THE ASSOCIATION BETWEEN DIETARY INTAKE, LIPID AND GLUCOSE PROFILE, AND COGNITIVE FUNCTION AMONG OLDER ADULTS WITH POSSIBLE SARCOPENIA AND SARCOPENIA IN KELANTAN: A CROSS-SECTIONAL STUDY

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by

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Dissertation submitted in partial fulfilment of the

requirements for the degree of

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CERTIFICATE

This is to certify that the dissertation entitled The Association Between Dietary Intake, Lipid and Glucose Profile, and Cognitive Function Among Older Adults with Possible Sarcopenia and Sarcopenia in Kelantan is the bona fide record of research work done by Ms Nurul Syafiqa binti Abdullah during the period from October 2023 to July 2024 under my supervision. I have read this dissertation and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation to be submitted in partial fulfilment for the degree of Bachelor of Health Science (Honours) (Dietetics).

DECLARATION

I hereby declare that this dissertation is the result of my own investigations, except where otherwise stated and duly acknowledge. I also declare that it has not been previously or concurrently submitted for any other degrees at Universiti Sains Malaysia or other institutions. I grant Universiti Sains Malaysia the right to use the dissertation for teaching, research, and promotional purposes.

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ABSTRAK

Sarkopenia merupakan keadaan di mana seseorang mengalami pengurangan jisim dan kekuatan otot dan ia belaku seiring dengan penuaan. Pengambilan diet harian, profil glukosa dan lipid sangat berkait dengan fungsi kognitif dalam kalangan warga emas dengan risiko sarkopenia dan sarkopenia. Kajian ini bertujuan untuk menyelidiki perkaitan antara pengambilan diet harian, profil glukosa dan lipid dengan fungsi kognitif dalam kalangan warga emas dengan risiko sarkopenia dan sarkopenia di Kelantan. Kajian keratan rentas telah dijalankan dalam kalangan 92 warga emas menggunakan teknik persampelan mudah di beberapa daerah di Kelantan termasuk Tumpat, Pasir Mas, dan Kota Bharu, berumur 60 tahun ke atas. Daripada 92 subjek (51 lelaki dan 41 wanita), didapati bahawa 9 wanita (22.0%) dan 3 lelaki (5.9%) mengalami *dementia* manakala 13 wanita (31.7%) dan 13 lelaki (25.5%) *Mild Cognitive Impairmrent* (MCI). Sosio-demografi, sejarah perubatan, dan corak pengambilan diet harian dilengkapkan semasa sesi temuduga. *Diet History Questionnaire* (DHQ) digunakan untuk menilai pengambilan diet harian, *Montreal Cognitive Assessment* (MoCA) digunakan untuk mengesan disfungsi kognitif dan tanda-tanda awal *dementia* manakala *Hand Grip Strength* (HGS), *Skeletal Muscle Index* (SMI), dan *Short Physical Performance Battery* (SPPB) digunakan untuk melihat kekuatan otot dan prestasi fizikal. Walau bagaimanapun, tiada hubungan yang signifikan antara pengambilan diet harian, profil glukosa dan lipid kecuali *high density lipoprotein* (HDL). Dapatan kajian menunjukkan bahawa status kognitif sahaja yang signifikan dalam kalangan subjek (p=0.015). Bagi keputusan glukosa dalam darah, mediannya

ialah 5.60 mmol bagi lelaki manakala 5.30 mmol bagi perempuan dimana (p=0.546). Bagi keputusan profil lipid pula, hanya HDL yang signifikan dengan (p=0.001) dimana mediannya ialah 1.23 mmol untuk lelaki dan 1.50 mmol untuk perempuan. Keputusan profil lipid yang lain seperti trigliserida, lipoprotein berketumpatan rendah dan total kolesterol merupakan tidak signifikan. Selain itu, bagi keputusan setiap pengambilan makanan, semua makronutrien dan mikronutrien pula adalah tidak signifikan sama sekali. Oleh itu, kajian lanjut perlu dijalankan untuk memberikan pemahaman yang lebih jelas mengenai hubungan antara pengambilan diet harian, profil glukosa dan lipid dengan fungsi kognitif, kerana faktor-faktor ini berkait secara langsung dengan status fungsi kognitif.

THE ASSOCIATION BETWEEN DIETARY INTAKE, GLUCOSE AND LIPID PROFILE, AND COGNITIVE FUNCTION AMONG OLDER ADULTS WITH POSSIBLE SARCOPENIA AND SARCOPENIA IN KELANTAN: CROSS SECTIONAL STUDY

ABSTRACT

Sarcopenia is the age-related progressive loss of muscle mass and strength. Dietary intake, glucose and lipid profile are extremely related to the cognitive function among older adults with possible sarcopenia and sarcopenia. The aim of this study was to explore the association between dietary intake, lipid and glucose profile and cognitive function among older adults with possible sarcopenia and sarcopenia in Kelantan. A cross-sectional study was conducted among 92 older adults using convenience sampling technique in several districts in Kelantan including Tumpat, Pasir Mas, and Kota Bharu aged 60 years old and above. Out of 92 subjects (51 males and 41 females), it was discovered that 9 females (22.0%) and 3 males (5.9%) were having dementia while 13 females (31.7%) and 13 males (25.5%) had mild cognitive impairment (MCI). Socio-demographic background, medical history, and dietary intake pattern were included during the interview session. Diet History Questionnaire (DHQ) was used to assess the dietary intake, Montreal Cognitive Assessment (MoCA) was used to detect cognitive dysfunction and early signs of dementia while Hand Grip Strength (HGS), Skeletal Muscle Index (SMI), and Short Physical Performance Battery (SPPB) were used to see the muscle strength and physical performance. However, there are no significant associations between dietary intake, glucose profile and lipid profile except high density lipoprotein (HDL). The findings of this study demonstrated that cognitive status alone was significant among the participants (p=0.015). The blood glucose results show that the median is 5.60 mmol for males, while it is 5.30 mmol for females which (p=0.546). For the lipid profile,

only HDL is significant with (p=0.001), where the median is 1.23 mmol for males and 1.50 mmol for females. Other lipid profile results include as triglycerides, low-density lipoproteins (LDL), and total cholesterol are not significant. In addition, all macronutrients and micronutrients are not significant at all for dietary intakes results. Nevertheless, it is recommended that further studies be conducted to provide a clearer understanding of the relationship between dietary intake, lipid, and glucose profiles with cognitive function, as these factors are directly linked to cognitive function status.

CHAPTER 1
INTRODUCTION

1.1 Background of Study

Sarcopenia is known as a geriatric disease which is characterized by a progressive loss of skeletal muscle mass and loss of muscle function. It is often recognized as an undiagnosed health problem (Papadopoulou, 2020). Asian Working Group Sarcopenia (AWGS) 2019 had revised its definition regarding sarcopenia which it is defined by either low muscle strength or low physical performance only which specifically for use in primary health care or community-based health promotion to enable earlier lifestyle interventions (Chen et al., 2019). Meanwhile, according to European Working Group of Sarcopenia in Older People (EWGSOP), the latest updated sarcopenia definition is focuses on low muscle strength as a vital characteristic of sarcopenia, uses detection of low muscle quantity and quality to confirm the sarcopenia diagnosis, and identifies poor physical performance as the indicative of severe sarcopenia (Cruz et al., 2019). Based on the recent research, the International Consensus for Sarcopenia Screening, Diagnosis, and Treatment (ICFSR) has recommended that sarcopenia should be defined as a disease of muscle insufficiency which could be screened by the SARC-F tool and diagnosed based on the low muscle strength and low physical performance (Dent et al., 2018). Sarcopenia is highly prevalent in the general population with its prevalence among older people above the age of 60 years old and can be estimated around 10%. Based on that number, the number of people that are above 65 years old is expected to become nearly double between 2019 and 2050, from 703 million to 1.5 billion while the proportion is predicted to increase from 9% to 16% (Nations Department of Economic et al., 2019). It is a major health issue among elderly due to the increased risk of adverse outcomes which include falls, frailty, disability, morbidity, and mortality. There are numbers of risk factors for sarcopenia including age, gender, level of physical activity, and comorbidities, (Therakomen et al., 2020).

One of the major contributing factors that lead to sarcopenia is a low-quality diet (Beaudart et al., 2019). There are some specific nutrients which are of particular interest for their demonstrated role on the muscular system and have been the object of earlier and more recent studies, either as a single supplement or even in the combination with other supplements. These nutrients include protein especially that are high in leucine, which is the most potent branched amino acid at stimulating muscle protein synthesis (MPS), vitamin D, and n-3 polyunsaturated fatty acids (n-3 PUFAs). Protein, leucine, vitamin D, and n-3 PUFAs play a vital role in skeletal muscle health. Due to that, inadequate intake of one of these nutrients could lead to several conditions such as sarcopenia (Tessier, 2018).

For vitamin D, its deficiency has been linked with an increased risk of various disorders including sarcopenia (Khan et al., 2023). It is because older people have a higher prevalence of low vitamin D levels as consequence of low dietary intake and reduced ultraviolet irradiation of the skin. (E. Chung et al., 2018) said that there is a potential of vitamin E in increasing the health of skeletal muscle. The mechanism is related to the attenuation of inflammation and oxidative stress specifically in age-associated muscle dysfunction. There is a study that shown a low concentration of plasma α-tocopherol can be associated with the decreased of muscle strength and physical function (Mulligan et al., 2021). According to (Alhussain et al., 2021), greater daily fat intake was positively related with skeletal muscle mass and lower sarcopenia prevalence. The supplementation of specific fatty acids like omega-3 fatty acids can increase muscle mass and physical function among elderly (Huang et al., 2020). In addition, it has been revealed that the plasma fatty acid profile which is modified by the diet can contribute to prevent sarcopenia (Corsetto et al., 2019). The intake of oleic acid (C18:1 (M)) also shows a similar association with the sarcopenia prevalence as fat in the present study. This acid is known to prevent muscle atrophy and increase muscle differentiation through the reduction of mitochondrial reactive oxygen species in vitro (Xue et al., 2021).

Then, blood lipid profile test is always being used as biomarkers of lipid metabolism which includes low-density lipoprotein cholesterol (LDL-C), total cholesterol (TC), triglyceride (TG), and high-density lipoprotein cholesterol (HDL-C) (Grundy et al., 2019). Regarding blood glucose profile, (Mesinovic et al., 2019) stated that a recent study has revealed that both sarcopenia and diabetes have a bidirectional relationship. Age-related skeletal muscle degeneration could worsen someone's insulin sensitivity and lead to the development of metabolic disorders such as diabetes. Diabetes-related will reduce muscle mass, strength and function which leads to sarcopenia which can also lead to disability, fracture, and mortality (Kang et al., 2021).

Sarcopenia which is the reduction of skeletal muscle mass causes the declination of cognitive function (Jo et al., 2022). Cognitive function in elderly people is likely related to Skeletal Muscle Health (Sui et al., 2021). Due to the increasing age, low cognitive function which a neurodegenerative process may happen, and it will impair the functions of multiple domains including attention, memory, execution, language, literacy, numeracy, reasoning, planning, and orientation (Ng et al., 2021). Aging plays a vital role in both skeletal muscle degeneration and low cognitive function which becomes the reason why sarcopenia and cognitive decline share a common pathophysiological pathway (Hollingworth et al., 2021). Besides, sarcopenia is notably associated with lower cognitive function and higher dementia risk score in Chinese older adults (A. Lin et al., 2023). Dementia affects over 50 million people worldwide and this number will triple by 2050, and it becomes the world's top ten causes of death. There is a cross-sectional study show that sarcopenia might be a good indicator of poor cognitive function and dementia (Beeri et al., 2021). Sarcopenia and cognition appear to share the influence of various risk factors, and it has been observed in a few studies which depression can also influence the association between sarcopenia and cognition (Cabett et al., 2019).

1.2 Problem Statement

Globally, sarcopenia is a recently arising issue which has become a heavily latest researched topic among the healthcare industry (Cruz, 2019). As the prevalence is quite high and it is also a disease-associated comorbidity and mortality, sarcopenia contributes significantly to the disease burden of the geriatric disease entity and needs more attention. On top of that, our life had been changed due to Coronavirus Disease (COVID-19). A study has shown that the strength of the biceps brachii and quadriceps of post-COVID-19 recoverees were reduced as the functionality of these large muscle groups was impaired likewise (Paneroni et al., 2021). There are several factors that lead to the impairment including physical inactivity and anorexia.

The reason for conducting this research is because the prevalence of sarcopenia is greatly varied in different countries as we depend on different methods of measurement, the population as well as the diagnostic criteria. The reported prevalence was higher among non-Asians compared to Asian individuals in both genders which was 11% vs 10% in men while for women, 12% vs 9% (Shafiee et al., 2017). According to (Iskandar et al., 2021), he discovered a high prevalence of sarcopenia among Malaysians elderly aged 60 years to 70 years (5 to 13%) and 80 years and older (11 to 50%). Sarcopenic elderly were prone to have a greater body weight, lower muscle mass, and greater fat mass than non-sarcopenic elderly even though their nutrition intake was the same (Gadelha et al., 2018).

As we know, sarcopenic patients have a poor dietary intake which can lead to mineral deficiency. It includes the deficiency of dietary protein, vitamin D, vitamin E, fatty acids, and antioxidant. The lower intake of those minerals is related to lower muscle mass and strength. Diet imbalance was commonly seen in sarcopenic patients especially on inadequate intake of vegetables, fruits, dairy products, soybeans, fish, excessive intake of cereals, eggs and salts and lack of diet variation (Ran et al., 2023). However, older adults with sarcopenia have less

appetite to fulfill daily dietary intake compared to non-sarcopenic adults. Commonly, the reduction of appetite leads to a deterioration in nutritional status which eventually leads to a decrease in skeletal muscle function (Ishizu et al., 2022).

Sarcopenic patients have a higher risk of cognitive impairment. (Lars et al., 2019)has demonstrated that sarcopenia is related to cognitive dysfunction. Cognitive impairment is affected by some factors such as vascular dysfunction, insulin resistance (Kong et al., 2018), high cholesterol (Yang et al., 2020), and lack of physical exercise (Law et al., 2020). The prevalence is estimated to rise quickly as age crossed 65 years which approximately 47 million people are enduring advanced cognitive impairment worldwide (Wallin et al., 2018). Unfortunately, this number is expected to rise to approximately 75 million in 2030 and 132 million in 2050.

1.3 Research Questions

The following questions are sought to be answered at the end of the study:-

i. How is dietary intake pattern among older adults with possible sarcopenia and sarcopenia in Kelantan?
ii. How is cognitive function among older adults with possible sarcopenia and sarcopenia in Kelantan?
iii. What is the mean blood glucose and lipid among older adults with possible sarcopenia and sarcopenia in Kelantan?
iv. Is there a significant association between dietary intake pattern and cognitive impairment with possible sarcopenia and sarcopenia among older adults in Kelantan?

v. Is there a significant association between lipid and glucose profile and cognitive impairment with possible sarcopenia and sarcopenia among older adults in Kelantan?

1.4 Research Objectives

1.4.1 General Objective

To determine the association between dietary intake, lipid and glucose profile, and cognitive function among older adults with possible sarcopenia and sarcopenia in Kelantan.

1.4.2 Specific Objectives

i. To determine the mean macro and micronutrients intake among older adults with possible sarcopenia and sarcopenia in Kelantan.

ii. To determine cognitive function status among older adults with possible sarcopenia and sarcopenia in Kelantan.

iii. To determine the mean blood glucose and lipid profile among older adults with possible sarcopenia and sarcopenia in Kelantan.

iv. To determine the association between mean dietary intake and cognitive impairment with possible sarcopenia and sarcopenia among older adults in Kelantan.

v. To determine the association between lipid and glucose profile with cognitive impairment among older adults with possible sarcopenia and sarcopenia in Kelantan.

1.5 Research Hypothesis

1.5.1 Hypothesis

Null hypothesis (H_0)

1. There is no association between dietary intake and possible sarcopenia and sarcopenia among older adults with possible sarcopenia and sarcopenia in Kelantan.

2. There is no association between lipid and glucose profile and possible sarcopenia and sarcopenia among older adults with possible sarcopenia and sarcopenia in Kelantan.
3. There is no association between cognitive function and possible sarcopenia and sarcopenia among older adults with possible sarcopenia and sarcopenia in Kelantan.

Alternative Hypothesis (H_A)

1. There is an association between dietary intake and possible sarcopenia and sarcopenia among older adults with possible sarcopenia and sarcopenia in Kelantan.
2. There is an association between lipid and glucose profile and possible sarcopenia and sarcopenia among older adults with possible sarcopenia and sarcopenia in Kelantan.
3. There is an association between cognitive function and possible sarcopenia and sarcopenia among older adults with possible sarcopenia and sarcopenia in Kelantan.

1.6 Justification of Study

The findings of the research will provide detailed information about the older adults' risk towards possible sarcopenia and sarcopenia in relation to the dietary intake, lipid and glucose profile and cognitive function among older adults in Kelantan. Nowadays, the studies available regarding the association between dietary intake and possible sarcopenia and sarcopenia are limited. Hence, the outcome of this research may provide insights of dietary intake which related to possible sarcopenia and sarcopenia among older adults in Kelantan. In addition, lipid and glucose profile, and cognitive function will also be assessed to see whether they are associated with the dietary intake apart from observing their association with possible sarcopenia and sarcopenia. Thus, the results of the research may be able to fill in the knowledge gap on the patients with possible sarcopenia and sarcopenia's management specifically related to their dietary intake, lipid and glucose profile, and cognitive function.

1.7 Conceptual Framework

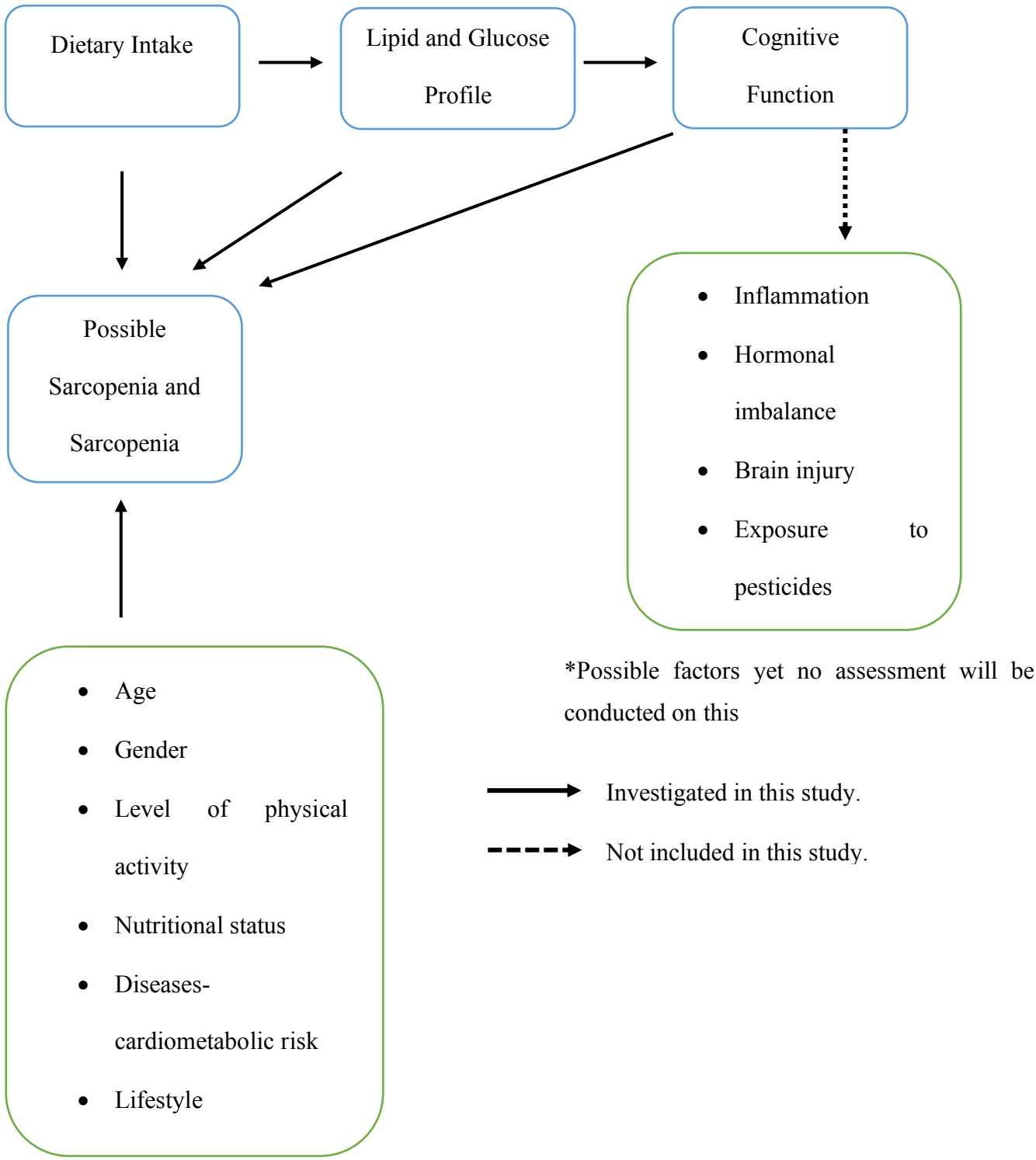

Figure 1: Conceptual framework of cause and effect related to dietary intake, lipid and glucose profile, and cognitive function among elderly with possible sarcopenia and sarcopenia in Kelantan.

Based on Figure 1, poor dietary intake will cause an effect towards lipid and glucose profile, and cognitive function. The role of the whole diet in sarcopenia with some evidence linking higher intake of individual nutrients such as protein, vitamin D, n-3 polyunsaturated fatty acids (n-3 PUFA) and antioxidants and other food groups like meats, fruits, and dairy products to reduce the risk of sarcopenia and has better muscle function in older adults. But there is a study that show older adults above age of 85 years old have higher prevalence of sarcopenia and high likely at increased risk of malnutrition (Mendonça et al., 2018) since they had poor nutritional status. Patients with sarcopenia will also have higher risk of comorbidities such as type 2 diabetes (Salom et al., 2023), heart failure (Curcio et al., 2020), and chronic kidney disease (CKD) (Chatzipetrou et al., 2022). Muscle strength and cognitive function are closely related. Lower handgrip (HGS) is used to measure muscle strength which is associated with cognitive impairment. It is measured by a short portable mental status questionnaire (SPMSQ) (Sui et al., 2020). The cognitive domains which are affected by muscle strength are poorly described. In one study, executive functions were observed. It is important and involved in task initiation, problem solving, attention, organization, working memory, inhibition, and others. So, the decline in these functions may disturb basic and instrumental daily living activities (Tessier et al., 2022). Although muscle mass is considered a predictor to the decline of cognitive function, the link between muscle mass and cognitive impairment is not consistently documented.

Regarding the factors that are not investigated in this study, inflammation is well known as a vital mechanism of cognitive dysfunction as the inflammation level is high in the body (Wang et al., 2022). As aging is associated with sarcopenia, hormones are also needed to be worried. Catabolic hormones like cortisol and angiotensin II can accelerate aged-induced muscle atrophy which are involved in muscle wasting (Priego et al., 2021). For brain injury, it is considered as the primary cause of disability which it attributes to changes of skeletal muscle

(Papadatou, 2020). Commonly, heavy metals are defined as those having a specific density of more than 5g/cm3 such as mercury, aluminum, manganese, and lead. They are widely distributed environmental pollutants. Although manganese is an essential metal in the human body as it regulates protein synthesis and metabolism, excessive manganese is toxic to the body as it can contribute to the neuromuscular disease and related to the prevalence of sarcopenia (Huang et al., 2024). As for chronic kidney disease (CKD), the progressive loss of renal function with low intake of animal protein within CKD patient could promote a negative balance of body creatinine which could favor the onset of sarcopenia (Amorim et al., 2022).

CHAPTER 2
LITERATURE REVIEW

2.1 Prevalence of Sarcopenia and Possible Sarcopenia Worldwide

The estimated overall prevalence ranges between 0.2% and 86.5% according to the recent systematic review of published studies conducted worldwide (Petermann et al., 2022). Sarcopenia affects approximately 15% of healthy older adults, up to 76% of acutely hospitalized patients, and as many as 69% for those undergoing post-acute geriatric rehabilitation. Moreover, its prevalence among patients with conditions like cardiovascular disease (CVD), diabetes mellitus (DM), and respiratory diseases stands at around 31.4%, 31.1%, and 26.8%, respectively. (Pacifico et al., 2020). Its prevalence varies depending on the presence of other associated diseases in patients. For instance, it ranges from 18% in individuals with diabetes (Feng et al., 2022) to 66% in those diagnosed with inoperable esophageal cancer. Tantai et al., 2022 report a significant prevalence of sarcopenia among patients currently requiring surgery for liver and kidney diseases. However, it is different with the different site-specific cancers (Surov, 2021). In addition, according to statistics in China, the elderly population who aged above 60 which includes 16.1% of China's total population face a severe ageing situation hence the people will pay more attention to sarcopenia (Xin et al., 2021). That 16.1% equals to 250 million individuals. The researcher from Hokkaido University says that the prevalence of sarcopenia can reach as high as 15% in healthy older adults and up to 56% in rehabilitation patients (Su et al., 2020). It is also reported that prevalence of sarcopenia ranges from 1% to 29% in community dwelling populations and from 14% to 92% in long-term care (LTC) homes in Western Countries (Bravo et al., 2018) while it is between 4.15% to 11.5% in the general communities in Asia.

In Malaysia, the prevalence of sarcopenia among elderly with type 2 diabetes mellitus (T2DM) ranges from 15.7% to 29.3% in public primary care clinics (Fung et al., 2019). Next,

the prevalence of sarcopenia among older adults in the Klang Valley of Malaysia stands at 59.8% when evaluated using the Skeletal Muscle Index (SMI) (Ranee et al., 2022). It is stated that the prevalence of sarcopenia of 50.5% using SMI and 32.2% when using a more comprehensive algorithm which is EWGSOP, with risk factors of patients aged above 75 years old and those with arthritis (Rosli et al., 2017). The prevalence of sarcopenia among elderly in LTC homes in Klang Valley is 51% while the prevalence of possible sarcopenia is 4% (Yap et al., 2020). Based on the study made by Ramoo and colleague (Ramoo et al., 2022), the prevalence of sarcopenia and severe sarcopenia are 5.0% and 3.6% respectively for elderly that lives in rural areas of Kuala Pilah District, Negeri Sembilan. For the elderly with T2DM is about 28% which is comparable with the finding in Singapore which is 27.4% (Sazlina et al., 2020). In the neurology and rehabilitation departments of three public hospitals in Malaysia, the prevalence of possible sarcopenia among older adults aged over 70 years with stroke in the advanced stage is 42.3%. Compared to the older adults that ranged from 60 to 69 years old, the prevalence of possible sarcopenia is 63.6% and 31.5% respectively (Wong et al., 2022).

2.2 Pathophysiology of Sarcopenia

Sarcopenia is a key component of physical frailty. In terms of its pathophysiology, aging disrupts the balance of skeletal muscle homeostasis, leading to an imbalance between anabolic and catabolic processes involved in protein production pathways. The inability to adequately stimulate muscle protein synthesis (MPS) results in gradual loss of muscle mass, particularly affecting the size of type II muscle fibers. Moreover, intramuscular and intermuscular fat infiltration are the markers of cellular changes observed in sarcopenic muscle (Cho et al., 2022). These changes are initiated by a few factors such as hormonal shifts and lack of physical activity. They will lead to diminished muscle repair and regenerative capacity which stemming from a decline in the amount of muscle satellite cells, increased inflammatory cell infiltration, oxidative stress, and mitochondrial dysfunction. They are all together responsible for leading to higher rates of muscle protein degradation that is related to synthesis (Nishikawa et al., 2021). There is also evidence that suggests both genetic and environmental factors contribute to an increased susceptibility to sarcopenia even though some of these factors may be unavoidable consequences of aging (Liu et al., 2022). So, when genetic factors predispose individuals to sarcopenia and being exposed to unfavorable environmental conditions, the combined effect can be more harmful than either factor alone (Aslam et al., 2023). Next, immunological dysfunction and inflammation with aging. As we know, elderly are more likely to develop chronic inflammation as the immune function is declined due to aging. The risk of getting inflammatory diseases such as infections and collagen diseases is increased for elderly with impaired immune function (Wilson et al., 2017). Due to that reason, pro-inflammatory cytokines like C-reactive protein (CRP) will mildly increase in the blood. Inflammatory cytokines will cause the dysfunction of mitochondria which can result in decreased Adenosine Triphosphate (ATP) production. When ATP production decreases, excessive production of reactive oxygen species (ROS) may occur. Excessive ROS production

induces proteolysis by enhancing the ubiquitin-proteasome system, one of the major pathways for protein degradation. This process leads to skeletal muscle atrophy (Tang et al., 2019).

2.3 Dietary Intake of Sarcopenia Patient

Dietary protein is extremely needed to provide amino acids for synthesis of muscle protein. For regulation of muscle protein, the muscle protein pool will be in a constant state of turnover which means that the protein synthesis and protein breakdown is balanced. However, it is crucial to ascertain whether they are balanced or not. If these two rates remain constant, the amount of muscle mass will not change. The problem will occur when MPS exceeds muscle protein breakdown (MPB) which muscle atrophy will happen. Dietary protein alone has the potential to generate a net increase in protein balance (Kim et al., 2020). Enough protein is expected to increase amino acid availability and stimulate the synthesis of sarcoplasmic and myofibrillar protein by activating the mammalian target on rapamycin (mTOR) and its downstream targets (Wilkinson et al., 2013). However, the problem is the aged muscle always shows anabolic resistance, a state of submaximal MPS in response to hyperaminoacidemia which suggests that more amount of protein is required to properly stimulate muscle anabolism in older adults (Moore et al., 2015).

For micronutrient, vitamin D has one important role which is to regulate Ca^{2+}content in the bloodstream. Besides, vitamin D is a vital regulator of the musculoskeletal system, and reduced levels of vitamin D can really give a big impact to the bone health (Wintermeyer et al., 2016). Vitamin D can also suppress FOXO1 gene expression by controlling calcium channel opening in the muscles which can continue to control downstream ubiquitin-proteasome system activity (Hirose et al., 2018). That ubiquitin-proteasome system is associated with sarcopenia and skeletal muscle atrophy (Kamwa, 2019). The receptor of vitamin D known as VDR is expressed in a range of tissues including skeletal muscle and can bind with 1,25,2(OH)D with high affinity subsequently regulating protein synthesis and the

number as well as volume of type II muscle fibers thereby controlling skeletal muscle quality and strength. But VDR expression will be reduced as the age is increased (Giustina et al., 2023). Next, vitamin E which includes four types of tocopherols (α, β, γ, and δ), who's their dietary sources mainly come from plant oils, nuts, seeds, fish, shellfish, and vegetables. The most common type in our body is α-tocopherol (Arai, 2021). Vitamin E can act as a stabilizer of the plasma membranes which can be effective in repairing the damaged membrane during aging especially in sarcopenic muscle (Khor et al., 2014).

2.4 Cognitive Impairment Among Sarcopenia Patients

There is a study show that several myokines are produced by skeletal muscle and secreted, including those regulating mood, learning, motor activity, and neuronal damage protection which all indicate the presence of muscle-brain crosstalk (Scisciola et al., 2021). Cerebral White Matter Hyperintensities (WMHs) show correlation with other measures of sarcopenia, such as muscle mass and hand grip strength. In addition, cerebral WMHs have also been shown to be related to cognitive impairment (Zhang et al., 2023). Based on the present study, older Chinese adults with possible sarcopenia are at higher risk of low cognitive function compared to those without sarcopenia. Thus, it shows that sarcopenia and cognitive function are closely related (Chen et al., 2021).

There are some explanations for the link between sarcopenia and cognitive disorders. First, sarcopenia shares the similar risk factors as cognitive disorders such as inflammation, characterized by interleukin-6 (IL-6) and tumor necrosis factor-α; oxidative stress; hormonal changes and malnutrition. These factors might be extremely important for the two aging phenotypes (Ali et al., 2018). Second, skeletal muscle may produce and secrete molecules which are known as myokines, which regulate the brain functions such as learning and locomotor activity. Not only that, when physical inactivity combines with sarcopenia can also impact cognitive function through changes in circulating myokine levels (Peng et al., 2020).

Third, frailty becomes one of the reasons which allow sarcopenia to impose an effect on cognitive disorders (Waite et al., 2021). Frail individuals commonly display deficiencies in executive control, particularly affecting the frontal cortex. It raises the possibility of abnormalities in motor skills as well as executive mechanisms (Fabrício et al., 2020). There is a study conducted with 356 elderly people from a community that has shown that the prevalence of people that has fallen is associated with sarcopenia can reach 90.7% (Kirk et al., 2021) and it can be happened by the declination of cognitive status (Rivan et al., 2021). Dementia is commonly diagnosed when acquired cognitive decline reaches a severity that significantly impacts social or occupational abilities. Sarcopenia plays a direct role in contributing to various neuropathologies, including dementia (Ogawa et al., 2018). A study by Yang et al., 2023 expected that the global prevalence of dementia will double every 20 years, and the number of patients could exceed 131.5 million by 2050.

2.5 Diabetes and Hyperlipidemia Among Sarcopenia Patients

As of 2017, an estimated 451 million adults globally have diabetes (Cho et al., 2018), with approximately 90% of these individuals having type 2 diabetes mellitus (T2DM), which shows the highest prevalence among older adults. For patients with diabetes, their age-related anabolic resistance worsens, fat mass increases, and lean mass decreases even rapidly compare to non-diabetics' patients (Al-Sofiani, 2019). Insulin plays a crucial in muscles tissue role by inhibiting protein catabolism. Furthermore, insulin resistance can also induce protein dysregulation. It causes dysregulation of the potential mediators of glucose and protein metabolism in the skeletal muscles. Moreover, the result of muscle mass reduction and sarcopenia are caused by advanced glycation end-products that accumulate in the skeletal muscles especially in the chronic condition (Mori, et al, 2019).

The prevalence of dyslipidemia in the elderly is 53.65% and there is approximately 40% dyslipidemia globally (Huang et al., 2023). There is evidence indicating that fatty acids and

other intermediates in lipid metabolism play a crucial role in modulating skeletal muscle mass and function (Lipina, 2017). Lipid and other derivatives accumulate both within muscle cells and intercellular compartments which lead to further promoting lipo-toxicity and inducing oxidative stress, mitochondrial malfunction, inflammation, and insulin resistance (Sousa et al., 2022). Serum levels of TC, TG, and LDL are significantly lower among patients with sarcopenia which proves that sarcopenia prevalence represents a significant decrease for increasing lipid profile. These findings are similar to an Italian based study (Perna et al., 2015), which presented that within the normal ranges, obesity and metabolic parameters' level increase can be protective against muscle loss.

2.6 Association Between Dietary Intake and Cognitive Impairment

It is doubtless that the development of cognitive impairment especially mild cognitive impairment (MCI) or Alzheimer's Dementia (AD) is affected by a series of modifiable risk factors associated with lifestyle and nutritional status especially dietary intake pattern (Lu et al., 2016). Commonly, a protein consumption above the recommended dietary allowance (RDA) which is 0.8g/kg/day is employed as a strategy to maintain muscle mass, particularly in elderly individuals (Coelho et al., 2020). This is done to ensure that the aged muscle requires a greater number of amino acids (AAs) to maximally stimulate MPS in response to hyperaminoacidemia which is known as anabolic resistance (Traylor et al., 2018). Inadequate stimulation of MPS increases the risk of progressive muscle mass loss, primarily of type II muscle fibers, which affects the development of muscle strength and bodily functions. Despite the widespread belief that consuming enough protein can either stop sarcopenia from developing or at least slow down its progression (Bauer et al., 2019). For those with an extreme decline in animal-based protein intake have a 48% higher risk of cognitive impairment compared to those who have normal protein intake (Xu et al., 2022). Consuming both plant- and animal-based proteins has been shown to have diverse associations of well-known risk

factors for cognitive impairment, including diabetes, obesity, cardiovascular disease, and hypertension (Shang et al., 2017) as higher animal protein intake is linked with a reduce risk of cognitive decline (Gao et al., 2022). Protein intake is positively associated with cognitive function (Li et al., 2020). In addition, there is also a recent review suggests that high adherence to some specific diet patterns such as Mediterranean diet (Critselis, 2020), the Dietary Approach to Stop Hypertension (DASH) diet, and anti-inflammatory diet which can help to improve cognitive function (Chen et al., 2019). Overall, dietary intake is strongly linked with cognitive impairment.

2.7 Association Between Diabetes and Hyperlipidemia and Cognitive Impairment

T2DM impacts approximately 25% of adults aged over 65, posing a considerable health burden on the elderly population. Over the coming decades, this percentage is predicted to rise even higher (Carrillo et al., 2019). Next, T2DM will contribute to the development of sarcopenia through various mechanisms including impaired insulin associated signaling pathways, accumulation of advanced glycation end-products, peripheral neuropathy, and chronic inflammatory status (Wen et al., 2022). The data that is currently available generally agrees that patients with type 2 diabetes have a higher prevalence of sarcopenia. This association may be explained by a variety of mechanisms, including subclinical inflammation, advanced glycosylation end products (AGEs), chronic hyperglycemia, reduced insulin sensitivity, and micro- and macrovascular complications (Izzo et al., 2021). The prevalence of sarcopenia in Japanese and Chinese adults aged over 60 years is also linked with T2DM, is 15% according to the AWGS criteria (Murata et al., 2018).

Elevated levels related to lipid metabolism have been demonstrated to protect against sarcopenia when they are within normal ranges. Adipose inflammation causes fat tissue to reallocate to the intra-abdominal area as people age, and lipids permeate skeletal muscles, leading to a decrease in physical activity (Xu et al., 2021). The accumulation of lipids and their

byproducts within and surrounding muscle cells results in insulin resistance, lipotoxicity, mitochondrial dysfunction, disruption of fatty acid β-oxidation, and increased release of pro-inflammatory cytokines (Kalinkovich, 2017). These cytokines can then cause inflammation, worsen the loss of adipose tissue, and start a vicious cycle of localized hyperlipidemia, inflammation, and insulin resistance that spreads throughout the body, speeding up the development of sarcopenic obesity (Antuña et al., 2022). Not to mention that sarcopenic obesity group defined using appendicular skeletal mass adjusted for weight (ASM/wt) had a higher chance for dyslipidemia (Baek et al., 2014). Not only that, more lipid abnormalities than the group with obesity or sarcopenia alone among Korean elderly men.

CHAPTER 3
METHODOLOGY

3.1 Study Design

This study adopts a cross-sectional study design to comprehensively allow the researcher to gather, summarize, present, and interpret information appropriately. A survey in the form of standardized questions were used to determine any existing sarcopenia parameter by evaluating their dietary intake pattern and cognitive function. The cross-sectional study design was preferred due to its ability to provide a snapshot of a population at a specific point in time, allowing for the efficient assessment of multiple variables simultaneously. This study design was also the best way to determine the prevalence and can study associations of multiple exposures and outcomes. Furthermore, cross-sectional studies were relatively quick, cost-effective, and could provide many findings to create in-depth research.

3.2 Study Location

This study would be conducted in several villages located in districts in Kelantan. The selection of this site was based on its optimal suitability for community-based research and its relevance for data collection among community-dwelling older adults. Specifically, the study would focus on the following areas within the districts in Kelantan: Tumpat, Pasir Mas, and Kota Bharu.

3.3 Study Population

Reference Population

Senior citizens that had been residing in Kelantan at least one year.

Target Population

Community-dwelling older adults aged 60 years old and above who lived independently in the community setting in Kelantan.

Source population

Senior citizens who were attending the data collection booth at the nearest community center such as mosque, prayer hall and community hall located within the selected village in. A week prior to the data collection day, the village head would hand over the invitation letter to participate in the research study to the senior citizens who lived in that selected village.

Sampling frame

Name list for senior citizens from the village head in the specific selected villages in Kelantan.

Table 1: Villages for Each District

District	Village
Tumpat	Kampung Bunohan, Kampung Jubakar, Kampung Kulim, Kampung Wakaf Bharu
Pasir Mas	Kampung Bechah Semak and Kampung Kubang Tembesu
Kota Bharu	Kampung Binjai, Kampung Gong Dermin, Kampung Kota, and Kampung Tembesu Limbat

3.4 Research Subjects

3.4.1 Inclusion and Exclusion Criteria

Inclusion Criteria:

i. Senior citizens aged 60 years and above.
ii. Older adults with sarcopenia and possible sarcopenia.
iii. Live in the community.
iv. Understand Malay or English language.
v. Agree to participate in this study.

Exclusion Criteria:

i. Those who cannot stand by themselves.
ii. Hip or knee replacement.
iii. Carpal tunnel syndrome.
iv. Severe hearing or visual impairment.
v. Cognitive impairment diagnosed by medical practitioner.
vi. Impaired mobility.

3.5 Sample Size Calculation

The sample size needed for the research was calculated according to the research objectives based on using the population variance of a given outcome variable.

Sample size for first objective

For the first objective which was to determine the daily dietary intake among older adults with sarcopenia and possible sarcopenia in Kelantan. The sample size calculation for this study would be based on the prevalence of dietary intake pattern from the study of (Chew et al., 2022). The study employed a cross-sectional design with a larger sample size and identified significant associations between age and dietary pattern as it focused

on elderly aged above 65 years old. The sample size calculation would be performed using the one proportion formula. According to (Chew et al., 2022), their study reported that 76% out of 694 participants had sarcopenia. Therefore, the anticipated population proportion is 0.76.

$$n = \left[\frac{1.96}{0.1}\right]^2 0.76\ (1 - 0.76)$$

$$= 70.07 \sim 70\ subjects$$

Sample size for second objective:

The second objective in this study was to determine the cognitive impairment among older adults with possible sarcopenia and sarcopenia in Kelantan, one proportion calculation was used to estimate the sample size (Sampaio et al., 2023). The formula for one proportion calculation was as shown below:

$$n = \left[\frac{Z}{\Delta}\right]^2 p\ (1 - p)$$

$n =$ sample size

$Z =$ value representing the desired confidence level.

$\Delta =$ absolute precision

$p =$ anticipated population proportion

Using Δ value of 0.1 and confidence level of 95% for the study, the Z-score would be 1.96. According to the first objective, prevalence of sarcopenia among older adults in an urban area Malaysia was used as the anticipated population proportion. Norshafarina et

al., 2013 stated that the overall prevalence of sarcopenia was 59.8% which was detected among 388 apparently healthy subjects aged 60 years and above. Therefore, the anticipated population was 0.598.

$$n = \left[\frac{1.96}{0.1}\right]^2 0.598\,(1 - 0.598)$$

$$= 92.4 \sim 92\ subjects$$

The sample size for the study was recalculated according to the specific objectives outlined above. This adjustment ensured that the sample would be adequately represent the target population and allowed for the appropriate statistical analysis of the data collected. The final sample size obtained for 80% power of study was 70 subjects for objective 1. Meanwhile, it would be 92 subjects for objective 2. Due to that reason, the highest value which was 92 subjects was chosen.