Sarcopenia Prevalence and Risk Factors among Residents in Aged Care

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Abstract

Sarcopenia is defined as an age-related decline in muscle mass and function and is associated with adverse health outcomes and loss of independence. The aim of this study was to evaluate the prevalence and risk factors of sarcopenia among older adults living in residential aged care (RAC). This cross-sectional study recruited 91 older adults (63% women, mean age 86.0 ± 8.3 years) across three RAC facilities within Auckland, New Zealand. Personal interviews were conducted, and physical measures were taken by trained researchers. Using the European Working Group on Sarcopenia in Older People criteria, sarcopenia was diagnosed from the assessment of; appendicular muscle mass/height^2, using an InBody S10-body composition analyser and a SECA portable stadiometer or ulna length to estimate standing height; grip strength using a JAMAR handheld dynamometer; and physical performance with a 2.4m gait speed test. Demographic and health data were collected. Malnutrition risk was assessed using the Mini Nutritional Assessment - Short Form (MNA-SF) and depression was evaluated using the Geriatric Depression Scale. Most (83%) of residents were malnourished or at risk of malnutrition, half (52%) had >5 comorbidities and 44% took >7 medications. Overall, 41% of the participants were found to be sarcopenic. Univariate logistic regression found increasing age, lower MNA-SF score, lower percentage body fat, higher depressive symptoms, and hospital versus rest home level of care were associated with sarcopenia. Multivariate regression analysis showed only lower body mass index (OR=1.4, 95% CI: 1.1, 1.7, *P*= .003) and lower MNA-SF score (OR=1.6, 95% CI: 1.0, 2.4, *P*= .047) were predictive of sarcopenia after controlling for age, level of care, depression and number of medications. The correlation between lower MNA-SF score and sarcopenia highlights the need for regular malnutrition screening in aged care to prevent the development and progression of sarcopenia. As decreasing BMI was also predictive of sarcopenia, low weight or unintentional weight loss should prompt screening and appropriate intervention.

Key Words: Sarcopenia; Aged care; Malnutrition

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Ehara tāku toa I te toa takitahi, engari he toa takitini

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List of Abbreviations:

BF% - Body fat percentage
BIA – Bioelectrical Impedance Analysis
BMI – Body mass index
CI – Confidence intervals
CT – Computed Tomography
DXA – Dual-energy X-ray absorptiometry
EPOA – Enduring power of attorney
EAR - Estimated average requirement
EAT-10 – Eating Assessment Tool-10
EWGSOP – European Working Group on Sarcopenia in Older People
GDS-15 – Geriatric Depression Scale-15
LiLAC NZ – Life and Living in Advanced age, a Cohort study in New Zealand
MNA – Mini Nutritional Assessment
MNA-SF - Mini Nutritional Assessment Short-Form
MNA-FF - Mini Nutritional Assessment Full-Form
MRI – Magnetic Resonance Imaging
m/s – metres per second
MST – Malnutrition Screening Tool
OR – Odds ratios
RAC – Residential age care
RDI – Recommended dietary intake
SF-12 – 12 Item Short Form Survey
SGA – Subjective Global Assessment
SCREEN - Seniors in the Community Risk Evaluation for Eating and Nutrition
SARC-F – Strength, Assistance in walking, Rising from a chair, Climbing stairs and Falls Questionnaire

Chapter One: Introduction

1.1 Introduction and Justification

This chapter provides the scope and justification of the research, aims, objectives & hypotheses, structure of the thesis and the researcher's contributions.

New Zealand is experiencing a change in its population demographics, with the older adult population predicted to double between the years of 2016 and 2048 (Stats New Zealand, 2020), which will increase the proportion of older adults in the population from 15% to 21%-26%. Population ageing is occurring across the world and is reflective of falling birth rates and longer life spans, both of which are hallmarks of better education and health care (United Nations, 2019). While these changes are markers of societal progress, they present a challenge for the health system. Older adults carry the majority of the burden for disabilities and disease, meaning as the population of older adults grows so will the demand for healthcare (World Health Organization, 2020b). As the pressure applied to health systems will be proportional to the health status of the population, greater emphasis on preventative healthcare measures is needed, particularly for concerns that arise in later years such as, functional decline, cognitive decline and falls and fractures (World Health Organization, 2020b).

In New Zealand, a large portion of the health care budget is allocated to Residential Aged Care (RAC) (Ministry of Health, 2016). To combat this, there has been a drive to increase in-home care to allow " ageing in place" where older adults can enhance their sense of independence and self-reliance without the need for admittance to RAC (Associate Minister of Health, 2016). This strategy has been largely successful with the total number of occupied beds in hospitals and RAC facilities increasing by only 2% between the years of 1988 and 2008 despite population growth (Broad et al., 2011). However, admissions to RAC only give one measure of dependency levels. This approach may be overly simplistic, as the level of dependency varies between RAC residents. Over time, those living in New Zealand's RAC facilities have become increasingly dependent, with

significantly fewer people being able to toilet, dress and shower themselves in 2008 compared to 1988 (Boyd et al., 2011). There has also been a significant decrease in physical functioning and overall self-care ability of residents over this period. Not only do reductions in the ability to care for oneself negatively impact on quality of life (Helvik, Engedal, & Selbaek, 2010), higher resident dependency also means more staff time is required and thus increases the cost of care per resident. Therefore, efforts should still be made to retain independence and quality of life among RAC residents despite admission to RAC being a key marker for 'independence loss'.

To promote a smooth transition into care where individuals retain as much functioning as possible, it is important to prioritise healthy lifestyles both in and out of RAC (Khaw, 1997). Earlier starts to lifestyle interventions yield greater effects as cell damage caused by unhealthy lifestyles accumulates over the lifespan (Marcos-Pérez et al., 2020). Although interventions have greater benefit in younger groups, this does not justify apathy towards treating older adults (Peterson, Sen, & Gordon, 2011). There is evidence that interventions at an advanced age or among residents in RAC facilities can yield positive results for reducing the rates of physical decline (Hassan et al., 2016; Peterson et al., 2011).

When considering the maintenance of independence, body composition is an important concern, as low muscle mass and strength are both significant predictors of dependency in activities of daily living for older adults (Wang, Yao, Zirek, Reijnierse, & Maier, 2020). Shifts in body composition occur naturally with age as muscle turnover is reduced leading to lower levels of muscle mass (Rezuş et al., 2020). While some muscle loss is inevitable with ageing, the rate of atrophy can be accelerated by disease, poor nutrition, or inactivity and can become problematic (Cruz-Jentoft et al., 2019). Sarcopenia is the term given to the harmful decline in muscle mass and strength that occurs in ageing (Cruz-Jentoft et al., 2019). As sarcopenia is an independent predictor for hospital admissions, infections, depression, cognitive decline and falls and fractures it is important to address the causes (Cruz-Jentoft et al., 2019). Sarcopenia may also be associated with increased hospital stay length and all-cause mortality (Zhao, Zhang, Hao, Ge, & Dong, 2019).

Undernutrition or malnutrition is a state resulting from inadequate nutrient intake which leads to reduced mental and physical functioning as well as altered body composition (Rojer et al.,

2016). Malnutrition is tightly linked to sarcopenia, as inadequate energy intake causes the body to rely on muscle as a fuel source (Wilkinson, Piasecki, & Atherton, 2018). Lower energy intakes also increase the risk of an individual falling short of their protein requirements which further perpetuates muscle atrophy (Landi et al., 2016; Wilkinson et al., 2018). Nutrition surveys provide evidence that many older adults in New Zealand are struggling to meet both protein and energy requirements (University of Otago & Ministry of Health, 2011; Wham et al., 2016). Those residing in RAC are particularly vulnerable, with studies finding rates of malnutrition risk in this setting as high as 90% (Chatindiara, Allen, et al., 2020).

Avoiding malnutrition is not just important for maintaining muscle mass, as malnutrition is also correlated with many negative health outcomes and increases both health care costs as well as the risk of mortality (Agarwal, Miller, Yaxley, & Isenring, 2013; Volkert et al., 2019). Supporting older adults to meet nutrition requirements is important for avoiding the negative consequences associated with both malnutrition and sarcopenia (Kondrup, Allison, Elia, Vellas, & Plauth, 2003). Although it is not mandatory, regular nutrition screening should be encouraged in care settings as it is recognised that early intervention is important to correct and prevent the progression of malnutrition (Kondrup et al., 2003). The Australian New Zealand Society for Geriatric Medicine position statement on undernutrition is that older adults across all settings should be screened for malnutrition to identify and treat those at risk and reduce the adverse health consequences that are associated with malnutrition (Visvanathan, 2009).

While inadequate energy intake is a known problem among older residents in RAC and can contribute to muscle atrophy, little is currently known about how many RAC residents in New Zealand are living with sarcopenia (Chatindiara, Allen, et al., 2020; Cruz-Jentoft et al., 2019). Identifying the prevalence of sarcopenia is an important primary step to beginning to develop appropriate interventions. Overseas, studies have found that sarcopenia is highly prevalent in RAC with rates up to 40% (Landi et al., 2012; Senior, Henwood, Beller, Mitchell, & Keogh, 2015) however, no such studies have been undertaken in New Zealand. This thesis seeks to begin to quantify the issue that sarcopenia presents in New Zealand residents in RAC, and to provide a

rationale for future intervention studies. Risk factors will also be investigated to identify factors associated with the risk of sarcopenia.

1.2 Research aims and objectives

This cross-sectional study aims to establish the prevalence of sarcopenia among older adults living in three long term RAC facilities and to investigate factors associated with risk. Investigating the risk factors for sarcopenia builds on previous evidence that can be used to provide more targeted screening for those at the highest risk in this setting.

The specific objectives of this study are to:

1. Report the percentage of people in these RAC facilities who meet the European Working Group on Sarcopenia in Older People (EWGSOP) diagnostic criteria for sarcopenia.

2. Investigate the association between positive sarcopenia diagnoses and nutrition markers such as Mini-Nutritional Assessment Short-Form (MNA-SF) score, body mass index (BMI) and percentage body fat.

3. Investigate the association between positive sarcopenia diagnoses and demographic factors such as age, gender, ethnicity, marital status, level of education, and length of stay.

4. Investigate the association between positive sarcopenia diagnoses and mental and physical wellbeing, using the validated Medical Outcomes Study Short-Form Health Survey SF-12 (SF-12) and the Geriatric Depression Scale 15-item (GDS-15) questionnaires.

Study Hypothesis: This study is designed to assess the hypothesis that there will be a prevalence of sarcopenia in New Zealand RAC like overseas reports of between 20 – 40% and that health and social factors will be significantly associated with sarcopenia.

1.3 Thesis structure

This thesis has been written in line with the Massey University thesis structure guidelines. Following this introductory chapter is a literature review. The overarching aim of the literature review is to provide context around the causes of sarcopenia and the importance of maintaining muscle mass to promote quality of life and health and to reduce the level of dependence of residents living in RAC.

Chapter three is the results chapter which reports the findings of the study including the prevalence of sarcopenia among older adults in the RAC facilities surveyed and the associated risk factors. This chapter has been written in the form of a manuscript ready for publication according to the Nutrients journal's format and structure. Chapter four is the conclusions and recommendations chapter which discusses the implications of sarcopenia and treatment strategies that should be explored in RAC.

1.4 Researcher Contributions

Contributor	Role
Phillipa Darroch	Participant recruitment, primary data collector and author of thesis
Carol Wham	Study design and organisation, application of ethics approval, funding application and management, editor, primary thesis supervisor
Wendy O'Brien	Study organisation, application of ethics approval, editor, thesis supervisor

Hajar Mazahery	Aided with statistics and editing
Brittany Malcolm	Research assistant, aided with recruitment and data collection
Amy Richter	Research assistant, aided with recruitment and data collection
Julia Scott	National Dietitian for the Arvida Group, aided with communications between Massey University and Arvida RAC facilities
Bevan Erueti	Ensured the study was co-developed alongside the principles of Te Tiriti o Waitangi
Marlena Kruger	Development of funding application
Management team at Arvida facilities	Communication with participants' families and help with participant recruitment

Chapter Two: Literature Review

2.1 Ageing in New Zealand

Today we are living longer than ever. Thanks to medical and sociological advancements, societies have largely triumphed over disease, injury and infection (United Nations, 2019). Whilst increasing life expectancy is a positive indication of progress, it generates a new set of challenges caused by changing population structures with increased proportions of older people. To ensure New Zealand will have the infrastructure available to support this changing demographic, systems must be proactively and progressively modified, particularly in the health care sector where most of the stress of the ageing population is likely to be applied (United Nations, 2019).

While older adults make up 15% of New Zealand's population, an average of 42% of total DHB funding is spent on older people's medical costs (Ministry of Health, 2016). Most of this spending goes towards RAC. Despite self-report of wishes to grow old at home, 47% of New Zealanders will lose their independence and require admission to RAC in later life (Broad et al., 2015; Wiles, Leibing, Guberman, Reeve, & Allen, 2012). In addition to this, New Zealand's "health expectancy" is lagging behind average "life expectancy", meaning that people are experiencing poor health for longer, therefore it is likely that many will require prolonged assistance from RAC facilities (Ministry of Health, 2017). For these reasons, the standard RAC model is unlikely to remain sustainable in the coming years, causing many to question how we can support health and allow more of our older adults to age successfully at home.

In 2002 the New Zealand Positive Ageing Strategy was put in place to support older adults wishing to retain as much independence as possible, whilst staying safe (Ministry of Health, 2017). This strategy was largely successful with growth in RAC being more gradual than anticipated for the proportional increase in older adults between the years of 1988 to 2008 (Broad et al., 2011). However, the level of dependency of those residing in RAC has increased, which has impacted heavily on staff burden (Boyd et al., 2011). Under-resourced nursing care is already a prevalent issue within the New Zealand health system (Willis, Carryer, Harvey, Pearson, & Henderson, 2017). Nursing staff report being understaffed and overworked, therefore it is important to

strategise ways to maintain older people's health in RAC to reduce the number of high need residents (Willis et al., 2017).

2.2 Health of Older People

Older adults should be supported to age successfully and optimise their functional capacity, so that all may have the opportunity to do what they value (World Health Organization, 2020a). Health care is an important aspect of healthy ageing as over time organ function declines and cell damage accumulates, leading to increased risk of chronic disease and disability in older adults (Marcos-Pérez et al., 2020). Healthy lifestyles throughout the lifespan can help people to attain their full health potential and reduce the rate of health decline (World Health Organization, 2020a).

Disability and disease disproportionately affect New Zealand's older people, with 45% of New Zealanders over the age of 65 living with at least one disability (Kowal, Towers, & Byles, 2014; Ministry of Health, 2017). The consequence of these accumulated health conditions is that it reduces people's capacity for self-care, leading to an increased requirement for support from health care systems and RAC facilities (Broad et al., 2011). These increases are highlighted in the ageing of RAC residents; the number of people in RAC doubles for every five year increase in age over 65 years (Broad et al., 2011). Strategies that support healthy ageing are important for enhancing quality of life as well as reducing pressure on the health system and RAC facilities.

2.3 Older Adults' Wellbeing and Quality of Life

Good physical health is associated with a higher quality of life and the effect increases in people's older years (Helvik et al., 2010; Pinkas et al., 2016; Zainab & Naz, 2017). Better health in older adults is correlated with improved psychological functioning, social engagement, and measures of physical ability (Zainab & Naz, 2017). Physical health is also important for the maintenance of social wellbeing as it determines how readily older adults can participate in social groups and access social support (Zainab & Naz, 2017). Furthermore, increasing wellbeing appears to give individuals greater capacity for further improvements, as healthier older adults have a more positive perception of self and have higher self-efficacy for health-promoting behaviours (Klusmann, Sproesser, Wolff, & Renner, 2019; Zainab & Naz, 2017).

Aiding older adults to maintain as much ability for self-care even once they have been admitted to RAC is important for maintaining their quality of life. A study in Chinese RAC residents with 10,797 participants found that an inability to carry out activities of daily living, negatively impacted health-related quality of life and increased the risk of depression and life dissatisfaction (Li et al., 2020). This association has been identified in other settings, where higher levels of functional impairment are associated with lower quality of life in older adults in both hospital and community settings (Helvik et al., 2010; Pinkas et al., 2016).

Improving older adults' health is important for the individual's quality of life, with small changes in health having exponential effects by empowering people to make further improvements to their wellbeing

2.4 Nutritional Health of Older Adults in New Zealand

Nutrition lies within the realm of controllable risk factors for preventing many diseases that impact people in later life. Twin studies suggest that only 20-30% of lifespan variation is determined by genetics, with the rest being influenced by lifestyle and environmental factors (Herskind et al., 1996). While some studies have championed the effects of specific nutrients for reducing risks of age-related diseases (Gopinath et al., 2011), it is clear that many older adults are struggling to simply eat enough to meet their energy requirements (van Kuijk et al., 2020; Wham, Teh, et al., 2015) and this is associated with adverse health outcomes (Volkert, Saeglitz, Gueldenzoph, Sieber, & Stehle, 2010).

The maintenance of a healthy body weight is a primary indicator of adequate energy intake (NHMRC, 2006). While the World Health Organisation (WHO) recommends maintaining a BMI of 18.5 – 24.9 kg/m^2 (World Health Organization, 2000), this has been contested for older people as they have a different body composition and require a heavier weight with more fat to maintain a similar amount of lean mass compared to younger people (Jahangir, De Schutter, & Lavie, 2014). The relationship between BMI and age was assessed in a meta-analysis of eight large scale longitudinal studies that compared mortality rates across BMI ranges for both people under and over the age of 65 (Winter, MacInnis, & Nowson, 2017). In older adults there was a significant increase in mortality for individuals with a BMI less than 22, however, this relationship was not

found in the younger age groups. The relationship between mortality risk and weight was more pronounced at a lower BMI, with a 77% increase in mortality for older people with a BMI lower than 20, with no parallel increases in mortality being found in the younger age group (Winter et al., 2017). Another meta-analysis with over 190,000 older adults, also found that mortality risk was lowest in those with BMIs of between 22 – 33 kg/m^2 (Winter, MacInnis, Wattanapenpaiboon, & Nowson, 2014). Researchers suggest that older adults should be encouraged to maintain a BMI of above 23 kg/m^2, with older adults with lower BMIs being monitored for signs of undernutrition to minimise further weight loss.

In New Zealand, results from the 2008/2009 Adult Nutrition Survey suggest older adults eat significantly less than the rest of the population, with median energy intakes for those over 71 years being 30% less than those in the 19-30 age group (University of Otago & Ministry of Health, 2011). The recommendations for energy intake to maintain body weight differ depending on body size and activity (NHMRC, 2006), however, rough estimations of energy requirements for older adults are between 25-30kcal/kg (National Collaborating Centre for Acute Care, 2006). In a study in 465 New Zealand, community-dwelling, pre-frail older adults, dietary intakes were analysed and assessed for dietary quality (Tay et al., 2021). The study sample had an average energy intake of 21.1kcal/kg for men and 19.7kcal/kg for women, which is significantly lower than the estimated requirements reported by National Collaborating Centre for Acute Care (2006). Roughly 30% of calories in the study sample population came from "empty calorie foods" with low nutrient density ie. oils, sugar, alcohol, or processed foods. Low energy intakes combined with a high proportion of nutrient-poor food makes meeting micronutrient requirements more difficult. While this study was undertaken in pre-frail older adults and so cannot be generalised to the dietary patterns of healthy older adults, similar dietary patterns have been reported in Life and Living in Advanced Age: A Cohort Study New Zealand (LiLACS NZ), a longitudinal cohort study of 578 octogenarians (Wham et al., 2016). In both studies by Tay et al. (2021) and Wham et al. (2016), fat intake was high compared to the acceptable macronutrient density ranges (AMDR) contributing 35 – 39% of energy, with carbohydrate contributing 43 – 47% and protein contributing 15 – 16% to the participants total energy intake (Wham et al., 2016). The dietary

intake seen in these studies may compromise the intake of nutrients such as fibre or particular vitamins (Zello, 2006).

According to the current recommended dietary intake (RDI) for protein in New Zealand, the need for protein increases by 25% for those 71 years and over, despite energy requirements decreasing (NHMRC, 2006). This can make consuming sufficient protein a challenge for many older adults, particularly those who are already struggling to meet their energy requirements. The 2008/2009 Adult National Nutrition Survey estimated that 13% of men and 16% of women aged 71 and older have inadequate protein intakes (University of Otago & Ministry of Health, 2011). LiLACS NZ found high rates of insufficient protein intakes among octogenarians. Using an estimated average requirement (EAR) for protein of 0.75g/kg/day for women and 0.86g/kg/day for men, 35% and 34% of Māori men and women did not meet the EAR respectively and 28% of non-Māori men and 27% of non-Māori women also fell short of this standard (Wham et al., 2016).

Many older adults struggle to consume enough protein-rich foods for several reasons. Meat is a source of highly biologically available protein however, the fibrous and tough texture of meat, can make preparing and eating meat difficult for older people. Overcoming these barriers is important as protein deficiency impairs immune function and increases susceptibility to infections (P. Li, Yin, Li, Kim, & Wu, 2007) and among octogenarians lower protein intakes have been independently associated with hospitalisation due to infections (Wham, Baggett, et al., 2015).

2.5 Malnutrition

While BMI gives a picture of energy balance, many other factors contribute to someone's nutritional status. Malnutrition is a state resulting from inadequate nutrient intake which leads to reduced mental and physical functioning as well as altered body composition (Rojer et al., 2016). Although malnutrition is generally classified by insufficient protein and energy intakes, a reduction in overall energy intake increases the risk of micronutrient deficiencies as well (Landi et al., 2016). Malnutrition negatively impacts the individual’s quality of life and contributes significantly to health care costs (Agarwal, Marshall, Miller, & Isenring, 2016; Stats, 2016; Taylor,

2018). This is because malnutrition is closely related to adverse health outcomes such as pressure injuries, infections, longer periods of sickness and mortality (Volkert et al., 2019).

Due to the importance of nutrition in healthy ageing, early identification and treatment of malnutrition is important. There are a variety of tools available for malnutrition screening in older adults, such as the Mini-Nutritional Assessment (MNA), the Subjective Global Assessment, Seniors in the Community Risk Evaluation for Eating and Nutrition version II (SCREEN II) tool, and the Malnutrition Screening Tool. The Mini-Nutritional Assessment (Kondrup et al., 2003) has two versions, a short (MNA-SF) and full form (MNA-FF) (Kondrup et al., 2003). The MNA-SF has been validated against the full MNA and is a quicker, more convenient malnutrition questionnaire, containing six questions on appetite, weight loss, physical/psychological stress, cognitive function and BMI (Kaiser et al., 2009).

In New Zealand, malnutrition in older adults is higher among those in RAC compared with those living in the community. A study of 152 community-dwelling older adults in Christchurch, New Zealand assessed nutrition risk using the SCREEN II questionnaire, 54% were found to be at nutrition risk (23% at risk and 31% at high risk) (Watson, Zhang, & Wilkinson, 2010). Another study using the SCREEN II questionnaire assessed 457 older adults living in Hawkes Bay and found nutrition risk to be present in 57% of the sample (24% at risk, 33% at high risk), Māori individuals were 5.2 times more likely to be at nutrition risk than non-Māori, those who lived alone were also more vulnerable and had 3.5 times increased likelihood of being at nutrition risk (McElnay et al., 2012). The LiLACS NZ study of 655 octogenarians living in the community found high nutrition risk in 49% of Māori and 38% of non-Māori participants, as assessed using SCREEN II (Wham, Teh, et al., 2015). A study of 157 participants across Auckland, New Zealand analysed malnutrition risk across older adults living in the community, as well as new admissions to RAC or hospital (Wham et al., 2017). Most (90%) of RAC residents were identified as being malnourished or at risk, 80% of those in the hospital setting were at risk or malnourished whilst only 7% of those in the community sample were at nutrition risk (Wham et al., 2017). Those in the RAC sample were newly admitted to RAC and thus these results may not truly reflect the nutritional status of people who have been living in RAC for an extended period.

A national dental survey of 987 New Zealand RAC residents found that 47% of females and 54% of males were malnourished or at risk of malnutrition as assessed by the MNA questionnaire (van Kuijk et al., 2020). Those with severely impaired cognitive function were twice as likely to be malnourished/at risk of malnutrition than those with normal cognitive function, for dentate individuals, the likelihood of being malnourished/at nutrition risk increased by 2% for every additional tooth affected by dental caries.

These studies show that malnutrition is prevalent within many groups of older people, this indicates that screening for malnutrition is needed both in RAC and the community to identify and treat malnutrition.

2.5 Anorexia of ageing

New Zealand's older adults need more support to ensure they have adequate nutrition compared to their younger counterparts. Both appetite and energy expenditure naturally decline with age, however, this effect is often compounded by accompanying physiological issues such as digestive problems and poor dentition (Agarwal et al., 2016). A qualitative study conducted in New Zealand revealed that many older adults feel that eating less is simply a normal part of ageing (Chatindiara, Sheridan, Kruger, & Wham, 2020; Kabayama, Mikami, & Kamide, 2018). Whilst some decrease in intake is to be expected with age, poor appetite and weight loss should be treated seriously as these issues are linked to both frailty and mortality (Morley, 2012). Anorexia of ageing is a condition that causes appetite loss in older adults and is associated with malnutrition, muscle wasting and reduced dietary diversity (Cox et al., 2020). Anorexia of ageing is thought to affect 15-30% of community-dwelling older adults, and 31% of those living in RAC (Malafarina, Uriz-Otano, Gil-Guerrero, & Iniesta, 2013). There are many contributing factors explaining why appetite and intake decline is drastic for many older adults, it is thought that this issue is created by a combination of physiological and social barriers (Landi et al., 2016; Morley, 2013).

2.5.1 Physiological Barriers to Eating

In ageing, the physiological signals that modulate hunger and satiety are dysregulated (Cox et al., 2020). Review studies show that older adults have higher circulating quantities of satiety hormones such as cholecystokinin, leptin and peptide YY (Johnson et al., 2020) and lower levels of the active form of ghrelin, a hunger hormone, than their younger counterparts (Morley, 2013). Mechanical changes to the digestive system also occur slowing gastric emptying and reducing the flexibility of the gastric wall (Morley, 2013). These changes mean that older adults feel hungry less often and less intensely and are satiated for longer after smaller amounts of food (Morley, 2013). This age group is often also afflicted with digestion issues such as dysphagia, reflux, diarrhoea and constipation, these problems can heavily impact appetite and food choice (Milan & Cameron-Smith, 2015).

Dysphagia or difficulty swallowing is prevalent in older adults living in RAC, with rates of 7-40% being reported (Namasivayam & Steele, 2015). Dysphagia can make eating more difficult and if eating difficulties are not addressed, they can lead to inadequate protein and energy intake. Insufficient energy and protein can cause the muscles of the jaw and throat to atrophy, reducing strength in the chewing and swallowing muscles and further perpetuating the eating difficulties (Tanıgör & Eyigör, 2020).

2.5.2 Social Barriers to Eating

Many older adults live alone and have fewer social interactions than younger adults, this has been associated with reduced meal duration and intake (Stroebele-Benschop, Depa, & de Castro, 2016). The social environment is important for eating as it can: stimulate appetite, initiate eating despite the absence of hunger and prolong mealtimes causing people to eat more (Berthoud, 2011; Herman, 2015; Vesnaver & Keller, 2011). In New Zealand, social factors such as living alone, having a lower level of education and having a lower health-related quality of life have been associated with malnutrition risk (Wham, Teh, et al., 2015). Widowhood is another challenge that faces many people in late life. The death of a spouse has large impacts on eating habits as partners are an external source of motivation to eat and many widows report that eating alone is a poignant reminder of their loss (Vesnaver, Keller, Sutherland, Maitland, & Locher, 2016).

Depression has been identified as another common cause of anorexia in older adults, as it can cause changes to neurotransmitters and reduce the internal cues to eat (Morley, 2013; Morley & Kraenzle, 1994). Social isolation (Alpass & Neville, 2003), loss of a spouse (Vesnaver & Keller, 2011) and age-related neurological changes put many older people at risk of depression (Fiske, Wetherell, & Gatz, 2009), with a high prevalence being reported in those living in RAC (14-42%) (Fiske et al., 2009; Pirkis et al., 2009). In a study of older adults living in RAC, depression accounted for 36% of weight loss (Morley & Kraenzle, 1994). The geriatric depression scale (GDS) is a validated tool designed specifically to assess depression in older adults (Yesavage et al., 1982), with highly significantly ($P<0.01$) different GDS scores between people with and without depression. While cognitive decline is a risk factor for depression in older adults (Fiske et al., 2009), it is important to note that the validity of the GDS questionnaire deteriorates when working with cognitively declined participants (Li et al., 2015). Overall, the combination of a reduced desire to eat matched with increasing challenges, de-incentivises eating, leaving many older people eating less than their requirements.

2.6 Sarcopenia

The term sarcopenia comes from the Greek words sarx meaning flesh and penia meaning loss and was coined to describe the reduction in muscle mass resulting in either a loss of strength or functionality that occurs in ageing (Zanker et al., 2019). This reduction in muscle and strength is not innocuous, as it is well established that muscle weakness is an independent predictor of mortality (Ruiz et al., 2008) as well as a variety of negative outcomes such as infections (Cosquéric et al., 2006), postoperative complications (Lieffers, Bathe, Fassbender, Winget, & Baracos, 2012), depression and cognitive impairment (Hsu et al., 2014). Consideration of sarcopenia is important when improving independence levels in older people as sarcopenia is associated with a 2.0–3.6-fold increase in functional impairment (Keller, 2019). The EWGSOP has classified sarcopenia into two types. Primary sarcopenia is the natural decline of muscle mass that occurs with ageing, a person can be considered to have primary sarcopenia if there are no other clear causes of muscle loss (Cruz-Jentoft et al., 2014). Secondary sarcopenia is muscle loss that is exacerbated by disease, inactivity or poor nutrition (Cruz-Jentoft et al., 2014).

2.7 Aetiology of Primary Sarcopenia

For most individuals, muscle mass begins to decline after the age of 30, with the most significant decreases in muscle mass occurring in the person's sixth and seventh decades (Keller, 2019). Lifestyle changes that typically occur in these years likely play a role however, it is clear that biology also contributes as even weightlifting athletes that train into late life display strength declines (Keller, 2019). In older age, reduced anabolic hormones, and inflammation and fatty deposits within the muscle cause a shift towards the favouring of catabolism over anabolism of muscle (Wilkinson et al., 2018). Strength is lost more quickly than muscle mass with age as structural changes to the muscle impair function (Stenholm et al., 2008). A study of 1880 older adults followed over 3 years reported that loss of strength was 3-fold greater than the loss of muscle mass (Goodpaster et al., 2006). This is because type-2 muscle fibres, which have a more dramatic effect on strength, decline more significantly than type-1 muscle fibres and type-2 muscle fibres (Zhang, Morris, & Ng, 2006). Type-2 fibres are less adapted to the metabolic changes that occur in late life and thus are more often damaged, this paired with the decreased ability for cellular repair that occurs in senescence leads to increased atrophy of these muscle cells (Carter, Justice, & Thompson, 2019). Sex hormones, testosterone and oestrogen, also play a role in the development of sarcopenia as these hormones stimulate muscle protein synthesis (Anderson, Liu, & Garcia, 2017; Jacob et al., 2018), and decline with advancing age, this impacts muscle retention and body composition contributing to muscle wasting and the development of sarcopenia (Rezuş et al., 2020).

2.8 Aetiology of Secondary Sarcopenia

While some muscle wasting is inevitable in ageing, accelerated muscle atrophy caused by additional factors is classified by the EWGSOP as secondary sarcopenia (Cruz-Jentoft et al., 2019). Secondary sarcopenia could be a result of endocrine dysfunction, disease-related inflammation states, or neurological disorders causing compromised muscle innervation (Cruz-Jentoft & Landi, 2014). The physical inactivity that commonly occurs with ageing further perpetuates age-related muscle loss and is listed as another cause for secondary sarcopenia (Cruz-Jentoft et al., 2019). In the presence of sufficient amino acids, exercise stimulates muscle protein synthesis and extends

the amount of time that muscle tissue is in an anabolic state (Wilkinson et al., 2018). Conversely, inactivity reduces muscle protein synthesis tipping the equilibrium towards catabolism and muscle atrophy (Wilkinson et al., 2018). Activity is required to protect muscle, as immobilisation causes changes to muscle mitochondria which triggers a cascade that leads to muscle cell death (Ji & Yeo, 2019).

Malnutrition, due to inadequate intake or absorption or overnutrition, has also been stated as a common cause of secondary sarcopenia (Cruz-Jentoft et al., 2019). Skeletal muscle cells are not static as the proteins within muscles are constantly turned over, thus adequate protein intake is required to keep muscle breakdown and synthesis at equilibrium (Murton, 2015). Overall energy intake is also important as when energy is inadequate, the body can utilise protein from muscle tissue as an energy source, compromising muscle mass to meet energy needs (Poortmans, Carpentier, Pereira-Lancha, & Lancha Jr, 2012b). For these reasons, malnutrition is a strong predictor for sarcopenia and nutrition interventions can improve muscle mass and strength in malnourished sarcopenic individuals (Beaudart et al., 2019; Sieber, 2019).

2.9 Sarcopenic Obesity

While sarcopenia and malnutrition go hand in hand, it should be noted that both conditions do not always occur in conjunction with an 'underweight' BMI. An Australian study that took place in the community and found that 34% of the older adults classified as 'at risk' of malnutrition were overweight or obese (Winter, Flanagan, McNaughton, & Nowson, 2013). Sarcopenia and obesity are also not mutually exclusive, as one can have low lean mass simultaneously with high-fat mass, the consequences of this are graver than sarcopenia alone (Wannamethee & Atkins, 2015). A meta-analysis with a total of 35,847 participants, found sarcopenic obesity increased all-cause mortality by 24% compared to healthy subjects (Tian & Xu, 2016). It also has a higher impact on disability levels. One study found sarcopenia in conjunction with obesity increased the risk of functional difficulties by 230 – 260%, while sarcopenia alone had no impact on functional difficulty when confounding factors were controlled for (Rolland et al., 2009). The aetiology of sarcopenic obesity is particularly insidious due to its cyclical nature. When a healthy person puts on weight, movement or impact triggers muscle and bone mass to increase proportionally

(Stenholm et al., 2008). When movement and exercise are inadequate to stimulate the secretion of the growth factors responsible for this, an individual can begin gaining fat without a proportional increase in muscle (Polyzos & Margioris, 2018). As muscle mass declines, so does metabolic rate, as well as the person's ability to be active, further reducing energy requirements and predisposing the individual to additional weight gain. In sarcopenic obesity fat accumulates both in and outside of the muscle cell, impacting muscle function and triggering further atrophy (Hong & Choi, 2020; Reilly & Saltiel, 2017). Obesity may disguise sarcopenia as the individual may maintain a similar weight despite muscle wasting occurring (Hong & Choi, 2020), therefore, screening for sarcopenia should take place in vulnerable older adults regardless of weight.

2.10 Sarcopenia Screening and Diagnosis

Despite a recognised definition of sarcopenia and the gravity of the disease, the diagnostic criteria for sarcopenia remain disputed internationally, making it difficult to determine the disease's worldwide prevalence (Morley, Anker, & Von Haehling, 2014; Walston, 2012). In 2017, the Australian and New Zealand Society for Sarcopenia and Frailty Research came to a consensus that the EWGSOP criteria would be the operational definition of sarcopenia in both clinical and research settings (Zanker et al., 2019). The EWGSOP focuses on the combination of loss of strength alongside a loss of muscle mass to diagnose sarcopenia, this contrasts previous definitions which focused primarily on muscle mass (Cruz-Jentoft et al., 2019). The EWGSOP has a stepwise process to diagnose sarcopenia and then to determine its severity (Cruz-Jentoft et al., 2019).

The EWGSOP guidelines recommend that screening for sarcopenia should be undertaken using the SARC-F questionnaire, a self-reported five-item questionnaire that considers a person’s self-perceived physical limitations (Cruz-Jentoft et al., 2019). If the SARC- F returns a result indicative of sarcopenia risk or there is clinical suspicion of sarcopenia, a strength test using approved measures such as handgrip strength or a chair stand test is recommended. To confirm the sarcopenia diagnosis, muscle quantity should be assessed using dual-energy X-ray absorptiometry (DXA), bioelectrical impedance analysis (BIA), computed tomography (CT) or magnetic resonance imaging (MRI) scans to calculate the individual’s appendicular skeletal

muscle mass (ASM) (Cruz-Jentoft et al., 2019). Severity of sarcopenia can then be determined through physical function tests such as a walking speed test, the short physical performance battery test or a timed up and go test.

The EWGSOP guidelines were adopted for the present study. A hand grip strength and BIA measurements to assess muscle strength and mass were used to minimise participant burden. A 2.4m walking speed test was the most appropriate measure to assess physical function due to the study setting and population.

The SARC-F screening tool (Strength, Assistance in walking, Rising from a chair, Climbing stairs and Falls) (Bahat, Yilmaz, Kiliç, Oren, & Karan, 2018), was also used in the present study. SARC-F has a moderate to poor sensitivity (29%-55%) and moderate to high specificity (69%-89%), therefore at best can find severe cases of sarcopenia (Bahat, Yilmaz, Kiliç, Oren, & Karan, 2018). The self-reported nature of SARC-F is challenging for participants with cognitive decline, which maybe an important exclusion factor (Zasadzka, Pieczyńska, Trzmiel, & Pawlaczyk, 2020). A more recent meta-analysis of SARC-F validation studies advises against the use of screening for sarcopenia using SARC-F due to the low to moderate sensitivity and suggests assessment without screening (Voelker, Michalopoulos, Maier, & Reijnierse, 2021).

BIA was the tool used to assess body composition in the current study. BIA is comparable to DXA, CT and MRI scanners, and is a portable and practical assessment tool that is cost-effective. Although BIA is an indirect measure of muscle mass, it has been validated against DXA scans with interclass correlation agreements of 0.95-0.96 for whole-body lean mass (Ling et al., 2011). One consideration of BIA however, is that due to the use of electrical currents, manufacturers advise that patients with pacemakers should not use this tool (Buch, Bradfield, Larson, & Horwich, 2012).

According to the EWGSOP guidelines, sarcopenia is confirmed if ASM measures are poor, alongside a poor result from a strength or functioning test, (Cruz-Jentoft et al., 2019). The severity of the condition can be assessed through physical performance tests such as gait speed and timed up and go tests. Poor performance on these tests is indicative of severe sarcopenia.

2.11 Prevalence of Sarcopenia

The establishment of an agreed sarcopenia diagnostic criteria enables more accurate reporting of sarcopenia prevalence across countries and an easier comparison between studies. A review study that assessed sarcopenia with the EWGSOP criteria found the prevalence of sarcopenia in community-dwelling older adults was between 1-29% and was higher among those in RAC at rates of 14–33% (Cruz-Jentoft et al., 2014). In an Australian study of people living in 11 RAC homes, the prevalence was found to be even higher, with 40% of participants being diagnosed as sarcopenic (Senior et al., 2015). This study used the EWGSOP criteria and found that BMI, physical performance scores, nutritional status, and sitting time were all associated with sarcopenia (Senior et al., 2015).

Slovene and Italian rest homes report sarcopenia prevalence similar to the Australian study with rates of 38.7% and 32.8% respectively (Landi et al., 2012; Urzi, Šimunič, & Buzan, 2017). Both studies used the EWGSOP criteria, and the average age of participants was around 85 years. An Egyptian study again using the EWGSOP criteria, reported significantly lower rates of sarcopenia at 17.7% (Rahman, Elkholy, & Mortagy, 2014). This study attributed the low prevalence to the Egyptian climate resulting in higher vitamin D status of participants, as vitamin D is thought to be protective against muscle atrophy (Rahman et al., 2014).

Research undertaken in Turkey with 402 RAC residents found sarcopenia prevalence to be 73.3% (Saka et al., 2016). This high prevalence is likely to be due to this study using mid-upper arm circumferences (MUAC) and tricep skin folds (TSF) to calculate mid-upper arm muscle circumference as a measure of muscle mass, rather than more direct techniques like BIA or DXA.

2.12 Sarcopenia Treatment

The Australia and New Zealand Society for Geriatric Medicine's position statement on undernutrition states that screening for both malnutrition and sarcopenia should be regularly undertaken in older adults to identify and treat those at risk (Visvanathan, 2009). Barriers to intake in older adults should be addressed to correct energy and protein deficiency and prevent the loss of muscle mass.

There is evidence that protein supplements and exercise in older adults may help to improve muscle mass, strength, and function. A randomized cross-over trial of 41 older sarcopenic women with a non-sarcopenic control group supplemented the intervention group with an 8g matrix of essential amino acids twice a day for four months and found significant increases in lean body mass after eight months (Solerte et al., 2008). At the eight-month measures, muscle mass had increased to the point that lean mass was not significantly different between the treatment (sarcopenic) group and the non-sarcopenic controls. Protein supplementation's impact on strength has also been investigated, and a review of five protein supplement trials in older adults found a mean positive difference of 1.97kg in grip strength between intervention and control groups (Rus et al., 2020).

The evidence for exercise's impact on sarcopenia is perhaps more pronounced than nutrition supplementation. A Cochrane review on progressive resistant strength training programs found 83 of 121 trials had large significant improvements on strength and small but significant benefits on physical ability (Liu & Latham, 2009). Another review of 49 studies found exercise had a positive impact on muscle, with an average increase in lean body mass across the studies of 1.1kg (Peterson et al., 2011). This review found increases in lean mass were dose-dependent, with higher volume interventions having a greater effect on lean body mass (Peterson et al., 2011).

Strategies should be employed to prevent malnutrition and subsequent muscle loss in the older population. There is good evidence that muscle mass, strength, and function in sarcopenic older adults can be improved, with many studies finding benefits from resistance exercise routines and protein supplements. While more studies in RAC residents are needed to determine intervention strategies that are suitable and effective in this setting, supporting all older adults to take part in physical activity and meet their nutrition needs is pertinent.

2.13 Summary

While studies suggest malnutrition is a prevalent issue in New Zealand's RAC residents, there is little known about the sarcopenia prevalence. International studies of sarcopenia prevalence show high rates in RAC residents, and so sarcopenia may also be an issue for New Zealand. Sarcopenia is a disease and therefore individuals suffering should be offered treatment.

Screening is the first step in treating the condition and it is important to analyse the extent that this disease affects those in RAC facilities so that appropriate interventions can be employed.

Chapter Three: Research Manuscript

3.1 Abstract

Sarcopenia is defined as an age-related decline in muscle mass and function and is associated with adverse health outcomes. This cross-sectional study recruited 91 older adults (63% women, mean age±SD; 86.0 ± 8.3 years) across three RAC facilities within Auckland, New Zealand. Using the European Working Group on Sarcopenia in Older People (EWGSOP) criteria, sarcopenia was diagnosed from the assessment of; appendicular skeletal muscle mass/height^2, using an InBody S10-body composition analyser and a SECA portable stadiometer or ulna length to estimate standing height; grip strength using a JAMAR handheld dynamometer; and physical performance with a 2.4m gait speed test. Malnutrition risk was assessed using the MNA-SF. Most (83%) of residents were malnourished or at risk of malnutrition and 41% were found to be sarcopenic. Multivariate regression analysis showed lower body mass index (Odds Ratio (OR)=1.4, 95% CI: 1.1, 1.7, P= .003) and lower MNA-SF score (OR=1.6, 95% CI: 1.0, 2.4, P= .047) were predictive of sarcopenia after controlling for age, level of care, depression and number of medications. These findings highlight the need for regular malnutrition screening in RAC to prevent the development and progression of sarcopenia, where low weight or unintentional weight loss should prompt additional sarcopenia screening.

3.2 Introduction

Sarcopenia describes the decline in muscle mass and function that occurs with age (Dos Santos, Cyrino, Antunes, Santos, & Sardinha, 2017) and is exacerbated by inadequate nutrient intake, reduced physical movement, inflammation and diseases that increase nutrient requirements or affect the endocrine system (Cruz-Jentoft & Sayer, 2019). Loss of muscle strength and function is associated with many negative outcomes for older adults, such as a reduced ability for self-care (Stolz, Mayerl, Rásky, & Freidl, 2019) and lower quality of life (Tsekoura, Kastrinis, Katsoulaki, Billis, & Gliatis, 2017). Sarcopenia is associated with increased risk of falls and fractures (Yeung et al., 2019), hospital admissions (Zhao et al., 2019), pneumonia, (Altuna-Venegas, Aliaga-Vega,

Maguiña, Parodi, & Runzer-Colmenares, 2019), chronic respiratory diseases (Bone, Hepgul, Kon, & Maddocks, 2017) and all-cause mortality (Liu et al., 2017).

In 2019, the EWGSOP criteria for sarcopenia was accepted as the operational definition for use by New Zealand clinicians and researchers (Zanker et al., 2019). Under these criteria, a positive sarcopenia diagnosis is represented by poor muscle strength determined by handgrip strength or chair to stand tests; and low muscle quantity or quality, assessed through DXA, BIA, CT or MRI technology. If physical performance is deemed to be poor via an appropriate measure such as gait speed, timed up and go, or the physical performance battery, then the sarcopenia is considered to be severe (Cruz-Jentoft et al., 2019). The establishment of a consensus definition for sarcopenia allows for better comparisons of studies as well as increased opportunity for agreement between health professionals, to provide more effective treatment to those diagnosed (Zanker et al., 2019).

Studies overseas, that use the EWGSOP criteria to assess residents living in RAC have reported varying rates of sarcopenia (Landi et al., 2012; Senior et al., 2015; Urzi et al., 2017). For example, sarcopenia prevalence among RAC residents of 40.2% in Australia (Senior et al., 2015) and 38.7% in Slovenia (Urzi et al., 2017) have been reported, while a slightly lower prevalence has been reported in Italy (32.8%), China (32.5%) and Egypt (17.7%) (Landi et al., 2012; Rahman et al., 2014; Yang, Lu, Jiang, Zeng, & Tang, 2019). While these studies had small sample sizes of 80 to 277 participants, results suggest that, among residents in RAC, sarcopenia may be a widespread issue.

Little is known about the prevalence of sarcopenia among RAC residents in New Zealand. Since the EWGSOP operational definition of sarcopenia has only recently been implemented in New Zealand, now is an appropriate time to begin to fill this knowledge gap (Zanker et al., 2019). Therefore, this study aimed to investigate the prevalence of sarcopenia and associated risk factors among older adults in RAC.

3.2 Materials and Methods

Study Design and Recruitment

This cross-sectional study was conducted among older adults living in three RAC facilities in Auckland, operated by a national aged care provider. Eligible residents were: aged ≥65 years, residing in rest home and hospital level of care, able to provide informed consent, or if unable, proxy-informed consent could be obtained from a family member. Exclusion criteria included residents with a pacemaker or those deemed ineligible by the clinical manager on the basis of an acute decline in cognition or function or the need for acute palliative care.

Eligible residents were guided through a Participant Information Sheet (Appendix A) and provided written informed consent (Appendix B). For those with an Enduring Power of Attorney (EPOA) enacted, the EPOA was sent the information sheet and consent form by email, phone calls were conducted to answer any questions, and consents were provided before data were collected. The study was approved by New Zealand Health and Disability Ethics Committee 20/NTB/120/AM01.

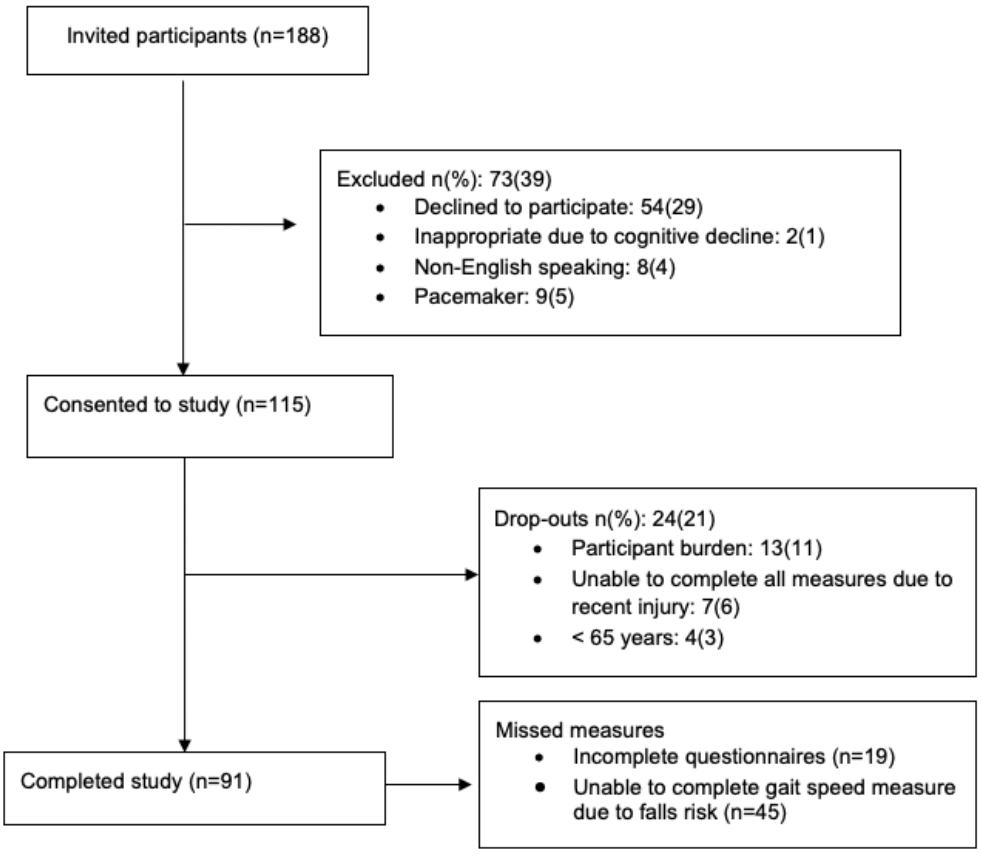


Figure 1. Participant flow from initial invitation to study completion

Data Collection

Data were collected at each facility by a dietitian and dietetic student researcher trained in all aspects of the assessments. In each facility, participant characteristics such as age, gender, ethnicity, highest level of education, marital status, length of stay, level of care, prescribed medications, comorbidities and fall history, were recorded from the rest home's clinical notes. Face to face personal interviews were then undertaken with each participant using validated questionnaires and responses were collected on electronic tablets.

Questionnaires

SARC-F

Strength, Assistance with walking, Rising from a chair, Climbing stairs, and experiencing Falls (SARC-F) is a five item screening tool for sarcopenia recommended for use by the EWGSOP diagnostic criteria (Cruz-Jentoft et al., 2019). Each question is scored between 0-2, with a score of ≥4 indicating risk of sarcopenia and requiring further assessment (Cruz-Jentoft et al., 2019).

Malnutrition

Malnutrition risk was identified using the MNA-SF, a six-item questionnaire validated for geriatrics across a range of settings (Kaiser et al., 2009). The MNA-SF considers food intake, weight loss and physical or psychological stress over the last three months, as well as BMI (Ranhoff, Gjoen, & Mowe, 2005). There are three possible classifications from the MNA-SF scoring, 0-7 points (malnourished), 8-11 points (at risk of malnutrition), or 12–14 points (normal nutrition status) (Kaiser et al., 2009). For participants unable to answer the MNA-SF questions due to cognitive decline, the participant's carer provided responses on their behalf.

Dysphagia

Dysphagia risk was assessed using the validated Eating Assessment Tool (EAT-10), a 10-item self-directed questionnaire (Belafsky et al., 2008). Each question identifies how much of a problem swallowing is in a variety of circumstances, each question is rated from zero to four, with zero

being no problem and four being a severe problem. A score of three or more is classified as being abnormal, with higher scores indicating more severe dysphagia (Belafsky et al., 2008).

Depression

Depression was measured using the 15-item Geriatric Depression Scale (GDS-15) designed as a screening tool in the older population and validated with a specificity of 95% and sensitivity of 84% (Brink et al., 1982; Yesavage et al., 1982). Each question has equal weighting with a value of zero or one and a total score of five or more is suggestive of depression (Greenberg, 2012).

Quality of life

The SF-12 tool was used to inform physical and mental quality of life. The SF-12 considers physical functioning, pain and energy levels, social functioning and mental and physical health and produces two summary results: a physical and a mental component summary score (Jakobsson, Westergren, Lindskov, & Hagell, 2012). The SF-12 has been validated for the older adult population, with significant correlations between physical and mental health and number of chronic illnesses (Resnick & Nahm, 2001).

Physical measures

Height and weight

Height (cm) was recorded to the nearest 0.1 cm using a portable stadiometer (model 213; SECA, Germany). For participants who were chair-bound or bed-bound, ulna length was measured to the nearest 0.5 cm and validated equations were used to predict height (Barbosa, Stratton, Lafuente, & Elia, 2012). Ulna length was chosen over demi-span as it was an easier measure for those with cognitive decline to complete. Weight (kg) was taken to the nearest 0.1 kg using a portable, calibrated scale (model 813; SECA, Germany). The rest home's calibrated chair hoist was used to measure the weight of non-weight bearing participants to the nearest 0.1 kg.

Grip Strength

Grip strength (kg) was measured with a JAMAR hydraulic hand dynameter (model #5030J1; Sammons Preston, USA). The protocol outlined in Roberts et al. (2011) was followed for this measure. In brief, participants were seated and held the hand dynamometer keeping the forearm at a 90-degree angle. Participants completed the measure three times on each hand and the highest of the six measures was recorded to the nearest kilogram. The EGWSOP cut-off point of 27 kg for men and 16 kg for women was used to indicate low muscle strength (Cruz-Jentoft et al., 2019).

Gait Speed

Physical functioning was assessed with a 2.4 m walking test. A cone was placed in a clear space with even flooring, a piece of tape was placed to mark 0.6 m after the cone, a second piece of tape was used to mark 2.4 m from the first piece of tape and a cone was placed 0.6 m after the final piece of tape. The participant was asked to walk at their normal pace between the two cones. Using a stopwatch (model 46-139; HART Sport, China), a researcher timed the walk between the two taped marks and recorded the time taken to 0.1 seconds. The timed walk was repeated a total of three times, the time was then converted into metres per second (m/s) speed by dividing 2.4 by the time taken. The fastest 2.4 m walk time was then converted into a 4 m gait speed using the following conversion equations (Guralnik et al., 2000):

For 2.4 m gait speed ≤ 1.0 m/s: 4 m gait speed = 0.01 + (2.4 m gait speed X 1.052)

For 2.4 m gait speed > 1.0 m/s: 4 m gait speed = 0.481 + (2.4 m gait speed X 0.581)

The EWGSOP cut-off point of 0.8 m/s was used to indicate poor physical function. Note was taken of any walking aids used to complete the measure. Those at a high risk of falls as determined by the RAC clinical manager or who were chair bound were given a score comparative to those who walked slower than 0.8 m/s for the gait speed test.

Body Composition

Participants' body composition was assessed using the Inbody S10 BIA scales (InBody Co., Ltd, Korea). The primary measure was appendicular muscle mass. Body fat percentage (BF%), fat mass, bone mineral composition, skeletal muscle mass and fat-free mass were recorded. InBody S10 uses direct segmental multifrequency bioelectrical impedance analysis to measure muscle mass and is a validated method for estimating skeletal muscle mass compared with DXA, the gold standard (Ling et al., 2011). BIA measurements were taken with participants in a supine position either in a reclined armchair or on the participant's bed, with arms placed away from the body and legs separated. While BIA is a practical and safe measure of muscle mass for most individuals, the current recommendations advise that measures are not undertaken on those who have implanted cardiac devices such as pacemakers (Chabin et al., 2019). Participants who had a pacemaker, implanted cardioverter-defibrillator, or injuries requiring bandages at the site of the electrodes were excluded from this measure. Appendicular muscle mass /height^2 was compared to the EWGSOP cut-off points for low muscle mass of <7 kg/m^2 for men and <5.5 kg/m^2 for women.

Sarcopenia

Sarcopenia was diagnosed according to the EWGSOP guidelines (Cruz-Jentoft et al., 2019). A positive diagnosis was determined when both grip strength and appendicular muscle mass/height^2 were below the EWGSOP sex specific cut off points presented above. Sarcopenia was deemed severe if the individual's gait speed was slower than 0.8 m/s.

Statistical analysis

Statistical analysis was carried out using SPSS statistical software (Version 27, SPSS Inc., Chicago, IL, USA). Continuous variables for population characteristics were assessed for normality using the Shapiro Wilk and Kolmogorov-Smirnov tests. The log was taken of non-normal data and normality was re-checked. Parametric data were presented as mean and standard deviation and non-parametric data as median with 25th and 75th percentiles. Categorical variables were presented as frequency and percentage. The association between factors and positive sarcopenia

diagnoses were assessed using independent sample t-tests for parametric data and Mann-Whitney U tests for non-parametric data. Chi-squared tests were used to compare categorical variables.

Predictors of sarcopenia were assessed employing binary logistic regression analysis (univariable and multivariable). Six independent variables with strong associations with sarcopenia were entered into the regression. Despite being significantly associated with sarcopenia in the preliminary cross-tabulation analysis, diabetes and cancer were not included in the regression due to the small number of people with these conditions. To avoid the violation of multicollinearity and incomplete information from the predictors due to many variables with many categories and because there was a strong relationship between BMI and BF% (r=0.7, X^2 (1)=19, P<0.0001), separate binary logistic regression analyses were performed, with either BMI or BF%. Imbalanced data with binary outcome variables are associated with biases in the estimated probability of an event. The models were investigated to determine if all the assumptions were met and which model had a better model fit. The regression model containing BMI had a better goodness of fit and was better at predicting sarcopenia, with a sensitivity of 83.3% and specificity of 90.7%. This was compared with the BF% regression model that had a sensitivity of 79.2% and specificity of 83.7%. Because of this, the regression model containing BMI was favoured over the model with BF% for the regression analysis. Interaction terms were added into the models to investigate for interaction effects between variables but no significant results were observed. Associations were described using adjusted odds ratios (OR) and 95% confidence intervals (CI). Statistical significance for all statistical tests was determined at P<0.05.

3.4 Results

3.4.1 Sarcopenia prevalence and significant demographics

A total of 37 (41%) participants were sarcopenic using the EWGSOP criteria. Sarcopenic individuals were older (P=0.01) and more likely to be receiving hospital rather than rest home level of care (P=0.005). The characteristics of the participants are provided in Table 1. Sarcopenic

individuals were less likely to be taking more than seven medications (*P*=0.004) and more likely to have diabetes (*P*=0.03) or a malignancy (*P*=0.05) than non-sarcopenic participants (Table 2).

Table 1: Demographic characteristics of participants

	Total (n=91)	**Sarcopenic n(%): 37 (41)**	**Non-sarcopenic n(%): 54 (59)**	***P*-value***
Age (years, mean (SD))	86.0 (8.3)	88.6 (7.6)	84.2 (8.4)	0.01*
Age, years, n (%)				0.14
<85	38 (42)	12 (32)	26 (68)	
≥85	53 (58)	25 (47)	28 (53)	
Gender, n (%)				0.80
Women	58 (64)	23 (40)	35 (60)	
Men	33 (36)	14 (42)	19 (58)	
Ethnicity (n=88)[1], n (%)				0.84
New Zealand European	59 (67)	23 (39)	36 (61)	
Other[2]	29 (33)	13 (45)	16 (55)	
Marital status (n=76)[1], n (%)				0.79
Partnered	29 (38)	12 (41)	17 (59	
No partner	47 (62)	18 (38)	29 (62)	
Level of education (n=72)[1], n (%)				0.48
Less than tertiary	25 (35)	8 (32)	17 (68)	
Tertiary and higher	47 (65)	19 (40)	28 (60)	
Length of stay (n=76)[1], n (%)				0.15
≤ 30 months	48 (63)	16 (33)	32 (67)	
> 30 months	28 (37)	14 (50)	14 (50)	
Level of care (n=91), n (%)				0.005*
Rest home level	53 (58)	15 (28)	38 (72)	
Hospital level	38 (42)	22 (58)	16 (42)	
Oral nutritional supplement (n=85)[1], n (%)				0.52
Yes	18 (21)	6 (33)	12 (67)	
No	67 (79)	28 (42)	39 (58)	

*Chi-square test; significant difference between sarcopenic and non-sarcopenic participants ($P<0.05$).
Abbreviations: SD, standard deviation
[1]Missing data for variable
[2]Other ethnicities: Māori, Fijian Indian, Chinese, South African, European, Australian, Fijian

Table 2: The association of sarcopenia with medication use and co-morbidities

	Total (n=91)	**Sarcopenic n (%): 37 (41)**	**Non-sarcopenic n (%): 54 (59)**	***P*-value***
Number of regular medications (n=81), n (%)[1]				0.004*
≤7	41 (51)	23 (56)	18 (44)	
>7	40 (49)	10 (25)	30 (75)	
Comorbidities (n=86), n (%)[1]				
Number of comorbidities				0.90
≤5	41 (48)	17 (42)	24 (58)	
>5	45 (52)	18 (40)	27 (60)	
Hypertension				0.22
No	45 (54)	16 (36)	29 (64)	
Yes	39 (46)	19 (49)	20 (51)	
Cardiovascular diseases				0.94
No	26 (31)	11 (42)	15 (58)	
Yes	59 (69)	24 (41)	34 (59)	
Diabetes				0.03*
No	71 (79)	26 (37)	45 (63)	
Yes	13 (21)	9 (69)	4 (31)	
Cognitive impairment				0.66
No	48 (57)	19 (40)	29 (60)	
Yes	36 (43)	16 (44)	20 (56)	
Renal diseases				0.35
No	68 (81)	30 (44)	38 (56)	
Yes	16 (19)	5 (31)	11 (69)	
Cancer				0.05*
No	74 (88)	28 (38)	46 (62)	
Yes	10 (12)	7 (70)	3 (30)	
Chronic respiratory diseases				0.72
No	71 (85)	29 (41)	42 (59)	
Yes	13 (15)	6 (46)	7 (54)	
Arthritis				0.23
No	64 (76)	29 (45)	35 (55)	

Yes	20 (24)	6 (30)	14 (70)	
Fracture				0.91
No	74 (88)	31 (42)	43 (58)	
Yes	10 (12)	4 (40)	6 (60)	
SARC-F Score (n=76)[1]				
<4	35 (46)	10 (29)	25 (71)	0.34
≥4	41 (54)	16 (39)	25 (61)	
Dysphagia (n=76)[1]				0.19
Not at risk	53 (70)	17 (32)	36 (68)	
At-risk	23 (30)	11 (48)	12 (52)	
Depression (n=72)[1]				0.006*
Low risk	47 (65)	11 (23)	36 (77)	
At-risk/high risk	25 (35)	14 (56)	11 (44)	
Malnutrition (n=87)[1]				0.004
Not at risk	15 (17)	1 (7)	14 (93)	
At-risk/malnourished	72 (83)	34 (47)	38 (53)	
SF-12 Physical Component Score (n=61)[1]				0.73
≥50	48 (80)	19 (86)	29 (76)	
<50	12 (20)	3 (14)	9 (24)	
SF-12 Mental Component Score(n=61)[1]				0.36
≥42	10 (17)	5 (23)	5 (13)	
<42	50 (83)	17 (77)	33 (87)	

*Chi-square test; significant at $P<0.05$.

Abbreviations: SF-12, Medical Outcomes Study's 12 item Short Form Survey

[1] Missing data for variable

3.4.2 Body composition

The association between anthropometric, body composition and strength/function measures is presented in Table 3. More sarcopenic individuals had a BMI less than 23 kg/m^2 compared with those in the non-sarcopenic group (*P*<0.001) (Figure 2). Fewer individuals in the sarcopenic group had a BF% above the total population gender-specific mean (*P*=0.01) (Figure 3). Bone mineral content (*P*=0.003*)*, total fat mass (*P*<0.001), total skeletal muscle mass (*P*<0.001) and grip strength (*P*<0.001) were all significantly lower in sarcopenic than non-sarcopenic participants. As all sarcopenic individuals walked slower than the EWGSOP cut-off for poor physical function (<0.8 m/s) they were all considered severe cases. Only seven participants had a walking speed faster than 0.8 m/s and they were not sarcopenic. Of those who completed this measure, 75.6% of participants used a walking aid such as a frame or stick.

Table 3: The association of sarcopenia with anthropometric, body composition and strength/function measures

	Total (n=91)	**Sarcopenic n(%): 37 (41)**	**Non-sarcopenic n(%): 54 (59)**	***P*-value***
BMI (kg/m^2)	24.9±6.1	21.6±3.7	27.7±5.9	<0.001*
Fat mass mean±SD (kg)	25±12	19±8	30±12	<0.001*
BF% mean±SD (kg)	37±11	33±9.7	39±11	0.01*
Fat free mass (kg)	40 (34, 47)	34 (31, 40)	42 (37, 51)	<0.001*
Skeletal mass index (kg/h^2)	6.1 (5.3, 7.1)	5.1 (4.7, 5.8)	6.8 (6.0, 7.7)	<0.001*
Skeletal muscle mass (kg)	20 (17, 25)	17 (15, 21)	22 (20, 27)	<0.001*
Appendicular lean mass (kg)	15 (13, 20)	13 (11, 15)	17 (15, 22)	<0.001*
Bone mineral content (kg)	2.4 (2.1, 2.8)	2.3 (2.0, 2.6)	2.5 (2.3, 2.9)	0.003*
Grip Strength, mean±SD (kg) (n=82) [1]	13.9±7.8	9.5±5.9	16.7±7.6	<0.001*
Gait speed, mean±SD (m/s) (n=46) [1]	0.55±1.42	0.49±1.30	0.57±1.45	0.175

*Independent sample t-test for normally distributed data and Mann-Whitney U test for not normally distributed data. Significant at *P*<0.05.
Abbreviations: BMI, Body Mass Index; BF%, Body Fat percentage; h, height in cm; SD, standard deviation
Values are reported as median (25th, 75th percentiles) unless otherwise stated.
[1] Missing data for variable

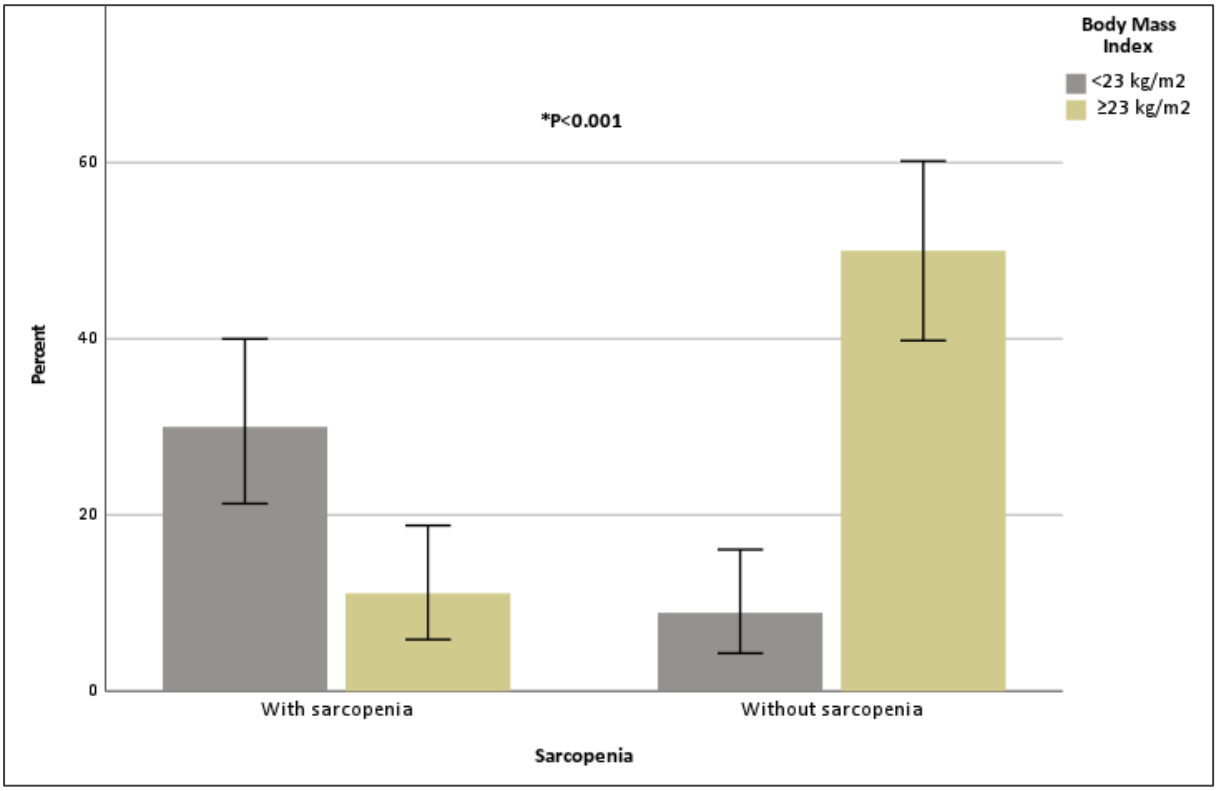


Figure 2. Proportion of participants with and without sarcopenia having BMI <23 and ≥23 kg/m2. Significant at P<0.05. Error bars: 95% CI.

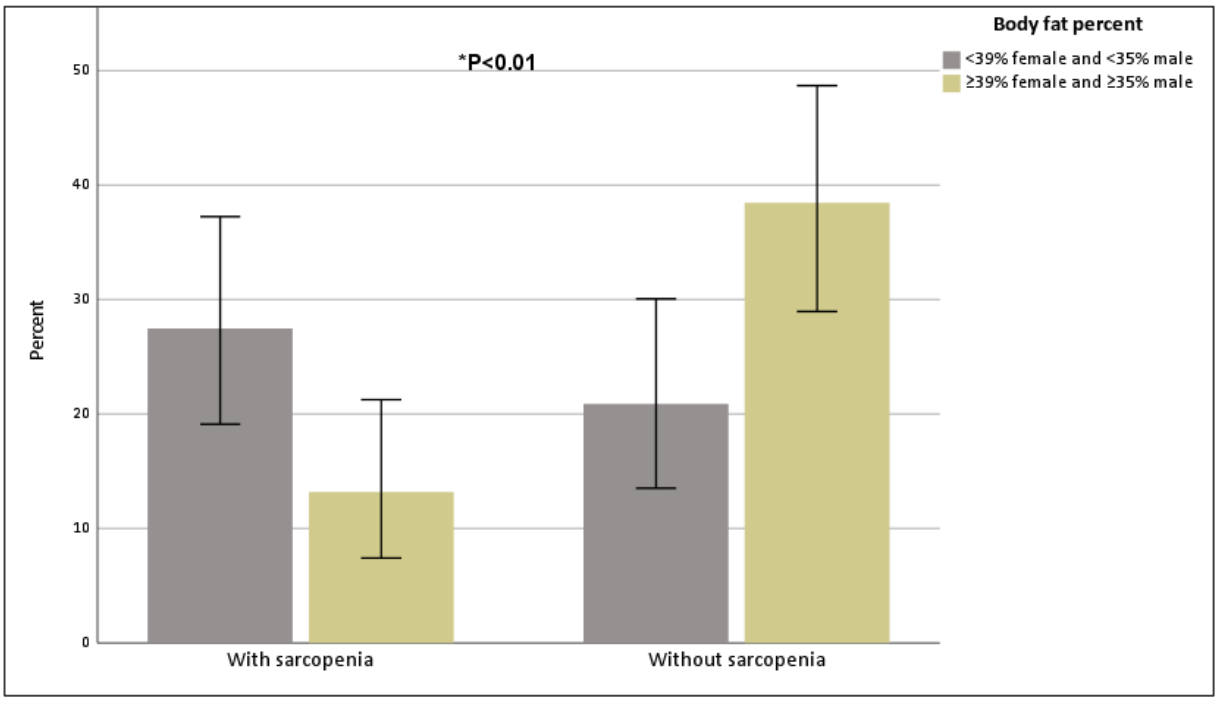


Figure 3. Proportion of participants with and without sarcopenia having a body fat percentage <39% and ≥39% for women and <35% and ≥35% for men. Significant at P<0.05. Error bars: 95%CI

3.4.3 Participants' nutritional status and mental/physical well-being

A fifth of the participants (21%) were taking an oral nutrition supplement at the time of data collection (Table 1). Most (83%) of the participants had MNA-SF scores indicative of malnutrition (26%) or at nutrition risk (63%) (Table 2). Participants with sarcopenia were significantly more likely to be malnourished or at risk of malnutrition (*P*=0.004) (Table 2). Participants with sarcopenia had significantly lower median (25^{th}, 75^{th} percentiles) MNA-SF scores than those without sarcopenia, 8 (6, 10) vs. 11 (10, 12) units, respectively (*P*<0.001) (Figure 4). Those with sarcopenia were more likely to have a GDS-15 score indicative of depressive symptoms (*P*=0.006). (Table 2).

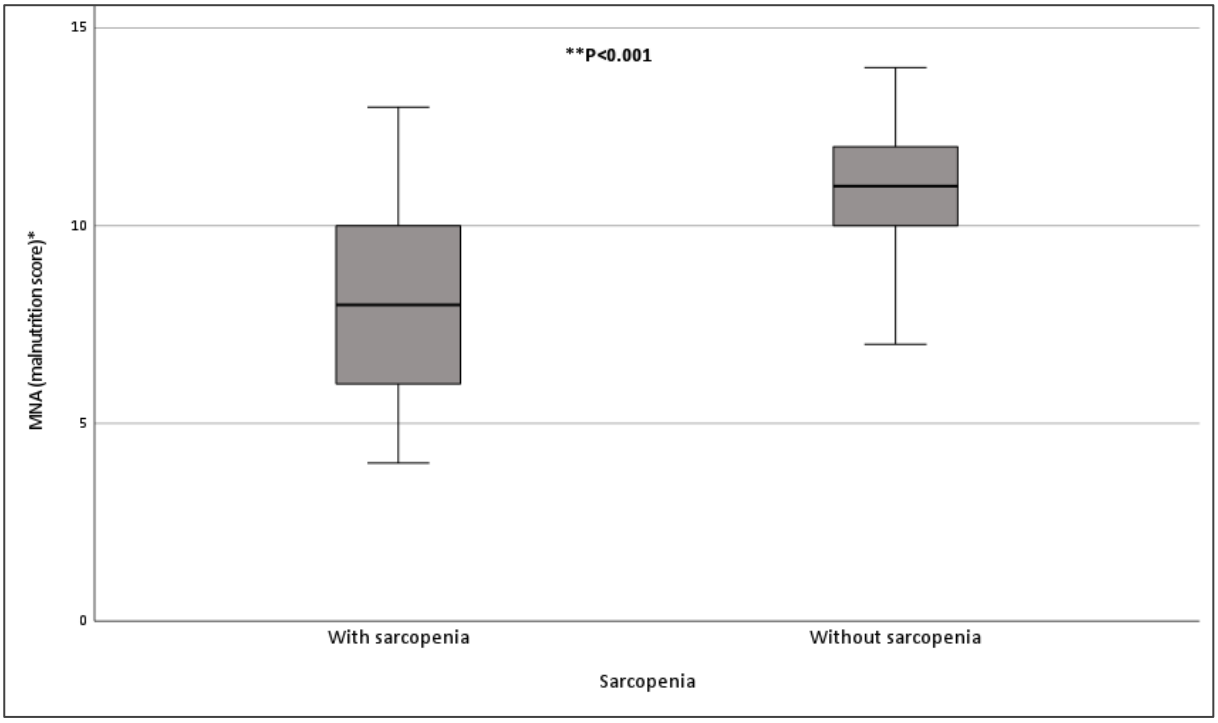


Figure 4. Malnutrition score (assessed by Mini Nutrition Assessment Short Form, MNA-SF) among participants with and without sarcopenia. Higher scores are indicative of better nutritional status. Significant at P<0.05. Error bars: 95% CI

3.4.4 Factors predicting sarcopenia

Odds ratios for all variables included in the multivariate logistic regression containing BMI and the regression model containing BF% are presented in Tables 4 and 5, respectively. Hospital level of care, depressive symptoms, lower BMI and MNA-SF score and increasing age were significantly associated with sarcopenia in the univariate analysis (*P*<0.05). After controlling for confounding variables, only BMI (OR: 1.4; 95% CI: 1.1 - 1.7) and MNA-SF score (OR: 1.6; 95% CI: 1.0, 2.4) remained significant predictors of sarcopenia in the regression containing BMI. MNA-SF score was also found to be predictive of sarcopenia in the regression analysis containing BF% (OR: 1.6; 95% CI: 1.1, 2.4). Whilst age was not a significant predictor of sarcopenia in the regression model containing BMI (OR=0.9, 95% CI: 0.8 - 1.0), it was marginally significant in the regression model where BF% was used (OR=1.1, 95% CI: 0.8 - 1.0).

Table 4: Factors predicting sarcopenia using regression model containing BMI

	Total	With sarcopenia	Without sarcopenia	OR (95% CI)	
				Univariate	Multivariate
Malnutrition score[1]	9.5±2.3	8.2±2.1	10.0±1.9	1.7 (1.3, 2.2)	1.6 (1.0, 2.4)
Depression score[2]	4.4±3.3	5.4±3.8	3.7±2.9	0.9 (0.7, 1.0)	0.8 (0.6, 1.1)
BMI (kg/m^2)	24.9±6.1	21.6±3.7	27.7±5.9	1.4 (1.2, 1.6)	1.4 (1.1, 1.7)
Age (years)	86.0±8.3	88.6±7.6	84.2±8.8	0.9 (0.9, 1.0)	0.9 (0.8, 1.0)
Number of regular medications	7.7±3.4	6.4±3.0	8.7±3.4	1.3 (1.0, 1.5)	1.1 (0.8, 1.4)
Level of care, n (%)					
Rest home care	53 (58)	15 (28)	38 (72)	Reference category	
Hospital care	38 (42)	22 (58)	16 (42)	3.5 (1.4, 8.4)	1.0 (0.2, 5.6)

Abbreviations: BMI, Body Mass Index; OR, Odds Ratio; CI, Confidence interval
Values reported as mean±SD unless otherwise stated
[1] Assessed by Mini Nutrition Assessment Short-Form (MNA-SF)
[2] Assessed by Geriatric Depression Scale 15-item questionnaire (GDS-15)

Table 5: Factors predicting sarcopenia using regression model containing BF%

	Total	With sarcopenia	Without sarcopenia	OR (95% CI)	
				Univariate	Multivariate
Malnutrition score[1]	9.5±2.3	8.2±2.1	10±1.9	1.7 (1.3, 2.2)	1.6 (1.1, 2.4)
Depression score[2]	4.4±3.3	5.4±3.8	3.7±2.9	0.9 (0.7, 1.0)	0.8 (0.6, 1.0)
BF%	37±11	33±10	39±11	1.1 (1.0, 1.1)	1.1 (1.0, 1.1)
Age (years)	86.0±8.3	88.6±7.6	84.2±8.8	0.9 (0.9, 1.0)	0.9 (0.8, 1.0)
Number of regular medications	7.7±3.4	6.4±3.0	8.7±3.4	1.3 (1.0, 1.5)	1.2 (0.9, 1.5)
Level of care, n (%)					
Rest home care	53 (58)	15 (28)	38 (72)	Reference category	
Hospital care	38 (42)	22 (58)	16 (42)	3.5 (1.4, 8.4)	1.0 (0.2, 4.7)

Abbreviations: BF%, Body Fat Percentage; OR, Odds Ratio; CI, Confidence interval
Values reported as mean±SD unless otherwise stated
[1] Assessed by Mini Nutrition Assessment Short-Form (MNA-SF)
[2] Assessed by Geriatric Depression Scale 15-item questionnaire (GDS-15)

3.5 Discussion

Using the EWGSOP diagnostic criteria, this study among RAC residents found sarcopenia prevalence to be 41%, with all cases deemed to be severe. Those with sarcopenia tended to be older (mean age±SD; 88.6±7.6 years) than those without sarcopenia (mean age±SD; 84.2±8.4 years). Sarcopenia affected many RAC residents in the sample surveyed, and while this study sample is not representative of the New Zealand population, our findings provide evidence to suggest sarcopenia may be prevalent in New Zealand RAC. While participants completed the recommended screening questionnaire: SARC-F, scores were not significantly different between sarcopenic and non-sarcopenic participants. This supports current evidence that the self-reported SARCF may have moderate to low sensitivity (Voelker et al., 2021) and is probably indicative of some degree of cognitive impairment among the participants.

Multivariate analysis identified decreasing BMI and decreasing MNA-SF score to be significant predictors of increasing sarcopenic risk among the participants, which highlights the importance of regular nutrition screening and treatment of malnutrition in RAC. Sarcopenia and malnutrition often overlap, with symptoms and drivers of each independent condition being tightly intertwined (Juby & Mager, 2019). Muscle wasting occurs as a direct consequence of malnutrition, as adequate protein and energy intake are required for the prevention of muscle protein breakdown (Cederholm et al., 2017; Mithal et al., 2013; Poortmans, Carpentier, Pereira-Lancha, & Lancha Jr, 2012a). In the current study, most (83%) residents were malnourished or at nutrition risk, which is similar to the 90% malnutrition risk reported among 174 New Zealand older adults newly admitted to RAC (Chatindiara, Allen, et al., 2020). The position statement on undernutrition by the Australian and New Zealand Society for Geriatric Medicine (Visvanathan, 2009) suggests all older people be screened and assessed for undernutrition and sarcopenia on a regular basis. Screening is necessary to prompt early intervention and to prevent the progression of malnutrition and sarcopenia with adverse health outcomes (Beaudart et al., 2019; Kondrup et al., 2003). The association between decreasing BMI and increasing sarcopenia risk is consistent with findings from previous studies, and further emphasises the need for malnutrition screening (Landi et al., 2012; Senior et al., 2015). Six sarcopenic individuals in the current study

had a BMI >25 kg/m^2, with one individual having a BMI >30. Sarcopenia existing alongside obesity has been described previously, with a prevalence between 4 and 12% among community-dwelling older adults (aged ≥60 years) in America (Baumgartner, 2000; Davison, Ford, Cogswell, & Dietz, 2002) and Italy (Zoico et al., 2004). Sarcopenia obesity in older adults is associated with higher physical disability and mortality rates than sarcopenia alone (Stenholm et al., 2008; Wannamethee & Atkins, 2015). Therefore, sarcopenia screening is recommended for all RAC residents regardless of the individual's BMI. In studies that have used the EWGSOP diagnostic criteria, the prevalence of sarcopenia in RAC residents has been reported between 17.7% and 40.2% (Rahman et al., 2014; Senior et al., 2015; Urzi et al., 2017; Yang et al., 2019) with variations in prevalence rates likely due to geographical, cultural or ethnic differences. For example, among residents in Egypt, a lower rate of sarcopenia (17.7%) was attributed to increased sunlight hours, as vitamin D status is well known to be protective of muscle mass in older adults (Rahman et al., 2014). A study analysing sarcopenia across older adults living in four RAC facilities in Chengdu City, China (mean age±SD; 81.6±3.3 years) found sarcopenia prevalence to be 32.5% when assessed using the EWGSOP criteria (Yang et al., 2019). This is similar to the prevalence of 32.8% found in an Italian study that took place in RAC facilities in Rome which also used the EWGSOP criteria (age±SD; 84.1±4.8 years) (Landi et al., 2012). Many studies report that Asian ethnicities typically have lower muscle mass than Caucasians (Sun et al., 2003; Zhong et al., 2012), however, the differences in sarcopenia rates in those living in RAC do not appear to reflect this. The current evidence available on sarcopenia in RAC residents, suggests it may be a prevalent issue regardless of culture, country or ethnicity.

We found that diabetes, as well as malignancies, was significantly associated with sarcopenia, although the small sample size meant that neither of these conditions could be included in the regression model. Diabetes has previously been associated with low muscle mass and strength among community-dwelling older adults (Park et al., 2007). Hyperglycaemia and diabetic neuropathy can impair muscle function and contribute to atrophy leading to sarcopenia (Mesinovic, Zengin, De Courten, Ebeling, & Scott, 2019; Nomura, Ishiguro, Ohira, & Ikeda, 2018; Russell, Rajani, Dhadda, & Tisdale, 2009). Sarcopenic individuals also have a reduced ability to oxidise glucose through muscle tissue thus contributing to insulin resistance and the

development of diabetes (Mesinovic et al., 2019). Sarcopenia prevalence among those with malignancies is reported to range from 11-74% in all adults, with prevalence often higher in older populations (Shachar, Williams, Muss, & Nishijima, 2016). Cancer cachexia causes muscle wasting due to metabolic alterations caused by the disease, such as a decreased appetite, and increased energy requirements and inflammation (Baracos, Martin, Korc, Guttridge, & Fearon, 2018). Medications, surgeries, and increased bed rest because of cancer can further perpetuate muscle wasting (Williams, Rier, McDonald, & Shachar, 2019).

There are several limitations in this study. The small sample size of participants limits generalisability. BIA measurements were not undertaken on participants with pacemakers or injuries requiring bandages on the hands or feet where electrodes were placed, which further limited the sample size. While all questionnaires used in this study were validated for the older adult population, some of the residents in this study were cognitively impaired. This does challenge the validity of responses to the questionnaires, for example, responses to the GDS-15 questionnaire have been shown to deteriorate when working with residents who are cognitively declined (Li et al., 2015). While the results of this study inform the sarcopenia prevalence of the participants surveyed, the cross-sectional design of this study means causation of sarcopenia cannot be derived from results.

3.6 Conclusion

This study is the first to assess the prevalence and risk factors of sarcopenia using the EWGSOP criteria within the New Zealand RAC setting. Our study found that sarcopenia and malnutrition rates were high among participants from three RAC facilities. Sarcopenia was associated with higher scores for malnutrition and lower BMI. The relationship between malnutrition score and sarcopenia provides further rationale to support regular malnutrition screening in RAC and the importance of optimising nutrition to prevent loss of body weight.

Chapter Four: Conclusion and Recommendations

4.1 What percentage of people in the RAC facilities assessed, met the EWGSOP diagnostic criteria for sarcopenia?

In this cross-sectional study, the EWGSOP diagnostic criteria were used to classify positive sarcopenia cases (Cruz-Jentoft et al., 2019). Gait speed, grip strength and appendicular mass/height^2 were the primary markers of strength, muscle mass and physical function. A total of 41% of the 91 RAC residents assessed for sarcopenia received a positive diagnosis. Although our study had a small sample size and did not represent the wider New Zealand older adult population, the prevalence found is comparable to other international studies (33 to 40%) that use the same diagnostic criteria to assess older adults living in RAC (Landi et al., 2012; Senior et al., 2015; Urzi et al., 2017). The alignment of our results with other studies reaffirms that sarcopenia is a prevalent issue, with many populations in RAC being vulnerable to sarcopenia. While lower rates of sarcopenia (17.2%) were reported in RAC residents in Egypt, these findings were attributed to the impact of weather and improved vitamin D status (Rahman et al., 2014).

4.2 What is the association between positive sarcopenia diagnoses and nutrition markers such as MNA-SF score, BMI and BF%?

All measures of body composition: BMI, muscle mass, fat mass, BF% and bone mineral content, were found to be significantly associated with sarcopenia status using independent t-tests and Mann-Whitney U tests. Sarcopenic individuals were more likely to have a lower: BMI, muscle mass, total body fat mass, percentage body fat and bone mineral composition. MNA-SF scores were also significantly lower in the sarcopenic group. In the multivariate analysis MNA-SF score and BMI were found to be significant predictors of sarcopenia after adjusting for other factors such as age, level of care, depression, and number of medications.

4.3 What is the association between positive sarcopenia diagnoses and demographic factors such as age, gender, ethnicity, marital status, level of care, level of education, and length of stay?

Gender, ethnicity, marital status, level of education and length of stay were not significantly associated with sarcopenia. Age and level of care had a significant association with sarcopenia using independent t-tests and Mann-Whitney U tests. The small sample size may have impeded other factors from reaching significance. Level of care lost significance when adjusting for confounding factors. Age did not remain a significant predictor of sarcopenia when BMI was included in the multivariate analysis, however, when percentage body fat was substituted for BMI in the regression model, age was a significant predictor.

4.4 What is the association between positive sarcopenia diagnoses and mental and physical wellbeing?

The SF-12 and the GDS-15 questionnaires were used to assess quality of life as well as mental and physical wellbeing. While the SF-12 was not significantly related to sarcopenia status, this may be due to the small sample size or the RAC setting. Studies of community-dwelling older adults have found that individuals with sarcopenia had significantly lower self-rated health scores, as measured by the 36-Item Short Form Health Survey questionnaire (Kull, Kallikorm, & Lember, 2012; Patel et al., 2013). In the current study, individuals with more depressive symptoms indicated by the GDS-15 were at higher risk of sarcopenia, however, depression did not remain significant once other covariates were controlled for in the multivariate analysis. There is a lack of consensus in the literature regarding sarcopenia and depression being significantly associated (Byeon, Kang, Kang, Kim, & Bae, 2016; Chang, Hsu, Wu, Huang, & Han, 2017), however, both have similar risk factors such as chronic inflammation, physical inactivity, poor diet quality and hormonal dysregulation (Cruz-Jentoft et al., 2019; Hallgren et al., 2016). The validity of the GDS deteriorates with cognitively impaired individuals (Li et al., 2015), and as participants in the current study had varying levels of cognition this may have contributed to the conflicting findings reported.

4.5 Other findings

Our study found that malignancies and diabetes were positively associated with sarcopenia among the participants. Other studies support these findings as muscle wasting can occur secondary to cancer or hyperglycaemia and metabolic changes that occur with diabetes (Mesinovic et al., 2019; Williams et al., 2019). This association is important as it identifies participants in RAC that are more vulnerable to sarcopenia and may help to guide clinicians towards those who need support to maintain their muscle mass.

4.6 Strengths and Limitations

The main strength of this study is its comparability to studies among RAC residents in other countries, as its design is like many other studies that have investigated the prevalence of sarcopenia. Despite the small sample size of the current study, comparable findings with other studies reinforce the legitimacy of our results. The predominant weakness of this study is the small number of participants recruited from three villages within the Arvida group in Auckland. Other limitations include the reliance on self-reported questionnaires when assessing older adults who may have some level of cognitive decline. Although all questionnaires were validated for use in older adults, questionnaires such as the SF-12, GDS-15 and EAT-10 require participants to accurately describe their own experiences. The validity of the GDS-15 has been shown to decline when working with individuals with reduced cognitive function (Li et al., 2015). Other questionnaire responses may also have been impacted by cognitive impairment. However, excluding cognitively declined individuals from a study in RAC would have been impractical and resulted in a sample considerably healthier and less representative than a true RAC population.

Body composition measurements using InBody S10 BIA scales over a more direct measure such as DXA was not a limitation in this study. BIA has been approved by the EWGSOP for use in determining sarcopenia and is a validated measure of lean mass (Cruz-Jentoft et al., 2019). When compared to lean mass measures collected by DXA scans, BIA has shown good intraclass correlations of 0.96 for men and 0.95 for women (Ling et al., 2011). The use of the InBody S10 scales enabled muscle mass to be measured in the supine position, making it ideal for this study

as it reduced participant burden and was practical regardless of participant mobility. Although BIA is ideally conducted after an overnight fast, this was not feasible due to time constraints and access to participants, hence measurements were taken throughout the day and the time since the participant's last meal was noted. Taking these measures unfasted can lead to a slight overestimation of muscle mass (Sergi, De Rui, Stubbs, Veronese, & Manzato, 2017), therefore there is a risk that sarcopenia prevalence may be slightly higher than is reported in our study.

4.7 Recommendations

Sarcopenia is a disease, and therefore needs to be treated. This study found 41% of residents had sarcopenia within the three RAC facilities surveyed. While this study is not representative of all older adults in this setting, it suggests that sarcopenia may affect New Zealand RAC residents. The position statement on undernutrition by the Australian and New Zealand Society for Geriatric Medicine recommends older people are screened and assessed for undernutrition and sarcopenia (Visvanathan, 2009). Our study found that lower MNA-SF scores were predictive of sarcopenia, which further emphasises the importance of screening and correcting malnutrition in the RAC setting. Low BMI was also found to be predictive of sarcopenia in our study, therefore individuals should be supported to maintain body weight to keep their BMI within a healthy range for older adults and weight loss and malnutrition should be identified and addressed as early as possible.

While there is no globally accepted diagnostic criterion for undernutrition or sarcopenia, screening and assessment tools are available for both, and these should be utilised regularly with older adults in all settings (Visvanathan, 2009). Individuals found to be at risk of malnutrition or sarcopenia through screening protocols should then be referred to a dietitian for a full nutrition assessment and appropriate treatment. Early identification of both malnutrition and sarcopenia is important as screening allows for early intervention to take place before these conditions progress (Beaudart et al., 2019; Kondrup et al., 2003). The causes of malnutrition and sarcopenia are multifactorial, so prevention and management of these conditions require a comprehensive approach involving all members of the multi-disciplinary team (Visvanathan, 2009). Older adults

experience numerous barriers to eating (i.e., poor dentition, dysphagia, depression, or deficits in nutrition), which can affect nutrition status. It is important that these issues are identified, and referrals are made to the appropriate health professionals such as dentists, speech-language therapists, psychologists, and dietitians, to maximise the effectiveness of treatment.

In care settings, all individuals should have the opportunity to meet their nutritional needs. This can be harder for those with feeding difficulties, and so RAC facilities need to be well-staffed to accommodate assisted feeding for residents who require it (Visvanathan, 2009). The enjoyment of food should also be maximised by avoiding dietary restrictions as much as possible and by taking cultural needs and preferences into consideration when preparing menus. Older adults have high protein requirements of 1.0–1.2 g/kg/day (Bauer et al., 2013), making it difficult for many to meet their needs, particularly when other eating challenges are present. When protein intake is increased among protein-deficient older adults, improvements in both muscle mass and strength result (Beaudart et al., 2017). Protein should be prioritised in RAC menu planning (Agarwal et al., 2016) and oral nutrition supplements should be provided to those struggling to meet protein requirements through food alone (Visvanathan, 2009).

Exercise programs have been found to be effective in helping older adults to both maintain and improve their strength and functional status (Beaudart et al., 2017). Although the impact that exercise has on muscle mass and strength varies between studies due to heterogeneity of exercise regimes, reviews have found overall significant, dose-dependent benefits of exercise among older adults (Peterson et al., 2011). Furthermore, the impact that exercise has on older adults appears to be bolstered when combined with nutrition interventions (Chalé et al., 2013; Trabal et al., 2015).

Sarcopenia was found to be 41% in the RAC residents assessed. Our results provide valuable insight into the prevalence of sarcopenia in these Auckland RAC facilities and add to the body of evidence highlighting the extent of sarcopenia among older adults in New Zealand. More large-scale studies across diverse RAC facilities are required to truly classify the burden of sarcopenia in New Zealand RAC residents. As malnutrition score and lower BMI were predictive of sarcopenia, screening for and managing malnutrition risk is important to minimise the impact

that sarcopenia has on health and quality of life. Maximising nutrition from food sources is important, however oral nutrition supplements should be offered when energy or protein needs cannot be met from food alone. Increasing RAC residents' participation in exercise programs should also be explored to improve strength and muscle mass and slow the progression of sarcopenia.

Appendices

Appendix A: Participant Information Sheet

Participant Information Sheet

MASSEY UNIVERSITY
COLLEGE OF HEALTH
TE KURA HAUORA TANGATA

Study title: Eating Well in Rest Home Care

Locality: Arvida Village

Ethics committee ref.: 20/NTB/120

Lead investigator: Professor Carol Wham

Phone: 09 213 6644

You are invited to take part in a study on understanding and improving food intake in residential care. Whether or not you take part is your choice. If you don't want to take part, you don't have to give a reason, and it won't affect the care you receive. If you do want to take part now, but change your mind later, you can pull out of the study at any time.

This Participant Information Sheet will help you decide if you'd like to take part. It sets out why we are doing the study, what your participation would involve, what the benefits and risks to you might be, and what would happen after the study ends. We will go through this information with you and answer any questions you may have. You do not have to decide today whether you will participate in this study. Before you decide you may want to talk about the study with other people. Feel free to do this.

If you agree to take part in this study, you will be asked to sign the Consent Form on the last page of this document. You will be given a copy of both the Participant Information Sheet and the Consent Form to keep. This document is 6 pages long, including the Consent Form. Please make sure you have read and understood all the pages.

WHAT IS THE PURPOSE OF THE STUDY?

The purpose of this study is to establish your nutrition, health and physical status as well as quality of life & psychological well-being, perceptions towards the food service and meal satisfaction.

Adequate nutrition in older people is an issue that rarely receives the attention it deserves. Depending on your nutrition status you may be invited to participate in a food-based intervention. The outcome of the research will help inform best practice for nutrition care by the Arvida Group and other aged care providers. This study is being undertaken by the department of Nutrition and Dietetics at Massey University in Albany and is led by Professor Carol Wham who can be contacted by calling 09 213 6644.

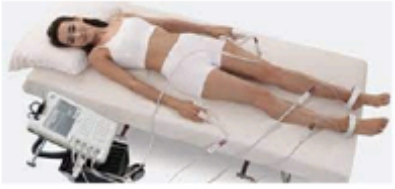
WHAT WILL MY PARTICIPATION IN THE STUDY INVOLVE?

If you agree to take part in the study a dietetic researcher will assess your nutrition status using a 6-item survey, the Mini Nutritional Assessment Short-form. Your demographic and health data will be obtained from the rest home clinical notes to record your medications, co-morbidities, weight, height (if available) and any recent falls or fractures.

You will be invited to complete four short surveys to assess your risk of swallowing difficulty (dysphagia), your health-related quality of life, any risk of depression and a Mealtime Satisfaction Survey.

The dietetic researcher will then undertake some physical measures including your hand grip strength using a hand dynamometer, and your usual walking speed by measuring how long it takes you to walk 2.4 meters (or 8 feet). Your muscle mass and fat mass will then be measured while you are lying down using portable bioelectrical impedance assessment (BIA) scales. The scales send a harmless electrical current up through your body to "read" the amount of fat body mass and lean body mass calculating your percentage of body fat.

Hand grip strength using a hand dynamometer



Muscle mass and fat mass measure using portable bioelectrical impedance assessment (BIA) scales.

WHAT ARE THE POSSIBLE BENEFITS AND RISKS OF THIS STUDY?

We do not envisage any risks or discomfort to yourself by taking part in the study. We anticipate the results will help inform best practice for Eating Well by the Arvida Group.

WHO PAYS FOR THE STUDY?

Participants will not incur any costs. Travel for the researchers and other costs will be met as part of a research grant by Massey University.

WHAT IF SOMETHING GOES WRONG?

If you were injured in this study, you would be eligible **to apply** for compensation from ACC just as you would be if you were injured in an accident at work or at home. This does not mean that your claim will automatically be accepted. You will have to lodge a claim with ACC, which may take some time to assess. If your claim is accepted, you will receive funding to assist in your recovery.

WHAT ARE MY RIGHTS?

Participation in this study is voluntary and you are free to decline to participate, or to withdraw from the research at any practicable time, without experiencing any disadvantage. You also have the right to access information collected as part of the study. All information collected will be de-identified to protect your privacy and confidentiality.

WHAT HAPPENS AFTER THE STUDY OR IF I CHANGE MY MIND?

All information will be stored in password protected computers accessible only by the investigators. Only the investigators will have access to the complete data set. Investigators are aware and will comply with all Privacy Act tenets and requirements. Information will be stored as de-identified numbers with no individual information reported. The Health (Retention of Health Information) Regulations 1996 require that some health information be retained for a period of ten years.

WHO DO I CONTACT FOR MORE INFORMATION OR IF I HAVE CONCERNS?

If you have any questions, concerns or complaints about the study at any stage, you can contact:

Professor Carol Wham
Telephone number: 09 213 6644
Email: c.a.wham@massey.ac.nz

If you want to talk to someone who isn't involved with the study, you can contact an independent health and disability advocate on:

Phone:	0800 555 050
Fax:	0800 2 SUPPORT (0800 2787 7678)
Email:	advocacy@advocacy.org.nz
Website:	https://www.advocacy.org.nz/

For Maori Heath support, please contact:

Dr Bevan Erueti, Associate Dean – Maori, Massey University
Telephone number: (06) 356 9099 ext. 83087
Email: B.Erueti@massey.ac.nz

You can also contact the Health and Disability Ethics Committee (HDEC) that approved this study on:

Phone: 0800 4 ETHIC
Email: hdecs@health.govt.nz

Appendix B: Participant Consent Form

Consent Form

MASSEY UNIVERSITY
COLLEGE OF HEALTH
TE KURA HAUORA TANGATA

Please tick to indicate you consent to the following

I have read or have had read to me in my first language, and I understand the Participant Information Sheet.		☐
I have been given enough time to consider whether to participate in this study.		☐
I have had the opportunity to use a legal representative, whanau/ family support or a friend to help me ask questions and understand the study.		☐
I am satisfied with the answers I have been given regarding the study and I have a copy of this consent form and information sheet.		☐
I understand that taking part in this study is voluntary (my choice) and that I may withdraw from the study at any time without this affecting my medical care.		☐
I consent to the research staff collecting and processing my information, including information about my health.		☐
If I decide to withdraw from the study, I agree that the information collected about me up to the point when I withdraw may continue to be processed.	Yes ☐	No ☐
I consent to my GP or current provider being informed about my participation in the study and of any significant abnormal results obtained during the study.	Yes ☐	No ☐
I consent to my personal health records being released to the research team by the Clinical Manager.	Yes ☐	No ☐
I agree to an approved auditor appointed by the New Zealand Health and Disability Ethic Committees, or any relevant regulatory authority or their approved representative reviewing my relevant medical records for the sole purpose of checking the accuracy of the information recorded for the study.		☐
I understand that my participation in this study is confidential and that no material, which could identify me personally, will be used in any reports on this study.		☐
I understand the compensation provisions in case of injury during the study.		☐
I know who to contact if I have any questions about the study in general.		☐

I understand my responsibilities as a study participant.		☐
I wish to receive a summary of the results from the study.	Yes ☐	No ☐

Declaration by participant:
I hereby consent to take part in this study.

Participant's name: _____

Signature: _____ Date: _____

Declaration by member of research team:

I have given a verbal explanation of the research project to the participant and have answered the participant's questions about it.

I believe that the participant understands the study and has given informed consent to participate.

Researcher's name: _____

Signature: _____ Date: _____

Questionnaires- Eating Well in Residential Aged Care

Start of Block: Introduction

Participant ID number

_____

Which study does this assessment relate to?

- Oral nutrition supplementation (1)
- Food fortification (2)

These measures are at:

- Baseline (1)
- Follow up (2)

Village

- Aria bays (1)
- Aria Gardens (2)
- Aria Parks (3)

End of Block: Introduction

Start of Block: MNA-SF

Nutrition status

Has your food intake declined over the past 3 months due to loss of appetite, digestive problems, chewing or swallowing difficulties?

- ○ Severe decrease in food intake (1)
- ○ Moderate decrease in food intake (2)
- ○ No decrease in food intake (3)

Have you lost weight in the last 3 months, if so how much?

- ○ No weight loss (1)
- ○ Weight loss between 1 and 3 kg (2.2 and 6.6 lbs) (2)
- ○ Weight loss greater than 3 kg (6.6 lbs) (3)
- ○ I do not know (4)

How would you describe your mobility?

- ○ Bed or chair bound (1)
- ○ Able to get out of bed/chair but does not go out (2)
- ○ Able to go out (3)

Have you suffered psychological stress or acute disease in the past 3 months?

- ○ Yes (1)
- ○ No (2)

Do you have any neuropsychological problems?
(Prioritise eCase answer over self reported answer. Take from medical information survey)

- ○ Severe dementia or depression (1)
- ○ Mild dementia (2)
- ○ No psychological problems (3)

What is your BMI?
(Take from excel spreadsheet)

- ○ BMI less than 19 (1)
- ○ BMI 19 to less than 21 (2)
- ○ BMI 21 to less than 23 (3)
- ○ BMI 23 or greater (4)

Calf circumference
(Take from functional measures survey. Only if non-weight bearing and BMI unavaliable)

- ○ Less than 31cm (1)
- ○ 31 cm or greater (2)

End of Block: MNA-SF

Start of Block: QOL SF-12 revised with all 12 questions

Health related quality of life The following questions are asking about your own health. Please select only one answer.

In general would you say your health is...

- ○ Excellent (1)
- ○ Very good (2)
- ○ Good (3)
- ○ Fair (4)
- ○ Poor (5)

Does your **health limit you** in your activities that you might do during a typical day. If so, how much?

	Yes, limited a lot (1)	Yes, limited a little (2)	No, not limited at all (3)
Moderate activities such as moving a table, pushing a vacuum cleaner, bowling, or playing golf (1)	○	○	○
Climbing several flights of stairs (2)	○	○	○

During the past **4 weeks**, have you had any of the following problems with your regular daily activities **as a result of your physical health**?

	Yes (1)	No (2)
Accomplished less than you would like (1)	○	○
Were limited in the kind of work or other activities (2)	○	○

During the past **4 weeks**, have you had any of the following problems with your regular daily activities **as a result any emotional problems** (such as feeling depressed or anxious)?

	Yes (1)	No (2)
Accomplished less than you would like (1)	○	○
Didn't do work or other activities as carefully as usual (2)	○	○

Page Break

During the past **4 weeks**, how much **did pain** interfere with your regular daily activities?

- ○ Not at all (1)
- ○ A little bit (2)
- ○ Moderately (3)
- ○ Quite a bit (4)
- ○ Extremely (5)

How much of the time during the past **4 weeks...**

	All of the time (1)	Most of the time (2)	A good bit of the time (3)	Some of the time (4)	A little of the time (5)	None of the time (6)
Have you felt calm & peaceful? (1)	○	○	○	○	○	○
Did you have a lot of energy? (2)	○	○	○	○	○	○
Have you felt down-hearted and blue? (3)	○	○	○	○	○	○

During the past **4 weeks**, how much of the time has your **physical health or emotional problems** interfered with your social activities (like visiting friends, relatives, etc.)?

- ○ All of the time (1)
- ○ Most of the time (2)
- ○ Some of the time (3)
- ○ A little of the time (4)
- ○ None of the time (5)

End of Block: QOL SF-12 revised with all 12 questions

Start of Block: GDS

Psychological well-being These last questions are to do with your psychological wellbeing over that past week.

Choose the best answer for how you felt **over the past week**.

	Yes (1)	No (2)
Are you satisfied with your life? (1)	○	○
Have you dropped many of your activities and interests? (2)	○	○
Do you feel that your life is empty? (3)	○	○
Do you often get bored? (4)	○	○
Are you in good spirits most of the time? (5)	○	○
Are you afraid that something bas is going to happen to you? (6)	○	○
Do you feel happy most of the time? (7)	○	○
Do you often feel helpless? (8)	○	○
Do you prefer to stay at home, rather than going out and doing new things? (9)	○	○
Do you feel you have more problems with memory than most people? (10)	○	○
Do you think its wonderful to be alive? (11)	○	○
Do you feel pretty worthless the way you are now? (12)	○	○
Do you feel full of energy? (13)	○	○
So you feel that your situation is hopeless? (14)	○	○
Do you think that most people are better off than you are? (15)	○	○

Start of Block: EAT 10

Swallowing The following questions are around swallowing while eating and drinking

Do you use an appliance to chew and eat (e.g. dentures)?

- ○ Yes, specify (5) _____
- ○ No (6)

How much of a problem is each of the following statements for you.

	Not at all (1)	A little (2)	A moderate amount (3)	A lot (4)	A great deal (5)
My swallowing problem has caused me to lose weight (1)	○	○	○	○	○
My swallowing problem interferes with my ability to go out for meals (2)	○	○	○	○	○
Swallowing liquids takes extra effort (3)	○	○	○	○	○
Swallowing solids takes extra effort (4)	○	○	○	○	○
Swallowing pills takes extra effort (5)	○	○	○	○	○
Swallowing is painful (6)	○	○	○	○	○
The pleasure of eating is affected by my swallowing (7)	○	○	○	○	○
When I swallow food sticks in my throat (8)	○	○	○	○	○
I cough when I eat (9)	○	○	○	○	○
Swallowing is stressful (10)	○	○	○	○	○

Page Break

Any notes?
e.g. participant didn't want to answer questions on PA today but willing to try again another day
e.g. refused questions on GDS

_____

_____

_____

_____

_____

End of Block: Block 10

Start of Block: QOL SF-12

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