن (ACE) على الأداء المعرفي لكبار السن المصابين بالاختلال المعرفي المعتدل. الأدوات والمنهجية: شارك 87 مشاركا في الدراسة، يتكونون من مجموعة تجريبية (ن = 43) ومجموعة ضابطة (ن = 44). تلقى المشاركون في المجموعة التجريبية برنامج ACE ثلاث مرات أسبوعيا على مدى 12 أسبوعا، في حين لم تتلق المجموعة الضابطة أي تدخل. قامت أداة Mini-Cog المعتمدة بتقييم الأداء المعرفي للمشاركين على ثلاث فترات: خط الأساس، الأسبوع 4، والأسبوع 12 بعد التدخل. تم إجراء اختبارات Chi-square واختبارات-ت المستقلة للتحليل أحادي المتغير، في حين تم استخدام معادلات التقدير المعممة للتحليل متعدد المتغيرات لقياس تغيرات الدرجات بين خط الأساس وما بعد التدخل داخل مجموعتي الدراسة وفيما بينهما. النتائج: أظهرت النتائج أن درجات اختبار رسم الذاكرة والساعة لم تكن مختلفة بشكل كبير بين المجموعتين التجريبية والضابطة بعد أربعة أسابيع ($P > 0.05$ لكلا المجموعتين). ومن المثير للاهتمام، بعد 12 أسبوعًا، لوحظ وجود اختلاف كبير في درجات الذاكرة ودرجات اختبار رسم الساعة بين المجموعتين التجريبية والضابطة (ع = 0.003) و (ع = 0.045)، على التوالي. بعد ضبط الإرباك، أظهرت التحليلات متعددة المتغيرات أن المجموعة التجريبية قد تحسنت بشكل ملحوظ في كل من درجات الذاكرة (ع = 0.036) واختبار رسم الساعة (ع = 0.041) مقارنة بالمجموعة الضابطة، مع احتمالية تحسين الدرجات بمقدار 2.322 و2.360 مرة. ، على التوالي. ولوحظ أيضًا وجود ارتباط كبير بين وقت التقييم والأداء المعرفي، مما يدل على أن 12 أسبوعًا من التدخل أدى إلى تحسن

كبير في الذاكرة (P <0.001) واختبار رسم الساعة (P = 0.035) مقارنة بأربعة أسابيع. الاستنتاج: لقد أدى برنامج ACE إلى تحسين الأداء المعرفي بين كبار السن الذين يعانون من MCI، مما يدل على أن تنفيذ الأنشطة الترفيهية البدنية والمعرفية على مستوى المجتمع قد يساعد في تأخير تطور الخرف بين كبار السن FELDA. وفي الوقت نفسه، قد يكون اختيار الأنشطة التي يمكن القيام بها في المنزل خيارًا عمليًا وغير مكلف وآمنًا ومناسبًا لكبار السن في المناطق الريفية.

APPROVAL PAGE (MASTER'S DEGREE)

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DECLARATION

I hereby declare that this dissertation is the result of my own investigations, except where otherwise stated. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at IIUM or other institutions.

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This dissertation is dedicated to my late Abah and my beloved Umi for laying the foundation of what turned out to be in life.

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LIST OF ABBREVIATIONS

ACE	Aerobic exercise and Cognitive activities for Elderly
BDNF	Brain-Derived Neurotrophic Factor
CCR	Conventional Cognitive Rehabilitation
CDT	Clock Drawing Test Score
COVID-19	Coronavirus Disease 2019
CPG	Clinical Practice Guideline
CVF	Category Verbal Fluency
FELDA	Federal Land Development Authority
GEE	Generalised Estimating Equation
HUBER	Core Resistance & Balance Training
IADL	Activities of Daily Living
ICT	Information And Communication Technology
IGF-1	Insulin-Like Growth Factor-1
IIUM	International Islamic University of Malaysia
IPACES	Interactive Physical and Cognitive Exercise System
MCI	Mild Cognitive Impairment
MMSE	Mini-Mental State Examination
MOCA	Montreal Cognitive Assessment
NA	Not Available
NCDs	Non-communicable diseases
NGF	Nerve Growth Factor
NGOs	Non-government Organizations
PICO	Participants, Intervention, Comparison, Outcomes

PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
RCT	Randomized Controlled Trial
REF	Reference
RR	Relative Risk
SD	Standard Deviation
SENAMAS	Senaman Warga Emas
SMART	Mental Activity and Resistance Training
TMT	Trail Making Test
VEGF	Vascular Endothelial-Derived Growth Factor
VR	Virtual Reality
VRCMR	Virtual Reality-Based Cognitive-Motor Rehabilitation
WHO	World Health Organization

CHAPTER ONE

INTRODUCTION

1.1 INTRODUCTION

This chapter provides background on the problems associated with ageing, dementia, and mild cognitive impairment (MCI). Physical and cognitive interventions have been introduced as part of non-pharmacological approaches to prevent the progression of dementia among the elderly with MCI. The current situation in Malaysia outlined in this chapter led to the development of research questions, which led to the initiation of this study.

1.2 BACKGROUND OF STUDY

The global demographic landscape is undergoing a significant shift as populations across nearly every country are not only growing but also displaying a notable rise in the proportion of the elderly. According to the United Nations Department of Economic and Social Affairs Population Division (2019), the number of reported elderlies reached 703 million worldwide in 2019. The growth is expected to double by 2050 when the elderly population increases to 1.5 billion (United Nations Department of Economic and Social Affairs Population Division, 2019). Africa is expected to be the fastest-growing region in the coming decades, with the number of elderly over 60 increasing more than threefold between 2017 and 2050, from 69 million to 226 million, followed by Asia, with the number of elderly over 60 will double from 549 million in 2017 to nearly 1.3 billion in 2050 (United Nations Department of Economic and Social Affairs Population Division, 2017). In Southeast Asia, the proportion of elderly over 60 was 9.8% in 2017, projected to increase to 13.7% by 2030 and 20.3% by 2050 (World Health Organization [WHO], 2021). The Malaysian population is no exception to this phenomenon.

The Department of Statistics Malaysia (2021) reported that the number of elderly in Malaysia was 3.6 million (11.1%) in 2022, compared to 3.5 million (10.7%) in 2021. Malaysia is projected to be an ageing country by 2030, with an estimated 15.3% of the population being elderly (Mahmud et al., 2017). Chang et al. (2020) reported that Malaysia's elderly population is increasing at a faster rate than in the majority of developed nations, which, consequently the country has less time to prepare for the growing elderly population.

1.2.1 **Ageing and Dementia**

In Malaysia, individuals aged 60 and above are generally considered elderly, in line with the definition given by the World Assembly on Ageing 1982 in Vienna MyGovernment (2023). According to the concept of productive aging, elderly can contribute to society and their families in various ways such as volunteering to support community initiatives and organizations and caregiving for an adult or child with a disability (Gonzales et al., 2015). Furthermore, elderly possess a wealth of experience and skills that can be shared with younger generations and community-based organizations, addressing skill shortages and providing technical expertise (Fenton & Draper, 2014; United Nations, n.d.). However, the ageing process significantly impacts how much these possibilities and contributions can be made. The individual's physical capabilities will progressively decline, the susceptibility to diseases will escalate, and eventually, death will occur. The brain is also vulnerable to the effects of ageing, as evidenced by structural and cognitive function changes. It can be seen in the most common cognitive disorder associated with ageing, such as dementia.

According to the World Health Organization (2023), dementia is a clinical syndrome characterised by the progressive decline of cognitive function and the inability to carry out daily tasks, in contrast to the effects that may be anticipated with ageing. Memory, thinking, judgement, language, learning capacity, calculation and orientation of people living with dementia are affected, leading to mood, emotional control, behaviour and motivation changes. World Health Organization (2023) reported that 55 million people are living with dementia globally, and more than 60% of them reside in low- and middle-income countries.

Approximately 10 million new cases are diagnosed annually (WHO, 2023). Presently, dementia ranks as the seventh most prevalent cause of mortality and a significant contributor to disability and increasing dependence among the elderly globally (WHO, 2023). Conditions such as decubitus ulcer, bronchitis, dysphagia, hip fracture, pneumonia, and bedridden status are some of the common factors contributing to mortality in individuals with dementia (Nichols, 2021). In Malaysia, dementia ranks as the third primary cause of disability among men aged 80 and the second leading cause of disability among women in the same age group (National Institute of Health, 2017). Mahmud et al. (2017) reported that the number of individuals affected by dementia in Malaysia is predicted to be 261,000 by 2030 and will further increase to 590,000 by 2050.

As dementia advances, individuals affected by the condition increasingly depend on their caregivers for assistance with daily life activities. On average, the caregivers provided five hours daily of supervision and care for the patients (WHO, 2023), which consequently caused a lot of strain and burden to the caregivers' physical, psychological, and financial state (Srivastava et al., 2016). In the year 2019, dementia incurred a global cost of 1.3 trillion US dollars, and approximately half of these expenses were associated with the provision of care by caregivers (WHO, 2023). The expenditure of treating a person with dementia in Malaysia is about RM10,034 per episode of care since patients with dementia are more likely to require hospitalisation and longer stays in hospitals (Muhd Nur et al., 2017). Ganapathy et al. (2020) found that the caregivers of individuals with dementia in Malaysia experienced a notably lower quality of life compared to caregivers of the elderly without dementia. Hence, due to the increasing population of the elderly, the rapid increment of dementia cases, and the undesirable consequences on families, society, the economy, and the healthcare sector, this study deems that it is crucial for delaying and preventing the progression of dementia among the elderly in Malaysia.

Generally, healthcare systems in Malaysia are focusing on promoting healthy lifestyle habits such as regular physical exercise, balanced diet, and social engagement to reduce the risk of dementia (Ministry of Health Malaysia et al., 2021). Additionally, efforts are made towards early detection and diagnosis of dementia in Malaysia to facilitate timely intervention and management, as this effort potentially slowing down the progression of the disease (Aziz et al., 2023). Education and awareness initiatives are also implemented among Malaysians to increase public knowledge about dementia, particularly related to dementia risk factors and symptoms. However, despite the ongoing efforts made by healthcare systems or independent units, it is possible that the implementation of effective interventions to reduce the risk of dementia is still inadequate, as indicated in the present study's systematic literature review. Bai et al. (2022) suggested that to prevent dementia, consideration should be given to the implementation of interventions and assessments that specifically target the subgroups of at-risk populations such as Mild Cognitive Impairment (MCI).

1.2.2 **Mild Cognitive Impairment (MCI)**

Mild Cognitive Impairment (MCI) serves as the preclinical transitional phase between normal ageing and the onset of dementia (Anderson, 2019). Hong et al. (2018) claimed that MCI is a critical intervention stage and may delay the progression of dementia. The first clinical criteria of MCI were proposed in 1999 by Petersen et al., primarily based on memory problems (Anderson, 2019). The initial criteria included complaints regarding memory, normal activities of daily living, normal general cognitive function, abnormal memory for the patient's age, and not demented. In light of the fact that non-memory issues may also contribute to cognitive decline, Petersen extended the Mayo criteria for MCI by categorising it into various subtypes. These subtypes represent the factorial intersection of single-domain/multiple-domain and amnestic/non-amnestic impairments. For instance, a patient with deficits in memory and one cognitive domain (e.g., executive function) would have an amnestic MCI-single domain. Patients with no memory deficits but impaired multiple cognitive domains would have non-amnestic MCI-multiple domains. The diagram in Figure 1.1 may help the diagnostic process of MCI subtypes.

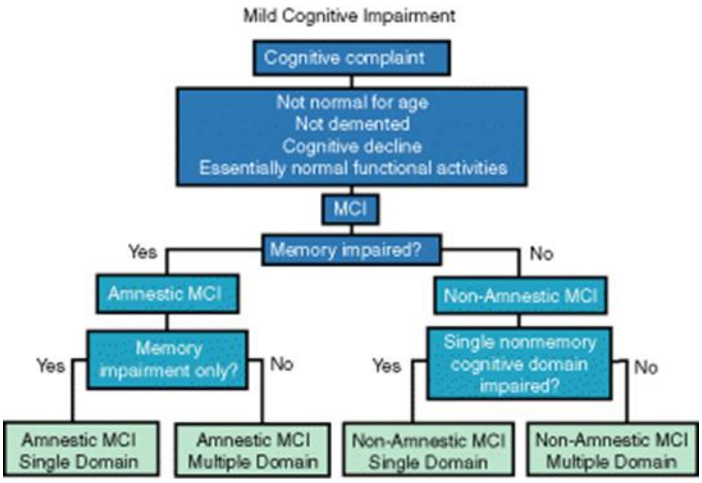

Figure 1.1 MCI subtypes

The key pathological hallmarks of MCI include structural and biochemical alterations in the brain. These alterations involve changes in dendritic architecture of hippocampal CA1 neurons, amyloid plaques, and biochemical neuroplastic responses such as increased activity levels of choline acetyltransferase (ChAT) in specific brain regions (Mufson et al., 2016). Additionally, MCI is associated with increased amyloid plaque loads and neurofibrillary tangles in the entorhinal cortex (Mufson et al., 2016). Meanwhile, Galasko et al. (2019) reported that cerebrospinal fluid biomarkers, particularly NPTX2 and neurogranin, are strong predictors of cognitive decline in individuals with MCI and AD beyond amyloid and tau biomarkers. Anderson (2019) added that hypoperfusion and hypometabolism in temporoparietal and posterior cingulate cortices, as well as atrophy medial temporal lobe regions, particularly the hippocampus and entorhinal regions, are commonly observed in individuals with MCI. The abnormal blood flow and metabolic dysfunction in these brain regions may lead to impaired neuronal function and synaptic activity, affecting memory, attention, and other cognitive processes commonly affected in MCI (Anderson, 2019). The epsilon 4a allele of the apolipoprotein gene (APOE-e4) also confers a risk for MCI, as it does for Alzheimer disease (Anderson, 2019).

The prevalence of MCI reported was based on the demographic under investigation and the specific concept or definition used for assessment. The prevalence also varies by study site region, age, gender, and educational attainment (Bai et al., 2022). For example, the global prevalence of MCI among elderly living in the community was 15%, according to a meta-analysis (Bai et al., 2022). In Malaysia, the prevalence of MCI has been documented as being greater in the community-based (68%) (Kamarolzaman et al., 2016) compared to the clinic-based population (27.3%) (Samy et al., 2020). Approximately 10% to 15% of elderly with MCI progress to dementia per year (Eshkoor et al., 2015; Tangalos, 2018; Untari et al., 2019). The progression rate to dementia is considered moderately high among the elderly with MCI (10%–15%) compared to healthy elderly, with only 1%–2% of the latter progressing to dementia yearly (Roberts et al., 2014). Moreover, the reported progression rate of elderly individuals with MCI to dementia over six years was 80%–90% (Eshkoor et al., 2015; Nagamatsu et al., 2013). Nevertheless, some studies support that MCI can be reverted to normal cognitive functioning at subsequent follow-up with a 30%–50% conversion rate (Overton et al., 2020; Sanford, 2017).

1.2.3 **Treatment of MCI**

Insufficient evidence supports that pharmacological treatment effectively treats MCI (Anderson, 2019). However, physicians are suggested to consider alternative approaches to managing MCI, such as treating modifiable risk factors that may also contribute to the condition. This is supported by the research of Livingston et al. (2020), who suggested that tackling the modifiable risk factors, such as addressing high-risk groups to increase cognitive and physical activity, may prevent or delay up to 40% of dementia cases. This notion is driven by the fact that in order to advance to dementia, an individual must experience substantial disruption to their daily activities due to severe cognitive impairment. If it is possible to enhance an individual's cognitive performance, that person will remain in a state of comparatively good cognitive health for an extended time prior to experiencing a more pronounced decline in cognitive function, which is a corollary to the concept of cognitive reserve (Anderson, 2019). The strategies outlined in the next section are some of the suggested approaches to enhance neural connection or cognitive reserve.

1.2.3.1 Physical exercise

Physical exercise helps preserve brain health and fuel neuroplasticity by decreasing the risk of vascular diseases (Demurtas et al., 2020) and improving cerebral perfusion (Cheng, 2016). This is due to the fact that regular exercise helps to regulate blood pressure, thereby alleviating the strain on blood vessels (Carpio-Rivera et al., 2016). Given that high blood pressure stands as a considerable risk factor for the development of vascular diseases such as stroke, the regulation of blood pressure through physical exercise is important for minimizing the risk of vascular-related cognitive impairments. In addition, Liu and Nusslock (2018) indicated that physical exercise has been shown to stimulate the production of new neurons (neurogenesis) in certain regions of the brain, particularly the hippocampus. This process is important for learning, memory, and overall cognitive function (Liu & Nusslock, 2018). By reducing the risk of vascular diseases, exercise helps create an environment that is conducive to neurogenesis and neuroplasticity. The improvement of cerebral perfusion refers to the enhanced blood flow to the brain (Bolduc et al., 2013). Given that the physical exercise can improve cerebral perfusion, better oxygen and nutrient delivery to brain tissue will occur, thus supporting overall brain function and health.

Neuroplasticity, also known as brain plasticity, refers to the brain's ability to reorganize itself by forming new neural connections. It involves the modification of existing neural pathways, the creation of new synapses, and the pruning of unused connections. Physical exercise stimulates growth factors that potently affect cellular neuroplasticity, such as Brain-Derived Neurotrophic Factor (BDNF) (Amidfar et al., 2020; Arazi et al., 2021; Basso & Suzuki, 2017; Valenzuela et al., 2020), Insulin-Like Growth Factor-1(IGF-1) (Amidfar et al., 2020; Arazi et al., 2021; Basso & Suzuki, 2017; Cheng, 2016), Vascular Endothelial Growth Factor (VEGF) (Basso & Suzuki, 2017) and Nerve Growth Factor (NGF) (Amidfar et al., 2020). The neurotrophins stimulated by physical exercise come with distinct functions: 1) BDNF facilitates the synaptic function and support for neuronal survival (Amidfar et al., 2020; Arazi et al., 2021); 2) IGF-1 promotes cell growth and repair (Arazi et al., 2021); 3) VEGF was linked to improve blood flow and vascular health in the brain (Kang et al., 2020); and 4) NGF is crucial for the growth, maintenance, and survival of nerve cells (Amidfar et al., 2020).

For instance, a 16-week aquatic exercise programme in elderly women led to significant increases in BDNF and IGF-1 levels, as well as VEGF (Kang et al., 2020). The functions of neurotrophins collectively contribute to the augmentation of cognitive functions and confer neuroprotective effects. Mental Activity and Resistance Training (SMART) results revealed that resistance training produced positive neuroprotective effects in protecting Alzheimer's disease-vulnerable hippocampal subfields from degeneration for at least 12 months (Broadhouse et al., 2020). Similar findings on the benefits of physical exercise have been reported in the elderly with amnestic MCI who carried out specially designed aerobic dance. The study identified a more significant increase in processing speed and episodic memory in the dance-training group than in those without dance training (Zhu et al., 2018). These promising findings should warrant further research regarding the benefits of physical exercise on cognitive performance.

1.2.3.2 Cognitive-based intervention

An additional method for augmenting cognitive reserve and enhancing daily functioning in individuals with MCI is through cognitive-based intervention, which encompass various approaches such as cognitive training, cognitive stimulation, and cognitive rehabilitation (Park et al., 2019). Generally, the aim of cognitive training and rehabilitation is to mitigate the risk of dementia and cognitive decline, slow down cognitive deterioration, restore functional abilities, or adaptively respond to disease progression. For example, prior meta-analyses and systematic reviews suggested that computerised cognitive training could be a viable strategy for enhancing global cognitive function (Gates et al., 2019; Li et al., 2022; Zhang et al., 2019), executive function, episodic memory and working memory (Gates et al., 2019; Zhang et al., 2019). According to van Balkom et al. (2020), cognitive training is believed to induce neuroplasticity through repeated engagement of cognitive processes using challenging and adaptive tasks. On the other hand, cognitive stimulation operates based on the general view that a lack of cognitive engagement accelerates cognitive decline (Park et al., 2019) and the "use it or lose it" hypothesis, which explains that engaging in intellectually demanding activities helps to preserve cognitive function of the elderly (Sala et al., 2019).

Cognitive stimulation has shown promise as an effective intervention for individuals with cognitive impairment, providing them with a range of enjoyable activities designed to stimulate their thinking, attention, and memory (Park et al., 2019). There is also a review defined any leisure activity that were intellectually stimulating and could be carried out indoors as “cognitive activity” or “mental activity” (Iizuka et al., 2019). The term “leisure” are often used in previous studies to describe the activities in which individuals can engage for enjoyment or well-being that are independent of work or the activities of daily living (Iizuka et al., 2019; Leung et al., 2011; Liu et al., 2021; Panpalli Ates et al., 2020). Leisure activities can be divided into physical leisure activities and cognitive leisure activities based on the process and purpose of the activities. As an essential part of elderly’s life, leisure activities offer to be cost-effective and easily accessible to promote health and well-being (Liu et al., 2021).

For example, engaging in meaningful intellectual and cognitive activity during leisure times such as reading, writing, and playing games protects against the development of MCI and improves cognition (Cheng, 2016). The repeated engagement in cognitive activity is thought to stimulate neuroplasticity, leading to the enhancement of cognitive reserve and the underlying neurobiological mechanisms (van Balkom et al., 2020). The mechanisms may include the formation of new neural connections, strengthening of existing connections, and alterations in functional connectivity, all of which contribute to neuroplasticity (van Balkom et al., 2020). The formation and strengthening of neural connections in response to learning and experience might explain how cognitive activities collectively enhancing cognitive functions. On top of that, education is often regarded as a precursor of the cognitive reserve as it can enable a lifetime engagement with higher-cognitive activity, partly via being employed with a cognitively stimulating job. For instance, according to Dekhtyar et al. (2015), occupation that involves high complexity with data such as analysing, synthesizing and computing (Sörman et al., 2019) reduced the risk of dementia.

1.2.3.3 The need for combined physical exercise and cognitive interventions

The integration of physical and cognitive intervention, particularly cognitive training, has gained attention in this field since a combined approach has demonstrated synergistic effects on the cognitive performance of the elderly with MCI compared to the impact of single training alone (Eggenberger et al., 2015; Hagovska & Nagyova, 2017; Karssemeijer et al., 2017; Phirom et al., 2020). Karssemeijer et al. (2017) revealed that the combination of physical exercise and cognitive training has a positive small-to-medium effect on global cognitive function in the elderly with MCI or dementia. However, there is a relative paucity of research empirically assessing studies on the application of physical and cognitive leisure activities from previous studies. More evidence-based research is required to verify if these leisure activities can be a valid nonpharmacological treatment in the prevention of dementia cases among MCI elderly. This is due to the reason that this study acknowledges the unique challenges and needs of Malaysian population, especially among those who live in rural areas.

There were a number of studies have been conducted on physical exercise and cognitive interventions, however, the unique challenges and needs of population in Federal Land Development Authority (FELDA) offers a rationale to carry out interventions with similar components, but with novel approaches using simple activities. Easily accessible and inexpensive intervention programme such as physical and cognitive leisure activities might be particularly useful for a FELDA population, given the importance to consider they are living in rural areas, low monthly income, and possessing lower education levels (Hassan et al., 2023). In the present study, the physical and cognitive exercise tasks were improved in terms of their simplicity with better language adaptation. Therefore, the activities were easier to understand and more suitable for participants' educational levels. These activities were designed to be integrated into daily life, making them leisure activities rather than structured training. Unlike previous studies that required monitoring, rigid schedules, and the utilisation of technology, these activities may be flexible and do not necessitate constant supervision.

1.3 PROBLEM STATEMENT

Federal Land Development Authority (FELDA) is a governmental agency in Malaysia that was established on 1 July 1956. FELDA managed the resettlement of the rural poor into newly developed areas, aiming to improve their economic status through large-scale agricultural activities. An individual who owns agricultural land allocated by the government, typically for the cultivation of crops like palm oil or rubber, is referred to as a FELDA settler. Currently, most of the FELDA settlers and the second generation are in late adulthood (Azam, 2017). In a cross-sectional study among FELDA elderly in Kuantan, Mohd Aznan et al. (2019) revealed that 19.3% of the participants had depression, with cognitive impairment emerging as a contributing factor. The findings also indicated that the elderly with cognitive impairment had a threefold higher risk of depression than those with normal cognitive function, indicating the importance of this study to address cognitive impairment among FELDA elderly in Kuantan, Pahang. Moreover, Mohd Aznan et al. (2019) found that 91.3% of the elderly were not working, and 88.8% were not exercising regularly. This is a concern, considering that Livingston et al. (2020) indicated 40% of dementia cases worldwide could be associated with modifiable risk factors, including physical inactivity and a lack of mental stimulation related to education, occupation, and leisure activities.

Din et al. (2014) suggested various initiatives that could enhance health conditions among the elderly in FELDA, such as health promotion and education, weight management, lifestyle modification and mental health programmes. While the Malaysian government has previously launched various programmes and health campaigns, many of these activities were not closely observed, and their efficacy and acceptability were not regularly evaluated (Din et al., 2014). Therefore, the previous study recommended that researchers collaborate with local FELDA staff, FELDA community representatives, FELDA social workers, primary health clinic staff, and research personnel to monitor and evaluate the health programme. FELDA’s primary health clinic is easily accessible to the elderly population. Nevertheless, one barrier to receiving care at the clinic and attending any health programme is the shortage of personal transport among the elderly who reside alone and have no children or neighbours to assist them (Din et al., 2014). Most of previous intervention studies were conducted at clinics or healthcare centres and commonly conducted via face-to-face sessions.

On top of that, in the past few years, the occurrence of the worldwide coronavirus disease 2019 (COVID-19) pandemic has kept residents indoors, particularly the elderly, who are vulnerable and face a markedly greater mortality risk (about 15%) than younger individuals (Morley & Vellas, 2020). Therefore, movement limitation due to COVID-19 was claimed as a barrier to physical activity (Ng et al., 2020). Additionally, Ismail et al. (2021) confirmed that the cognitive functions of patients with dementia and MCI decreased dramatically during the lockdown compared to before the lockdown due to the lack of physical activity, which further increased the likelihood of the elderly engaging in prolonged sedentary behaviour. The cancellation of in-person hospital visits, disruptions to cognitive interventions and physiotherapy programmes, coupled with limited familiarity with telecommunication can also exacerbate the challenges presented by both the COVID-19 pandemic and cognitive impairment (Ismail et al., 2021).

Lokman et al. (2019) reported that 24.4% of the FELDA elderly in Kuantan, Pahang were identified with MCI, while 12.8% were categorized as having severe cognitive impairment. These findings underscore the importance of implementing interventions to promote cognitive health among this population. As suggested by previous studies, a combined physical exercise and cognitive interventions programme has the potential to ensure a healthy lifestyle and prevent further cognitive decline among the elderly.

However, limited studies have examined the combination of these two interventions delivered remotely as effective preventative measures for dementia. This problem needs to be addressed due to the movement limitation faced by the FELDA elderly because it might be unsuitable to deliver the programme face-to-face. An alternative approach is needed, such as physical and cognitive activites that can be performed at home. Therefore, for this study, home-based Aerobic exercise and Cognitive Activities for Elderly (ACE) programme was introduced to the FELDA population.

Debate also continues about the best duration required to identify the effects of the intervention. Past studies (Hagovska & Nagyova, 2017; Jurakic et al., 2017; Karssemeijer et al., 2017; Park et al., 2019; Yogev-Seligmann et al., 2019) reported that interventions conducted in less than 12 weeks were adequate to yield positive effects on cognitive performance. Various nature of interventions were used in each of these studies. For example, Hagovska and Nagyova (2017) implemented a combined intervention where the control and intervention groups received balance training, but the intervention group had computerised cognitive training added to their program. Jurakic et al. (2017) in their study compared two different types of training: core resistance and balance training versus Pilates training.

Park et al. (2019) involved a simultaneous design where participants engaged in counting numbers while performing an elastic band exercise. In general, there are very few published results about the combination aerobic and cognitive exercises. There is also a lack of clarity on the duration of studies. Gavelin et al. (2021) demonstrated no significant difference in the efficacy of 12 weeks or shorter interventions compared to interventions of more than 12 weeks. Thus, this study aims to compare the effectiveness of ACE programme in improving cognitive performance between the elderly who received the intervention and the elderly without intervention. Moreover, this study intends to determine the time needed for the intervention to be effective.

1.4 OBJECTIVES

1.4.1 General Objective

The general objective of this study is to evaluate the effectiveness of ACE programme in improving cognitive performance between experimental and control groups after 4 and 12 weeks.

1.4.2 Specific Objective

The specific objectives of this study are as follows:

1) To identify the association between participants' characteristics and cognitive performance at week 4 and week 12.

2) To compare the cognitive performance of the elderly receiving ACE programme at baseline, week 4 and week 12.

3) To compare the cognitive performance of the elderly without receiving ACE programme at baseline, week 4 and week 12.

4) To compare the cognitive performance between experimental and control groups after 4 and 12 weeks of ACE programme.

1.5 RESEARCH QUESTIONS

The research questions of the study are as follows:

1) Are there associations between participants' characteristics and cognitive performance at week 4 and week 12?

2) Are there significant differences in cognitive performance of the elderly receiving ACE programme at baseline with week 4 and week 12?

3) Are there significant differences in the cognitive performance of the elderly without receiving ACE programme at baseline with week 4 and week 12?

4) Are there significant differences in cognitive performance between experimental and control groups after 4 weeks and 12 weeks of ACE programme?

1.6 RESEARCH HYPOTHESIS

Null hypothesis (H_0)- There is no significant difference in cognitive performance between the experimental and control groups after 4 weeks and 12 weeks of ACE programme.

Alternate hypothesis (H_A)- There is a significant difference between the experimental and control groups in cognitive performance after 4 weeks and 12 weeks of ACE programme.

1.7 SIGNIFICANCE OF STUDY

This study contributes to the existing body of knowledge on the potential of home-based physical exercise and cognitive acitivities in improving cognitive performance among the elderly with MCI. This ACE programme may be delivered to the elderly population in rural settings as it does not require them to commute to the training or community centres. Furthermore, should the ACE programme positively affect cognitive performance, it is expected to promote long-term disease prevention for the elderly in a community setting and help maintain the health and social care system as a whole towards preventing dementia. The nurses and institutional care could also refer to this programme as an affordable and safe strategy to promote cognitive health and maintain functional status among the elderly in Malaysia.

In addition, this study may enhance the understanding of MCI among FELDA elderly and caregivers, provides some insights into the impact of MCI on their lives, raises awareness of the importance of cognitive health as well as helps the elderly to identify MCI at an early stage. According to Sanford (2017), primary care physicians are undertrained and frequently lack the time and support staff to detect and address MCI accurately. Last but not least, given that this study was conducted during pandemic, Mustaffa et al. (2020) suggested that the healthcare system should pay more attention to the most at-risk population during the pandemic to help them preserve their mental and physical health. As the present study as conducted during pandemic, social distancing measures and lockdown restrictions made face-to-face interactions difficult. Thus, requiring a shift to remote communication and monitoring throughout the programme. Moreover, it was challenging to ensure participants' adherence to the program without in-person supervision. There were also difficulties in providing technical support among the elderly who were unfamiliar with digital platforms.

Despite these challenges, the ACE programme were effectively implemented through several strategies. The use of WhatsApp groups for reminders and support helped maintain communication and adherence among the participants. Caregivers played a crucial role in assisting participants with the exercises and reporting attendance. Furthermore, the flexibility of the ACE programme allowed the participants to perform tasks at their convenience. It is hoped that the implementation of ACE programme can contribute to physical and cognitive well-being and reduce the risk of progression from MCI to dementia among the elderly. Finally, this study may enhance the physical activity levels of FELDA elderly cost-effectively, especially for those who are unable to participate in group exercise programmes or lack the interest to do so.

1.8 DEFINITION OF TERMS

Mild Cognitive Impairment (MCI): MCI is a transitional state between normal ageing and dementia (Karssemeijer et al., 2017). The operational definition for MCI refers to the presence of a cognitive complaint, objective evidence of impairment in cognitive domains as screened by the Mini-Cog test (Borson et al., 2000), and essentially normal function in activities of daily living as measured by the Instrumental Activities of Daily Living (IADL) scale.

Physical exercise: Physical exercise is a subset of physical activity that involves planned, structured, and repetitive bodily movements to improve or maintain one or more components of physical fitness (Siti Aishah, 2016). Specifically, aerobic exercise is defined as an activity in which the body's large muscles move rhythmically for a sustained period of time and improves cardiorespiratory fitness (Piercy et al., 2022). For this study, the operational definition of physical exercise refers to chair aerobic exercise that is designed to be performed in seated position at participant's home environment, using minimal equipment and space. The chair aerobic exercise demonstration was conducted face-to-face one time at Dewan Felda Bukit Goh, prior to participants independently performing the exercises at home for 12 weeks.

Cognitive activities: According to Iizuka et al. (2019), cognitive activities refer to leisure activities that could be carried out indoors and were intellectually stimulating. Unlike interventions targeting specific cognitive processes, cognitive stimulation activities do not focus on any particular cognitive function but instead engage general cognitive resources (Bamidis et al., 2014). In this study, cognitive activities were conducted within the participants' home environment, utilizing paper-and-pencil exercises. These activities comprised tasks such as writing, calculation exercises, and maze-solving activities. Similar to chair aerobic exercise, a briefing session regarding the activities was conducted face-to-face one time at Dewan Felda Bukit Goh, prior to participants independently performing the exercises at home for 12 weeks.

Cognitive performance: The study’s endpoint focused on assessing cognitive performance, categorised as improved, static, or decreased. To determine the outcome measure, Mini-Cog instrument (Borson et al., 2000) which comprising a 3-word recall and a clock drawing task was utilised. An elevation in the Mini-Cog score was indicated as improvement, no change was categorised as static, and a decline in the Mini-Cog score was considered as decreased.

Elderly: In Malaysia, the elderly are 60 years and over (MyGovernment, 2023). For this study, the operational definition of elderly refers to a person who is 60 years and above, living in the FELDA community and has MCI.

1.9 SUMMARY

In summary, the first chapter introduces the background of the study, emphasizing the importance of addressing MCI and its potential progression to dementia. It also outlines the need for alternative approach for the physical and cognitive interventions to meet the specific needs of FELDA population. The objectives, research questions, hypotheses that guide the study, and the operational definition of terms that provides a clear direction for the study were also explained in this chapter.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

The previous chapter highlights the significance of dementia prevention and the promising prospects of combined physical exercise and cognitive interventions in enhancing cognitive performance. This chapter delves into a systematic review aimed at collecting and evaluating evidence regarding the various methods employed in delivering the intervention and their overall effectiveness. The review further categorises the evidence based on training characteristics, encompassing aspects such as the type of training, combination mode, the frequency and duration of the studies.

2.2 OBJECTIVES OF SYSTEMATIC REVIEW

Recent systematic reviews have explored the effectiveness of physical exercise and cognitive interventions. However, the type of delivery method, i.e., home-based or centre-based for the physical exercise and cognitive intervention programmes, has yet to be identified in prior reviews. In general, prior work in physical exercise and cognitive intervention does not consider the movement limitations faced by the elderly to attend a physical session. Consequently, conclusions regarding the effectiveness of a home-based approach remain unclear. In addition, prior reviews have varied sample characteristics, involving studies of individuals with mixed conditions such as dementia, Alzheimer’s, and Parkinson’s disease, while some included healthy subjects.

The focus of the study on the elderly with MCI is lacking in previous literature. Moreover, the crucial components of effective training highlighted by (Untari et al., 2019), i.e., duration, frequency, intervention, type, and combination mode, still need to be determined. The objective of this systematic review is to determine the types of delivery methods used by previous studies to conduct physical exercise and cognitive intervention, besides their effectiveness in improving cognitive performance. Additionally, the optimum study duration of the intervention to be effective was also identified.

2.3 METHODS

The Participants, Intervention, Comparison, Outcomes (PICO) and Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were applied in the design of this review, as illustrated in Figures 2.1 and 2.2.

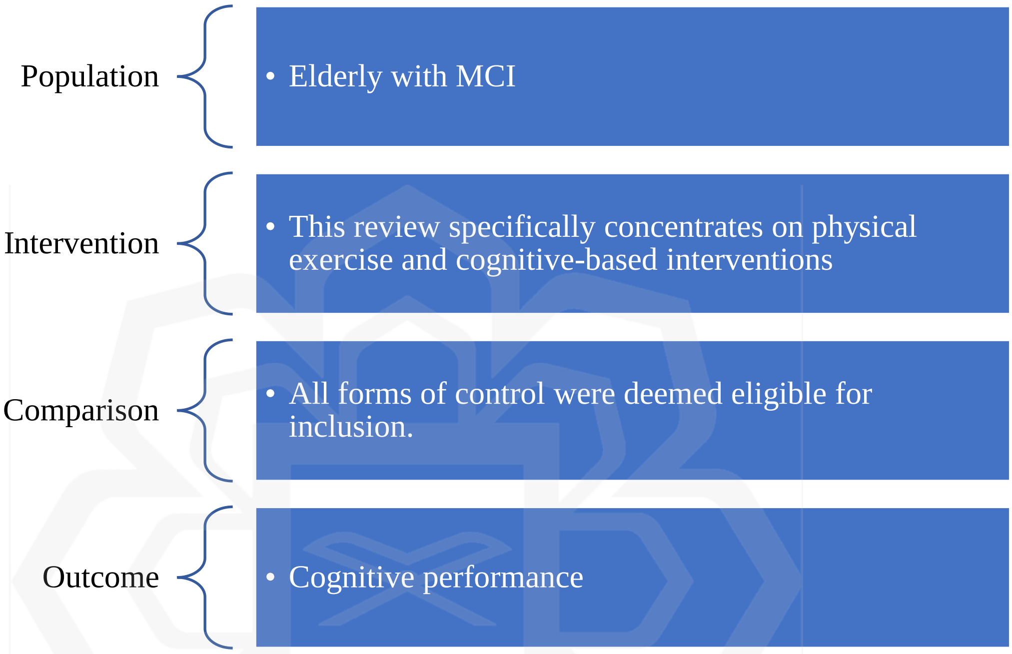

Figure 2.1 PICO framework

2.3.1 **Data sources and literature search**

A systematic literature search was performed online utilising four electronic databases, including Scopus, PUBMED, ScienceDirect, and EBSCO, published between 2014 and 2023. Articles examining the effectiveness of physical exercise and cognitive interventions were identified systematically. This search strategy was carried out via several databases using keyword terms: (“physical exercise” OR “physical activity”) AND (“cognitive training” OR “cognitive activity” OR “cognitive intervention” OR “leisure activity”) AND (“elderly” OR “older adult”) AND (“combine” OR “dual-task intervention”) AND (“mild cognitive impairment” OR “MCI” OR “cognitive impairment”).

Initially, potential articles were identified through the search process. Subsequently, the researcher, with the assistance of the database or through manual screening, categorised the articles as either included or excluded. During the screening stage, articles not meeting the inclusion criteria were excluded from the review. The eligibility process involved manual checks by the researcher, who assessed the remaining papers by reading the title, abstract, or entire paper to identify eligible studies. Full-text versions of the remaining articles were then thoroughly reviewed. Articles not aligned with the aim of the systematic review were removed at this stage. All selected articles underwent critical appraisal, and those passing the quality assessment were included in the review.

2.3.2 Study selection and data extraction

The physical exercise and cognitive interventions can be performed in either a single training (e.g., cognitive training only) or by a combined method (e.g., physical exercise and cognitive training), where the combination of the intervention was conducted simultaneously or sequentially. The age of the elderly was based on the definition applied by every country. Cognitive performance was defined as the outcome of global cognitive function or specific cognitive domains such as memory, reasoning, attention, language, and executive functions.

The following inclusion criteria were implemented: (1) interventional studies (randomised controlled trial [RCT] or quasi-experimental); (2) physical exercise or cognitive intervention exposure (performed either single or combined) and the combination could be simultaneously or sequentially (3) study subjects were elderly with MCI; and (4) studies that examined cognitive outcomes as an endpoint. Meanwhile, the exclusion criteria comprised (1) studies involving healthy subjects, (2) conference papers and dissertations, (3) non-English papers, and (4) studies published solely as abstracts without a full text.

From the selected papers, the researcher extracted the following information: author's name, publication year, title, subjects, study design, sample size, study setting, type of intervention, mode of combination, delivery method, outcome measures, and the results of the outcome, particularly pertaining to cognitive performance.

2.3.3 **Assessment risk of bias**

The risk of bias was assessed to ensure that the selected studies' methodology was completed satisfactorily. For this purpose, Joanna Briggs Institute’s (2017) appraisal tool for RCT, systematic review and quasi-experimental studies were utilised. These critical appraisal tools aid in evaluating the trustworthiness, relevance, and results of published articles. Each article was assessed based on 13 criteria for RCT and 9 criteria for quasi-experimental. Four options were provided in presenting their answers: “yes”, “no”, “unclear”, and “NA”. The articles were included in the review if they met at least 75% of “yes”, as agreed by the supervisory team.

2.4 RESULTS

Initially, 7,170 articles were identified from the databases. A total of 6155 records were removed due to being published in 2014 and earlier; published in non-English; and non-full text. Subsequently, a total of 1015 articles were screened. Of the 1015 screened articles, 778 articles were removed because of duplication and the titles and abstracts were not relevant to the objectives. As a result, 237 full texts were analysed. Of the 237 articles, 14 aligned with the inclusion criteria and successfully passed the quality assessment. The remaining 223 studies were excluded due to low quality and a lack of focus on physical exercise, cognitive intervention, cognitive outcomes, and subjects with MCI. Thus, a total of 14 studies were included in the review. Figure 2.2 depicts the flow diagram of the literature search following the PRISMA guidelines.

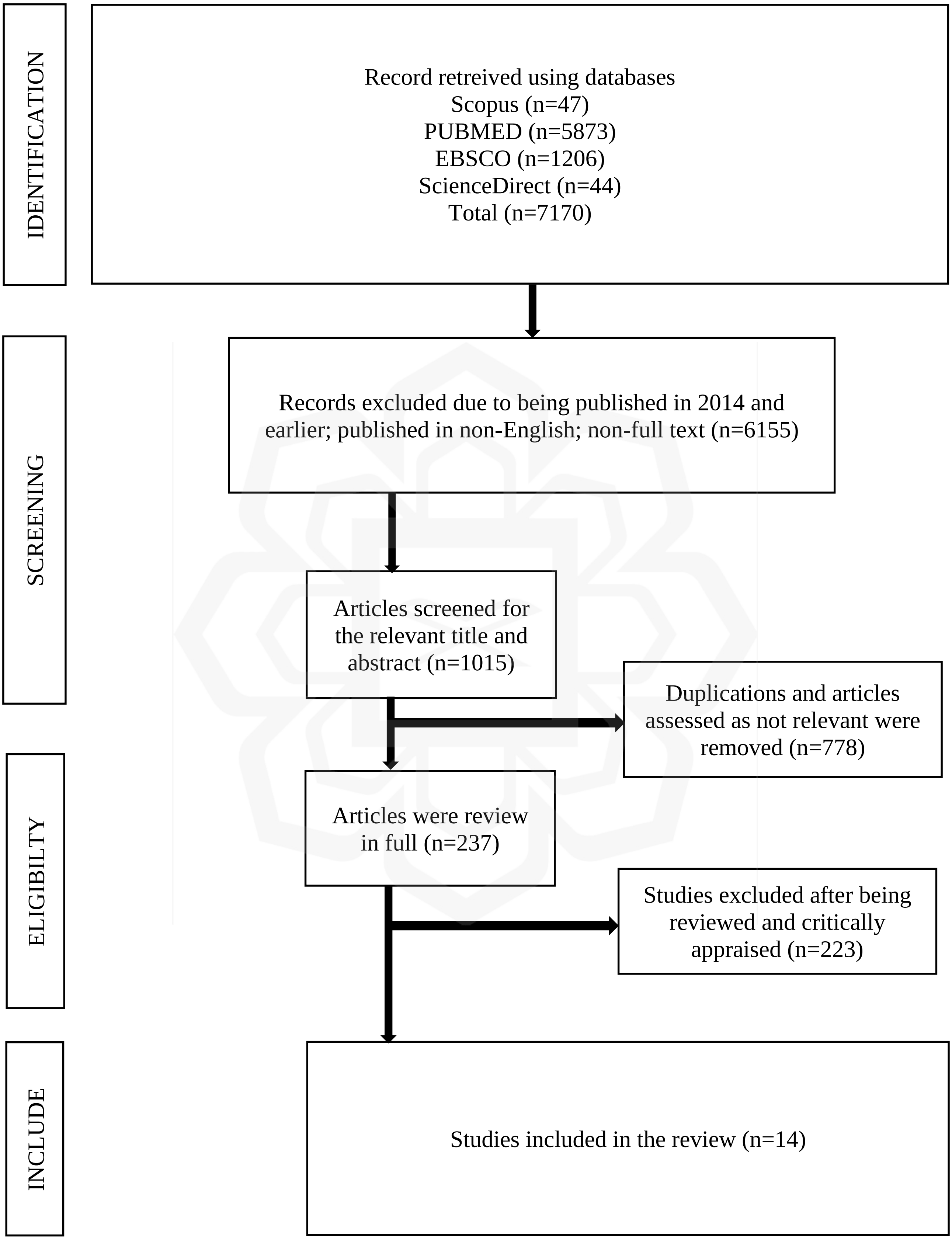

Figure 2.2 PRISMA flow diagram

2.4.1 Study characteristics

The study's characteristics are detailed in the Table 2.1. There are 12 randomised controlled trials (Bisbe et al., 2020; Cardalda, López, & Carral, 2019; Doi et al., 2017; Hagovska & Nagyova, 2017; Hong et al., 2018; Jurakic et al., 2017; Li et al., 2019; J. Park et al., 2020; Peng et al., 2019; Sungkarat et al., 2017; Thapa et al., 2020; Zhu et al., 2018) and two quasi-experimental studies (Kim & Shim, 2018; Zhao et al., 2021), with all studies incorporated subjects who had MCI. The studies were conducted in Japan (Doi et al., 2017), Croatia (Jurakic et al., 2017), Spain (Bisbe et al., 2020; Cardalda et al., 2019), China (Li et al., 2019; Peng et al., 2019; Zhao et al., 2021; Zhu et al., 2018), South Korea (Hong et al., 2018; Kim & Shim., 2018; Park et al., 2020; Thapa et al., 2020), Slovakia (Hagovska & Nagyova, 2017), and Thailand (Sungkarat et al., 2017).

Of the 14 studies, only two studies (Sungkarat et al., 2017; Zhu et al., 2018) stated using a home-based approach as the delivery method, while the others were conducted at hospitals, community centres, and residential homes. Four studies included physical exercise only (Bisbe et al., 2020; Cardalda et al., 2019; Hong et al., 2018; Jurakic et al., 2017), four involved cognitive training (Kim & Shim, 2018; Li et al., 2019; Peng et al., 2019; Thapa et al., 2020) and one study involved cognitive activities. Two additional studies integrated cognitive-physical exercise with various intervention components (Hagovska & Nagyova, 2017; Park et al., 2020). Hagovska and Nagyova (2017) implemented a sequential design that integrated physical exercise and cognitive training, with the interventions being delivered in separate sessions. For instance, walking over obstacles, followed by computerised cognitive training.

Park et al. (2020) implemented a simultaneous design, which involved counting numbers while performing an elastic band exercise. Tai chi and dance were among the mind-body exercises utilised in the remaining three studies (Sungkarat et al., 2017; Zhao et al., 2021; Zhu et al., 2018). The intervention duration ranged from six weeks to ten months, with a frequency of one to five sessions per week. Only one study reported that the intervention was conducted every two weeks (Peng et al., 2019). For each session, the duration ranged from 30 to 160 min. Most studies used the Montreal Cognitive Assessment (MoCA) and Mini-Mental State Examination (MMSE) to assess global cognition.

2.4.2 **Quality Appraisal**

Of the 14 studies, four passed more than 90% study criteria (Cardalda et al., 2019; Hagovska & Nagyova, 2017; Jurakic et al., 2017; Zhu et al., 2018). Seven studies met 80%–89% quality checklist (Bisbe et al., 2020; Doi et al., 2017; Kim & Shim, 2018; Li et al., 2019; Park et al., 2020; Thapa et al., 2020; Zhao et al., 2021) and three studies (Hong et al., 2018; Park et al., 2020; Peng et al., 2019) passed 75%–79% of the total checklist. The overview of the quality assessment is presented in Appendix I.

Table 2.1 Characteristics of studies included in the review.

Author	Study design	Study setting	Study participants	Delivery method	Type of intervention	Combination method	Duration, frequency	Measurement	Results
Jurakic et al. (2017)	Pilot RCT	Europe	28 elderly with MCI (average age: 72.88).	Hospital	Core resistance & balance training (HUBER) vs Pilates training. No control group was involved.	Physical exercise only	8 weeks. 3x/week (60mins).	MoCA	Both groups significantly improved overall MoCA and the cognitive domains of language and abstraction ($p \leq 0.05$). HUBER group had significantly better MoCA, visuospatial/executive functions and orientation ($p \leq 0.05$). Pilates group had significantly higher delayed recall ($p \leq 0.05$).
Hong et al. (2018)	RCT	South Korea	47 elderly with MCI (average age: 78.33).	Community center	Resistance exercise vs Control with current lifestyle.	Physical exercise only	12 weeks. 2x/week (60mins).	K-MoCA, DF, DB, 15-Item Recognition Trial, COWAT, Stroop test	Only DB test showed significant changes after 12 weeks, whereby the DB test in control group was significantly decreased ($p = 0.032$).
Cardalda et al. (2019)	RCT	Spain	77 elderly with MCI (average age: 84.8).	Residential care homes	Therabands Group vs. Multi-Callisthenics vs. Control Group with no exercise.	Physical exercise only	12 weeks. 2x/week (60mins).	MMSE, Pfeiffer test	The TG group significantly improved MMSE score between all groups ($p = 0.014$). The control group had significant deterioration in the Pfeifer test between all groups ($p = 0.015$).
Bisbe et al. (2020)	RCT	Spain	36 elderly with a-MCI (average age: 72.88).	Hospital	Choreography (aerobic dance) vs Physical therapy (strength, flexibility, balance, gait training).	Physical exercise only	12 weeks. 2x/week (60mins).	Delayed Recall WMS III, Recognition WMS-III, Delayed Recall	Within-group change: Choreo group significantly improved Recognition WMS-III ($p = 0.003$) and Delayed Recall RBANS ($p = 0.022$). Physio group significantly improved Delayed Recall RBANS ($p=0.030$).

								RBANS, Recognition RBANS, TMT-A, TMT-B, LVF, BNT, CVF, JLO, MMSE	Between-group change: Choreo group had significantly higher Recognition WMS-III (p=0.003). Physio group had significantly higher CVF (p=0.013).
(Doi et al., 2017)	RCT	Japan	201 elderly adults with MCI	Community center	Dance vs Music vs Control (Health Education).	Cognitive activities	40 weeks. 1x/week (60mins).	MMSE, TMT-A and TMT-B	After 40 weeks, participants in the dance program showed improvement in memory compared to the control group (P = 0.011). For MMSE, both dance and music programs showed greater improvement in MMSE scores compared to the control group (dance P = 0.026, music P = 0.008).
Kim & Shim (2018)	Quasi-experi mental	Korea	48 elderly with MCI (average age: 76.33).	Community center	Cognitive therapy. No control group was involved.	Cognitive training only	12 weeks. 1x/week (90mins).	CERAD-K	Sub-items such as Verbal Fluency Test, the Modified Boston Naming Test, MMSE, and the Word List Memory and Word List Delayed Recall tests significantly improved (p < 0.05). However, no significant improvement in Constructional Praxis (p = 0.078).
Peng et al. (2019)	RCT	China	140 elderly with MCI (average age: 68.99).	Classroom	Cognitive training vs. Control with no exercise.	Cognitive training only	6 months. Every 2 weeks (90mins).	MoCA	The percentage of participants who improved to normal MoCA scores after 3 and 6 months of intervention was significant (p< 0.001).

Li et al. (2019)	Pilot RCT	China	141 elderly with MCI (average age: 69.5).	Hospital	Computerized cognitive training at patients' homes online vs Control with usual care.	Cognitive training only	6 months. 3-4x/week (120-160mins).	MMSE, ACER, CFT, AVLT, SCWT, STT, SDST	At 3-month: ACER attention ($p = 0.002$) and memory ($p = 0.006$), as well as SCWT interference index ($p = 0.038$) and CFT copy ($p = 0.035$). At 6-month: MMSE ($p < .001$), attention in ACER ($p < .001$), CFT copy ($p=.05$), SDS ($p=.027$), SCWT-color ($p=.013$) and STT-B ($p=.020$). At 12-month, all differences between the changes in two groups were not statistically significant.
Thapa et al. (2020)	RCT	South Korea	68 elderly with MCI (average age: 72.6).	Healthcare center	VR-based cognitive training vs Control with an educational program.	Cognitive training only	8 weeks. 3x/week (100mins).	MMSE, TMT A & B, SDST	TMT B time decreased significantly in the intervention group compared to the control group ($p = 0.03$).
Hagovska & Nagyova (2017)	RCT	Slovakia	80 elderly with MCI (average age: 68.22).	Clinic	Control and intervention groups received physical training, but CogniPlus was added to the intervention group.	Combined sequentially	10 weeks. 2x/week. (30-60mins).	MMSE, AVLT, Stroop test, TMT, DRT-II, NHPT	After 10 weeks, the CogniPlus group showed significant improvement in MMSE and AVLT ($p < 0.0001$), Stroop test ($p < 0.002$), DRT ($p < 0.005$), TMT ($p < 0.01$) and NHPT ($p < 0.01$) than the control group.
Park et al. (2020)	RCT	Korea	40 elderly with MCI (average age: 75.8).	Healthcare center	Conventional cognitive rehabilitation (CCR) vs Computer-based cognitive rehabilitation (VRCMR).	Combined simultaneously	6 weeks. 5x/week. (30 mins).	MoCA, TMT A & B, DST forward and backward	VRCMR group showed a significantly greater improvement in MoCA ($p = 0.045$), TMT-A ($p = 0.039$), TMT-B ($p = 0.040$), and DST-forward ($p = 0.011$) scores compared to the CCR group, but not in the DST-backward score ($p = 0.424$).

Sungkarat et al. (2017)	RCT	Thailand	66 elderly with MCI (average age: 68.3).	3 weeks: University 12 weeks: Home	Tai Chi vs. Control with educational materials.	Mind-body exercise	12 weeks. 3x/week (50mins).	LM, Block Design, DST forward and backwards and TMT B–A	LM (p = 0.006) and TMT B-A (p = 0.01) were significantly better in the Tai Chi group than the control group.
Zhao et al. (2021)	Pilot quasi-experimental	China	107 elderly with MCI (average age: 72.29)	Community center	Square dance vs Control with health education.	Mind-body exercise	12 weeks. 2x/week (60 mins).	MoCA	A statistically significant difference was observed in MoCA scores between the experimental and control group after 3 months intervention (p < 0.001) and 3 months follow-up period (p < 0.001).
Zhu et al. (2018)	RCT	China	60 elderly with MCI (average age: 69.6).	3 months: Hospital 3 months: Home	Usual care and dance routine vs Control with usual care.	Mind-body exercise	12 weeks. 3x/week (35mins).	WMS-LM MoCA, SDMT, TMT, DST Forward and backward, ERP	Compared to control group, WMS-R-LM significantly improved at 3 months (p < 0.001) and ERP significantly improved at 6 months (p < 0.05) in intervention group.

Note: ACER: Addenbrooke's Cognitive Examination-Revised; AVLT: Auditory Verbal Learning Test; BNT: Boston Naming Test; CERAD: Consortium to Establish a Registry for Alzheimer’s Disease Assessment; CFT: Complex Figure Test; COWAT: Controlled Oral Word Association Test; CVF: Category Verbal Fluency; DB: Digit span backward; DF: Digit span forward; DRT: Disjunctive Reaction Time; DST: Digit Span Test; ERP: Event Related Potential; JLO; Judgement of Line Orientation; LM: Logical Memory; LVF: Letter Verbal Fluency; MMSE: Mini-Mental State Examination; MoCA: Montreal Cognitive Assessment; NA: Not Available; NHPT: Nine Hole Peg Test; RBANS: Repeatable Battery for the Assessment of Neuropsychological Status; SCWT: Stroop Color and Word Test; SDMT: Symbol Digit Modalities Test; SDST: Symbol digit substitution test; STT: Shape Trail Test; TMT: Trail Making Test; WMS-III: Wechsler Memory Scale Third Edition; WMS-LM: Wechsler Memory Scale-revised logical memory

2.4.3 Physical exercise and cognitive performance

Several clinical trials indicated that physical exercise improved cognitive performance among the elderly with MCI. A summary of physical exercise intervention was presented in Table 2.1. Jurakic et al. (2017) conducted a study in Europe for eight weeks to determine the effects of two types of non-aerobic training on cognitive functions in the elderly with MCI. The first group utilised a novel feedback-based balance and core resistance training device called HUBER, simultaneously capturing balance and strength in the MCI elderly. Another group carried out pilates training, which emphasised maintaining a stable core and neutral posture in various orientations of gravity. After eight weeks, the findings revealed that both groups significantly improved overall global cognitive scores. Other cognitive benefits were also found, including the potential to improve executive functions, delayed recall, language and abstraction (Jurakic et al., 2017).

Furthermore, convincing data from a randomised trial by Cardalda et al. (2019) have demonstrated that strength-based exercise also improved global cognitive function, with a 13.4% MMSE increment score. In the same study, multi-callisthenics exercise group results exhibited a tendency toward stabilisation of cognitive parameters despite the absence of statistically significant changes. In contrast, the control group demonstrated a deterioration in global cognitive function, with 34.9% significant differences between the other two groups (Cardalda et al., 2019).

A study was conducted in Korea by Hong et al. (2018) to investigate the impact of a 12-week resistance exercise programme on memory. A total of 47 seniors with MCI were allocated to either the intervention or control group. The control group was instructed to adhere to their existing way of life, whereas the intervention group engaged in resistance exercises utilising an elastic band for one hour per session. It was found that the control group demonstrated a significant decrease in the digit span backwards test for working memory, whereas the intervention group maintained a stable score. These results indicate that resistance exercise may have the potential to prevent further memory deterioration.

In addition, an investigation by Bisbe et al. (2020) compared the cognitive impacts of choreographed exercise and multimodal physical therapy in the elderly with amnestic MCI. The choreography included aerobic dance, while physical therapy included strength, flexibility, balance, and gait training. According to the findings, the memory domain exhibited a substantial improvement in the choreographed exercise group in comparison to the multimodal physical therapy group. Category verbal fluency (CVF), commonly used to assess the integrity of semantic memory, demonstrated a substantial improvement in the multimodal physical therapy group compared to the choreographed exercise group. Bisbe et al. (2020) claimed that other functions were cognitively stable.

Of the four studies mentioned above, only Jurakic et al. (2017) conducted the intervention in less than 12 weeks, while the other three studies were completed within 12 weeks. None of the studies used a home-based approach. Two studies took place in hospitals (Bisbe et al., 2020; Jurakic et al., 2017), one in a community centre (Hong et al., 2018), and another in a residential care home (Cardalda et al., 2019).

2.4.4 **Cognitive intervention and cognitive performance**

Table 2.1 summarised the findings from previous studies regarding the effectiveness of cognitive intervention on cognitive performance. In a 40-week randomized controlled trial involving elderly with MCI, participants were allocated to engage in leisure activities, either a dance program, a music program (played percussion instruments), or a health education control group. The study found that the dance program led to significant improvements in story memory test performance and MMSE scores compared to the control group, indicating enhanced memory function and general cognitive status. However, the music program only showed a positive impact on MMSE scores. No significant improvements were observed in tests of attention and executive functions for both groups. These findings suggest that structured cognitive leisure activities, particularly dance, may be effective in improving cognitive performance in elderly with MCI.

A large body of work also considers cognitive training to improve targeted cognitive functions. A pre- and post-test quasi-experimental study was conducted in Korea by Kim and Shim (2018) to examine the impact of a group cognitive programme on cognitive performance among the elderly with MCI. The intervention group received cognitive therapy for 90 min weekly for three months. Statistically significant improvement was found in executive function, visual confrontation naming, global cognitive function and memory tests ($p < 0.05$) post-intervention.

In this way, it can be considered similar to the approach proposed by Peng et al. (2019), who conducted a study assessing the effectiveness of cognitive training in 140 elderly with MCI in China. However, the subjects were separated into two groups: one receiving cognitive training as part of the intervention group and the other serving as a control group devoid of any training. The cognitive training intervention included six months of memory, attention, and calculation training. In contrast to the control group, the intervention group exhibited an increase in total global cognitive function scores subsequent to the intervention.

The cognitive training results in a study conducted by Peng et al. (2019) showed that some participants in the intervention group improved to normal levels (23.73%), and none progressed to dementia (0.00%) after three months. In the same period, one participant in the control group (1.59%) improved to normal levels, and one progressed to dementia (1.59%). Subsequently, after six months, some participants in the intervention group improved to normal levels (31.48%), and none progressed to dementia (0.00%), while only one participant in the control group (1.69%) improved to normal levels, and three progressed to dementia (5.08%).

Conceptually similar work by Li et al. (2019) in China examined a comparison between MCI elderly who underwent computerised cognitive training and a control group that did not receive any training. After six months of follow-up, the intervention group exhibited improved MMSE by 0.23 standard deviation (SD), while the control group had a 0.5 SD decline. The training effect was further supported by the good scores on attention, memory, the Stroop colour-word test interference index, and the complex figure test-copy score obtained from Addenbrooke's cognitive examination.

In Korea, other techniques using virtual reality (VR) games were used as cognitive training (Thapa et al., 2020). The MMSE and symbol digit substitution test also observed small but insignificant positive changes. Despite the lack of positive outcomes regarding overall cognitive function, the research documented noteworthy progress in executive function domains following an eight-week intervention involving VR games. Executive function is frequently assessed using the Trail Making Test (TMT); TMT A evaluates psychomotor speed and visual scanning, whereas TMT B assesses working memory (Thapa et al., 2020). The study found that the VR games improved working memory as assessed by TMT B, in which the test demonstrated that time was decreased significantly in the intervention group compared to the control.

Thapa et al. (2020) were the only researchers to have completed the intervention in less than 12 weeks, whereas the remaining three studies all lasted for 12 weeks or longer. None of the studies used a home-based approach. Various training centres have been used for the studies, such as hospitals (Li et al., 2019), classrooms (Peng et al., 2019), community centres (Doi et al., 2017; Kim & Shim, 2018), and healthcare centres (Thapa et al., 2020).

2.4.5 Combined physical exercise and cognitive intervention

Despite all these positive effects of single physical exercise and cognitive intervention on cognitive performance, Hagovska and Nagyova (2017) and Park et al. (2020) have attempted to compare the effects of combined intervention and single intervention. In a randomised controlled trial, Hagovska and Nagyova (2017) investigated the relative benefits of cognitive training and physical exercise. Physical exercise served as the foundation for both the control and intervention groups, while cognitive training (CogniPlus) was subsequently incorporated into the intervention group. After ten weeks, the CogniPlus group showed significant improvement in essential cognitive functions, memory, and attention, especially in the lower number of errors in all tests and visual-motoric coordination compared with physical exercise alone.

Meanwhile, Park et al. (2020) compared two groups of MCI elderly in the VR-based cognitive-motor rehabilitation (VRCMR) group and a conventional cognitive rehabilitation (CCR) group. During cognitive training, the VRCMR group used MOTOcog, a computer recognition programme that necessitated consistent upper extremity movement. In contrast, the CCR group participated in traditional cognitive activities, such as maze-building, card construction, puzzles, and woodblocks. The study results suggested that VRCMR improved cognitive function, including memory and attention, in the elderly with MCI more than CCR. However, Park et al. (2020) suggested that combining the CCR with physical exercise might bring comparable benefits to cognitive function as VRCMR.

Both studies were conducted in less than 12 weeks. In terms of study approach, the studies were held at clinics (Hagovska & Nagyova, 2017) and healthcare centres (Park et al., 2020). None of the studies implement a home-based approach to deliver the intervention. The results were presented in Table 2.1.

2.4.6 Mind-body exercises and cognitive performance

A summary of mind body exercises used in previous studies were also presented in Table 2.1. Tai chi was selected as an intervention in a randomised controlled trial by Sungkarat et al. (2017). The study noted that elderly with MCI in Thailand who attended tai chi programmes improved memory delayed recall after 12 weeks. The intervention was held for 3 weeks at the community centre, and the participants were asked to practice tai chi at home 3 times per week for 12 weeks. Besides improving memory, the study also revealed the feasibility of implementing home-based training for the elderly with MCI.

Zhao et al. (2021) studied the effects of nurse-led square dancing on the elderly with MCI. In contrast to the control group, which received health education, the intervention group engaged in square dance for 60 min thrice weekly for 60 min per session. After three months, the findings revealed a statistically significant difference in the overall cognitive function scores of the dance group participants between the pre-intervention and post-intervention periods. Zhu et al. (2018) also found that the elderly with MCI who carried out a specially designed aerobic dance routine for three months demonstrated significant improvements in global cognitive function, memory, and processing speed. After 6 months, the intervention group still showed a more remarkable improvement in processing speed.

2.5 DISCUSSION

2.5.1 **Rationale for combined intervention**

Based on this review, the majority of studies have consistently shown that both singular physical exercise and cognitive training are effective in enhancing cognitive performance. While each intervention has shown positive outcomes individually, their combination offers complementary advantages that may lead to enhanced cognitive performance in elderly. For instance, Hagovska and Nagyova (2017) proved that the combination of physical exercise and cognitive training exhibited the potential for even better cognitive outcomes than single training. This is consistent with the meta-analysis data reported by Karssemeijer et al. (2017), which demonstrated that combined cognitive-physical exercise interventions had a small to moderately positive impact on the overall cognitive function of elderly diagnosed with MCI or dementia. The results from the network meta-analysis of Gavelin et al. (2021) also showed that the cognitive effects of combined training exceeded all control conditions apart from cognitive training alone.

The rationale for selecting a combined cognitive and physical intervention approach lies in its potential for superior benefits compared to single interventions (Hagovska & Nagyova, 2017; Karssemeijer et al., 2017; Park et al., 2020). By integrating cognitive intervention which benefits cognitive domains (e.g., memory and executive function) with physical exercise which also promotes overall physical health and cardiovascular fitness (Piercy et al., 2022), the combination underscores potential as a compelling strategy for simultaneously promoting cognitive and physical health in late life. It also can address multiple aspects of aging-related decline simultaneously. According to Gavelin et al. (2021), the therapeutic rationale behind combined interventions posits that physical and cognitive activities can impact brain plasticity through separate but complementary pathways. The physical exercise can lead to physiological changes such as increased BDNF levels and stimulation of hippocampal neurogenesis. These changes, in turn, facilitate the experience-dependent neuroplastic effects of cognitive engagement (Gavelin et al., 2021). Further neurophysiological mechanisms underlying the benefits of physical exercise and cognitive training on cognitive function are complex and not fully understood, with limited knowledge on moderators and mechanisms (Ferrer-Uris et al., 2022).

It is important to acknowledge that the elderly may encounter challenges when participating in the combined intervention programme. The barriers to engage in these interventions include extended time commitment, individual’s capabilities, opportunities, and motivation (Piercy et al., 2022). However, these challenges can be overcome with flexible scheduling options, incremental progression approaches and incorporation of social support to mitigate the perceived burden of time commitment and enhance adherence rates among participants (Piercy et al., 2022). Apart from that, it is suggested to create opportunities for exercise in settings where elderly already spend their time. For example, engaging in exercise within their home environment can alleviate several barriers, such as those arising from unfavorable weather conditions, transportation limitations or time constraints (Piercy et al., 2022).

2.5.2 **Gap of knowledge**

In previous systematic reviews, Gheysen et al. (2018) and Biazus-Sehn et al., (2020) suggested that superior cognitive benefits may be gained from naturally combined physical exercise or cognitive intervention, such as dance and tai chi. This is in line with the findings of the current review, whereby cognitive benefits of dance had been reported in several studies conducted by Doi et al. (2017), Zhao et al. (2021) and Zhu et al. (2018). Previous researchers proposed that dance could be an effective intervention because it is enjoyable and would promote high adherence among the elderly (Chan et al., 2020; Zhu et al., 2018). Nevertheless, since majority of the FELDA settlers are Muslims, the dance intervention might not be culturally suitable for the elderly in the local context. Another gap found from the review was related to the utilisation of technology-based approaches such as VR, exergames and computerised cognitive training. Out of five researchers who conducted cognitive intervention, only Doi et al. (2017) implemented leisure activity as an intervention. The usage of advance system such as the remaining studies may pose a challenge for the FELDA elderly, particularly those with limited literacy in information and communication technology (ICT).

According to Malek et al. (2012), the FELDA elderly did not utilise ICT due to the following reasons: ignorance of its benefits, lack of ICT-related skills, fear of using ICT, and difficulties in operating it. Additionally, most of the elderly in this study attained less than six years of education. Despite the top-notch advantages that can be gained from the advancement of technology, Park et al. (2020) suggested that the conventional method such as maze-building, card construction, puzzles, and woodblocks might also bring comparable benefits to cognitive function as VR if it is combined with physical exercise.

A large body of evidence supports the concept that these kind of cognitively stimulating leisure activities were associated with reduced risk of cognitive decline (Armstrong et al., 2022; Mao et al., 2020; Sala et al., 2019; Song et al., 2022; Xu et al., 2022; Yang et al., 2022). However, there is little evidence of this work being applied in experimental research as most of them were using prospective study method. The present review only found Doi et al. (2017) conducted clinical trial to explore the effectiveness of leisure activity on cognitive performance of MCI elderly. Additionally, Doi et al. (2017) did not combined both physical and cognitive components in their research. Therefore, the methodological gap identified in previous studies supports the need for further exploration on the effectiveness of physical exercise and cognitive activities in the present experimental study. The selection of intervention content was discussed explicitly in subsequent chapter.

In terms of study duration, Gheysen et al. (2018) discovered that studies that combined physical exercise and cognitive training sessions of a short (≤ 45 min) as well as medium duration (> 45 to ≤ 60 min) obtained significant effect sizes compared to studies with long session durations (> 60 min). On average, effect sizes were smaller for the highest frequency of delivery (Gheysen et al., 2018). Gheysen et al. (2018) claimed that high doses (high frequency, long intervention, and long session duration) are unnecessary to produce higher efficacy. The findings are similar to Biazus-Sehn et al. (2020), who reported that interventions with the lowest volumes (40–45 min per week) presented better results on cognitive function in elderly with cognitive impairment. Besides, Gavelin et al. (2021) found no significant difference in the effectiveness of interventions lasting 12 weeks or less compared to those lasting longer than 12 weeks. In this review, four studies (Hagovska & Nagyova, 2017; Jurakic et al., 2017; Park et al., 2019; Thapa et al., 2020) that conducted the intervention less than 12 weeks were found to be effective in improving cognitive performance among the elderly with MCI. Such aspects should be considered when prescribing exercise as a routine for the elderly with MCI to see the impact on cognitive performance. The optimum duration for the studies to be conducted requires further confirmation due to inconsistent findings.

2.6 CONCLUSION OF SYSTEMATIC REVIEW

Overall, physical exercise and cognitive intervention are effective in enhancing cognitive performance. Nevertheless, the existing interventions in this field are restricted in applicability due to the differences in participants' cultural backgrounds. The usage of high-end technology and the lack of remotely delivered physical exercise and cognitive intervention programmes justifies that a new strategy is needed to cater for the movement limitation issues among the local population, particularly for the elderly in rural areas with low level of education. A deeper understanding of the required intervention duration to observe the effectiveness of the programme also needs to be further determined in future studies.

2.7 CONCEPTUAL FRAMEWORK

Figure 2.3 provides an overview of the conceptual framework. This study incorporates several independent variables, including age, gender, education level, comorbidity, marital status, and employment status of the participants. These variables are essential for understanding the demographic and health-related characteristics of the participants and their potential influence on cognitive performance. The dependent variable in this study is cognitive performance, which is assessed through changes in memory and clock drawing test (CDT) scores from baseline to post-intervention.

The time of assessment is a critical component of the conceptual framework as it allows for the examination of changes in cognitive performance over the course of the intervention. The time of assessment provides insights into the potential effects of the ACE programme at different time points, specifically at baseline, week 4, and week 12 post-intervention. Overall, the conceptual framework posits hypothesized relationships between the independent variables, time of assessment, and cognitive performance. It is hypothesized that the ACE programme, in conjunction with the time of assessment, would lead to improvements in cognitive performance among elderly with MCI.

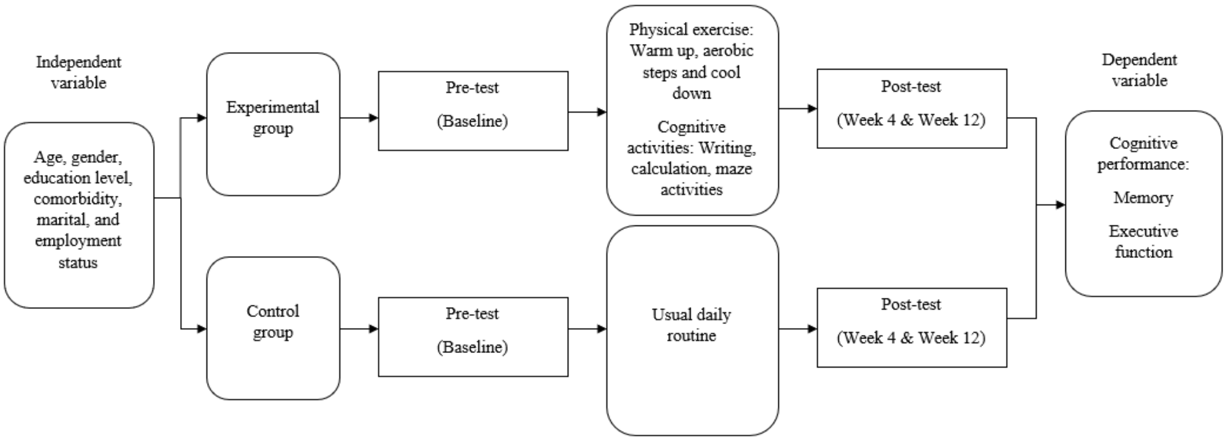

Figure 2.4 Conceptual framework

2.8 SUMMARY

The second chapter provides a systematic review of relevant literature, offering insights into the existing research on physical exercise and cognitive interventions among elderly individuals with MCI. It also outlines the methods, results, discussion and conclusion from the literature search. The final part of the chapter includes the conceptual framework of the study.

CHAPTER THREE

MATERIALS AND METHODS

3.1 INTRODUCTION

This chapter elaborates on all aspects of the study methodology, including study design, setting, study population, sampling method, participants, sample sizes, variables, recruitment process, data collection procedures and the statistical tests used to achieve the objectives of the study. The final part elaborates on the ethical considerations.

3.2 STUDY DESIGN

This study involved quasi-experimental research aimed to evaluate the causal relationship between an intervention and an outcome using experiments without randomisation. It was not practical for the participants to be randomly assigned to the intervention due to the small sample size, high drop rate chance, time constraints, and logistics issues. Therefore, the randomised controlled trial design was not applied in this study. To ensure that the causal inference is strengthened, an experimental group and a control group were involved in this study. The Aerobic exercise and Cognitive activities for Elderly (ACE) programme was introduced in the experimental group, whereas the control group received no intervention.

The selection of no-intervention approach for the control group allows researchers to attribute observed changes in cognitive function specifically to the intervention itself. By comparing the outcomes of those who received the intervention with those who followed their usual routines, this study would gain insights about the effectiveness of the intervention in the real world setting. In a meta-analysis, Au et al. (2020) indicated that employing an active intervention for the control group may introduce confounding variables and incur additional expenses that may not be feasible within the scope of the study. Therefore, passive control group was selected for this study.

In regards to outcome measure, the control and the experimental groups' cognitive performance were assessed based on two cognitive domains which included memory and executive function. All participants in both groups were measured at baseline during an identical time before the ACE programme started. Then, the cognitive performance was remeasured in both groups after four weeks (midway assessment) and 12 weeks (final assessment) to identify the changes before and after participants completed the intervention.

3.3 STUDY SETTING

The study was conducted at FELDA settlements in Kuantan, Pahang, involving FELDA Bukit Goh and FELDA Bukit Sagu. These two FELDA settlements are approximately 30 km from Kuantan City. Given that the FELDA Bukit Goh and FELDA Bukit Sagu elderly need more commute time to access health facilities in town conveniently, a study on the effects of physical exercise and cognitive training at home setting is highly suitable for the population. The data collection and follow-up of this study were conducted at the participants' homes.

3.4 STUDY POPULATION

The study population was elderly with MCI ($\geq$ 60 years old) recruited among the settlers who lived in FELDA Bukit Goh and FELDA Bukit Sagu, Kuantan, Pahang.

3.5 SAMPLING METHOD

Convenience sampling was adopted in recruiting the study participants. Random selection was not possible due to the nature of the study population in the study setting, whereby the willingness to participate in exercise programmes among the elderly was hard to obtain. Besides, time constraints and the lack of human resources were also identified as the main issues. Therefore, convenience sampling was applied due to easy accessibility, geographical proximity, and readily available participants. Even though the present study tried to ensure that the experimental and control groups were balanced and comparable in terms of their characteristics by only selecting the study sample who lived in FELDA, it is important to acknowledge that the use of convenience sampling may limit the generalizability of the findings.

To avoid potential contamination resulting from the contact of the two groups of participants, the present study clustered the participants as geographically distinct. A total of 50 participants from FELDA Bukit Goh were selected as the experimental group, while 50 participants from FELDA Bukit Sagu were selected as the control group. The participants in the experimental group were asked not to share or expose the intervention content and materials until the completion of the study. Researchers were also ensured not to share intervention content with the control group.

3.6 ELIGIBILITY CRITERIA OF STUDY PARTICIPANTS

3.6.1 Inclusion criteria

i. 60 years and older.

ii. Had MCI confirmed by the Mini-Cog test (test score ≤4).

iii. Had full score for the Lawton Instrumental Activities of Daily Living Scale. The score ranges from 0 (low function, dependent) to 8 (high function, independent) for women and 0 through 5 for men to avoid potential gender bias. Thus, a score of 8 (for women) and 5 (for men) represents normal or full independence in instrumental activities of daily living (Pedrosa et al., 2010).

iv. No severe impairment in vision and hearing.

v. Had basic literacy.

3.6.2 Exclusion criteria

i. Confirmed clinical diagnosis of dementia.

ii. Had uncontrolled comorbidities such as hypertension and diabetes through the patient's self report. Medical compliance, related symptomps and health records were checked to ensure that they were not in uncontrolled conditions, which could severely impact their ability to participate in the study.

iii. Existing neurological diseases and brain injury (i.e. Parkinson’s disease, multiple sclerosis, epilepsy, organic brain syndrome, stroke) or psychiatric disorders such as major depression and schizophrenia.

iv. History of alcohol and illegal drug abuse. This criteria was screened by verbally asking them whether they had ever used drugs and alcohol or not. The exclusion was to ensure that their cognitive status were not due to substance abuse, as it is one of the major social problems FELDA settlements (Khairi et al., 2017).

v. Participation in any other structured exercise programme. Examples of structured exercise programmes may encompass activities like gym workouts, fitness classes (e.g., aerobics, yoga, Pilates) or prescribed home exercise routines. Participants engaging in any of these activities would be considered as participating in a structured exercise programme. To determine their involvement, participants were asked to report any regular exercise routines or programmes they participate.

3.7 SAMPLE SIZE CALCULATION

The sample size calculation was performed using G-Power software (G-Power, V3.0). Based on a study by Zhu et al. (2018), the effect size of 0.8, a significance level (α) of 0.05, and a power (1-β) = 0.95 were determined. According to the calculation, each group required at least 42 subjects as show in Figure 3.1. Based on previous research conducted by (Zhao et al., 2021), this study considered the inclusion of at least 50 participants in each group to allow for a 20% dropout rate.

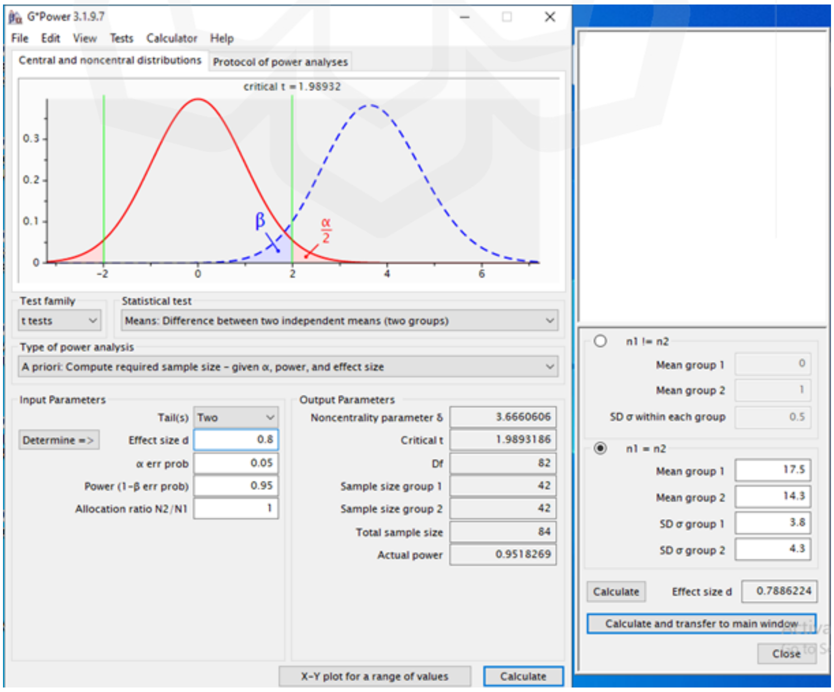

Figure 3.1 Sample size calculation using G-Power software

3.8 DATA COLLECTION AND MATERIALS

3.8.1 Stage 1: Selection of training content

Selection of the training content was based on the materials that were easily accessible, culturally appropriate, and relevant to the daily lives of the participants. Based on the systematic review, a number of existing programs had limitations that precluded their use. Attempts to contact potential authors of these programs through email were made; however, as expected, the identified programs required equipment that incurs a certain amount of expenditure or cost.

For example, Park et al.'s (2020) programme utilized the software that used virtual reality for activities such as driving, bathing, and cooking to enable memory, problem-solving, and executive training. Whereas, the hardware components of the system consisted of touchscreen monitor, grip air bulb, and various type of joysticks. The system used in the study may not be suitable for home implementation due to the specialized equipment and software required. These components also may require professional setup and supervision. Plus, virtual reality technology can be expensive, especially when specialized hardware and software are involved. It is important to consider the financial implications before attempting to replicate a virtual reality system at home.

Hagovska & Nagyova (2017) used a software for the cognitive training, which also require access to a computer or tablet with the necessary software installed. The cognitive training involved sub-programmes such as Alert, Nback, Names, Pland, and Vismo, which targeted memory and executive functions using complex system. As stated above, it is important to consider the needs and limitations of participants in rural areas such as access to such technology. In the (izuka et al. (2019) systematic review, however, demonstrated that cognitive leisure activities such as writing were the most common intervention tool used among elderly, and it was associated with a lower risk for developing dementia (Duffner et al., 2022; Iizuka et al., 2019).

Furthermore, previously conducted brain imaging studies have indicated that simple math (Barahimi et al., 2021; Montefinese et al., 2017; Yusoff et al., 2014) activated the frontal cortex and the cortices of the parietal lobes. The frontal cortex, particularly the dorsolateral prefrontal cortex, plays a crucial role in executive tasks such as concentration, planning, and problem-solving. The parietal regions, including the superior parietal lobe were activated during tasks involving number operations and arithmetic processing. It was found that there was an elevated amount of oxyhemoglobin in the frontal cortex compared to the resting state during the mental calculation task (Barahimi et al., 2021). Kulason et al.'s (2018) findings also suggested that the simple calculation intervention has the potential to improve cognitive function, emotional well-being, and quality of life in elderly.

Additionally, navigating a maze is also one of the most recommended exercises for cognitive benefits such as enhancing memory, attention, and inhibition because it involves several essential cognitive abilities (Medgueb et al., 2023). For example, solving the maze requires a combination of cognitive skills such as attentional, visuospatial, and visuo-constructional, and executive function as well as visuomotor function. Similar with video games, mazes can be modified in difficulty to match the participants' level of cognitive ability (Nef et al., 2020). Mazes are non-verbal, simple to understand and use, relatively independent of educational level and suitable for a wide range of elderly and persons with cognitive impairment (Nef et al., 2020).

Cheng (2016) highlighted that the training programs need to address barriers to real-life implementation in the long run. Adapting the training programme to suit the specific circumstances and resources available in rural areas would be essential for its feasibility and effectiveness. Given that all of the mentioned activities have been found to offer cognitive benefits, suitable for home implementation and require minimal equipment for FELDA population, thus, the writing, calculation and maze exercises was agreed by the research and supervisory team to be selected as an intervention programme for cognitive component. These chosen activities were believed to align with the principles of simplicity and relevance to the local context.

The selection of aerobic exercise was based on established recommendations from Ministry of Health and existing research by Cheng (2016). This is because aerobic exercise improves cognitive function, activates BDNF expression, restricts the accumulation of β-amyloid protein and enlarges the hippocampal volume ((Iizuka et al., 2019). Iizuka et al. (2019) also categorised the aerobic exercise as leisure activity. Similar to cognitive activities, this study focused on physical activities that can be easily implemented at home with minimal equipment, such as chair-based exercise. Chair-based exercise is a seated, structured and progressive exercise programme, which uses a chair to provide stability (Klempel et al., 2021). Therefore chair aerobic is a form of aerobic exercise that is performed using a chair for support. This alternative can be used by elderly and particularly beneficial for individuals with mobility issues, balance problems, or other physical limitations that may prevent them from engaging in traditional standing aerobic exercises. By using a chair for support, individuals can still experience the benefits of aerobic exercise in a safe and accessible manner.

The content of the physical and cognitive activities were then validated through the expert judgment of a medical doctor with credentials in non-communicable disease and geriatric field in Malaysia, Asst. Prof. Dr. Mohd Shaiful Ehsan Bin Shalihin [Malaysian Medical Council Number: 50601]. The expert is working in an academic role as a Clinical Lecturer at the International Islamic University Malaysia (IIUM) Kuantan Campus. The expert was also a family medicine specialist at IIUM Family Health Clinic Bandar Indera Mahkota. Discussion was held between the expert and supervisory team to determine whether the content of the programme were suitable for elderly in FELDA, and whether any additional topics were needed. This was necessary as the expert and supervisory team could provide input into the content of the training programme.

3.8.1.1 Expert feedbacks and validation

As shown in Appendix II, the expert highlighted that the physical exercise had provide safety elements and accessibility to the elderly regardless of their physical abilities or limitations. Furthermore, the content of the training was believed to improve overall health and functional ability among elderly. This includes promoting cardiovascular health, muscle strength, flexibility, balance, and coordination. Moreover, it was mentioned in the comments that the variety of activities in the module helped to prevent boredom and kept participants motivated and engaged. According to the expert, incorporating elements such as background music could enhance enjoyment, increase adherence to the program and promote long-term participation.

The expert feedback on the cognitive part underscored the suitability of the cognitive exercise to assess various cognitive functions of the elderly. These cognitive functions include attention, concentration, problem-solving, decision-making, brain teasers, word searches, and vocabulary-building exercises. The mind-challenging tasks were recognized as valuable brain training exercises that can contribute significantly to the improvement of cognitive performance. This is due to the reason that the training incorporated a diverse range of cognitive activities such as numbers, sequences, mathematical operations, mazes, and general knowledge (refer Appendix II).

In response to the expert feedback, several adjustments were done to the cognitive exercise module to enhance its relevance and effectiveness. Specifically, the expert suggested to remove the questions related to "*Rukun Islam*" and "*Rukun Iman*" as these knowledge would be depend on the participants' education and religious practice level. For physical exercise, suitable backgound music was selected to provide the element of enjoyment. The expert feedback was not only validated the contents of the intervention component but also informed refinements to ensure that the program would achieve its objectives. By incorporating expert insights, the content of the training may fulfill the evolving needs and preferences of elderly individuals, ultimately contributing to the improvement of cognitive function among participants.

3.8.1.2 Physical exercise

After the training content had been reviewed and consensus was reached, the intervention was commenced. Figure 3.1 illustrates the participants actively participating in aerobic exercises as part of the ACE programme. Senaman Warga Emas (SENAMAS), a chair-aerobic programme tailored for the elderly, was designed by a certified health fitness instructor operating under the Ministry of Youth and Sports Malaysia. The programme prioritises the specific needs and comfort of elderly participants, offering a structured exercise routine that can be conveniently performed at home in a seated position. This thoughtful approach aims to provide a safe and accessible fitness solution, ensuring that individuals with mobility constraints can actively participate in the programme without compromising their safety.

An instructional video featuring the certified health fitness instructor demonstrating SENAMAS was recorded and distributed to participants to facilitate accessibility and adherence after the completion of a face-to-face demonstration. The video provides detailed guidelines for a 5-min warm-up, 5-min stretching, 5-min aerobic steps, and a 5-min cool-down session, all designed to promote physical activity and well-being among the elderly within the comfort of their homes. Participants were also provided with a hard copy booklet featuring step-by-step visual instructions for the physical exercises during the briefing session (refer Appendix III). This resource served as a valuable alternative, particularly beneficial in instances where accessing the video was challenging.

Figure 3.2 Participants conducted the chair-aerobic exercises at home

3.8.1.3 Cognitive activities

Figure 3.2 shows participants engaged in cognitive activities, which the programme was administered remotely at the participants' homes through online supervision. During the briefing session, each participant in the experimental group received a paper-and-pencil-based booklet comprising cognitively stimulating activities incorporated in writing, calculation, and maze exercises (refer Appendix III). The difficulty levels of these activities were intentionally designed to progressively increase with each session, offering a gradual cognitive challenge throughout the programme. The components of the exercises are detailed as follows.

i. **Writing**: Participants were directed to generate as many words as possible under both phonological (letter-based) and semantic (category-based) conditions. For example, in the phonological condition, participants were instructed to write words beginning with designated letters ("A", "F", and "P"), excluding proper names, numbers, repetitions, or variations. Conversely, in the semantic condition, participants were tasked with producing words belonging to specific categories, such as flowers, fruits, and cars. Additionally, participants were instructed to construct sentences based on given words or themes, further diversifying the cognitive demands of the writing section.

ii. **Calculation:** Participants were tasked with exercises such as digit span backwards, digit span forward, as well as calculations involving subtraction and addition. Specific real-life scenarios, including the calculation of electric bills and grocery receipts, were incorporated. The difficulty of these tasks incrementally intensified to provide participants with a comprehensive and progressively challenging numerical experience.

iii. **Maze:** As the final part of the cognitive activities programme, participants were engaged in maze completion exercises, where the complexity of the maze ranged from easy to challenging. The mazes aim to enhance spatial and problem-solving skills, providing a progressively more complex cognitive workout throughout the programme.

Figure 3.3 Participants engaged in cognitive activities as part of the ACE programme

Table 3.1 Training protocol for ACE programme

Activity	Duration	Time	Levels of Difficulty
Physical exercise			
• Warm up	5 mins	Every Monday, Wednesday and Friday	Moderate
• Chair aerobic	15 mins		
• Cool down	5 mins		
Cognitive activities	15 mins	Every Monday, Wednesday and Friday	Week 1-Week 4: Easy Week 5-Week 8: Moderate Week 9-Week 12: Hard
• Writing			
• Calculation			
• Maze			

3.8.2 **Stage 2: Recruitment of participants**

All elderly (age ≥ 60) who resided in FELDA Bukit Goh and FELDA Bukit Sagu were screened for eligibility to participate in the study. The screening phase was performed at some social centres near their house, including Dewan Semai Bakti FELDA Bukit Goh, Masjid FELDA Bukit Goh and Masjid FELDA Bukit Sagu. The researcher conducted the screening phase at the participants' home for those unable to attend the assigned location due to transportation limitations. In the present study, the recruitment process involved the engagement between researcher and gatekeepers, which included administrative FELDA officers and the residence representative. These gatekeepers assisted the researcher to access potential participants and facilitate the recruitment process.

To engage with the gatekeepers, the researcher employed various strategies such as making phone calls, sending letters, conducting in-person meetings, and utilizing professional networks to seek approval and support for accessing the target population. It was also to ensure that the recruitment process was conducted ethically and effectively. Regarding the scheduling of screening dates, the researcher received assistance from the gatekeepers to identify specific dates and times for screening sessions, especially when the target population had social gathering. For example, the gatekeepers suggested to conduct the screening session during *"Kuliah Dhuha"* and *"Jum'ah"* prayer. The gatekeepers also helped to make announcements during the social gathering to promote ACE programme among the target population. In addition, flyers and posters were posted through the WhatsApp application to attract more participants to the programme.

Subsequently, all participants aged 60 years and above were screened for cognitive performace and independent living skills. The inclusion criteria for participants were determined based on achieving score of 4 or lower for Mini-Cog test by (Borson et al., 2000) and a full score on the IADL, developed by Lawton and Brody in 1969. For the Mini-Cog test, any participants had passing score was not consider as having MCI. A passing score was defined as 4 or 5 out of 5, which can occur only with a normal clock draw (2 points) and correct recall of at least two of three words (2–3 points). Therefore, only participants who obtained score of 4 (with abnormal clock) or less than 4 were selected.

The IADL instrument was used to assess how a person is functioning at the present time. The range score is from 0 (indicating low function and dependence) to 8 (high function, independent) for women and from 0 to 5 for men (Brody et al., 2008). The participants were only included if they obtained full score for the IADL screening. Individuals with confirmed diagnosis of dementia, existing neurological diseases and uncontrolled comorbidities were excluded. Medical records and self-reported medical history were used to identify individuals with these conditions. Participants with a history of alcohol or illegal drug abuse were also excluded from the study to avoid potential confounding factors that could affect cognitive performance, such as the long-term effects of substance abuse on brain function.

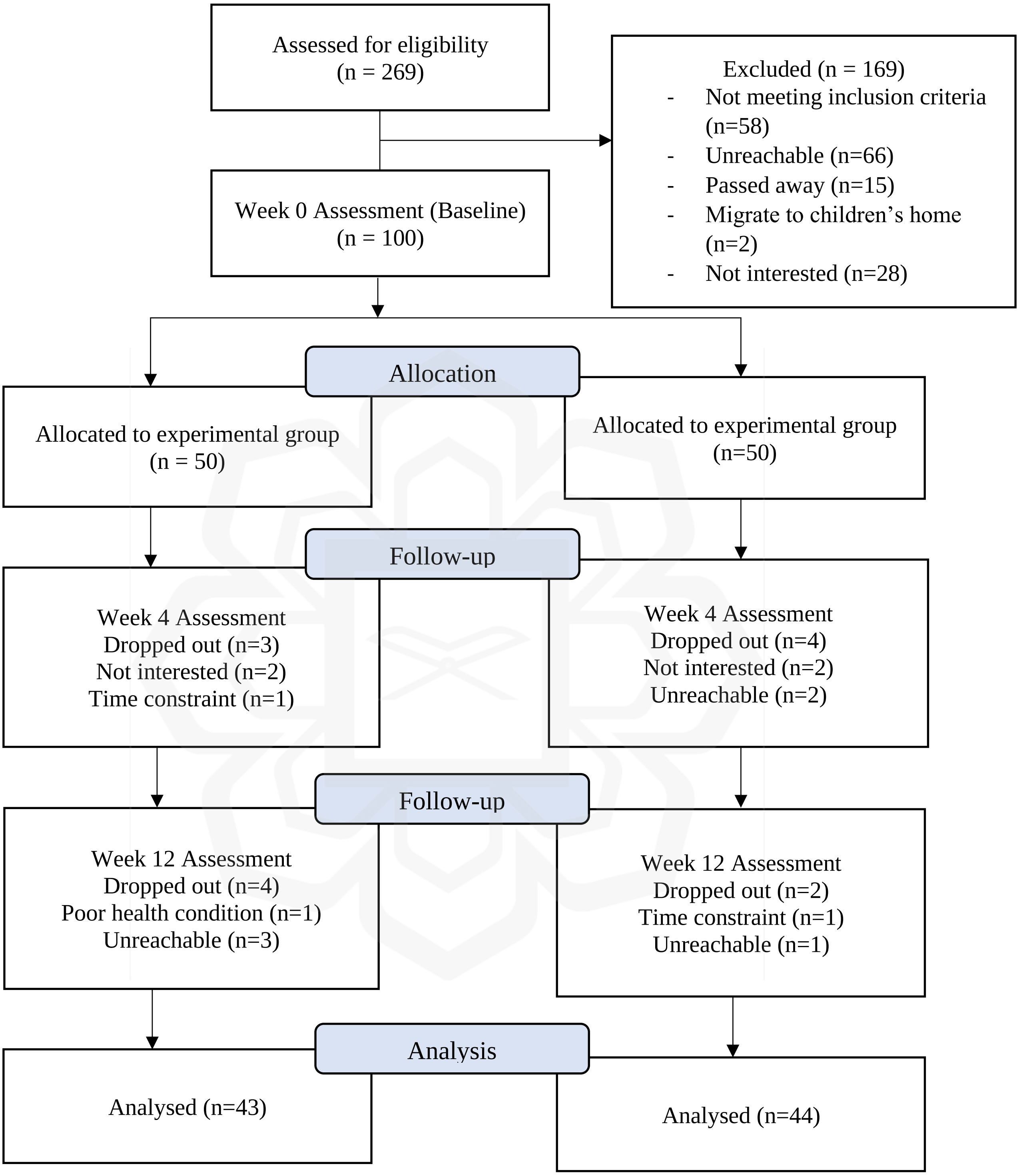

Figure 3.4 Consolidated Standards of Reporting Trials (CONSORT) flow diagram of study recruitment.

(Schulz et al., 2010)

3.8.3 **Stage 3: Participants allocation**

The elderly participants preliminarily screened as having MCI and fulfilled other eligibility criteria were invited to participate in the study. Each participant was briefed with a thorough explanation of the procedure and was provided written informed consent as an agreement for their participation in the study. A total of 100 participants were subsequently assigned either to the experimental group (n = 50) or the control group (n = 50). The allocation process was completed according to their locality (i.e., FELDA Bukit Goh as the experimental group and FELDA Bukit Sagu as the control group). The characteristics and cognitive performance of the participants were assessed for baseline assessment before they started the home-based physical exercise and cognitive intervention.

3.8.4 **Stage 4: Implementation of intervention**

Briefing session: A week before the programme started, participants in the experimental group had a face-to-face briefing session regarding the tasks that needed to be completed at home. During the briefing, a certified physical instructor demonstrated aerobic steps to ensure the participants were familiar with the training. As for cognitive activities, the researcher explained the instructions for each section to be completed according to the assigned date. Participants had the opportunity to ask the researcher if there was anything vague regarding both training sessions. At the end of the briefing session, participants were given a booklet of exercise guides (aerobic steps and cognitive stimulating activities), a diary of attendance, and a 20-min video of physical exercise to assist them in undertaking the ACE programme.

Actual experimental manipulation: The experimental group was assigned to carry out physical exercise and cognitive activities at home, while the participants allocated to the control group were not given any programmes related to physical exercise and cognitive components. There were 36 sessions, scheduled as 3 non-consecutive sessions a week for 12 weeks, with a duration of 35 min per session. Participants were instructed to engage in chair aerobic exercise and cognitive activities at home every Monday, Wednesday, and Friday on their own for a duration of 12 weeks, following a set schedule.

They were encouraged to prioritize cognitive activities for 10-15 minutes in the morning, followed by 20 minutes of chair aerobic exercise. However, participants had the flexibility to choose any time of day to complete the exercises as long as they met the requirement of three exercise sessions per week. In case of any issues or concerns regarding the intervention, participants were permitted to contact the researcher via phone call or text message for assistance. Attendance tracking for the intervention was facilitated through a WhatsApp group created by the researcher, comprising both participants and their caregivers. A day prior to each scheduled training session, participants received reminder messages via the WhatsApp group to prompt adherence to the upcoming session.

To monitor attendance, participants were instructed to record their activity in a provided logbook and submit a photo as evidence of themselves engaging in the activities to the researcher. The caregivers played a significant role in supporting participants' compliance with the intervention regimen. According to a systematic review by Room et al. (2017), social connectedness, implementation of monitoring systems, and maintainence of regular contact with the researcher can provide ongoing support and positively impact individuals' commitment. Apart from that, the most active participant would receive a reward as positive reinforcement. The control group were also given the honorarium and the same intervention materials as the experimental group to prevent bias in receiving the benefits of the programme. The researcher provided a softcopy of the exercise book and a link to access the exercise video to all participants in the Felda Bukit Sagu after the 12 weeks of intervention completed.

Outcome Measurement Procedures: Post-intervention assessments were conducted face-to-face at weeks 4 and 12. Trained research assistants conducted home visits to follow-up the participants and assess the outcome variable. The dropout rate for the present study was 13%. Of 100 participants, seven participants were lost to follow up during 4-week assessment, three from experimental group and four from control group. Of the remaining 93 participants, six participants were lost to follow up during 12-week assessment, four from experimental group and two from control group. Therefore, only 87 participants completed the intervention. There were several reasons for the dropped out such as health problems, other commitments and failure to reach.

Data Analysis and Comparison: Following the experimental manipulation phase, data collected from cognitive performance assessments at different intervals were analyzed to compare the outcomes between the experimental and control groups. Statistical analyses which includes Chi-square tests, independent t-tests, and generalised estimating equations were employed to measure score changes within and between the groups.

3.8.5 **Implementation of measures**

Several measures were taken to control potential contamination or bias. While participants were not randomized due to practical and logistical reasons, a quasi-experimental design was adopted to establish strong links between variables. This design aimed to improve the comparability of the two groups by ensuring homogeneity in participant baseline characteristics. Furthermore, the inclusion of a control group in the study design helps in comparing the outcomes of the intervention group with those who did not receive the intervention. This allows for a more accurate assessment of the impact of the intervention on cognitive performance. Although blinding of participants and researchers to treatment assignment may not have been feasible in this study, efforts were made to ensure blinding of outcome assessors. This helps in reducing bias in the assessment of cognitive performance.

Participants in both experimental and control groups were educated on the importance of adhering to the assigned interventions. They were refrained from initiating any new physical exercise or cognitive activities that could influence the outcomes being measured. The importance of accurate reporting was also delivered to the participants. Participants in the control group were explicitly instructed not to engage in any structured exercise or cognitive-based interventions during the study period. Clear instructions were provided to minimize the likelihood of participants sharing information about the intervention tasks with each other, thus reducing contamination. Furthermore, the intervention arms were seperated geographically to minimize the likelihood of interaction between participants from different intervention arms. By incorporating these additional measures into the study design, the internal validity of the study and the attribution of cognitive improvement to the ACE programme could be enhanced. It is also aimed to minimize potential sources of bias or contamination in the study.

3.8.6 **Data collection instrument**

3.8.6.1 Characteristic of participants

The participants were given a set of questionnaires developed by the researcher regarding their demographic data. The questions included age, gender, marital status, education level, employment status and the presence of comorbid conditions such as hypertension and diabetes.

3.8.6.2 Mini-Cog Test

The Mini-Cog was proposed by Borson et al. (2000) and is commonly used in primary care and community settings to assess cognitive impairment. Recent investigations have demonstrated that the Mini-Cog was superior to the MMSE in identifying MCI patients. The validity and sensitivity of the Mini-Cog in elderly people is high, and it could identify MCI early (Li et al., 2018). Mini-Cog has higher sensitivity score (0.91, range 0.80- 0.96) in comparison to MMSE (0.81) (Borson et al., 2005; MOH, 2021). Mini-Cog is also brief and easy to implement in comparison to MMSE (MOH, 2021). The assessment is short (3–4 min) and easily accepted by the patients compared to the 7 min required for MMSE and 15 min for MoCA.

As for MoCA, it presents several limitations including time-consuming to administer. For instance, the one-point correction for under 12 years of education might not be appropriate for elderly with lower levels of education in some regions, especially in rural areas (Limpawattana & Manjavong, 2021). Hassan et al. (2023) in their study demonstrated that more than 60% of the first generation FELDA settlers went to primary schools only, which maximum of six years education. The MoCA might, thus, not be suitable for detecting MCI in FELDA population. A validated test that is more accurate in detecting cognitive impairment in patients with low levels of education may be more suitable for use in this setting, such as Mini-Cog.

The Mini-Cog consists of two components: a three-word recall task that assesses memory impairment and the clock drawing test (CDT) that assesses cognitive domain such as executive function (Limpawattana & Manjavong, 2021). The rationale of dividing the scores is to see which domains are affected. Participants were given three words and instructed to memorise them later. For CDT, the participants were required to draw a clock filled with numbers and set the hands at 11:10. The maximum time to complete the clock drawing task was 3 min.

Scoring is from 1–3 for the three-word recall, based on the number of words the participant successfully memorised. Meanwhile, for the CDT, score of 2 is for the correct clock drawing and 0 for the abnormal clock drawing. For the sreening phase, the elderly was identified as MCI if they obtained score of 4 (with abnormal clock) or less than 4 in the Mini-Cog test (McCarten et al., 2011). While to measure the changes in cognitive performance throughout the study, an elevation in the Mini-Cog score was indicated as improvement, no change was categorised as static, and a decline in the Mini-Cog score was considered as decreased.

Mini cog can be used to measure prognostic outcomes of cognitive impairment. In fact, it is a potentially preferable tool to assess cognitive impairment in terms of providing prognostically relevant information compared to MMSE (Saito et al., 2020). Previous study has also used Mini-Cog to study the cognitive outcome after certain intervention (Yoo et al., 2023).

3.9 STUDY VARIABLES

The independent variables included in this study are age, gender, education level, comorbidity, marital, and employment status. Meanwhile, the dependent variable is cognitive performance. Table 3.1 shows the brief descriptions of each variable stated.

Table 3.2 The operational definition and coding of each variable

Variables		**Operational definition**	**Coding**
Participants' characteristics	Age	Age (in years) of participants at the time of recruitment.	NA
	Gender	Refers to an individual's personal and social identity as a male or female.	1: Male 2: Female
	Education level	Refers to the highest formal education attained.	1: Primary school 2: Secondary school
	Marital status	Categorised into single, married, divorced, and widowed.	1: Single 2: Married 3: Divorced 4: Widowed
		During analysis, only three groups emerged: single, married, and widowed.	1: Single 2: Married 3: Widowed
	Employment status	Classified based on involvement in any activity to gain income or not. Categories include working and not working.	1: Working 2: Not working
	Presence of comorbid	Refers to the history of any types of comorbid such as hypertension and diabetes.	1: Comorbid 2: No comorbid
Cognitive performance	Memory	The difference between baseline and further follow-up score ranged from 1 to 3 marks.	1: Decreased 2: Static 3: Improved
	CDT	Difference between baseline and further follow up in terms of score, either 0 to 2 marks.	1: Decreased 2: Static 3: Improved

3.10 STATISTICAL ANALYSES

3.10.1 Descriptive Analysis

All statistical analyses were analysed using IBM SPSS Statistics, version 27. Descriptive analyses were performed on participants' characteristics and cognitive performance. For numerical data, normality assumptions were checked, and data were presented as mean and SD if normally distributed. For categorical data, the frequency and percentage were presented. Independent sample t-test and chi-square test were conducted to determine the background similarity between experimental and control groups.

3.10.2 Univariate Analysis

Categorical variables underwent analysis using the chi-square test, while numerical data were assessed using independent t-tests. The within-group analysis focused on determining the association between week of assessment (baseline, 4 weeks, and 12 weeks post-intervention) and cognitive performance (memory and CDT). Simultaneously, the between-group analysis aimed to identify the association between the intervention programme and cognitive performance. Participant scores were categorised as improved, static, or decreased. Statistical significance was set at $p < 0.05$.

3.10.3 Multivariate Analysis

The generalised estimating equation (GEE) was used for the analysis of repeated measurements as the type of outcomes in this study were categorical. The main advantage of GEE is that it can estimate population-averaged regression coefficients without bias, even if the correlation structure is not specified correctly (Ghisletta & Spini, 2004). The longitudinal associations between ACE programme and cognitive performance were assessed at baseline, week 4, and week 12 post-intervention. In this study, only participants with the complete data throughout all stages were included in the analysis.

The final sample size was 87 out of 100 participants who initially participated. Regression coefficients and a 95% confidence interval were reported, and the significance level was set at $p < 0.05$. During the analysis, the distribution of cognitive performance (memory and CDT) was set as "ordinal logistic" and the link function as logit, where the estimated outcome is the relative risk (RR). The working correlation structure was independent, as there was no missing data, and the follow-up period for each participant was similar.

3.11 ETHICAL CONSIDERATION

Prior to the commencement of study, ethical approval was obtained from the relevant institutional review board and ethics committee. The study was approved by the Kuliyyah of Nursing Postgraduate Research Committee dated 7 April 2022 and the International Islamic University of Malaysia (IIUM) Research Ethical Committee (IREC 2022-066), registered on 11 May 2022. The study protocol was reviewed by the ethics committee to ensure that the intervention adhered to ethical guidelines and standards for research involving human participants. Any ethical concerns or considerations raised during the review process were addressed and incorporated into the study design to protect the rights and welfare of the elderly.

Informed consent was acquired from each of participant before enrolment in the study. The participants were provided with detailed information about the study objectives, procedures, potential risks and benefits, and the rights as participants. Participants were given sufficient time to review the consent form, ask questions, and make an informed decision about their involvement in the study. Privacy and confidentiality were maintained where no personal information was disclosed. The researcher also sought consent from the participants to use their images, while ensuring that their real faces would not be revealed to be included in the thesis for research purposes.

Participant autonomy was respected throughout the research process. The participants were given the freedom to choose whether or not to participate in the study without any pressure. They were informed that they could withdraw from the study at any time without facing any negative consequences. Apart from that, the present study considered the potential risks and benefits associated with the programme for elderly populations. Risks such as physical strain from the exercise component or cognitive fatigue from the activities were minimized through tailored intervention plans and regular monitoring of participants' well-being. The benefits of the ACE programme including potential improvements in cognitive function and overall well-being were explained to participants to ensure they had a clear understanding of the potential positive outcomes of their participation.

3.12 SUMMARY

In summary, this chapter outlines the methodology employed in the study, including the design, participants, data collection methods, and data analyses. Figure 3.1 illustrates the flow of the study. The results of the intervention are presented and discussed in detail in the next chapter.

CHAPTER FOUR

RESULTS

4.1 INTRODUCTION

This chapter reports the findings of the study, which consists of four sub-sections including the process evaluation, baseline information, univariate analyses and multivariate analyses. The data of cognitive performance were grouped into categories. Thus, the patterns and trends of the results can be identified more efficient.

4.2 PROCESS EVALUATION

4.2.1 **Respond rate**

A total of 100 MCI elderly completed the baseline assessment (experimental group n = 50, control group n = 50). Seven participants were dropped from the experimental group, where three participants were lost to follow-up during the first assessment, and four were lost to follow-up the during the final assessment. Meanwhile, six participants dropped out from the control group; where four participants lost to follow-up during first assessment, and two were lost to follow-up at the end of the study. Therefore, only 87 participants (experimental group n = 43, control group n = 44) were included in the final analysis. The completion rate of the study was 87%.

4.3 BASELINE INFORMATION

4.3.1 **Sociodemographic characteristics and comorbidities status of participants**

The experimental and control group comprised 43 and 44 elderly with MCI. The mean age of all participants was 70.46 ± 6.8 years old. Most of them had at least a primary education level (n = 61, 70.1%). More than half (n = 47, 54.0%) were married, followed by 39 (44.8%) who were widowed, and only one participant was single. Approximately a quarter of the participants in this study are still working (n = 22, 25.3%), while the others are no longer working (n = 65, 74.75%). A total of 62 (71.3%) participants had comorbidities such as hypertension, diabetes, and high cholesterol. Only 25 (28.75%) of them were free from any diseases. The demographics and comorbidities of the participants in this study are shown in Table 4.1.

Table 4.1 Sociodemographic characteristics and comorbidities status of participants

	All (n=87)	**Experimental group (n=43)**	**Control group (n=44)**
Age (years), *mean ± (SD)*	*70.46 (6.8)*	*71.0 ± 6.0*	*69.9 ± 7.6*
Gender, n (%)			
• Male	22 (25.3%)	12 (54.5%)	10 (45.5%)
• Female	65 (74.7%)	31 (47.7%)	34 (52.3%)
Education level, n (%)			
• Primary school	61 (70.1%)	32 (52.5%)	29 (47.5%)
• Secondary school	26 (29.9%)	11 (42.3%)	15 (57.7%)
Marital status, n (%)			
• Single	1 (1.1%)	0 (0.0%)	1 (100.0%)
• Married	47 (54.0%)	23 (48.9%)	24 (51.1%)
• Widower	39 (44.8%)	20 (51.3%)	19 (48.7%)
Employment status:			
• Working	22 (25.3%)	8 (36.4%)	14 (63.6%)
• Not working	65 (74.75%)	35 (53.8%)	30 (46.2%)
Comorbidity:			
• Has comorbid	62 (71.3%)	32 (51.6%)	30 (48.4%)
• No comorbid	25 (28.7%)	11 (44.0%)	14 (56.0%)

4.3.2 **Cognitive performance assessment of participants**

In the Mini-Cog test, the maximum scores that participants could achieve for each task are 3 for Memory and 2 for Clock Drawing Test (CDT). At baseline, the mean score of cognitive performance for the participants' memory is 1.55 ± 0.89, while the mean score of the CDT is 0.34 ± 0.76. Table 4.2 shows the cognitive performance of participants at baseline, and Figure 4.1 presents the chart of the scores gained.

Table 4.2 Cognitive performance score of participants at baseline

Variables	**All (n=87)**	**Experimental group (n=43)**	**Control group (n=44)**
Cognitive performance, *mean ± (SD)*			
Mini-Cog test score:			
• Memory	*1.55 ± 0.89*	*1.6 ± 0.8*	*1.5 ± 1.0*
• Clock drawing test	*0.34 ± 0.76*	*0.3 ± 0.7*	*0.4 ± 0.8*

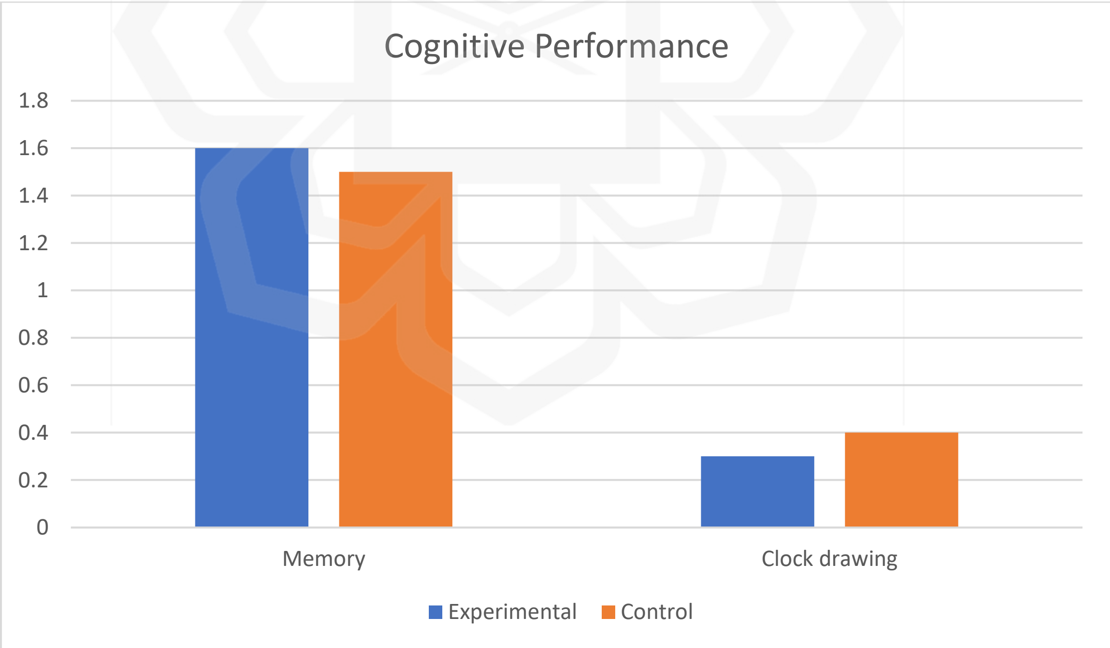

Figure 4.1 The score of cognitive performance in both groups at baseline

4.3.3 Comparison of sociodemographic characteristics, comorbidities and cognitive performance between experimental and control group

The baseline information was compared between the experimental and control groups. As shown in Table 4.3, independent t-test results revealed that the mean age of participants in both groups is similar at baseline, p = 0.469. The mean age is 71.0 ± 6.0 years old for the experimental group and 69.9 ± 7.6 years old for the control group. A total of 22 males were recruited from the study: 12 (54.5%) from the experimental group and 10 (45.5%) from the control group. Meanwhile, 65 female participants were involved in the study: 31 (47.7%) from the experimental group and 34 (52.3%) from the control group. No significant differences are observed between the groups in terms of gender at baseline, p = 0.628.

Many of the participants have primary education (n = 61): 32 (52.5%) from the experimental group and 29 (47.5%) from the control group. More participants in the control group had secondary school education (n = 15, 57.7%) than the experimental group (n = 11, 43.3%). However, no significant difference is observed in both groups in terms of education level, p = 0.484. A similar marital status characteristic is noted in the experimental and control groups, p = 1.000. More than half (n = 47, 54.0%) are married: 23 (48.9%) from the experimental group and 24 (51.1%) from the control group. Some participants are widowers (n = 39, 4.8%): 20 (51.3%) from the experimental group and 19 (48.7%) from the control group. Meanwhile, one (1.1%) participant from the control group is single.

The findings revealed no statistical difference in terms of employment status between both groups (p = 0.218). Out of 22 (25.3%) participants who are still working, 8 (51.6%) are from the experimental group, and 14 (63.6%) are from the control group. These participants were still engaged in agricultural or plantation-related work, overseeing the operations and maintenance of palm oil plantations. The statistical analyses showed no significant difference in the presence of comorbidity among the experimental and control groups, p = 0.637. A total of 32 (51.6%) participants with comorbidities are from the experimental group, while another 30 (48.4%) are from the control group. No statistical difference is noted in terms of score in the cognitive performance assessed by the Mini-Cog questionnaire between the two study groups: p = 0.585 for memory and p = 0.817 for CDT.

Overall, no significant differences in all these sociodemographic characteristics, comorbidities and cognitive performance were found between the experimental and control groups before the training. The descriptive analysis of the baseline data is shown in Table 4.3.

Table 4.3 Comparison of sociodemographic characteristics, comorbidities and cognitive performance between experimental and control group

Variables	**All (n=87) n (%)**	**Experimental group (n=43) n (%)**	**Control group (n=44) n (%)**	**p-value**
Age (years) ***mean*** **±** ***(SD):***	*70.46 (6.8)*	*71.0 ± 6.0*	*69.9 ± 7.6*	0.469^
Gender:				0.628º
• Male	22 (25.3%)	12 (54.5%)	10 (45.5%)	
• Female	65 (74.7%)	31 (47.7%)	34 (52.3%)	
Educational level:				0.484º
• Primary school	61 (70.1%)	32 (52.5%)	29 (47.5%)	
• Secondary school	26 (29.9%)	11 (42.3%)	15 (57.7%)	
Marital status:				1.000*
• Single	1 (1.1%)	0 (0.0%)	1 (100.0%)	
• Married	47 (54.0%)	23 (48.9%)	24 (51.1%)	
• Widower	39 (44.8%)	20 (51.3%)	19 (48.7%)	
Employment status:				0.218º
• Working	22 (25.3%)	8 (36.4%)	14 (63.6%)	
• Not working	65 (74.75)	35 (53.8%)	30 (46.2%)	
Comorbidity status:				0.637º
• Has comorbid	62 (71.3%)	32 (51.6%)	30 (48.4%)	
• No comorbid	25 (28.7%)	11 (44.0%)	14 (56.0%)	
Cognitive performance, ***mean*** **±** ***(SD):***				
• Memory	*1.55 ± 0.89*	*1.6 ± 0.8*	*1.5 ± 1.0*	0.585^
• Clock drawing test	*0.34 ± 0.76*	*0.3 ± 0.11*	*0.4 ± 0.8*	0.817^

The chi-square was used to compare categorical variables and t-test for continuous variables; ^Independent T-test ; ºPearson chi-square test; *Fisher's exact test

4.4 UNIVARIATE ANALYSIS

4.4.1 RQ 1: Are there associations between participants' characteristics and cognitive performance at week 4 and week 12?

An analysis of the association between characteristics of participants and cognitive performance was performed within the experimental and control groups. For the experimental group, the analysis demonstrated that all participants' characteristics, such as age, gender, level of education, comorbidity, marital and employment status, are not associated with the cognitive performance (i.e., memory and CDT score) at any time points of assessment, all $p > 0.05$. Tables 4.4 and 4.5 illustrate the association between participants' characteristics and cognitive performance in the experimental group.

Nevertheless, some characteristics are associated with cognitive performance in the control group. For example, the analysis revealed that at week 4 of assessment, comorbidity status ($p = 0.049$) and age ($p = 0.044$) are significantly associated with the memory test scores, while gender ($p = 0.08$) and employment status ($p = 0.024$) are significantly associated with the CDT scores. In contrast, at week 12 of assessment, an association between marital status and memory test scores among participants in the control group is noted, $p = 0.022$. The association of participants' characteristics and cognitive performance in the control group is shown in Tables 4.6 and 4.7.

Table 4.4 Associations between participants' characteristics and memory score in experimental group

Variables	From baseline to week 4			Chi-square/t value	P-value	From baseline to week 12			Chi-square/t value	P-value
	Improved	Static	Decreased			Improved	Static	Decreased		
Age (years) Mean ± SD	69.25±6.89	73.87±3.88	70.75±2.75	2.978	0.062[a]	71.44±6.01	67.33±5.69	65.00±0.00	1.166	0.322[a]
Gender:				3.736	0.225[b]				2.773	0.424[b]
• Male	6 (50.0%)	6 (50.0%)	0 (0.0%)			0 (0.0%)	0 (0.0%)	12 (100%)		
• Female	4 (12.9%)	9 (29.0%)	18 (58.1%)			1 (3.2%)	3 (9.7%)	27 (87.1%)		
Education level:				3.338	0.235[b]				0.680	1.000[b]
• Primary	4 (12.5%)	12 (37.5%)	16 (50.0%)			1 (3.1%)	2 (6.3%)	29 (90.6%)		
• Secondary	0 (0.0%)	3 (27.3%)	8 (72.7%)			0 (0.0%)	1 (9.1%)	10 (90.9%)		
Marital status:				0.024	1.000[b]				1.748	0.785[b]
• Single	11 (55.0%)	7 (35.0%)	2 (10.0%)			18 (90.0%)	2 (10.0%)	0 (0.0%)		
• Married	13 (56.5%)	8 (34.8%)	2 (8.7%)			21 (91.3%)	1 (4.3%)	1 (4.3%)		
Employment status:				2.676	0.235[b]				0.791	1.000[b]
• Working	3 (37.5%)	3 (37.5%)	2 (25.0%)			7 (87.5%)	1 (12.5%)	0 (0.0%)		
• Not working	21 (60.0%)	12 (34.3%)	2 (5.7%)			32 (91.4%)	2 (5.7%)	1 (2.9%)		
Comorbidity:				2.602	0.377[b]				0.680	1.000[b]
• Yes	17 (53.1%)	13 (40.6%)	2 (6.3%)			29 (90.6%)	2 (6.3%)	1 (3.1%)		
• No	7 (63.6 %)	2 (18.2%)	2 (18.2%)			10 (90.9%)	1 (9.1%)	0 (0.0%)		

[a]Independent T-test
[b] Likelihood Ratio

Table 4.5 Associations between participants' characteristics and CDT score in experimental group

Variables	From baseline to week 4			Chi-square/t value	P-value	From baseline to week 12			Chi-square/t value	P-value
	Improved	Static	Decreased			Improved	Static	Decreased		
Age (years) Mean ± SD	71.75±6.58	70.74±6.06	74.00±0.00	0.211	0.811[a]	70.47±5.90	71.24±6.29	74.00±0.00	0.202	0.818[a]
Gender:				1.035	0.761[b]				1.025	0.806[b]
• Male	0 (0.0%)	9 (75.0%)	3 (25.0%)			0 (0.0%)	8 (66.7%)	4 (33.3%)		
• Female	1 (3.2%)	25 (80.6%)	5 (16.1%)			1 (3.2%)	17 54.8%)	13 (41.9%)		
Education level:				1.680	0.568[b]				0.705	1.000[b]
• Primary	1 (3.1%)	24 (75.0%)	7 (21.9%)			1 (3.1%)	18 (56.3%)	13 (40.6%)		
• Secondary	0 (0.0%)	10 (90.9%)	1 (9.1%)			0 (0.0%)	7 (63.6%)	4 (36.4%)		
Marital status:					0.568[b]					
• Single	3 (15.0%)	16 (80.0%)	1 (5.0%)	1.800		8 (40.0%)	11 (55.0%)	1 (5.0%)	1.597	0.868[b]
• Married	5 (21.7%)	18 (78.3%)	0 (0.0%)			9 (39.1%)	14 (60.9%)	0 (0.0%)		
Employment status:					1.000[b]					
• Working	2 (25.0%)	6 (75.0%)	0 (0.0%)	0.632		5 (62.5%)	3 (37.5%)	0 (0.0%)	2.374	0.377[b]
• Not working	6 (17.1%)	28 (80.0%)	1 (2.9%)			12 (34.3%)	22 (62.9%)	1 (2.9%)		
Comorbidity:				1.217	0.745[b]				1.808	0.483[b]
• Yes	5 (15.6%)	26 (81.3%)	1 (3.1%)			11 (34.4%)	20 (62.5%)	1 (3.1%)		
• No	3 (27.3%)	8 (72.7%)	0 (0.0%)			6 (54.5%)	5 (45.5%)	0 (0.0%)		

[a]Independent T-test
[b] Likelihood Ratio

Table 4.6 Associations between participants' characteristics and memory score in control group

Variables	From baseline to week 4			Chi-square/t value	P-value	From baseline to week 12			Chi-square/t value	P-value
	Improved	Static	Decreased			Improved	Static	Decreased		
Age (years) Mean ± SD	67.50±5.89	73.50±9.49	69.33 3.08	3.241	**0.049**[a]	70.00±7.99	69.14±7.20	72.25±3.69	0.256 [b]	0.775[a]
Gender:				3.326	0.304[b]				2.543 [b]	0.316[b]
• Male	3 (30.0%)	4 (40.0%)	3 (30.0%)			4 (20.0%)	4 (40.0%)	2 (40.0%)		
• Female	3 (55.9%)	12 (35.3%)	19 (8.8%)			22 (5.9%)	10 (29.4%)	2 (64.7%)		
Education level:				4.542	0.156[b]				0.916 [b]	1.000[b]
• Primary	14 (48.3%)	13 (44.8%)	2 (6.9%)			17 (58.6%)	9 (31.0%)	3 (10.3%)		
• Secondary	8 (53.3%)	3 (20.0%)	4 (26.7%)			9 (60.0%)	5 (33.3%)	1 (6.7%)		
Marital status:				0.647	0.704[b]				8.958 [b]	**0.022[b]**
• Single	11 (55.0%)	6 (30.0%)	3 (15.0%)			16 (80.0%)	2 (10.0%)	2 (10.0%)		
• Married	11 (45.8%)	10 (41.7%)	3 (12.5%)			10 (41.7%)	12 (50.0%)	2 (8.3%)		
Employment status:				1.209	0.548[b]				0.199 [b]	1.000[b]
• Working	7 (50.0%)	4 (28.6%)	3 (21.4%)			8 (57.1%)	5 (35.7%)	1 (7.1%)		
• Not working	15 (50.0%)	12 (40.0%)	3 (10.0%)			18 (60.0%)	9 (30.0%)	3 (10.0%)		
Comorbidity:				7.019	**0.044[b]**				3.503 [b]	0.293[b]
• Yes	19 (63.3%)	8 (26.7%)	3 (10.0%)			19 (63.3%)	10 (33.3%)	1 (3.3%)		
• No	3 (21.4%)	8 (57.1%)	3 (21.4%)			7 (50.0%)	4 (28.6%)	3 (21.4%)		

[a]Independent T-test
[b] Likelihood Ratio

Table 4.7 Associations between participants' characteristics and CDT score in control group

Variables	From baseline to week 4			Chi-square/t value	P-value	From baseline to week 12			Chi-square/t value	P-value
	Improved	Static	Decreased			Improved	Static	Decreased		
Age (years) Mean ± SD	66.14±5.64	70.76±7.73	69.75±8.81	1.080	0.349[a]	67.71±6.40	70.14±7.81	74.00±8.49	0.592	0.558[a]
Gender:				8.729	**0.008[b]**				1.022	0.886[b]
• Male	3 (30.0%)	4 (40.0%)	3 (30.0%)			1 (10.0%)	8 (80.0%)	1 (10.0%)		
• Female	4 (11.8%)	29 (85.3%)	1 (2.9%)			6 (17.6%)	27 (79.4%)	1 (2.9%)		
Education level:				0.533	0.753[b]				1.908	0.504[b]
• Primary	5 (17.2%)	22 (75.9%)	2 (6.9%)			5 (17.2%)	22 (75.9%)	2 (6.9%)		
• Secondary	2 (13.3%)	11 (73.3%)	2 (13.3%)			2 (13.3%)	13 (86.7%)	0 (0.0%)		
Marital status:				3.629	0.224[b]				0.496	0.839[b]
• Single	1 (5.0%)	17 (85.0%)	2 (10.0%)			4 (20.0%)	15 (75.0%)	1 (5.0%)		
• Married	6 (25.0%)	16 (66.7%)	2 (8.3%)			3 (12.5%)	20 (83.3%)	1 (4.2%)		
Employment status:				8.535	**0.024**[b]				6.091	0.085[b]
• Working	0 (0.0%)	11 (78.6%)	3 (21.4%)			0 (0.0%)	13 (92.9%)	1 (7.1%)		
• Not working	7 (23.3%)	22 (73.3%)	1 (3.3%)			7 (23.3%)	22 (73.3%)	1 (3.3%)		
Comorbidity:				5.050	0.125[b]				3.122	0.312[b]
• Yes	6 (20.0%)	20 (66.7%)	4 (13.3%)			6 (20.0%)	22 (73.3%)	2 (6.7%)		
• No	1 (7.1%)	13 (92.9%)	0 (0.0%)			1 (7.1%)	13 (92.9%)	0 (0.0%)		

[a]Independent T-test
[b] Likelihood Ratio

4.4.2 **RQ 2: Are there significant differences in cognitive performance of the elderly receiving ACE programme at baseline with week 4 and week 12?**

The table 4.8 below illustrates that 24 of 43 (55.8%) participants in the experimental group have improved memory scores when observed from baseline to week 4. The memory scores of 4 (9.3%) participants decreased at week 4, while 15 (34.9%) of them remained with the same score. After 12 weeks, the number of participants with improved memory scores increased (n = 39, 90.7%), 3 (7.0%) remained with the same score, and 1 (2.3%) decreased. The difference is statistically significant, indicating there is an association between time of assessment (week 4 and week 12) and memory score ($p < 0.043$). As for the CDT, 8 (18.6%) participants in the experimental group had improved scores, 34 (79.1%) had the same score, and only 1 (2.3%) declined in terms of score performance after 4 weeks of receiving the intervention. After 12 weeks, the CDT results demonstrated an increasing trend in the number of participants with improved memory (n = 17, 39.5%), 1 (2.3%) participant had a declining score, and 25 (58.1%) had similar scores. From Table 4.8, it can be seen that the number of participants who improved in CDT scores from baseline to week 4 and from baseline to week 12 are significantly different ($p < 0.001$), indicating there is a significant association between the time of assessment (week 4 vs week 12) with the CDT scores.

Table 4.8 Cognitive performance score of experimental group between baseline and post-intervention assessment

Variables	**From baseline to week 4[&] n (%)**	**From baseline to week 12[&] n (%)**	**Chi-square value**	**P-value**
Memory test				
• Decrease	4 (9.3%)	1 (2.3%)		
• Static	15 (34.9%)	3 (7.0%)	9.028[b]	0.043
• Improved	24 (55.8%)	39 (90.7%)		
CDT				
• Decrease	1 (2.3%)	1 (2.3%)		
• Static	34 (79.1%)	25 (58.1%)	18.968[b]	<0.001
• Improved	8 (18.6%)	17 (39.5%)		

[&]Improved and no improvement are calculated as the outcome measure at follow-up minus the measure at baseline
[b]Likelihood Ratio

4.4.3 **RQ 3: Are there significant differences in the cognitive performance of the elderly without receiving ACE programme at baseline with week 4 and week 12?**

Table 4.9 presents an overview of memory and CDT score changes among participants who did not receive the ACE programme. Out of the 44 participants, 22 (50.0%) had improved memory scores after 4 weeks, 16 (36.4%) remained the same as baseline, and 6 (13.6%) had declining scores. At week 12, 26 (59.1%) participants in the control group had improved memory scores, with 14 (31.8%) of them exhibiting unchanged scores and 4 (9.1%) exhibiting decreasing scores. The difference is statistically significant, indicating there is an association between time of assessment (week 4 vs week 12) and memory score (p-value < 0.001). In regard to the CDT, 7 (15.9%) participants had improved scores, 33 (75.0%) had similar scores, and 4 (9.1%) had declining scores from baseline to week 4. Meanwhile from baseline to week 12, a total of 7 (15.9%) participants had improved scores, 35 (79.5%) participants had similar scores, while 2 (4.5%) had declining scores. There is no significant change is observed in the number of participants who had improvement from baseline to week 4 and from baseline to week 12 in terms of CDT score among control group (p = 0.505).

Table 4.9 Cognitive performance score of control group between baseline and post-intervention assessment

Variables	From baseline to week 4[&] n (%)	From baseline to week 12[&] n (%)	Chi-square value	P value
Memory test				
• Decrease	6 (13.6%)	4 (9.1%)	21.572[b]	<0.001
• Static	16 (36.4%)	14 (31.8%)		
• Improved	22 (50.0%)	26 (59.1%)		
CDT				
• Decrease	4 (9.1%)	2 (4.5%)	4.031[b]	0.505
• Static	33 (75.0%)	35 (79.5%)		
• Improved	7 (15.9%)	7 (15.9%)		

[&]Improved and no improvement are calculated as the outcome measure at follow-up minus the measure at baseline
[b]Likelihood Ratio

4.4.4 **RQ 4: Are there significant differences in cognitive performance between experimental and control groups after 4 weeks and 12 weeks of ACE programme?**

4.4.4.1 Memory

The table 4.10 below presents no significant difference in memory scores between the experimental and control groups at week 4 of assessment (p = 0.827). Interestingly, a significant difference is observed in the memory score after the participants completed 12 weeks of intervention (p = 0.003). The results obtained from the statistical analyses of memory scores between both groups are shown in Table 4.10.

Table 4.10 Memory score between two study groups at different time points

Variables	Experimental group (n=43)			Control group (n=44)			Chi-square	p-value
	Scores at different time point[&]			Scores at different time point[&]				
	Decreased	Static	Improved	Decreased	Static	Improved		
Week 4	4 (9.3%)	15 (34.9%)	24 (55.8%)	6 (13.6%)	16 (36.4%)	22 (50.0%)	0.510 [b]	0.827
Week 12	1 (2.3%)	3 (7.0%)	39 (90.7%)	4 (9.1%)	14 (31.8%)	26 (59.1%)	12.257 [b]	0.003

[&]Improved and no improvement are calculated as the outcome measure at follow-up minus the measure at baseline
[b] Likelihood Ratio

4.4.4.2 CDT

Table 4.11 compares the CDT scores between the two study groups based on time of asssessment. The results indicate no significant difference in CDT scores between the experimental and control groups at week 4 (p = 0.523). However, there is a significant difference in CDT scores between these two groups at week 12 (p = 0.045).

Table 4.11 CDT score between two study groups at different time points

Variables	Experimental group (n=43)			Control group (n=44)			Chi-square	P-value
	Scores at different time point[&]			Scores at different time point[&]				
	Decreased	Static	Improved	Decreased	Static	Improved		
Week 4	1 (2.3%)	34 (79.1%)	8 (18.6%)	4 (9.1%)	33 (75.0%)	7 (15.9%)	1.998[b]	0.523
Week 12	1 (2.3%)	25 (58.1%)	17 (39.5%)	2 (4.5%)	35 (79.5%)	7 (15.9%)	6.229[b]	0.045

[&]Improved and no improvement are calculated as the outcome measure at follow-up minus the measure at baseline
[b] Likelihood Ratio

4.5 MULTIVARIATE ANALYSIS

4.5.1 The association between time of assessment (weeks 4 and 12) and study groups (experimental and control) towards memory score

The multivariate analysis indicates a significant difference between the experimental and control groups (p = 0.036) by adjusting for the time of assessment, age, gender, comorbidity, and marital and employment status. Furthermore, the analysis shows that those in the experimental group had better memory test scores than the control group (RR = 2.322, 95% CI: 1.057–5.101, p = 0.036). The result also shows significant difference between the week of assessment (week 4 vs week 12) and memory scores (RR = 8.225, 95% CI: 2.467–27.42, p < 0.001). These analyses show that by adjusting for the time of assessment, age, gender, comorbidity, and marital and employment status, the association between time of assessment and the study groups towards memory score remain significant, as shown in Table 4.12.

Table 4.12 Generalised estimating equations analysis to determine the association of memory score results within and between experimental and control groups

Variables	B	Standard error	RR (95% CI)	p-value
Week of assessment (follow up)				
• Week 12	2.107	0.614	8.225 (2.467-27.42)	<0.001
• Week 4 (ref)				
Group				
• Experimental	0.842	0.402	2.322 (1.057-5.101)	0.036
• Control (ref)				

[a]Improved and no improvement are calculated as the outcome measure at follow-up minus the measure at baseline
Dependent variable: memory
Adjusted for age, gender, level of education, marital status, employment status and the presence of comorbidity, time of assessment

4.5.2 **The association between time of assessment (weeks 4 and 12) and study groups (experimental and control) towards CDT score**

The results revealed a significant difference between the experimental and control groups in terms CDT scores by adjusting for time of assessment, age, gender, comorbidity, and marital and employment status (RR = 2.360, 95% CI: 1.037–5.372, p = 0.041). The results also showed a significant difference in terms of CDT scores between week 4 and week 12 (RR = 1.882, 95% CI: 1.047–3.385, p = 0.035). These analyses show that by adjusting for the time of assessment, age, gender, comorbidity, and marital and employment status, the association between time of assessment and the study groups towards CDT score are significant, as shown in Table 4.13.

Table 4.13 Generalised estimating equations analysis to determine the association of CDT score results within and between experimental and control groups

Variables	B	Standard error	RR (95% CI)	p-value
Week of assessment (Follow up)				
• Week 12	0.633	0.300	1.882 (1.047-3.385)	0.035
• Week 4 (ref)				
Group				
• Experimental	0.859	0.420	2.360 (1.037-5.372)	0.041
• Control (ref)				

[a]Improved and no improvement are calculated as the outcome measure at follow-up minus the measure at baseline
Dependent variable: CDT
Adjusted for age, gender, level of education, marital status, employment status and the presence of comorbidity, time of assessment

4.6 SUMMARY

This chapter presents the results of the intervention, highlighting the effects of the ACE programme on the cognitive performance of elderly individuals with MCI.

CHAPTER FIVE

DISCUSSION

5.1 INTRODUCTION

This chapter discusses the key findings of the home-based ACE programme targeted for the elderly with MCI in the FELDA community. It elucidates the characteristics of MCI elderly in agricultural land in Pahang, the effects of the ACE programme in enhancing the cognitive performance of the elderly with MCI, and the strengths and limitations of the study.

5.2 CHARACTERISTICS OF FELDA ELDERLY WITH MCI

This study recorded 87 elderly with a mean age of 70.46. The participants' age was comparable to the studies by Li et al. (2019) in China and Devenney et al. (2019) in Germany, where on average the participants were 70.4 and 70.5 years old. This may be related with the results reported in a study in China, which identified that the risk of getting MCI is nearly three times higher in persons aged 70–79 than in those aged 60–69 (Xu et al., 2020). Likewise, a community-based cross-sectional study conducted in Malaysia revealed noteworthy positive correlations between MCI and participants of an older age group (Kamarolzaman et al., 2016). This is because as people age, their brain tissue starts to shrink and their physiological function gradually decreases (Xu et al., 2020). Brito et al. (2023) futher indicated that synaptic complexity and white matter volumes of the brain reduced during ageing, leading to functional impairments that affect brain plasticity and function. According to Brito et al. (2023), older individuals tend to experience decreased neuronal activation compared to younger individuals.

The gender distribution in this study is significantly imbalanced, with 74.7% of participants being females and only 25.3% males. This pattern is consistent with other studies, supporting the notion that a greater proportion of females tend to participate in health-related research. For instance, Cardalda et al. (2019) from Spain and Kim et al. (2021) from Korea reported similar gender distributions in their intervention studies, with around 70% of elderly participants being females.

In another study conducted in Korea by Lee et al. (2020), a substantial 84.6% of participants were females. Meanwhile, Devenney et al. (2019) and Cox et al. (2019) noted that half of the participants in their intervention study were females. This may be related to the fact that the prevalence of MCI was higher in women than in men (Lin et al., 2015; Liu et al., 2022). In Malaysia, Lee et al. (2012) indicated that women may have a higher risk of developing MCI due to hormonal changes during menopause and a higher prevalence of certain risk factors such as depression and anxiety. Meanwhile other studies stated that the potential influence of genetic factors such as the APOE ε4 genotype (Lin et al., 2015), sleep disturbance, social isolation, and comorbid disabilities were associated with a higher risk of MCI in women (Burke et al., 2019). In addition, a report from United Nations (2020) revealed that women tend to live longer than men on average, and thus may explain the high proportion of females elderly in most of studies.

In addition, the present study found that participants with primary education accounted for a higher percentage (70.1%) than secondary education. Notably, none of them attained a tertiary education. Similarly, in Korea, Kim et al. (2021) found that 88.8% of their participants attained less than 12 years of education. Poor education among the participants in this study is likely the result of the priority given by FELDA to select poor Malay families from rural areas for the FELDA scheme (Mehmet, 1982). Mehmet (1982) revealed that the first FELDA generation comprised of over 96% of Malays, and their usual educational background extends up to six years of primary schooling. Consistent with the findings from Ramely and Harith (2018), the majority of the elderly in Malaysia possess low levels of education, with only 7.5% having pursued tertiary education. This can be explained by the historical context of education in Malaysia, including the lack of awareness about the importance of higher education and the limited availability of financial assistance for pursuing studies at higher levels (Ramely & Harith, 2018).

Meanwhile, the educational attainment of Korean elderly in the study of Kim et al. (2021) may be related to the place of study. The participants were recruited from community Dementia Reassurance Centers in Korea, where it is possible that individuals with lower levels of education may be more likely to seek out these types of services. However, the small sample size, which is less than nine participants may also contribute to the signficant imbalance of the education level among participants in the study of Kim et al. (2021).

Contradictory to the findings of the present study, Zhu et al. (2018) in China reported that 88.3% had minimum secondary education and went to university. In 1990, a significant proportion of older people in China did not have any formal education, with 70.45% of the older population falling into this category. However, by 2010, the proportion of older people without any education had declined to 22.5%, reflecting a significant decrease in the number of older individuals who had not received formal education. This improvement in educational attainment among the older population suggests progress in expanding access to education in China over the years (Han et al., 2020).

Cox et al. (2019) in Australia also claimed that their participants were well-educated, with an average of 14.16 years of education. According to Australian Institute of Health and Welfare (2023), older Australians living in major cities were more likely to have a bachelor degree or postgraduate qualification as their highest educational attainment compared to those living in remote and very remote areas. The report found that 16% of older Australians in major cities had a bachelor degree or postgraduate qualification, while only 5.6% of older Australians in remote and very remote areas had the same level of educational attainment. Given that the study was conducted in Melbourne, which is the capital of the Australian city, it is possible that the high proportion of participants with high education attainment in this study may be related to the location of the study.

Individuals in rural areas may find it difficult to pursue a higher education, where issues like poor infrastructure, limited resources, and socio-economic factors limit their chances for personal and professional growth. Mohd Aznan et al. (2019) added that they were unable to obtain a proper education due to the struggles and poverty in their childhood. According to Mehmet (1982), the occupations of the FELDA elderly before entering the scheme were reported as paddy farmers, rubber smallholders, or having a background as ex-servicemen. In the present study, a quarter (25.3%) of the participants in this study were employed, with most of them reporting that they were still involved in monitoring the palm oil plantation.

The employment status is consistent with a survey by the (Institute for Public Health [IPH], 2019). The survey revealed that 26.4% of the elderly population remained employed, while 73.6% were unemployed. With regard to marital status, more than half (54.0%) of the participants in this study were married, followed by 44.8% were widower. The possible explanation for this finding may be related to the selection criteria for the first generation of FELDA, i.e., the settlers must be married. There were 7.7% of men and 92.3% of women in the widowed category. According to recent data from DOSM (2023), Malaysian women have a greater life expectancy than Malaysian men, with 77.4 and 72.5 years, respectively. This disparity could explain why there are more female widowers participate in the study.

As for comorbidity status, a high percentage (71.3%) of the participants have comorbidities, such as diabetes and hypertension. As stated by Mordarska and Godziejewska-Zawada (2017), type 2 diabetes and prediabetes become more common as people become older. The two main causes of hyperglycemia are aging-related insulin secretion deficiencies and increasing insulin resistance brought on by sarcopaenia and changes in body composition (Mordarska & Godziejewska-Zawada, 2017). Similarly, the artery vasculature undergoes several structural and functional alterations as a person ages (Oliveros et al., 2020).

Certain underlying mechanisms, such as mechanical hemodynamic alterations, arterial stiffness, neurohormonal and autonomic dysregulation, and ageing kidney, are associated with hypertension in the elderly (Oliveros et al., 2020). Kim (2023) indicated that cardiovascular disease risk is significantly increased with age. Ismail et al. (2016a) added that individuals residing in rural areas with only a primary school education had a consistently higher prevalence of hypertension and cholesterol levels than those with higher levels of education residing in urban areas. Likewise, Fiatarone Singh et al. (2014), in their SMART study, noted that the most common chronic conditions of their participants were hypertension (42%) and diabetes (11%).

Cultural beliefs, practices, and environmental factors within the FELDA community may influence cognitive health and well-being of the elderly. The educational background and historical context in Malaysia play a role in cultural attitudes toward aging. Since the majority of elderly individuals in FELDA have low levels of education, this might influence their perception of aging and cognitive health. For example, Goodson et al. (2021) found that perceptions about dementia among rural Malaysians are influenced by low awareness levels, indicating a need for increased education and outreach efforts in these areas. Environmental factors in rural areas such as limited access to healthcare services also may influence cognitive function among the elderly population. In previous studies, it was found that individuals in rural settings have been found to have higher prevalence of certain health conditions like hypertension and diabetes (Ismail et al., 2016), highlighting the impact of living conditions on cognitive health.

5.3 THE EFFICACY OF THE HOME-BASED PROGRAMME ON COGNITIVE PERFORMANCE

Cognitive performance is often classified into four general processes: (1) memory, (2) attention, (3) language, and (4) executive functioning (Harvey, 2019). Other ways of classifying cognitive performance are based on regional brain functions, including the frontal lobe, temporal lobe, parietal lobe, hippocampus, and other structures (Harvey, 2019). According to Cheng (2016), the hippocampus and pre-frontal cortex are vulnerable to grey matter reduction over time, making the brain network less efficient.

The hippocampus plays a vital role in learning and memory (Li et al., 2017), while the pre-frontal cortex is crucial for performing complex executive function tasks such as planning, problem solving, and decision making (Theill et al., 2013). This research investigated the cognitive functioning of patients with MCI based on the scores of these two domains: memory and executive function. Overall, the results show that participation in the ACE programme is significantly associated with better memory and executive function based on 3-word recall and CDT scores.

The participant's memory performance was measured using a three-word recall test, the first subsection in the Mini-Cog questionnaire. Both univariate and multivariate analyses found significant differences in memory scores between the experimental and control groups at 12 weeks post-intervention, showing that the experimental group outperformed the control group. Particularly, the multivariate analysis revealed that the experimental group was 2.322 times more likely to have improved memory scores than the control group after adjusting for the time of assessment, age, gender, comorbidity, and marital and employment status. The result of this study is comparable to Yu et al., (2021), who found that the intervention group that underwent computerised cognitive training followed by physical activity for 12 weeks improved their memory more than the control group. A study by Anderson-Hanley et al. (2018) also documented that 12 weeks of in-home-trial interactive Physical and Cognitive Exercise System (iPACES) yielded a significant increase in the memory score of MCI patients who completed training compared to patients without completed doses. The performance for executive function was determined based on CDT scores. In the present study, univariate analysis of CDT scores revealed no significant difference between experimental and control groups from baseline to week 4.

As from baseline to week 12, the analysis showed there is a higher number of participants from experimental group improved in CDT compared to control group, and the difference was statistically significant. The result remains significant at multivariate analysis after adjustment for relevant confounders. The multivariate analysis revealed that the experimental group was 2.36 times more likely to have improved CDT scores than the control group. The improvement of CDT scores in the experimental group implies better executive function following the ACE programme. The findings align with the results of meta-analyses by Guo et al. (2020), which indicated that the control group experienced less substantial improvements in executive functions compared to the combined physical and cognitive interventions.

Furthermore, Donnezan et al. (2018) compared the advantages of combined training with those obtained from cognitive and physical training alone. The results of their research demonstrated a statistically significant difference in the improvement of executive function between the combined and single groups. In Thailand, Sungkarat et al. (2018) discovered that the tai chi group performed significantly better on memory-delayed recall and executive function tests than the control group. Additionally, the improvement in CDT scores may also suggest that the intervention not only effecttive to improve executive function among elderly with MCI, but also had a positive impact on other cognitive domains related to visuospatial abilities. This is because, CDT is not only used to assess cognitive skills such as executive functions and memory, but also visuospatial abilities (Claus et al., 2023; Reiner et al., 2017; Talasila & Vijaya Kumari, 2022). This makes CDT act as a valuable tool for screening cognitive impairment alongside the MMSE (Claus et al., 2023).

The difference in cognitive performance between the experimental and control groups could be attributed to several factors. Firstly, the results might be related to the aerobic exercise performed by participants in the experimental group. This is because the release of BDNF from the brain is a well-documented phenomenon during exercise (Arazi et al., 2021; Valenzuela et al., 2020; Jeon & Ha, 2015). BDNF, a crucial neurotrophin, plays a pivotal role in various aspects of neuronal function, including survival, differentiation, and synaptic plasticity (Miranda et al., 2019; Arazi et al., 2021; Valenzuela et al., 2020). These effects are mediated by several mechanisms, including increased neuronal activity, activation of intracellular signaling pathways, and enhanced blood flow and oxygen delivery to the brain (Ruiz-González et al., 2021). Devenney et al. (2019) discovered that the concentration of BDNF significantly increased in MCI patients who performed a short bout of high-intensity aerobic exercise, whereas the BDNF level in the resting control condition group was decreased.

In another randomised controlled trial, Ten Brinke et al. (2015) reported that the hippocampus volume increased by 4.1% in the aerobic training group compared to other training. Notably, BDNF has been identified as a key contributor to the persistence of long-term memory storage (Valenzuela et al., 2020) and is instrumental in neuroplasticity, the brain's ability to reorganize itself by forming new neural connections throughout life (Miranda et al., 2019; Ruiz-González et al., 2021; Arazi et al., 2021). According to Foster (2015), aerobic exercise increases BDNF levels and increases the volume of the anterior hippocampus selectively in older humans. This effect is observed in the dentate gyrus, which is known to be an area susceptible to neurogenesis, as well as the subiculum and CA1 subfields, which are responsible for encoding spatial memory. Other than that, physical exercise has been demonstrated to enhance the secretion of growth hormone, consequently stimulating the production of IGF-1 (Arazi et al., 2021).

The IGF-1 is a crucial growth factor known for its modulation of synaptic plasticity, synapse density, neurotransmission, and adult neurogenesis. IGF-1 plays a vital role in the growth and differentiation of neuronal units within the brain, mediating the regulation of genes associated with BDNF-related neurogenesis and serving as a key factor in growth and differentiation during neural development. Positioned at the upper part of a signaling pathway, IGF-1 acts as a carrier regulating the expression of BDNF (Jeon & Ha, 2015). Some studies also suggest that consistent aerobic exercise increases the growth of blood vessels (Gaertner et al., 2018) and blood flow in the brain (Biazus-Sehn et al., 2020; Fonte et al., 2019; Rashid et al., 2020). For example, Steventon et al. (2020) found that a single aerobic exercise session is sufficient to produce transient changes in hippocampal perfusion. A subgroup analysis showed that VEGF levels rose after aerobic training, likely because of the rise in capillarity after exercise, known as angiogenesis (Morland et al., 2017).

The VEGF is a protein that plays a crucial role in promoting the formation of blood vessels and vascular tissues, particularly in the hippocampus and skeletal muscle, and is associated with improved memory and cognitive function (Kang et al., 2020). The increased density of capillaries provides increased oxygen and nutrient supply to the brain (Perrey, 2013); hence, they could precede changes in cognition. Physical exercise has also been shown to have a positive effect on NGF levels. A study by Sari & Vakili (2022) showed that after 8 weeks of circuit training, serum NGF levels among women elderly increased significantly. The mechanism by which exercise increases NGF levels is not fully understood, but it is believed to be related to the release of IGF-1 in response to exercise. Exercise-induced increases in blood flow and oxygen delivery to the brain may also contribute to the increase in NGF levels (Sari & Vakili, 2022).

Regarding psychological well-being, prior research has documented the benefits of physical exercise in reducing depression. Even though the primary aim of the current study was not to examine the psychological implications, the potential benefit of exercise on depressive symptoms is vital because cognitive decline is commonly associated with late-life depression. For example, Zhao et al. (2021) demonstrated that elderly with MCI who participated in square dance interventions experienced improvements in cognitive function and a reduction in depressive symptoms. Additionally, Tortosa-Martínez et al. (2018) indicated that engaging in physical exercise has a positive impact on managing chronic stress and normalizing cortisol regulation, accompanied by improvements in cognitive function. This is because excessive levels of cortisol over time decreasing levels of BDNF, hippocampal volumes and cognitive function, all considered risk factors for developing cogntive decline. The stress hypothesis suggests that the cognitive benefits associated with exercise could be mediated by changes in cortisol secretion (Tortosa-Martínez et al., 2018).

Another possible explanation regarding the improved cognitive performance in the experimental group might be due to the engagement in cognitive activities. The cognitive intervention applied in this study consisted of mentally stimulating activities that included writing, calculation, and maze exercises. Ghisletta (2006, cited in Hussin, 2019) stated that mental activity correlates with improved executive function, language, memory, and cognitive abilities, as well as a diminished perception of speed reduction. In a recent longitudinal study among the Malaysian elderly, Hussin et al. (2019) indicated that a one-unit increase in mental activity was associated with a 10% reduction in the risk of cognitive decline during the one-and-a-half-year follow-up period. In China, mental activity was correlated with enhanced global cognition, language proficiency, and executive function (Wang et al., 2013). According to van Balkom et al. (2020), the brain undergoes changes in neural activity and connectivity patterns during cognitive activities. Cognitive activities-induced changes occur mainly in neural networks important for cognitive function such as hippocampus and seem to counteract dysfunctional activation and connectivity patterns associated with aging and neurodegenerative diseases. This convergence of evidence provides a strong basis for the potential of cognitive activities as a non-pharmacological intervention for improving cognitive functioning in aging and neurodegenerative diseases.

Cheng (2016) classified that reading, writing, and board games as leisure activities, and claiming that leisure activities build cognitive reserve. Cognitive reserve means the brain can tolerate atrophies and insults, delaying symptom onset by compensating for tissue or functional loss with harder neurons. The hypothesis that cognitive reserve posits that life experience can impact synaptic organisation and neural processing by enabling more efficient, adaptable, and plastic neurological processes, thereby enabling some individuals to cope with the progressive pathology of dementia more effectively than others (Wang et al., 2013). For example, the maze exercises required the elderly to find a path from start to finish. Cognitive and motor processes such as attentional, visuospatial, visuomotor, and executive functions were needed to complete the mazes (Nef et al., 2020). Enhancing pre-frontal network efficiency through executive function training (e.g., working memory) protects brain function against cognitive decline. Additionally, Damirchi et al. (2018) discovered that after 24 sessions of computerised mental training, elderly women with MCI showed an improvement in cognitive abilities and serum BDNF levels. The same reasoning as the elevation of BDNF level in physical exercise may be replicated to explain why the experimental group had better cognitive function scores than the control group.

5.4 DURATION OF THE STUDY

In this study, both univariate and multivariate analyses demonstrated significant associations between week of assessment (week 4 and week 12) and memory score. Based on the longitudinal analysis, participants who received training for 12 weeks were 8.225 more likely to have improved memory score than those without training. The memory score showed no significant changes in both groups at week 4 post-intervention. Similarly, previous experimental studies that were conducted for more than 12 weeks showed positive outcome on cognitive performance.

For example, United Nations Department of Economic and Social Affairs Population Division (2019) explored the impact of multicomponent physical exercise and cognitive training on cognitive performance in elderly for six months, and followed by a one year follow-up. The study involved three groups: a dance and memory training group, a memory training group, and a physical training group. Cognitive performance was evaluated using a test battery assessing transfer to different cognitive domains. The results indicated that multicomponent simultaneous cognitive–physical training programs contributed to maintaining episodic memory and processing speed over the course of one year.

Other than that, Shimada et al. (2018) conducted a 40-week programme of combined cognitive and physical activity for an experimental group, while a control group participated in a 40-week health education program. They found that combined activity group exhibited significantly greater score changes on the MMSE and Wechsler Memory Scale-Revised Logical Memory II, indicating positive effects on memory and cognitive function compared to the control group. In contrast to the present findings, Shin et al. (2020) examined the effects of process-based cognitive training revealed that the intervention had significant effects in memory after 4 weeks. These effects were maintained at the 4-week follow-up assessment (eight weeks from baseline). Given that the process-based cognitive training specifically targeted working memory and cognitive control, the effectiveness of this intervention on memory may be attributed to its focus on these specific cognitive processes. In comparison, the implementation of the present ACE programme was not specific to the memory function. Therefore, the positive improvement of memory scores may be observed in the study of Shin et al., (2020) even though within a short duration.

As for CDT, the analyses also showed that there was also association between week of assessment (week 4 and week 12) and CDT scores. It was found that experimental group were 1.882 more likely to have improved CDT scores at week 12 rather than week 4 post-intervention. This finding is similar to the research of United Nations Department of Economic and Social Affairs Population Division (2017) which participants in the intervention group demonstrated significantly better performance at the end of the 12-week trial, with improvements in executive function, attention, and abstraction subtests of the MoCA. Besides, WHO (2021) who investigated the impact of a 24-month physical activity intervention on cognitive outcomes in sedentary older adults revealed that participants aged 80 years and older showed better performance on executive function tasks after the physical exercise intervention. These evidences from previous studies support the present findings which proposed that the effects of home-based physical exercise and cognitive interventions may be observed at 12 weeks or longer, instead of 4 weeks.

It is possible that the effects of the interventions were not fully apparent at the 4-week assessment due to the relatively short duration of the intervention period. The ACE programme may require a longer period of time to produce significant cognitive benefits. Additionally, the participants may have needed more time to master the challenges of the interventions and to fully reap the benefits of the enhanced exercise experience. On the contrary to the results of the present study, Biazus-Sehn et al. (2020) indicated that the duration of the intervention was not a significant moderator of the physical exercise effects on executive function. Surprisingly, the meta-regression analysis demonstrated a negative correlation between the length of the trial and executive function, indicating that higher effects were observed in shorter studies (Biazus-Sehn et al., 2020). They indicated that apart from study duration, another factors such as the specific intervention methods, the characteristics of the participants, and the frequency of the training might also influence the outcome.

For example, Department of Statistics Malaysia (2021) stated that executive function and attention were improved in their study was due to the characteristics of the games in the training program, which required selective attention, inhibition of task-irrelevant stimuli, divided attention, and planning or decision-making. These elements were likely responsible for the improvement in executive function and attention. Moreover, in a systematic review of home-based programmes, Jenkins et al. (2021) discovered that interventions integrating several neurocognitive domains substantially improved function in MCI patients. Govindakumari et al. (2020) implemented a combination of activities in their study, including visual aid-assisted memory exercises, transfer tasks, name presentations, time and space orientation exercises, and visual and auditory attention exercises. After 4 weeks, they found that the home-based cognitive intervention resulted in significant improvement in cognitive function of patients who received the intervention compared to the control group. Wang et al. (2013) in their study suggested that a greater variety of activities offered more protective effects on cognitive function than a fewer variety.

Moreover, the intensity and frequency of physical and cognitive activities may also be important factors in improving cognitive function in older adults. Shorter studies may have focused on more intensive or concentrated exercise interventions, which could have led to more pronounced cognitive effects within the shorter timeframe. For example, Govindakumari et al. (2020) conducted the intervention for one hour per session compared to only 30 minutes per session in the present study. As suggested by Guo et al. (2020), the best intervention impact was achieved with medium session durations (>30 min to 60 min) and low frequency (≤3 sessions/week). Therefore, the intensive intervention in the study of Govindakumari et al. (2020) might also play a role in contributing to the improvement. Other than that, the characteristics of participants such as their baseline cognitive status and overall health may have influence the cognitive performance. Education background is a potential confounding factor that could have influenced the outcomes of the study in elderly with MCI. Higher levels of education have been linked to greater cognitive reserve, potentially influencing the response to interventions targeting cognitive function.

Overall, the duration of the study appears to have played a significant role in the observed enhancements in cognitive performance. It contributes novel insights, suggesting that a short duration of less than four weeks may not be adequate to yield cognitive benefits from the ACE programme. Existing systematic reviews, such as those by Gheysen et al. (2018) and Gavelin et al. (2021), support the idea that interventions of varying durations can be beneficial for cognitive function in the elderly. However, it is noteworthy that none of the studies in these reviews had a duration of less than 4 weeks; the minimum duration was 6 weeks. Further research is needed to validate these findings. Therefore, the best duration can be implemented to design effective interventions.

5.5 METHODOLOGICAL CONSIDERATION

5.5.1 Limitations

There were a number of limitations need to be addressed in this study. Initially, the participants were not randomized due to practical and logistical reasons. Therefore, the cause-and-effect relationships could not be established with the same level of certainty as randomized experiments. Nonetheless, the quasi-experimental design adopted in this study can demonstrate strong links between variables. The study's homogeneity in participant baseline characteristics suggests that despite the lack of randomization, it could improve the comparability of the two groups. Implicit in this approach is the assumption that the greater the similarity between groups, the smaller the likelihood that confounding will threaten inferences of causality of effect for the intervention. This also helps mitigate bias concerns and ensures that observed differences between groups are attributed to the studied intervention rather than pre-existing differences. Furthermore, the long-term cognitive gains have not been investigated because there was no follow-up following the end of the programme. Physical exercise and activities aim not just to induce short-term benefits but to ensure that these improvements are sustained over an extended period. Therefore, longer studies are essential to provide a greater knowledge of the sustainability of cognitive benefits following programme termination.

Another notable limitation involves the criteria for participant inclusion, which relied on the utilisation of the Mini-Cog screening instrument. In an effort to identify individuals with MCI, this study employed the Mini-Cog as a primary screening tool for elderly individuals aged 60 years and above. Participants who did not achieve a perfect score on the Mini-Cog were selected, assuming potential MCI status. However, it is crucial to acknowledge that this screening method represents a single facet of cognitive assessment, lacking comprehensive consideration of other contributory factors. The reliance on a singular screening instrument, without additional diagnostic measures, introduces a limitation in the accuracy of MCI diagnosis. Consequently, while our findings contribute valuable insights into the effects of the ACE programme, the results necessitate cautious interpretation due to the inherent limitations associated with a reliance on a singular screening test for participant selection.

Additionally, the participants' completion rate of intervention was self-reported. There is a possibility that the participants are likely to demonstrate satisfactory performance in terms of attendance and may be less inclined to report incomplete homework to the researcher. Furthermore, discussion among participants might occur regarding the tasks given even though they were reminded not to do so. Since the intervention was conducted in a home-based setting and the attendance was recorded in the logbook themselves, this is a challenge that needs to be tackled in future studies. Plus, for the memory test, there is also a possibility that the participants might have the initiative to memorise the words by jotting down the notes of the question or preparing beforehand for repeated assessments. This could be a bias that the researcher could not measure and control. However, the CDT was added to the instruments, knowing that brief memory tests can produce too many false positives. The CDT was challenging to memorise among the elderly, unlike the 3-word recall. It has been statistically proven that experimental group had much improved CDT scores and this test can give more weightage to the improvement. Given these limitations, it is also crucial to interpret the conclusions of quasi-experimental studies with caution.

5.5.2 **Strengths**

A noteworthy strength of this study lies in its adoption of a home-based approach for both physical exercise and cognitive activities. This delivery method presents several advantages, particularly for individuals with busy schedules, limited mobility, or those who prefer the comfort of their homes for training. The home-based approach aims to overcome barriers such as transportation challenges and scheduling conflicts, which often hinder elderly from participating in in-person training programs. This approach eliminates the need for travel to healthcare or fitness centers, addressing issues related to cost, time, and energy, especially in areas with limited fitness facilities. Moreover, a home-based exercise programme has the potential to enhance long-term adherence by making it convenient for participants to incorporate exercise routines into their daily lives, while also encouraging family involvement in practicing healthy lifestyles.

Notably, the study's findings suggest that a duration of four weeks or shorter may not be sufficient for observing improvements in cognitive function, emphasizing the importance of longer durations. However, challenges related to movement limitations among the elderly could impact long term adherence to the intervention. Despite this, the study demonstrates the effectiveness of the home-based approach, making it a viable method to promote long-term adherence. The inclusion of longitudinal analysis is another strength of the study, enabling the examination of the relationship between duration of the training and cognitive performance at two distinct time points—four weeks and twelve weeks post-intervention. This approach enhances the robustness of the study's findings by providing insights into the potential duration to design the intervention.

Besides, given that the FELDA community has a high proportion of elderly, the study on the risk reduction of dementia among elderly with MCI was still limited. Hence, by concentrating on the FELDA community, the present study addresses this population's specific needs and challenges. This targeted approach allows for a more tailored intervention, recognizing the cultural, social, and economic background of FELDA elderly that might influence the feasibility of conducting physical exercise and cognitive intervention. Unlike previous studies, no high-end technology such as VR, exergames, telerehabilitation, video conferencing and computerised training was required for the elderly to conduct the home-based training. Creating an innovative or complex physical or cognitive intervention was not the goal of this study. Instead, this study implemented pragmatic approaches to leisure activities for aerobic exercise and cognitive intervention. These activities are easily accessible and readily adaptable to local culture, especially for the elderly population in rural areas.

According to Cheng et al. (2016), leisure activities are enjoyable and encouraging to the individual. Thus, it is more likely to last over time. They believe that these kinds of activities are timely, inexpensive, safe, and convenient interventions for the burgeoning incidence of dementia. In addition, cognitive decline, lack of technological skills, and lack of desire are barriers for the elderly to utilise the technology (Contreras-Somoza et al., 2022). Past researchers have proven that paper-and-pencil based has comparable effects with home-based electronic Constant Therapy applications (Marin et al., 2022), mobile-based multidomain intervention (Lee et al., 2023), and SmartTapestery devices (Maselli et al., 2019). Given that the income of the elderly reduces with age, Contreras-Somoza et al. (2022) noted that inexpensive device is also crucial to be considered. Approximately 88% of participants in the experimental group completed the intervention and had satisfactory adherence, demonstrating the practicality and feasibility of this strategy.

5.6 SUMMARY

In summary, the findings of the study adds to the growing body of evidence that ACE programme effectively improves cognitive performance. This study highlights the efficacy of combined physical exercise and cognitive activities interventions as risk reduction strategies for dementia. In addition, the present study underscores the necessity and practicality of remote delivery interventions, especially in rural areas where movement limitations exist. This emphasizes the importance of accessible cognitive health interventions for the rural population. The use of multivariate analyses to measure score changes within and between study groups adds methodological depth and rigor to the existing research on cognitive interventions and outcome assessments. The present study not only enhances our understanding about the benefits of physical exercise and cognitive activities on cognitive performance among elderly individuals with MCI, but also provides valuable insights that can facilitate the development of future interventions in this field.

CHAPTER SIX

CONCLUSION

This study reveals that the the ACE programme has improved cognitive performance among the elderly with MCI, and the time of assessment may influence the cognitive outcome. The effects of the ACE programme can be seen through the differences in memory and CDT scores from baseline to post-intervention and between experimental and control groups. This study also shows that the programme may help to reduce the risk of cognitive decline by providing better cognitive health through the implementation of physical exercise and cognitive intervention as recommended by WHO. While most of the previous studies were completed at healthcare and fitness centres, this study may stimulate further research in the future or serve as baseline information about the benefits of conducting leisure activities at home, particularly to combat non-communicable diseases (NCDs) such as dementia. Home-based interventions for cognitive impairment have shown promising results in improving cognitive performance, offering convenience and accessibility to individuals.

Research suggests that home-based cognitive training programs can be as effective as center-based programs in improving cognitive function, with the added benefit of being more cost-effective and convenient for individuals. The flexibility and personalized nature of home-based interventions may contribute to better adherence and engagement, potentially leading to more sustainable improvements in cognitive performance over time, as compared to those conducted in healthcare or fitness centers. It is noteworthy that a significant number of participants are aware of the health benefits of exercise but are not aware of the effects simple exercises might have on cognitive performance. Apart from improving this study with better methodological quality, future studies should explore the main components that can motivate the community to practice healthy ageing during late adulthood, as it may also contribute to the success of dementia prevention programmes. A cost-effective analysis on the implementation of intervention at home setting should also be further explored since the rising cost of healthcare services is known as one of the challenges faced by the nation.

The present study is aligned with the third Sustainable Development Goal of the United Nations, which promotes mental health and well-being and targets to reduce premature mortality from NCDs by one-third through prevention and treatment by 2030. Additionally, this study supports the Government Health Research Priorities for the 12th Malaysia Plan 2021–2025 under older people's health issues, which highlights the need for the research to assist in the planning of preventive activities for the high-risk groups based on evidence-based interventions, as well as in the treatment and management of dementia. The 12th Malaysia Plan 2021–2025 aims to address the rising incidence of NCDs and promote an active lifestyle.

Therefore, it is hoped that the findings of this study, together with its list of limitations and recommendations, could provide some evidence for the policymakers, such as the Ministry of Health and the Ministry of Women, Family and Community Development, to achieve the goals. This study could also be a reference to be used by the Ministry of Health personnel for Clinical Practice Guideline (CPG), related agencies, non-governmental organisations (NGOs), senior centres, as well as caregivers of the elderly with MCI to implement physical exercise and cognitive activities in local settings. The necessity of remote delivery interventions and ensuring continuity of treatment for patients with cognitive impairment has been highlighted by the recent COVID-19 emergency. By implementing this approach, healthcare could shift the services focus to the community level rather than tertiary care. Thus, it may reduce dementia cases among older people, which consequently could also reduce the dependency on caregivers and subsequent nursing home and hospital admission.

6.1 RECOMMENDATION

To ensure the validity of physical exercise and cognitive activities interventions for dementia prevention, future studies should implement rigorous research designs, such as randomized controlled trials. This will contribute to methodological improvements in this area. Additionally, researchers should include larger sample sizes in their studies to allow for more representative results and increase the generalizability of findings. Exploring the long-term effects of these interventions on cognitive function and quality of life would also be valuable, along with incorporating long-term follow-ups into study designs to provide insights into sustained effects.

Furthermore, conducting qualitative studies to explore participants' experiences and perspectives in the programme could yield meaningful understanding. Considering environmental factors that may influence intervention effectiveness is important; thus understanding how cultural norms and living environments impact implementation and outcomes is essential for developing targeted approaches. Motivating factors related to practising healthy aging during late adulthood should also be explored. Finally, it’s vital for future studies to consider economic implications by exploring cost-effectiveness and potential impacts on healthcare systems. These considerations need collaboration with policymakers and healthcare professionals toward effective implementation strategies at a larger scale benefitting individuals at risk from dementia. The insights from the study can also inform the development of evidence-based guidelines and recommendations for healthcare professionals as well as policymakers by emphasizing the importance of implementing multifaceted interventions to address aging-related cognitive decline.

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APPENDICES

APPENDIX I: QUALITY APPRAISAL

Criteria used to determine the rigor of the methodology and analysis used in the selected articles.

Research Design	Assessment criteria
Randomized Controlled Trial (RCT)	Q1- Was true randomization used for the assignment of participants to treatment groups? Q2- Was allocation to treatment groups concealed? Q3- Were treatment groups similar at the baseline? Q4- Were participants blind to treatment assignment? Q5- Were those delivering treatment blind to treatment assignment? Q6- Were outcomes assessors blind to treatment assignment? Q7- Were treatment groups treated identically other than the intervention of interest? Q8- Was follow-up complete, and if not, were differences between groups in terms of follow-up adequately described and analysed? Q9-Were participants analysed in the groups to which they were randomized? Q10- Were outcomes measured in the same way for treatment groups? Q11- Were outcomes measured in a reliable way? Q12- Was appropriate statistical analysis used? Q13- Was the trial design appropriate, and any deviations from the standard RCT design (individual randomization, parallel groups) accounted for in the conduct and analysis of the trial?

Quasi-experimental	Q1- Is it clear in the study what is the 'cause' and what is the 'effect' (i.e., there is no confusion about which variable comes first? Q2- Were the participants included in any comparisons similar? Q3- Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest? Q4- Was there a control group? Q5- Were there multiple measurements of the outcome both pre and post the intervention/exposure? Q6- Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analysed? Q7- Were the outcomes of participants included in any comparisons measured in the same way? Q8- Were outcomes measured in a reliable way? Q9- Was appropriate statistical analysis used?
Systematic Reviews and Research Syntheses	Q1- Is the review question clearly and explicitly stated? Q2- Were the inclusion criteria appropriate for the review question? Q3- Was the search strategy appropriate? Q4- Were the sources and resources used to search for studies adequate? Q5- Were the criteria for appraising studies appropriate? Q6- Was critical appraisal conducted by two or more reviewers independently? Q7- Were there methods to minimize errors in data extraction? Q8- Were the methods used to combine studies appropriate? Q9- Was the likelihood of publication bias assessed? Q10- Were recommendations for policy and/or practice supported by the reported data? Q11-Were the specific directives for new research appropriate?

Summary of quality appraisal of the included studies using the Joanna Briggs Institute Scale

Author	**Research design**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Q11**	**Q12**	**Q13**	**Percentage of criteria fulfilled (%)**
(Jurakic et al., 2017)	RCT	/	/	X	/	UC	UC	UC	/	/	/	/	/	/	90
(Hong et al., 2018)	RCT	/	UC	/	UC	UC	UC	/	X	X	/	/	/	/	78
(Cardalda et al., 2019)	RCT	/	/	/	UC	UC	/	/	/	/	/	/	/	/	100
(Bisbe et al., 2020)	RCT	/	/	X	UC	UC	/	/	/	X	/	/	/	/	82
(H. Kim & Shim, 2018)	QE	/	UC	UC	X	/	/	/	/	/					86
(Peng et al., 2019)	RCT	/	X	/	/	/	UC	/	X	X	/	/	/	/	75
(B. Y. Li et al., 2019)	RCT	/	UC	X	/	X	/	/	/	/	/	/	/	/	83
(Thapa et al., 2020)	RCT	/	/	X	X	UC	/	/	/	/	/	/	/	/	83
(Hagovska & Nagyova, 2017)	RCT	/	/	/	/	X	/	/	/	/	/	/	/	/	92
(J. S. Park et al., 2020)	RCT	/	/	/	UC	UC	UC	/	X	X	/	/	/	/	80
(Sungkarat et al., 2017)	RCT	/	/	/	/	X	X	/	/	/	/	/	/	/	85
(Zhao et al., 2021)	QE	X	/	/	/	/	/	/	/	/					89
(Zhu et al., 2018)	RCT	/	/	/	UC	UC	/	/	/	X	/	/	/	/	91
(Doi et al., 2017)	RCT	/	X	/	X	/	/	/	/	/	/	/	/	/	85

Notes: RCT=Randomized Controlled Trial, QE=Quasi Experimental, UC=Unclear

APPENDIX II: EXPERT VALIDATION

CHAIR AEROBIC EXERCISE

Expert comments on MODUL SENAMAN DUDUK WARGA EMAS.

Thank you very much for such a clear one-to-one step module with series of pictures describing each physical movement. This module still able to incorporate the element of warming up and cooling down for its beginning and end. From my understanding, this module is concise and able to fulfill following components specifically confined for elderly in physical activity:

- Safety: Safety is paramount when designing physical activity modules for the elderly. The activities in this module are low-impact and tailored to the individual's fitness level.
- Accessibility: The activities also noted to be accessible to all elderly individuals, regardless of their physical abilities or limitations.
- Effectiveness: This physical activity module is believed improve overall health and functional ability in the elderly. This includes promoting cardiovascular health, muscle strength, flexibility, balance, and coordination.
- Enjoyment: I believed with some element of background music, this module is able to let the elderly participants enjoy and find engaging. This increases adherence to the program and promotes long-term participation.
- Variety: This module provides a variety of activities that can prevent boredom and monotony, keeping participants motivated and engaged.
- Flexibility: Recognizing that the needs and abilities of elderly participants may change over time, this module is able to be flexible enough to accommodate adjustments as needed.

Shaiful Ehsan

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COGNITIVE ACTIVITIES

Expert comments on MODUL LATIHAN KOGNITIF WARGA EMAS.

Thank you very much for such a comprehensive module. There are elements of numbers, sequence, mathematical operation, maze and general knowledge in this module. This multiple cognitive assessment module is believed to detect the improvement of respondents' cognitive function after adequate training or even detect any deterioration. As none of the items are similar or repeated in nature, therefore each assessment is unique on its own and unable to be memorized by the respondents for the answer. This criterion makes this assessment more robust and precise.

Overall, this module would definitely be great in assessing attention and concentration, problem-solving and decision-making, brain teasers, word searches, or vocabulary-building exercises. All these can be good brain training exercises that are useful for cognitive training.

Nevertheless, there are some elements that I find probably unnecessary for all elderly on topic "Rukun Islam". These would depend on the patient's education and religious practice level (that need to be individualized).

Shaiful Ehsan

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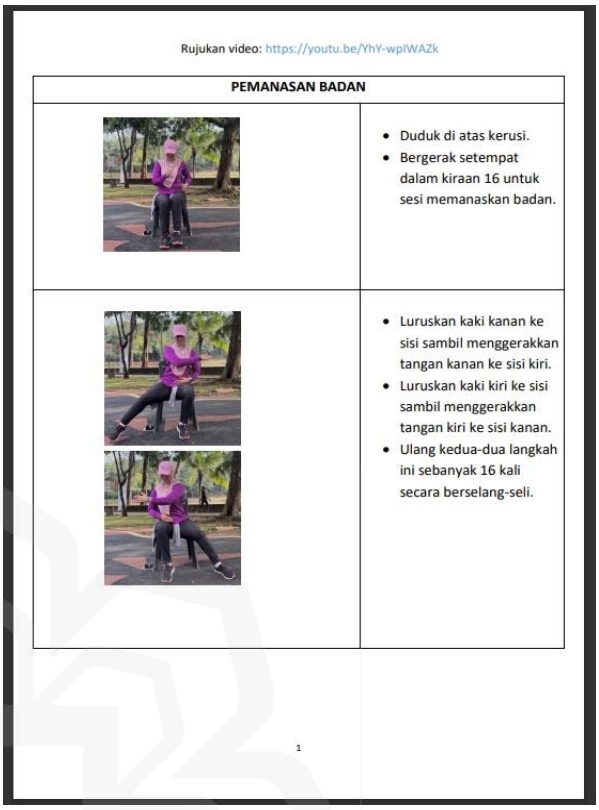
APPENDIX III: ACTIVITY BOOKLET

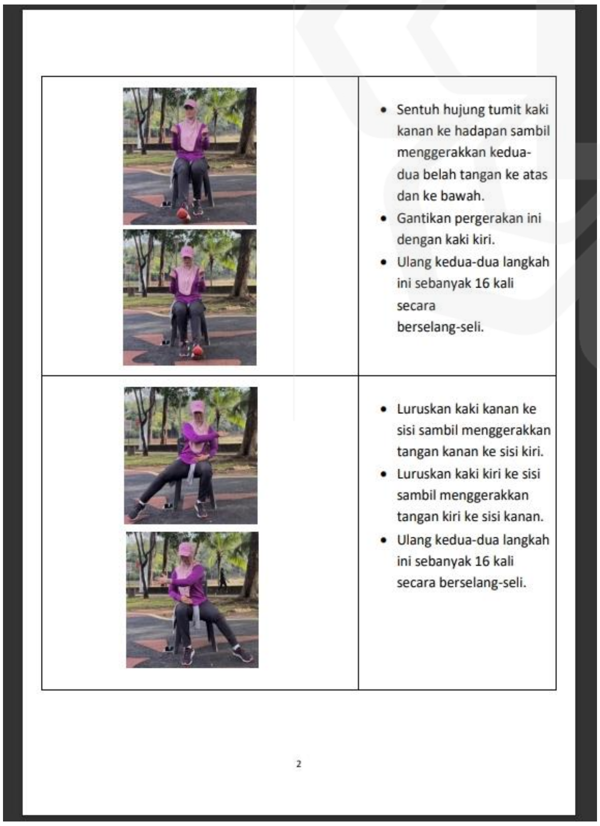
MODUL SENAMAN DUDUK WARGA EMAS



Rujukan video: https://youtu.be/YhY-wplWAZk

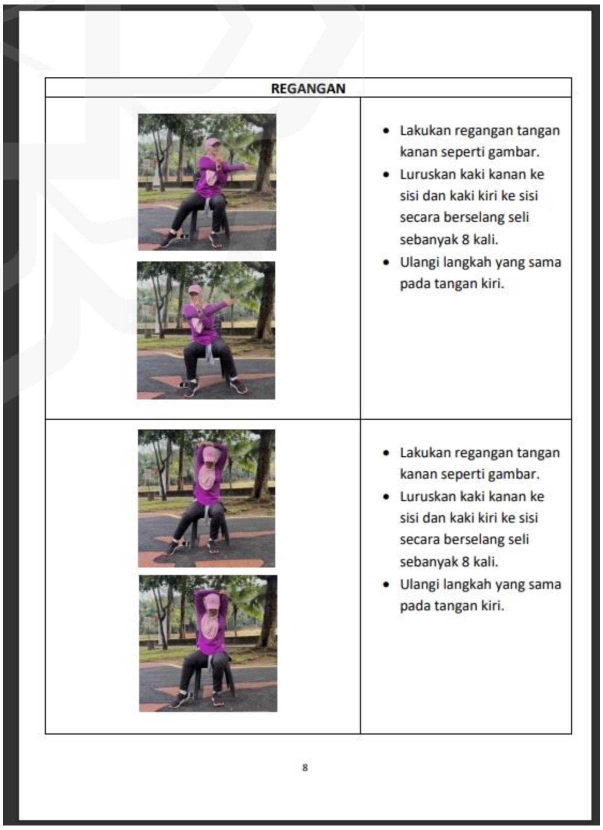
PEMANASAN BADAN	
	• Duduk di atas kerusi. • Bergerak setempat dalam kiraan 16 untuk sesi memanaskan badan.
	• Luruskan kaki kanan ke sisi sambil menggerakkan tangan kanan ke sisi kiri. • Luruskan kaki kiri ke sisi sambil menggerakkan tangan kiri ke sisi kanan. • Ulang kedua-dua langkah ini sebanyak 16 kali secara berselang-seli.

1



	• Sentuh hujung tumit kaki kanan ke hadapan sambil menggerakkan kedua-dua belah tangan ke atas dan ke bawah. • Gantikan pergerakan ini dengan kaki kiri. • Ulang kedua-dua langkah ini sebanyak 16 kali secara berselang-seli.
	• Luruskan kaki kanan ke sisi sambil menggerakkan tangan kanan ke sisi kiri. • Luruskan kaki kiri ke sisi sambil menggerakkan tangan kiri ke sisi kanan. • Ulang kedua-dua langkah ini sebanyak 16 kali secara berselang-seli.

2



REGANGAN	
	• Lakukan regangan tangan kanan seperti gambar. • Luruskan kaki kanan ke sisi dan kaki kiri ke sisi secara berselang seli sebanyak 8 kali. • Ulangi langkah yang sama pada tangan kiri.
	• Lakukan regangan tangan kanan seperti gambar. • Luruskan kaki kanan ke sisi dan kaki kiri ke sisi secara berselang seli sebanyak 8 kali. • Ulangi langkah yang sama pada tangan kiri.

8

	• Lakukan regangan tangan kanan seperti gambar. • Luruskan kaki kanan ke sisi dan kaki kiri ke sisi secara berselang seli sebanyak 8 kali. Ulangi langkah yang sama pada tangan kiri.
	• Luruskan kaki kanan ke depan dengan hujung tumit mencecah ke lantai. • Letakkan kedua-dua belah tangan di pinggang selama 8 saat. • Kembalikan kaki kanan ke posisi asal. • Gunakan tangan kanan untuk tarik hujung kaki kanan sambil meluruskan dan membengkokkan tangan kiri ke sisi sebanyak 8 kali.

	• Luruskan kaki kiri. • Gerakkan hujung kaki kiri ke atas dan ke bawah sebanyak 8 kali sambil menggerakkan kedua-dua belah tangan ke atas dan ke bawah secara berselang-seli. • Gerakkan hujung kaki kiri ke kiri dan kanan sebanyak 8 kali sambil menyilangkan kedua-dua belah tangan ke kiri dan kanan secara berselang-seli.
	• Berdiri tegak. • Bengkokkan kaki kanan ke belakang dan gunakan tangan kanan untuk memegang kaki kanan sambil meluruskan dan membengkokkan tangan kiri ke sisi sebanyak 8 kali. • Bengkokkan lutut kiri dan luruskan kaki kanan sambil mendepakan dan membengkok kedua-dua belah tangan ke sisi 8 kali.

Rujukan video: https://youtu.be/OWKiZGTGlgE

PENYEJUKAN BADAN	
	• Lakukan setiap pergerakan di bawah menggunakan kaki kanan dalam kiraan 8 bagi setiap pergerakan. • Ulangi langkah ini pada kaki kiri.
	• Lakukan setiap pergerakan di bawah menggunakan kedua-dua belah kaki dalam kiraan 8 bagi setiap pergerakan.

MODUL
LATIHAN
KOGNITIF
WARGA EMAS

Tarikh:

LATIHAN 1

PENGIRAAN

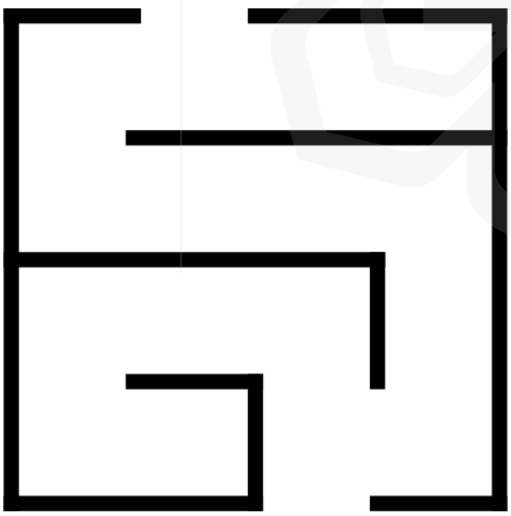
1. Apakah nombor selepas nombor 1?
   ____
2. Apakah nombor sebelum nombor 3?
   ____
3. Apakah nombor selepas nombor 3?
   ____

PENULISAN

Senaraikan 5 perkataan bermula huruf B

1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________

4 by 4 orthogonal maze



Tarikh:

LATIHAN 15

a) PENGIRAAN

Anda diminta untuk mengira dengan menambah 5 daripada 100, dan kemudian, teruskan menambah 5 daripada jawapan yang anda dapat tersebut sebanyak lima kali.

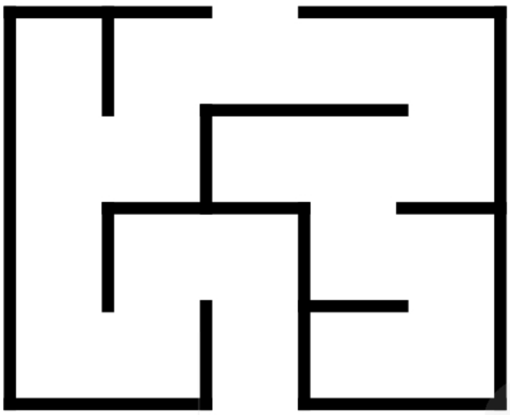
Jawapan: 100, 105, ____, ____, ____, ____, ____

b) PENULISAN

Kelaskan perkataan di bawah mengikut kumpulan yang betul.

1. Ayam goreng, Roti, Kek
   ____
2. Buku, Pen, Pemadam
   ____
3. Biru, Hijau, Ungu
   ____

5 by 4 orthogonal maze



Tarikh:

LATIHAN 36

a) PENGIRAAN

Kira jumlah bil air di bawah.

Februari RM 12.20

Mac RM 15.10

April RM 10.30

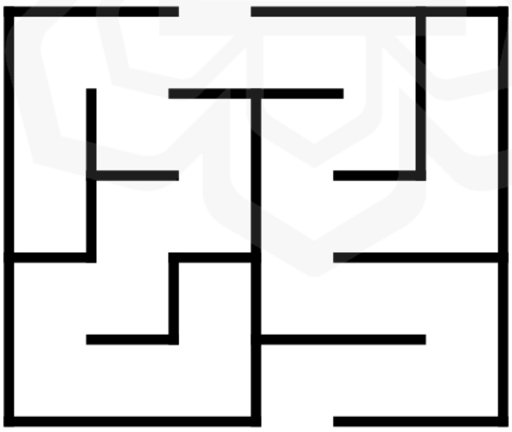
Jawapan: _____________

b) PENULISAN

Tuliskan resepi masakan kampung kegemaran anda secara ringkas.

____
____
____
____
____

6 by 5 orthogonal maze



APPENDIX III: QUESTIONNAIRE

PART A: CHARACTERISTICS OF PARTICIPANTS

ID: ____________________

BAHAGIAN A:
Bahagian ini mengandungi data demografi. Sila tandakan (√) pada kotak yang disediakan.

1. Umur :_________________________

2. Jantina

Lelaki	
Perempuan	

3. Status perkahwinan

Bujang	
Berkahwin	
Bercerai	
Balu	

4. Tahap Pendidikan

Tidak bersekolah	
Sekolah rendah	
Sekolah menengah	
Kolej/Universiti	
Lain-lain (Sila Nyatakan):	

5. Pekerjaan

Tidak bekerja:	
Masih berkerja:	
Lain-lain (Sila Nyatakan):	

6. Status masalah kesihatan

Darah tinggi	
Kencing Manis	
Anemia	
Jantung	
Asthma	
Sakit buah pinggang	
Arthritis	
Gout	
Sawan	
Lain-lain: (Sila nyatakan)	

PART B: MINI-COG TEST

TARIKH__________ ID__________UMUR_____JANTINA L / P LOKASI ________________PEMERIKSA_____________ TAHAP PENDIDIKAN SUBJEK____________

Development of a novel objective assessment of unilateral spatial neglect post-stroke, A TesT of Unilateral spatial Neglect (ATTUNE): A pilot normative study

Cognition screening tool: MINI-COG ™

1) **Dapatkan perhatian pesakit lalu katakan: " Bolehkah saya menyemak memori anda? Ini akan membawa kepekatan tertentu. Saya akan mengatakan tiga perkataan yang saya mahu anda ingat sekarang dan juga kemudian. Perkataannya adalah**

   Rambutan Angin beg

   Katakanlah perkataan-perkataan tersebut kepada saya sekarang. (Boleh membentangkan perkataan hingga tiga kali jika perlu. Jika gagal setelah tiga percubaan, pergi ke item seterusnya).

   Serahkan subjek pen atau pensil, dan berikan sehelai kertas dengan dengan bulatan yang disediakan. Jangan tunjukkan halaman ini pada subjek.

2) **KATAKAN SEMUA FRASA BERIKUT DALAM ATURAN YANG DINYATAKAN: "Bulatan ini menyerupai muka jam. Sila lukiskan jam dengan meletakkan semua nombor di dalam bulatan." (Setelah selesai, katakan) "Sekarang, tetapkan tangan jam untuk menunjukkan 11:10 (10 minit selepas pukul 11)."** Jika subjek belum selesai lukisan jam dalam 3 minit, berhenti dan meminta perkataan-perkataan yang diberikan. Ambil perhatian bahawa anda mesti meminta perkataan-perkataan tersebut dan skor item yang diingat walaupun peserta tidak mengulangi perkataan tersebut semasa fasa pengulangan tadi.

3) **Kata: "Apakah tiga perkataan yang saya minta awak ingat?"** Tuliskan perkataan yang diberikan oleh peserta dalam ruang di bawah.

   ____________ ____________ ____________(Skor satu mata untuk setiap perkataan yang diingat dengan betul) Skor peringatan 3 perkataan ☐

   Skor lukisan jam (rujuk kebelakang mukasurat untuk arahan): Jam normal 2 mata; Jam tidak normal 0 mata. Skor lukisan jam ☐

Jumlah skor = Skor Peringatan Tambah Skor Jam ☐

0, 1 atau 2 = Kemungkinan besar kemerosotan kognitif yang penting secara klinikal

3, 4 atau 5 = Kemungkinan kecil kemerosotan kognitif yang penting secare klinikal

SKOR LUKISAN JAM

JAM NORMAL

JAM YANG NORMAL MEMPUNYAI KESEMUE ELEMEN BERIKUT:

Semua nombor 1 – 12, Setiap hanya sekali, dalam susunan dan arah yang betul (arah jam). Mempunyai dua tangan. Tangan pendek di nombor 11 dan yang panjang di nombor 2.

JAM YANG TIDAK MEMPUNYAI ELEMEN-ELEMEN BERIKUT DI ANGGAP TIDAK NORMAL. JIKA PERSERTA ENGGAN MELUKIS JAM JUGA DIANGGAP TIDAK NORMAL.

SOME EXAMPLES OF ABNORMAL CLOCKS (THERE ARE MANY OTHER KINDS)

Tangan jam tidak normal

Nombor yang hilang

PART C: INSTRUMENTAL ACTIVITIES OF DAILY LIVING (IADL)

Patient Name:____________________ **Date:**____________

Patient ID #______________________

LAWTON - BRODY
INSTRUMENTAL ACTIVITIES OF DAILY LIVING SCALE (I.A.D.L.)

Scoring: For each category, circle the item description that most closely resembles the client's highest functional level (either 0 or 1).

A. Ability to Use Telephone		**E. Laundry**	
1. Operates telephone on own initiative-looks up and dials numbers, etc.	1	1. Does personal laundry completely	1
2. Dials a few well-known numbers	1	2. Launders small items-rinses stockings, etc.	1
3. Answers telephone but does not dial	1	3. All laundry must be done by others	0
4. Does not use telephone at all	0		
B. Shopping		**F. Mode of Transportation**	
1. Takes care of all shopping needs independently	1	1. Travels independently on public transportation or drives own car	1
2. Shops independently for small purchases	0	2. Arranges own travel via taxi, but does not otherwise use public transportation	1
3. Needs to be accompanied on any shopping trip	0	3. Travels on public transportation when accompanied by another	1
4. Completely unable to shop	0	4. Travel limited to taxi or automobile with assistance of another	0
		5. Does not travel at all	0
C. Food Preparation		**G. Responsibility for Own Medications**	
1. Plans, prepares and serves adequate meals independently	1	1. Is responsible for taking medication in correct dosages at correct time	1
2. Prepares adequate meals if supplied with ingredients	0	2. Takes responsibility if medication is prepared in advance in separate dosage	0
3. Heats, serves and prepares meals, or prepares meals, or prepares meals but does not maintain adequate diet	0	3. Is not capable of dispensing own medication	0
4. Needs to have meals prepared and served	0		
D. Housekeeping		**H. Ability to Handle Finances**	
1. Maintains house alone or with occasional assistance (e.g. "heavy work domestic help")	1	1. Manages financial matters independently (budgets, writes checks, pays rent, bills, goes to bank), collects and keeps track of income	1
2. Performs light daily tasks such as dish washing, bed making	1	2. Manages day-to-day purchases, but needs help with banking, major purchases, etc.	1
3. Performs light daily tasks but cannot maintain acceptable level of cleanliness	1	3. Incapable of handling money	0
4. Needs help with all home maintenance tasks	1		
5. Does not participate in any housekeeping tasks	0		
Score		**Score**	

Total score________________

A summary score ranges from 0 (low function, dependent) to 8 (high function, independent) for women and 0 through 5 for men to avoid potential gender bias.

Source: *try this:* Best Practices in Nursing Care to Older Adults, The Hartford Institute for Geriatric Nursing, New York University, College of Nursing. www.hartfordign.org.

MaineHealth

APPENDIX IV: ETHICAL APPROVAL

الجامعة الإسلامية العالمية ماليزيا
INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA
Garden of Knowledge and Virtue

LEADING THE WAY
KHALIFAH • AMANAH • IQRA' • RAHMATAN LIL-ALAMIN | SUSTAINABILITY INSTITUTION OF THE YEAR

KULLIYYAH OF NURSING

Our Reference: IIUM/313/14/3/1
Date : 20 April 2022 / 18 Ramadan 1443H

Zurratul Aina Mohd Zahidin
G2027518
Postgraduate Student
Master of Health Science
Kulliyyah of Nursing IIUM

Dear Sr. Zurratul Aina,

APPROVAL OF RESEARCH PROPOSAL
- MASTER OF HEALTH SCIENCE

May this letter find you in the best of health.

With reference to the above matter, kindly be informed that your research proposal entitled *"The Effect of Home-Based Physical Exercise and Cognitive Training to Reduce the Risk of Dementia Among Elderly with Mild Cognitive Impairment"* has been approved by the Kulliyyah of Nursing Postgraduate and Research Committee (KNPGRC) No. 2/2022 dated 7th April 2022.

Kindly proceed with necessary action accordingly.

Thank you, والسلام

DR. MUHAMMAD KAMIL CHE HASAN
Dean
Kulliyyah of Nursing
International Islamic University Malaysia

cc : Deputy Dean (Postgraduate & Responsible Research)
Kulliyyah of Nursing

: Filing/ Student file

KULLIYYAH OF NURSING (KON)
International Islamic University Malaysia, Jalan Sultan Ahmad Shah, Bandar Indera Mahkota, 25200 Kuantan, Pahang Darul Makmur
(Company No: 101067-P)
Tel: +609 570 7300 Email: nursingadmin@iium.edu.my | www.iium.edu.my/kulliyyah/kon

LEADING THE WAY
KHALĪFAH · AMĀNAH · IQRA' · RAHMATAN LIL-'ĀLAMĪN | SUSTAINABILITY INSTITUTION OF THE YEAR

RESEARCH MANAGEMENT CENTRE (RMC)

Our Ref. : IIUM/504/14/11/2/ IREC 2022-066
Date : 16 June 2022

Asst. Prof. Dr. Norlinda Binti Abd. Rashid (Principal Investigator)
Kulliyyah of Nursing, IIUM Kuantan Campus
25200 Kuantan Pahang

Dear Asst. Prof. Dr.,

The IIUM Research Ethics Committee (IREC) has reviewed your study protocol as mentioned below:-

ID NO.	:	**IREC 2022-066**
RESEARCH TITLE	:	**The Effect Of Home-Based Physical Exercise And Cognitive Training To Reduce The Risk Of Dementia Among Elderly With Mild Cognitive Impairment**
REGISTRATION DATE	:	**11 May 2022**
CO-INVESTIGATOR	:	**Asst. Prof. Dr. Nurasikin Mohamad Shariff**
STUDY SITE	:	**Felda Sungai Panching Timur and Felda Bukit Goh**
SAMPLE SIZE	:	**100**
ETHICAL EXPIRY DATE	:	**16 June 2023**

The IIUM Research Ethics Committee (IREC) operates in accordance to the Declaration of Helsinki, International Conference of Harmonization Good Clinical Practice Guidelines (ICH-GCP), Malaysia Good Clinical Practice Guidelines and Council for International Organizations of Medical Sciences (CIOMS) International Ethical Guidelines

The following documents have been received and reviewed to the above study:-

1. Study Proposal/Protocol: Version 1, dated 10 May 2022
2. Informed Consent Form (ICF) –
   i. Information Sheet (Malay) – Version 2, dated 13 Jun 2022
   ii. Consent Form (Malay) - Version 2, dated 13 Jun 2022
3. Questionnaire - Version 1, dated 10 May 2022
4. Approval Letter from Kulliyyah of Nursing, IIUM
5. Principal Investigator's CV

Research Management Centre
International Islamic University Malaysia, Jalan Gombak, 53100 Kuala Lumpur
Telephone: (+603) 6421 5002 / 5010 | Fax: (+603) 6421 4862

PEJABAT FELDA BUKIT GOH
26050 KUANTAN,
PAHANG DARUL MAKMUR.

FELDA

No. Tel : 09-5478843
No. Faks : 09-5478843
Email : bktgoh.f@felda.net.my

Bil : (23) 3231/ 6-1
Tarikh : 01.07.2022

KEPADA :

SEMUA WARGA RANCANGAN FELDA BUKIT GOH

Tuan/Puan,

KEBENARAN MEMBUAT KAJIAN PENDUDUK (WARGA EMAS) DI DALAM RANCANGAN FELDA BUKIT GOH

Merujuk kepada perkara diatas, dimaklumkan bahawa pelajar dari Kulliyyah Kejururawatan UIAM Kuantan dalam proses menyiapkan projek Sarjana berkaitan Kesan Senaman Fizikal Dan Latihan Kognitif di Kalangan Warga Emas FELDA yang mempunyai kemerosotan kognitif ringan.

Oleh yang demikian, pihak pengurusan FELDA dengan ini memberi kebenaran kepada pelajar tersebut **Zurratul Aina Binti Mohd Zahidin (980424-06-5710)** dalam menjalankan aktiviti kajian di rumah peneroka dan juga kawasan blok.

Dengan ini besarlah harapan pihak kami agar semua komuniti dapat memberikan kerjasama dan komitmen yang baik agar dapat membantu beliau dalam menyelesaikan tugasan dengan jaya.

Sekian, terima kasih.

Yang Menjalankan Amanah,

....
(RADUAN BIN ROZALI)
RADUAN BIN ROZALI
PENGURUS
FELDA BUKIT GOH
26050 KUANTAN

FELDA BUKIT SAGU 01
25730 KUANTAN, PAHANG DARUL MAKMUR
TEL : 09-5479141
Email : bktsagu01.f@felda .net.my

Tarikh : 01 Julai 2022

Kepada:
SEMUA WARGA RANCANGAN FELDA BUKIT SAGU 01

Tuan/Puan,

PERKARA : KEBENARAN MEMBUAT KAJIAN PENDUDUK (WARGA EMAS) DI DALAM RANCANGAN FELDA BUKIT SAGU 01

Merujuk perkara diatas, dimaklumkan bahawa pelajar dari Kuliyyah Kejururawatan UIAM Kuantan dalam proses menyiapkan projek Sarjana berkaitan Kesan Senaman Fizikal Dan Latihan Kognitif di kalangan warga emas FELDA yang mempunyai kemerosotan kognitif ringan.

Oleh yang demikian, pihak pengurusan Felda Bukit Sagu 01 dengan ini memberi kebenaran kepada pelajar seperti nama dibawah dalam menjalankan aktiviti kajian di rumah peneroka dan juga kawasan blok. sehingga 31.01.2023.

Nama	: **Zurratul Aina Binti Mohd Zahidin**
No. Kad Pengenalan	: **980424-06-5710**

Dengan ini besarlah harapan pihak kami agar semua komuniti dapat memberikan kerjasama dan komitmen yang baik agar dapat membantu beliau dalam menyelesaikan tugasan dengan jaya.

Sekian, terima kasih.

Yang menjalankan amanah,

b/p

MOHD SHAHRIZAM BIN ABD HALIM
PENGURUS
Felda Bukit Sagu 01
26130 KUANTAN
Pahang Darul Makmur

APPENDIX V: INFORMED CONSENT

Version: 2

Date: 13/6/2022

TAJUK KAJIAN:
KESAN SENAMAN DAN LATIHAN KOGNITIF DALAM MENGURANGKAN RISIKO DEMENSIA DI KALANGAN WARGA EMAS YANG MEMPUNYAI KECACATAN KOGNITIF RINGAN

Kepada Tuan/Puan,

Bersama-sama ini disertakan satu set borang soal selidik untuk mengumpulkan maklumat tentang tahap fungsi kognitif dan Aktiviti Instrumental Kehidupan Seharian (*IADL*) di kalangan warga emas yang tinggal di komuniti FELDA.

Bilangan warga emas di dunia pada tahun-tahun kebelakangan ini menunjukkan peningkatan yang tinggi. Di Malaysia, peratus warga emas berumur 60 tahun ke atas dianggarkan sebanyak 10.7% pada tahun 2020 dan meningkat kepada 11.2% pada tahun 2021. Peratus ini dijangka akan mencecah sebanyak 15.3% menjelang 2030. Ekoran peningkatan kadar statistik ini, akan muncul pelbagai penyakit yang menyerang warga emas termasuklah masalah kognitif seperti demensia.

Oleh itu, kajian ini bertujuan untuk mengkaji kesan senaman dan latihan kognitif terhadap peningkatan fungsi kognitif warga emas yang mempunyai kecacatan fungsi kognitif ringan selepas 4 dan 12 minggu program dijalankan.

Anda telah terpilih sebagai peserta dalam kajian ini dan penyertaan anda adalah secara sukarela. Anda berhak menolak untuk menyertai kajian ini atau anda boleh menamatkan penyertaan anda pada bila-bila masa, tanpa sebarang hukuman atau implikasi kepada diri anda pada masa akan datang.

Segala maklumat anda yang diperolehi dalam penyelidikan ini akan disimpan dan dikendalikan secara sulit. Sekiranya hasil penyelidikan ini diterbitkan atau dibentangkan kepada orang ramai, identiti anda tidak akan didedahkan tanpa kebenaran anda terlebih dahulu. Hanya penyelidik yang terlibat sahaja dibenarkan untuk melakukan penelitian rekod, penyimpanan maklumat dan pemindahan data.

Borang soal selidik ini mengandungi tiga bahagian iaitu **Bahagian A: Maklumat Diri, B: Tahap fungsi kognitif dan C: Aktiviti Instrumental Kehidupan Seharian (*IADL*).** Pengisian borang soal selidik ini akan mengambil masa sehingga 15 minit. Sekiranya terdapat sebarang keciciran maklumat, pihak kami boleh menghubungi peserta tersebut.

Sebarang pertanyaan dan penerangan tentang kajian ini boleh didapati terus daripada penyelidik secara langsung semasa kajian dilakukan. Terima kasih atas kerjasama anda.

____

Tandatangan Penyelidik

KEIZINAN UNTUK MENYERTAI KAJIAN.

Saya telah di beri penerangan terhadap saya berkenaan maklumat di atas dalam bahasa yang saya fahami. Isi kandungan dan maksud maklumat tersebut telah diterangkan sepenuhnya kepada saya.

Saya telah mempunyai masa dan peluang untuk mengemukakan sebarang soalan mengenai kajian dan borang ini dan semua soalan saya telah dijawab. Saya telah membaca atau telah diterangkan kepada saya semua helaian borang keizinan ini dan semua risiko telah diterangkan.

Saya sukarela bersetuju untuk mengambil bahagian dalam kajian ini selama tempoh yang ditetapkan. Dengan menandatangani borang keizinan ini, saya mengesahkan segala maklumat yang saya berikan adalah benar dalam pengetahuan saya.

____

Tandatangan Peserta

KEIZINAN PENJAGA UNTUK MENYERTAI KAJIAN. (JIKA BERKAITAN)

Saya telah di beri penerangan terhadap saya berkenaan maklumat di atas dalam bahasa yang saya fahami. Isi kandungan dan maksud maklumat tersebut telah diterangkan sepenuhnya kepada saya.

Saya telah mempunyai masa dan peluang untuk mengemukakan sebarang soalan mengenai kajian dan borang ini dan semua soalan saya telah dijawab. Saya telah membaca atau telah diterangkan kepada saya semua helaian borang keizinan ini dan semua risiko telah diterangkan.

Saya bersetuju untuk membenarkan ibu atau bapa saya mengambil bahagian dalam kajian ini selama tempoh yang ditetapkan. Dengan menandatangani borang keizinan ini, saya mengesahkan segala maklumat yang saya berikan adalah benar dalam pengetahuan saya.

____

Tandatangan Penjaga