The prevalence of nutrition risk and associated risk factors among older adults recently admitted to age-related residential care within the Waitemata District Health Board region.

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Abstract

Background: New Zealand has a rapidly growing ageing population, aligned with the ageing population trend occurring globally. Older adults account for a significant proportion of the government health care expenditure, primarily due to higher needs for disability services and a higher level of care, such as residential care. Malnutrition is multi-factorial and may result in disability and poor health contributing to a significant decline in the independence in older adults. Internationally, previous research has found a high prevalence of malnutrition among older adults in the residential care setting. This study aims to investigate the prevalence of malnutrition and associated risk factors among older adults (aged 64 to 84 years) newly admitted to residential care facilities across the Waitemata District Health Board (WDHB) region.

Methods: A cross-sectional study was undertaken among older adults newly admitted to WDHB residential care facilities. A questionnaire was used to assess participant sociodemographic and health characteristics. Anthropometric and body composition measurements were recorded. Grip strength was measured using a handgrip dynamometer and gait speed was measured by a 2.4m walk test. Nutrition risk was assessed using the Mini Nutritional Assessment- Short Form (MNA-SF), dysphagia risk was determined from the 10-item Eating Assessment Tool (EAT-10) and the Montreal Cognitive Assessment (MoCA) examined cognitive function.

Results: The mean age of participants was 78.7 ± 5.0 years. Of 77 participants, just under half (45.5%) were malnourished with a further 49.4% were at high nutrition risk. Over a third (37.7%) of participants were at dysphagia risk. Malnourished participants were more likely to require daily help prior to admission ($p=0.011$) and have a slower gait speed ($p=0.014$). A higher nutrition risk (lower MNA-SF score) was strongly correlated with a lower BMI ($r=0.274$, $p=0.024$), grip strength ($r=0.368$, $p=0.001$), higher dysphagia risk ($r=-0.248$, $p=0.029$) and higher medication use ($r=-0.213$, $p=0.043$).

Conclusion: Nearly half the participants were malnourished, and over a third were at risk of dysphagia. This study highlights that low BMI, grip strength and higher dysphagia risk and medication use are potential risk factors for malnutrition. Findings highlight the importance of malnutrition and dysphagia screening among older adults upon admission to residential care. This will ensure appropriate diagnosis and treatment for those identified at risk.

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Dedication

I would like to dedicate this thesis to my grandfather (seeya), Ananda Hettige, who has taught me the true meaning of determination and dedication. Although his battle with cancer is not over, he lives every day with courage.

"We cannot direct the winds but we can adjust our sails"

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Abbreviations

ADL Activities of Daily Living

ANSI Australian Nutrition Screening Initiative

ARRC Age-related Residential Care

BIA Bioelectrical Impedance Analysis

BMI Body Mass Index

CC Calf Circumference

Cm Centimetre

DXA Dual- Energy X-Ray Absorptiometry

EAT-10 10- item Eating Assessment Tool

GP General Practitioner

Kg Kilogram

m Metre

MCI Mild Cognitive Impairment

MMSE Mini Mental State Examination

MNA Mini Nutrition Assessment

MNA-SF Mini Nutritional Assessment – Short Form

MoCA Montreal Cognitive Assessment

MST Malnutrition Screening Tool

MUST Malnutrition Universal Screening Tool

NRV Nutrient Reference Value

OECD Organisation for Economic Co-operation and Development

OTC Over The Counter

RDI Recommended Daily Intake

SCREEN II Seniors in the Community: Risk Evaluation for Eating and Nutrition, Version II

SD Standard Deviation

SGA Subjective Global Assessment

SNAQ Simplified Nutritional Appetite Questionnaire

WDHB Waitemata District Health Board

WHO World Health Organisation

Chapter 1: Introduction

1.1 Background

Population ageing is a globally significant trend, referring to the growing proportion of the older adult population within the total population (United Nations 2013). The older adult population in New Zealand (NZ) is defined as adults aged 65 years and older. NZ population ageing is in line with many other Organisation for Economic Co-operation and Development (OECD) countries; it is proposed, that by the year 2051, about a quarter of the NZ population will be made up of older adults (Statistics New Zealand 2000, Cotis 2003). A rapid growth of the older adult population is also predicted in the next decade when the 'baby boom' cohort from 1945- 1975 reach retirement age (Ministry of Health 2004).

The rising older adult population is expected to contribute to a rise in government health expenditure, predicted to increase from 40% in 2002 to 63% in 2051 (Ministry of Health 2004). The key component of health care expenditure for older adults is the provision of disability services. The high prevalence of disability observed in the NZ residential care setting required over half (60%) of the DHBs' funding for the provision of disability services in 2015/16 (Ministry of Health 2016). The higher rate of disability and diminishing health with age will have severe consequences on the government health care system (Statistics New Zealand 2000). This suggests the need to focus on increasing optimal health status within this age group.

Improvements in health care costs would be expected if older adults had a delayed development of chronic disease and disability until very advanced age (Ministry of Health 2004). The NZ government has therefore implemented policies to highlight the importance of lifelong optimal health and wellbeing. The *New Zealand Positive Ageing Strategy* and the *Health of Older People Strategy* are policy initiatives that concentrate on older people maintaining independence while living in the community. These initiatives promote positive ageing with the support from good quality integrated health and disability services (Ministry of Social Development 2001, Ministry of Health 2002). These policies enable older adults to maintain independence through the provision of adequate health service access, ultimately supporting healthy ageing within the community.

A NZ study reported that older adults who were more familiar with and had greater knowledge surrounding these government policy initiatives were more likely to remain living within the community (Jorgensen, Arksey et al. 2009). This study also found that required assistance and support with performing daily activities and lack of family support were significantly correlated with older adults being admitted into residential care facilities. Additionally, the proportion of NZ

older adults residing in residential care is also expanding, increasing from 14% between 2006 and 2013 (Statistics New Zealand 2013). With increasing age, older adults may find it difficult to maintain independence within the community resulting in a higher need for health services and residential care.

Older adults in residential care are at a significantly higher nutrition risk as a result of health issues and physical impairments that can significantly compromise nutrition status (Pauly, Stehle et al. 2007). Malnutrition in older adults refers to poor nutritional status and under-nutrition as a result of inadequate dietary consumption and muscle and weight loss (Gaskill, Black et al. 2008). Many changes with age can increase the risk for malnutrition. This includes, but is not limited to, decreased appetite, altered taste and smell perception, poor oral health, and physical inactivity (Hickson 2006). Malnutrition results in adverse health outcomes, including increased mortality and morbidity, and a higher risk of pressure ulcer development, infections, falls and impaired physical functions, resulting in a decreased quality of life (Gaskill, Black et al. 2008). This suggests the importance of identifying older adults at high nutrition risk to ensure adequate nutrition interventions are implemented to prevent malnutrition and associated adverse health outcomes.

The prevalence of malnutrition in residential care in NZ is largely unknown. However, in a multinational perspective study assessing the frequency of malnutrition among older adults using the Mini Nutritional Assessment (MNA), 67.2% of nursing home residents were found to be at nutrition risk (Kaiser, Bauer et al. 2010). A study examining the prevalence in malnutrition among six residential care facilities in Queensland, Australia, reported similar results, with more than 50% of residents classified as malnourished (Banks, Ash et al. 2007). Internationally, a high prevalence of malnutrition has been reported in residential care facilities and suggests the importance of identifying the prevalence of malnutrition within the NZ residential care setting.

From the small number of studies assessing nutrition risk among the older population in NZ, most studies have investigated the prevalence of nutrition risk of those living independently in the community. A screening study in Christchurch, NZ, found that 31% of 152 community living older adults (mean age 79.5 years) were at high nutrition risk, and a further 23% of the participants were regarded as at risk of poor nutrition (Watson, Zhang et al. 2010). Another study conducted in three North Island locations among community living older adults aged 75 to 80 years reported 52% of participants were at high risk of malnutrition (Wham, Teh et al. 2011). The high prevalence of malnutrition within community living older adults in NZ suggests the need to determine the prevalence of nutrition risk at early admission to a residential care setting, which remains an unstudied area in NZ.

Validated nutrition screening tools are available to identify those at malnutrition risk (Holmén, Robertsson et al. 2006). The MNA-SF is a malnutrition screening tool consisting of six questionnaire items, including body mass index (BMI), recent weight loss, acute illness or stress, mobility, neuropsychological problems and appetite or swallowing difficulty (Rubenstein, Harker et al. 2001). Studies have found the MNA-SF, a revised version of the Mini Nutritional Assessment (MNA), has a strong sensitivity, specificity and diagnostic accuracy when compared with the MNA, highlighting its usefulness in screening for malnutrition among older adults (Rubenstein, Harker et al. 2001, Guigoz, Jensen et al. 2006).

Ageing may not only increase the risk of malnutrition, but is also associated with significant changes in body composition, with a substantial loss in skeletal muscle mass and an increased gain in fat mass (Fielding, Vellas et al. 2011). This reduction in skeletal muscle mass is related to a progressive deterioration in muscle strength and function, otherwise known as sarcopenia (Chen, Schilling et al. 2001). Sarcopenia can result in functional impairment and physical disability. Physical disability is the most prevalent type of disability in residential care facilities, affecting 95% of older adults living in this setting in NZ (Statistics New Zealand 2002). Poor physical function and muscle strength may result in impairments in performing daily tasks, such as shopping and meal preparation, which in turn can result in decreased food intake and thus increase nutrition risk (Volkert 2011).

Sarcopenia can also result in the loss of swallowing muscle mass and function (Wakabayashi and Sakuma 2014). Dysphagia, otherwise known as swallowing difficulties, is another concern that is growing among the ageing population (Sura, Madhavan et al. 2012). This is associated with increased risk of malnutrition due to decreased oral intake as a result of poor swallowing efficacy (Hickson 2006). In the US, 68% of older adults living in residential care facilities suffer from dysphagia (Sura, Madhavan et al. 2012). The prevalence of dysphagia in residential care is significantly higher than other care settings or living arrangements i.e. hospital (30%) or living independently (13- 38%) (Sura, Madhavan et al. 2012). The dysphagia prevalence among older adults living in residential care in NZ is unknown, suggesting an important focus for further research.

This present study aims to investigate the malnutrition risk and associated risk factors within the Waitemata District Health Board (WDHB) region. The WDHB has formed a partnership with Massey University to determine the prevalence of nutrition risk and associated risk factors among this population. For the treatment and prevention of undernourishment in older adults, it is necessary to gain a perspective of nutritional risk factors contributing to the development of health outcomes. This will help to identify and implement possible policies and programmes that contribute towards positive ageing.

1.2 Statement and Significance of Research Problem

With NZ facing an increasingly ageing population, the health sector is going to be under immense pressure to meet the needs of those under its care. Malnutrition risk in older adults can largely contribute to a vast array of adverse health outcomes, in which most result in a decreased quality of life. In NZ however, the majority of research investigating the prevalence of high nutrition risk in the older adult population has been conducted in a community setting. This suggests the importance of investigating the prevalence of nutrition risk and related risk factors among older adults newly admitted into residential care facilities. This can allow for the development and implementation of effective policy initiatives to improve nutrition status among the older adult population, and help them to remain living independently within the community.

1.3 Aims and Objectives

1.3.1 Aim

The aim of this study is to investigate the prevalence of nutrition risk and associated risk factors among older adults recently admitted to residential care facilities within the Waitemata DHB region.

1.3.2 Objectives

1. To determine the nutrition risk of older adults newly admitted to WDHB residential care facilities using the Mini Nutritional Assessment – Short form (MNA-SF)
2. To determine dysphagia risk of older adults newly admitted to WDHB residential care facilities using the 10-item Eating Assessment Tool (EAT-10).
3. To measure body composition and muscle mass of older adults newly admitted to WDHB residential care facilities using bioelectrical impedance analysis (BIA) scales.
4. To measure muscle strength and function of older adults newly admitted to WDHB residential care facilities using a grip strength dynamometer and a self-paced 2.4m walk test.
5. To identify the association between characteristics, dysphagia risk, anthropometric measures and muscle strength and function with nutrition risk.

1.4 Thesis Structure

This thesis consists of six chapters. Chapter 1 outlines the significance of conducting this research. Chapter 2 provides a literature review of nutrition risk among older adults and associated risk factors. Chapter 3 consists of a research manuscript including an abstract, introduction, study methodology, results, discussion and conclusion. This research manuscript is targeted for publication for the Australian and New Zealand Journal of Public Health, see **Appendix A** for

author guidelines. The referencing style for the research manuscript has been conformed to be consistent between thesis chapters and to accommodate the ease of reading. Chapter 4 outlines the study summary, limitations and strengths and provides recommendations for future research.

1.5 Researcher Support

Table 1.1 Researchers' Contributions

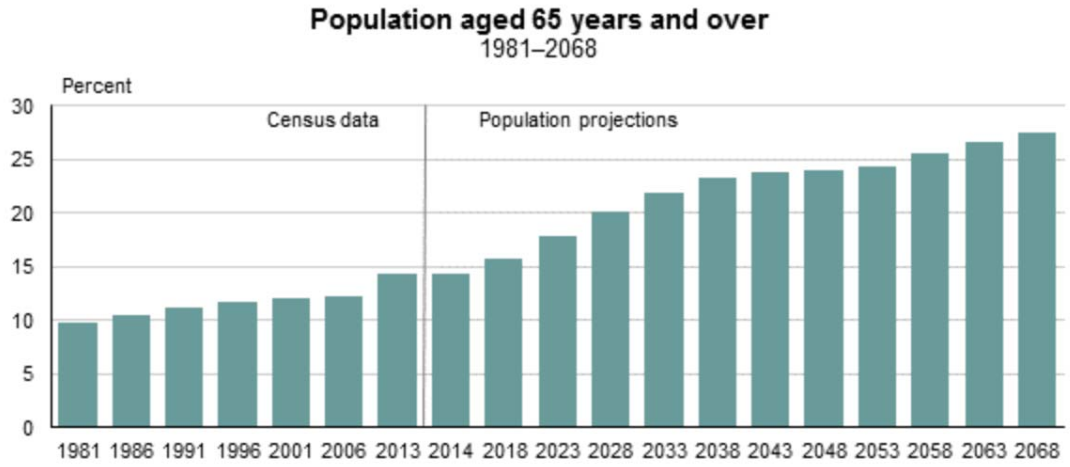
Researchers	Contributions
Dushanka Hettige	Student researcher; recruited and interviewed participants, data input, data analysis, interpreted results and authored thesis manuscript.
A/Prof Carol Wham	Academic supervisor; designed study, provided assistance with structure of thesis manuscript and interpretation of results, revised and approved thesis manuscript.
Dr Marilize Richter	Academic co-supervisor; assisted with statistical analysis and interpretation of results and revision of the thesis final draft.
Dr Jacqueline Allen	Professional supervisor; designed study, applied for ethics, and assisted with participant recruitment.
Teresa Stanbrook	Professional supervisor; provided training on data collection procedures and assisted with participant recruitment.
Stacey Senior	Associate student researcher; assisted with data collection and input.
Idah Chatindiara	Associate student researcher; assisted with data collection.

Chapter 2: Literature Review

2.1 Population Ageing in New Zealand

It is predicted that NZ's ageing population will increase significantly in coming years. Population ageing is a worldwide phenomenon and refers to a decline in both mortality and fertility. This results in a rise in the older adult population and a decline in the proportion of children within the population (Statistics New Zealand 2006, United Nations 2013). By the year 2063, older adults (65 years and above), are expected to account for 26.7% of the total population as shown in **Figure 2.1** (Statistics New Zealand 2015). This projected increase has already become apparent, with the older adult population almost doubling from 1981 to 2013 (Statistics New Zealand 2015). In 2013, the census reported that older adults make up 14.3% of NZ's total population, a 4.4% increase since 1981 (Statistics New Zealand 2015).

Figure 2. 1: *Percentage of the older adult population aged 65 years and over from 1981 to 2068* (Statistics New Zealand 2015).



For men and women born in 1951 who turned 65 in 2016, there is a suggested life expectancy at birth of 77.5 years and 82.5 years respectively (Statistics New Zealand 2016). The population of older adults aged 85 years and older has also markedly increased over the years, making up 12.1% of the older adult population in 2013. This is predicted to rise to 19.7% by the year 2043 (Statistics New Zealand 2015). The expected increase in the advanced age population suggests life expectancy will further increase in the future.

The 2013 Census highlighted older adults of European ethnicity make up the largest proportion (87.8%) of the older adult population (Statistics New Zealand 2015). In 2013, the Asian and

Pacific ethnic group accounted for 4.7% and 5.6% of the older adult population, respectively. The Māori older adult population has increased from 4.1% in 2006 to 5.6% in 2013 (Statistics New Zealand 2013).

2.1.1 Ageing among the Waitemata District Health Board Catchment

The Waitemata District Health Board (WDHB) is the largest DHB population in NZ, making up 12.4% of the total NZ DHB population in 2013 (Statistics New Zealand 2014). The WDHB has a rapidly growing older adult population, rising by 29% from 2006 to 2013. In 2006, 2.3% of older adults living within the WDHB region identified as Māori, this has increased by 49% in 2013 and 13% of the older adults identified as belonged to the Pacific ethnic group (Statistics New Zealand 2014). The Asian adult population has showed the most rapid growth of all ethnic groups, indicating a 54% increment in growth from 2006 to 2013 (Statistics New Zealand 2014).

2.1.2 Ageing and Government Health Expenditure

Currently in NZ, the average health care costs for older adults are five times more than any other age group (Bryant, Teasdale et al. 2004). Older adults are the main consumers of health care services, expecting to account for 63% of government health expenditure by the year 2051 (Ministry of Health 2004). Annual per capita health expenditure increases markedly with age. In 2001, an average of $3,312 was consumed per adult aged 65 – 95 years, which substantially increased to an average of $21,738 per adult aged over 95 years in NZ (Ministry of Health 2004).

Ageing is associated with a higher prevalence of disability, chronic disease and mortality (Christensen, Doblhammer et al. 2009). The 2013 Disability Survey in NZ found the prevalence of disability increased with age finding that on average, 59% of older adults had a disability, significantly higher than any other age group (Statistics New Zealand 2013). As a result, the main contributors of health expenditure for older adults are the provision of disability support services, alongside disease management health services (Ministry of Health 2004). The Ministry of Health (2016) estimated that during 2015/16, the DHB's funding for older adults' health services was 42%, and is expected to rise to 50% by 2025. The significant proportion of health services used by older adults suggests the need for government policy initiatives to promote optimal health and well-being in older adults to reduce health expenditure.

Residential care facilities accounts for a large proportion (60%) of the DHB's budget due to an exceedingly high prevalence of disability within this setting (Ministry of Health 2016). In 2006, 99.7% of adults living in residential care in NZ were reported to have a disability. This is significantly higher than older adults living with a disability in their own homes (17.4%)

(Statistics New Zealand 2007). The high rates of disability in the residential care setting accounted for 9% of total health expenditure in NZ in 2009/10, reported in the Health Expenditure Trends in New Zealand Report (Ministry of Health 2012). This suggests the importance of government strategies focusing on older adults maintaining independence within the community, thus reducing the number of those moving into residential care and thereby reducing overall health expenditure.

2.1.3 Healthy Ageing Strategies

With a growing older adult population, the NZ government has introduced and promoted the "Ageing in Place" concept, which has been the underlying concept to implemented policy initiatives. "Ageing in Place" recognises that the ageing process does not prevent older adults from the capability to be independent and autonomous (Ministry of Social Development 2001). Similar to the "Ageing in Place" concept, the Positive Ageing Strategy designed by the Ministry of Social development encourages the active participation of older adults within the community in a way that they wish (Ministry of Social Development 2001). This strategy recognises ten priority goals for the promotion of effective positive ageing regarding income, health services, housing, transport, "Ageing in Place", culturally appropriate services, rural communities access to services, positive attitudes towards ageing, employment and opportunities for personal growth, and community participation (Ministry of Social Development 2001).

The Health of Older People Strategy designed by the Ministry of Health aims to support older adults making their own decisions in regards to their health and well-being (Ministry of Health 2002). This strategy outlines eight objectives that focus on the provision of health and disability services for older adults aiming to maintain those living within the community without the need of institutional care. These objectives include decision making, planning, funding, meeting Maori disability service needs, community health programmes, community health service access, hospital services, and disability service access (Ministry of Health 2002). These strategies promote positive and healthy ageing, providing older adults with adequate services and community involvement allowing them to live independently within the community.

2.1.4 Residential Care Facilities: Loss of independence

The proportion of older adults living in residential care facilities in NZ has grown substantially over the years, increasing by 14.1% from 2006 to 2013 (Statistics New Zealand 2013). The Auckland region had the largest residential care population, accounting for 27% of the total NZ residential care population (Statistics New Zealand 2013). In 2013, there were 822 residential care facilities across NZ, home to 31,899 older adults with, 93% of this population regarded as

being of European ethnicity (Statistics New Zealand 2013). The remaining residential care population was made up of 3.3% Maori ethnicity, 1.5% Pacific Island ethnicity and 2.1% Asian ethnicity (Statistics New Zealand 2013). The rising older adult population in the residential care setting may suggest future increases in health expenditure in this area and the higher need for support from residential care and health services.

Older people maintaining independence and living in their own homes within the community is less costly than residential care and is the preferred option by many (Wiles, Leibing et al. 2011). Older adults whom transition into residential care may have experienced a loss of a partner, spouse or family member, poor health conditions, and/or illness or disability, resulting in dependency on another person or caregiver (Rodgers and Neville 2007). A NZ study found that those needing a higher level of support with activities of daily living (ADLs), and/or those living a long distance from family were significantly related to transitioning into residential care (Jorgensen, Arksey et al. 2009). With a change in living situation, older adults may feel stressed, depressed, and isolated, and may face a challenge having to adjust to new and unfamiliar daily routines and social environments (Lee, Woo et al. 2002). Residential care is often required for older adults in need of a higher level of long-term care that prevents them from living independently in their own homes.

2.2 Health of Older Adults

Functional impairment, frailty, dementia, coronary heart disease, cancer and other chronic diseases are often associated with increasing age, making older adults vulnerable to disability and multiple health conditions (Colón-Emeric, Whitson et al. 2013). Fried, Ferrucci et al. (2004) recognised that the terms 'disability' and 'comorbidity' are strongly interrelated with the term ‘frailty’ when describing older adults whom present challenging health problems and may require advanced care. Frailty is a growing health concern among older adults, however there has been controversy over identifying a clear consensus definition. Rodríguez-Mañas, Féart et al. (2013) investigated and agreed upon an operational definition of frailty for clinical use, defining frailty as a “multidimensional syndrome characterised by decreased reserve and diminished resistance to stressors”. Frailty results in adverse health outcomes, increasing the risk of mortality, falls, disability, impaired cognitive function and the poor ability to perform essential daily activities (Torpy, Lynm et al. 2006, Wooton 2016).

2.2.1 Changes in Body Composition with Age

Ageing results in body compositional changes which may result in declines in muscle strength, functional mobility, disability and mortality (Guo, Zeller et al. 1999, Goodpaster, Park et al.

2006). Fat free mass (FFM) increasingly declines after the age of 40 – 50 years with a subsequent increase in fat mass (Kyle, Genton et al. 2001, Goodpaster, Park et al. 2006, Hickson 2006). A study in Switzerland investigating body composition changes in 191 adults aged over 60 years, reported a higher decrease in FFM and skeletal muscle mass in those aged over 80 years (Kyle, Genton et al. 2001). An average of 1 to 2% of muscle mass is lost every year after the age of 50, accounting for a 35% muscle mass loss over an average lifetime (Thomas 2007, Henwood, Keogh et al. 2012). Loss of muscle mass is attributed to the reduced size of type II muscle fibres and decreased number of motor units (Thomas 2007). This age-related decrease in muscle mass and subsequent loss in muscle strength is otherwise known as sarcopenia, and is associated with a decline physical function, decreased self-perceived quality of life, and disability (Goodpaster, Park et al. 2006). This highlights the importance of maintaining muscle mass with increasing age to prevent a number of adverse health effects but to also maintain functional mobility.

The European Working Group on Sarcopenia for Older People (EWGSOP) defines sarcopenia as "a syndrome characterised by progressive and generalised loss of skeletal muscle mass and strength with a risk of adverse outcomes such as physical disability, poor quality of life and death" (Cruz-Jentoft, Landi et al. 2014). Inadequate dietary protein and energy intake are considered to play a key role in developing sarcopenia (Evans 2004, Fielding, Vellas et al. 2011). More specifically, protein- energy malnutrition (PEM) can result in unintentional weight loss, decreased muscle mass and strength (Gary and Fleury 2002). Sarcopenia is also related to several adverse health risks including chronic diseases, specifically rheumatoid arthritis, osteoporosis, elevated insulin resistance and a higher risk of falls and mortality (Walston 2012, Cruz-Jentoft, Landi et al. 2014). Increasing age results in significant reductions in muscle mass resulting in reduced or impaired physical functions that may require additional support, disability and long term health care services.

2.2.2 Changes in Muscle Strength and Physical Function with Age

Sarcopenia encompasses a 50% loss in muscle strength over an average life span (Henwood, Keogh et al. 2012). Doherty (2003) reported an average loss in knee extensor muscle strength of 50% and greater in subjects aged 90 and above. This loss was significantly higher compared to subjects of a younger age (70 – 80 years) with an average muscle strength loss of 20 – 40%. This study highlights the substantial decrease in muscle mass and strength with age. It is these changes that can significantly impact the functional ability to perform daily activities, resulting in a loss of independence.

Malnutrition and sarcopenia are both associated with poor nutritional intake, a decline in body weight, loss in muscle mass, strength and functional mobility. Vandewoude, Alish et al. (2012)

calls this the “Malnutrition- Sarcopenia Syndrome (MSS)”. Landi, Liperoti et al. (2012) found that sarcopenia was highly prevalent among nursing home residents aged over 70 years in Italy, with 32.8% of residents classified as sarcopenic. In this study, malnutrition was classed as a BMI <21 kg/m^2 and was associated with an increased risk of developing sarcopenia.

The EWGSOP developed an algorithm for the assessing and diagnosing sarcopenia in older adults according to the following three primary domains: gait speed, handgrip strength and muscle mass. This diagnostic algorithm has been used in studies among Turkish nursing home residents. Saka, Ozkaya et al. (2016) found that among 401 Turkish nursing home residents, 73.3% of residents were identified as sarcopenic. A study by Yalcin, Aras et al. (2016) found a markedly lower prevalence (29%) in sarcopenia among 141 Turkish nursing home residents. However, both these studies were only performed in one nursing home hence may not be a representative sample of the Turkish older adult population. Another Turkish study of 211 nursing home residents from different facilities in the Izmir, Turkey region, found that of the 33.6% of residents that were identified as sarcopenic, 25.6% were classified “at risk” of malnutrition and 7% were classified as malnourished (Tasar, Sahin et al. 2015). This signifies that malnutrition and sarcopenia are interrelated, and are highly prevalent among older adults in residential care. This suggests the need for early intervention for older adults with these conditions, to prevent further declines in physical strength and function and other adverse health outcomes.

Similarly, a study among residents living in nursing homes and residential care facilities in Queensland, Australia, found a slightly higher prevalence of sarcopenia using the EWGSOP diagnostic criteria: muscle mass measured using Bioelectrical Impendence Analysis (BIA), hand-grip strength and gait speed measured using a 2.4 m walk test (Henwood, Keogh et al. 2014, Senior, Henwood et al. 2015). These measures were reported as practical to implement and as an feasible diagnostic tool for sarcopenia in the residential care setting (Henwood, Keogh et al. 2014). Of the 40.2% of residents identified as sarcopenic, 66.7% of residents were classified as “malnourished” and 38.8% of residents were classified as “at risk” of malnutrition assessed through the Mini Nutritional Assessment (MNA) (Senior, Henwood et al. 2015). This suggests that nutrition status is correlated with sarcopenia and highlights the importance of preventing the development of malnutrition older age to maintain adequate muscle stores. A strength of this study was that 102 randomly selected participants across 11 nursing homes achieves a representative sample signifying that adequate nutritional status and intake is essential for maintaining muscle mass and strength and reducing the risk of developing sarcopenia.

2.2.3 Assessing Muscle Mass

For the measurement of skeletal muscle mass, Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) techniques are regarded as the methods of choice for examining muscle mass (Erlandson, Lorbergs et al. 2016). Bioelectrical Impedance Analysis (BIA) however, is a more cost-effective and commonly used method in assessing muscle mass (Janssen, Heymsfield et al. 2000). This method determines total body water (extracellular water and intracellular water) and fat free mass by measuring the resistance and reactance of an electrical current passing through the body (Kyle, Bosaeus et al. 2004). The BIA procedure does not need to be administered by a trained worker and is considered to be a non-invasive method with a high reproducibility (Di Sebastiano and Mourtzakis 2012). BIA measurements however can be easily influenced depending on hydration status of the individual, for example, dehydration may result in inaccurate BIA readings (Di Sebastiano and Mourtzakis 2012). Despite the invalid use of BIA in individuals with an abnormal hydration status, accurate readings can be obtained from those who have a stable and normal hydration status (Kyle, Bosaeus et al. 2004). Janssen, Heymsfield et al. (2000) found that the BIA provided accurate measurements of skeletal muscle mass in healthy adults in comparison to established MRI reference values.

2.2.4 Assessing Muscle Strength and Physical Performance

There are several widely used methods for the measurement of muscle strength and function. The European Working Group on Sarcopenia in Older People identified handgrip strength as an easy and simple technique for the measurement of muscle strength (Cruz-Jentoft, Baeyens et al. 2010). The Jamar handgrip dynamometer is considered the gold standard dynamometer with widespread normative data available (Roberts, Denison et al. 2011). Poor handgrip strength is strongly associated with a decreased ability to perform daily activities, poor functional mobility and lower strength of leg muscles (Cruz-Jentoft, Baeyens et al. 2010). Grip strength is a validated measure of muscle strength and is strongly correlated with lower extremity muscle strength (Cruz-Jentoft, Baeyens et al. 2010). Evidently, a study among NZ community-living older adults (75 – 85 years) found that lower grip strength was associated with a higher risk of malnutrition, assessed by the SCREEN II tool (Wham, Teh et al. 2015). This highlights compromised nutritional status is correlated with lower grip strength, which may impair functional capacity in older adults.

The short physical performance battery has been evaluated as a suitable measure of physical performance in older adults and assesses muscle strength, gait speed, balance and endurance through a series of different activities (Cruz-Jentoft, Baeyens et al. 2010). Although usual gait

speed is just one of the measures of the short physical performance battery, it can be used as a single indicator for lower extremity strength, and is equally predictive of the onset of disability compared to the short physical performance battery (Guralnik, Simonsick et al. 1994, Cesari, Kritchevsky et al. 2009).

2.2.5 Chronic Disease and Health Loss

Ageing is associated with a higher prevalence of chronic disease, with older adults accounting for a significant proportion of the population with a chronic disease in NZ (National Advisory Committee on Health and Disability 2007). Health loss refers to the loss of healthy life resulting from the early onset of morbidity, mortality or disability. In 2013, older adults made up a third of the total health lost primarily caused by chronic diseases such as coronary heart disease, dementia, lung cancer, chronic obstructive pulmonary disease and stroke (Ministry of Health 2016).

In 2013, cardiovascular disease was the leading cause of health loss followed by cancer, accounting for 28% and 22% respectively of all health loss in older adults (Ministry of Health 2016). Neuropsychiatric and musculoskeletal disorders are also primary causes of health loss, responsible for 14% and 9% of all health loss in the older adult age group (Ministry of Health 2016). The 2014/15 NZ Health Survey reported that risk factors for cardiovascular disease and cancer including obesity, physical inactivity, high blood pressure and high cholesterol were the highest among the population (Ministry of Health 2015). In addition, Maori and Pacific Island individuals have a disproportionately greater susceptibility to chronic diseases due to higher rates of smoking, alcohol consumption, obesity, sedentary lifestyle and a high degree of unattended health needs not met by the primary health care system (Ministry of Health 2015).

The presence of a single chronic condition is likely to be accompanied by other chronic conditions, resulting in increased clinical needs and a higher risk of disability (Wolff, Starfield et al. 2002). Chronic disease can result in poor nutrition status through a wide range of mechanisms including decreased appetite, altered absorption and metabolism of nutrients, poor response to inflammation, infection and trauma (Norman, Pichard et al. 2008). A cross-sectional study by Saka, Kaya et al. (2010) found that 52% of older adults (≥65 years) that had multiple chronic conditions (3 or more) had a poor nutritional status, scoring ≤ 23 on the Mini Nutritional Assessment indicating an evident relationship between nutrition risk and chronic disease.

2.2.6 Depression, Mood and Anxiety Disorders

Depression in older adults presents a significant public health issue resulting in poor cognitive and physical functioning, a higher suicide risk and increased mortality and morbidity (Fiske, Wetherell et al. 2009). There is a higher risk of older adults experiencing depression due to factors such as the loss of family and friends, impaired function and mobility, loss of independence and social roles (Crogan and Pasvogel 2003).

A study by Bruce, McAvay et al. (2002) found that among 539 nursing home patients in the US, 13.5% of these patients were diagnosed with depression, yet only 22% of these patients were receiving adequate treatment. Another study in Australia found a higher prevalence of depression among 168 aged-care facilities, with 40% of older adults living in high care homes and 25% of older adults living in low care homes classified as depressed (Snowdon and Fleming 2008). The substantially high prevalence of depression in residential care highlights the importance for depression screening in this setting, and more importantly may identify if depression is a possible risk factor for developing malnutrition in older adults.

Depression in older adults is associated with changes in nutritional intake and eating patterns due to the loss of appetite resulting in low BMI, frailty and nutritional inadequacy (Blazer 2003, Saka, Kaya et al. 2010). Depression has found to be significantly associated with high nutrition risk in Brazilian community living older adults, aged 60 to 74 years (Cabrera, Mesas et al. 2007, Yoshimura, Yamada et al. 2013). In the residential care setting, a systematic review of 16 studies performed in nursing homes across the US, Australia, Hong Kong, Hungary, Germany, Finland and Netherlands, investigated factors affecting weight loss, low BMI and malnutrition in nursing home residents. This review reported that depression is significantly correlated to weight loss however is not significantly associated with low BMI and malnutrition (Tamura, Bell et al. 2013). Given that weight loss is a key contributor to malnutrition in older adults, this indicates the importance of detecting and treating depression in those residing in residential care to reduce the likelihood of weight loss and ultimately, malnutrition.

2.2.7 Age-associated Cognitive Decline

Cognitive decline is a common manifestation among the older adult population and increases with age (Park, O'Connell et al. 2003). Decline in cognitive function can advance to a chronic illness known as dementia, resulting in decreased functioning (Park, O'Connell et al. 2003). Cognitive decline is associated with a higher risk of disability, frailty, mortality and a decreased quality of life (Lee, Kim et al. 2015). A NZ study investigating needs assessments for older adult support

services found that cognitive impairment was associated with an increased risk for entry into residential care (Weatherall, Slow et al. 2004).

Dementia is associated with clinically significant weight loss, causing alterations in brain structures resulting changes in appetite regulation and increases energy expenditure due to extensive wandering (Brooke and Ojo 2015). Furthermore, progressive stages of dementia can increase the risk of malnutrition as a result of decreased concentration during meal times, inability to use cutlery, changes in taste and smell perception, dysphagia and behavioural problems resulting in food refusal (Jansen, Ball et al. 2015). The high prevalence of cognitive impairment and dementia and its impact on nutritional status among older adults indicates the importance of nutrition screening among cognitively impaired adults. This will help to identify those at high nutrition risk and develop tailored nutrition interventions to prevent and treat malnutrition.

2.2.8 Assessing Cognition

The Mini Mental State Examination (MMSE) is a commonly used screening tool that identifies dementia, however has very poor sensitivity to those who present mild cognitive impairment (Cockrell and Folstein 2002, Smith, Gildeh et al. 2007). To eliminate the limitations of the MMSE, the Montreal Cognitive Assessment (MoCA) was developed (Crogan and Pasvogel 2003). The MoCA is recognised as a more sensitive test. This 30-point assessment tool takes 10 minutes to administer and is used to screen for mild cognitive impairment (Smith, Gildeh et al. 2007). Nasreddine, Phillips et al. (2005) conducted the first validation study, and reported the MoCA indicated high sensitivity in detecting both mild cognitive impairment (90%) and Alzheimer's Disease (100%). The MoCA has also been identified as a useful tool to predict the onset of dementia in those who present with mild cognitive impairment.

2.3 Nutritional Health of Older Adults

2.3.1 Compromised Energy, Macronutrient and Micronutrient Intake with Age

The recommended level of energy intake declines with older age as a result of reduced levels of physical activity, muscle mass and metabolic rate (Drewnowski and Evans 2001, National Health and Medical Research Council 2006). Coincidentally, older adults experience a reduction in energy intake due to factors such as lack of cooking facilities, self-esteem, changes in thirst, hunger and satiety regulation, impaired ability to self-feed and acute or chronic diseases (Drewnowski and Evans 2001, Donini, Savina et al. 2003). In many older adults, the reduction in energy intake exceeds energy expenditure leading to a negative energy balance, resulting in unintentional weight loss (Ahmed and Haboubi 2010). Involuntary weight loss is associated with

an increased risk of mortality and morbidity, outlining the importance of adequate energy intake to maintain weight with age (Alibhai, Greenwood et al. 2005, Ahmed and Haboubi 2010)

The 2008/09 Adult Nutrition Survey reported that men and women aged 71 years and over had lower average energy intakes compared to the younger adult population (Ministry of Health 2011). Reductions in energy intake among older adults may result in dietary inadequacies of protein, vitamins and minerals (Drewnowski and Evans 2001). Older adults may face a challenge of meeting their nutritional requirements as a result of a number of social and physiological factors leading to involuntary weight loss and an increased risk of malnutrition.

For older adults aged over 70 years, the estimated average requirement (EAR) for protein is set 25% higher than the EAR for younger adults and the RDI is set 12% higher (National Health and Medical Research Council 2006). Higher protein requirements are recommended for older adults to maintain nitrogen balance and prevent the onset and progression of sarcopenia (Robinson, Cooper et al. 2012). The Health, Ageing and Body Composition study examined the relationship between inadequate protein intake and muscle mass loss in older community living adults (mean age 74.5 years) in America. Findings indicate that those in the higher quintiles for protein intake had significantly less lean mass loss (40%) over three years compared to those in the lower quintiles for protein intake (Houston, Nicklas et al. 2008). This emphasizes the importance of maintaining adequate protein intake with age to prevent muscle mass loss, the onset of sarcopenia and malnutrition. The PROT- AGE study recommends a protein intake of 1.0 – 1.2 g/kg per day for older adults to achieve this (Bauer, Biolo et al. 2013).

Older adults gain adequate energy from a sufficient macronutrient distribution obtained from consuming a variety of major food groups. Older adults eating a variety of foods including dairy, grains, fruits, vegetables and meat food groups will be likely to meet their micronutrient needs. Iron, calcium and vitamin D specifically, are important micronutrients for older adults' health that can be obtained from eating different food groups**.** Iron status of older adults can be affected by many factors, including low dietary iron intake, impaired iron absorption, blood loss, altered iron metabolism due to chronic disease and medication use (Fairweather-Tait, Wawer et al. 2014). Poor calcium intake has been found to be positively correlated with decreased bone mass, increasing the risk of fragility, fractures, osteoporosis and osteomalacia (Gennari 2001). Inadequate vitamin D status can lead to decreased calcium absorption and increased parathyroid hormone concentrations (secondary hyperparathyroidism) resulting in bone mass loss (Lips 2001, Flynn 2003).

2.3.2 Malnutrition

Malnutrition is defined as "a state resulting from the lack of uptake or intake of nutrition leading to altered body composition (decreased fat free mass) and body cell mass leading to diminished physical and mental function and impaired clinical outcome from disease" (Cederholm, Bosaeus et al. 2015). Malnutrition is a common condition affecting older adults and increases the risk of morbidity and mortality, and is associated with impaired immune function, decreased physical function, disability, and decreased quality of life (Chen, Schilling et al. 2001). Malnutrition arises from many factors, including inadequate nutritional intake, nutrient losses, malabsorption, decreased appetite, altered taste and olfactory function, depression, medications, low socioeconomic status and a poor ability to acquire and prepare foods (Carol Evans 2005, Chapman 2006). This highlights the importance of identifying associated risk factors for malnutrition in order for appropriate interventions to be implemented, preventing the adverse effects of malnutrition from occurring.

2.3.3 Malnutrition Screening Tools

Many validated nutrition screening tools have been developed to identify older adults at risk of malnutrition, allowing for the provision of appropriate treatment and care (Phillips, Foley et al. 2010). Nutrition screening should aim to detect if an individual is malnourished or at risk of malnutrition. If a person is identified as malnourished, then a more complex assessment and treatment plan is needed (Green and Watson 2006). Nutrition screening tools are generally presented as a questionnaire, where each question assesses an individual risk factor for malnutrition (Green and Watson 2006).

The UK National Minimum Standards for Care homes for Older People recommend that nutrition screening should be performed upon admission and regularly throughout a residents stay in residential care (Department of Health 2003). These screening tools are recommended to include weight, height, BMI, recent weight loss, and reductions in food intake. The Malnutrition Universal Screening Tool (MUST), which includes the above measures, is recommended by UK national guidelines (Merrell, Philpin et al. 2012). A study examined whether the national guidelines for nutritional screening had been implemented in two residential care facilities in Wales (Merrell, Philpin et al. 2012). This study reported that the MUST tool was not used to screen for nutritional risk upon a resident's admission in these facilities, and malnutrition risk was commonly identified through observation. Findings also indicated that care facility managers and staff needed more training and education regarding nutritional health and nutrition screening for

older people (Merrell, Philpin et al. 2012). Although a limitation of this study was that nutrition screening practices were only assessed in two residential care facilities, it may have wider application to facilities that are run similarly. This does however indicate that a lack of nutritional screening upon admission may allow for those whom are malnourished or at risk of malnutrition to go unrecognised and untreated.

There have been many validated screening tools developed for the screening of malnutrition in the older adult population**.** These screening tools have similar screening items to each other including BMI, weight, food intake and acute disease (Young, Kidston et al. 2013). Common screening tools used in the residential care setting are highlighted in **Table 2.1 and Table 2.2** (Baker, Detsky et al. 1982, Guigoz, Vellas et al. 1996, Wright 1999, Laporte, Villalon et al. 2001, Rubenstein, Harker et al. 2001, Elia 2003, Kruizenga, Seidell et al. 2005).

The European Society for Clinical Nutrition and Metabolism (ESPEN) recommend the use of the Mini Nutritional Assessment (MNA) as a malnutrition-screening tool among older adults living in residential care (Kondrup, Allison et al. 2003). Isenring, Banks et al. (2012) reported that the Mini Nutritional Assessment – Short Form (MNA- SF) also presented appropriate specificity and sensitivity when compared to other screening tools used in residential care (Mini- Nutritional Assessment and the Subjective Global Assessment).

2.3.4 Mini Nutritional Assessment (MNA)

The Mini Nutritional Assessment was developed by Guigoz, Vellas et al. (1996) to provide an assessment of nutritional status in older adults in order to provide early treatment and care for those at risk of malnutrition (Vellas, Guigoz et al. 1999). The MNA has been validated across older adult populations in different settings, including those in hospital and residential care settings (Vellas, Guigoz et al. 1999). The MNA however, takes 10 to 15 minutes to administer, hence has not been used as frequently in primary care settings. (Rubenstein, Harker et al. 2001). As a result, Rubenstein and Colleagues (2001) developed a revised version of the MNA, known as the Mini Nutritional Assessment- Short Form (MNA-SF) (Rubenstein, Harker et al. 2001).

2.3.5 Mini Nutritional Assessment – Short Form (MNA – SF)

The initial validation study found the MNA-SF had a strong correlation with the MNA, with high sensitivity (97.9%), specificity (100%) and diagnostic accuracy (98.7%) for predicting those at risk of malnutrition (Rubenstein, Harker et al. 2001). Similarly, a review by Guigoz, Jensen et al. (2006) reported that from 6 different studies, the MNA-SF reported high sensitivity (86 – 96%). The MNA-SF is a six-item screening tool that assesses loss of appetite affecting food decline,

weight loss, psychological stress, acute disease, neuropsychological issues and body mass index (Rubenstein, Harker et al. 2001).

Kaiser, Bauer et al. (2009) developed a revised version of the MNA- SF, adding the option of calf circumference measurement as a substitution for BMI, where height and weight measurements may be difficult i.e. bedridden patients. A validation study on the revised MNA-SF found that the inclusion of calf circumference measurements correlated strongly with BMI and is highly applicable to any older adult, particularly those who may be immobile or bedridden (Kaiser, Bauer et al. 2009). These results were based on a sample of 2032 older adults with a mean age of 82.3 years, obtained from 12 data sets across the community, nursing homes, and rehabilitation facilities, indicating validity in a range of different settings. It was unknown however, who performed nutrition screening between data sets, hence standardisation of nutrition screening procedures could not be confirmed. This was a limitation of this study.

Table 2.1 *Nutrition screening tools for older adults in the community, hospital and residential care setting*

Screening Tool (Reference)	Country of Origin	Population Group	Items Assessed	Risk Categories
Subjective Global Assessment (SGA) (Baker, Detsky et al. 1982)	Canada	Hospital/acute, residential care and community	4 item tool Weight loss, gastrointestinal issues, mobility, physical examination of subcutaneous fat, muscle wasting and oedema.	A: Normal nutrition status B: Mild to moderate malnutrition C: Severe malnutrition
Mini Nutritional Assessment (MNA) (Guigoz, Vellas et al. 1996)	Switzerland	Hospital/acute, residential care and community	18 item tool Anthropometry, medication use, lifestyle factors, mobility, living arrangement, dementia, depression, dietary assessment, self-perception of health.	Maximum score: 30 >24: well- nourished 17 – 23.5: At risk of malnutrition <12: malnourished
Mini Nutritional Assessment Short Form (MNA-SF) (Rubenstein, Harker et al. 2001)	Switzerland	Hospital/acute, residential care and community	6 item tool Food intake (appetite loss, digestive issues or chewing or swallowing impairment), weight loss, mobility, psychological stress, neuropsychological problems and BMI.	Maximum score: 14 <12: Normal nutrition status 8 – 11: At risk of malnutrition 0 – 7: Malnourished
Malnutrition Universal Screening Tool (MUST) (Elia 2003)	United Kingdom	Hospital/acute, residential care and community	4 item tool BMI, weight loss and acute disease.	Maximum score: 6 0: Low risk 1: Medium risk 2: High risk
Simplified Nutritional Appetite Questionnaire (SNAQ) (Kruizenga, Seidell et al. 2005)	Netherlands	Residential care and community	4 item tool Appetite, satiety, taste perceptions and dietary intake.	≤14 indicates significant weight loss (5% in the last 6 months)

Table 2.2 *Nutrition screening tools for older adults in the residential care setting only*

Screening Tool (Reference)	Country of Origin	Population Group	Layout and Markers Assessed	Risk Categories
Simple Screening Tools (1, 2) (Laporte, Villalon et al. 2001)	Canada	Residential care	Tool 1: BMI and weight loss Tool 2: BMI, serum albumin and weight loss.	Low risk High risk
Nutrition Screening Tool (Wright 1999)	United Kingdom	Residential care	5 item tool Weight loss, BMI, appetite, eating ability and medical stress factor.	Low risk Needs Monitoring High risk

2.3.6 Malnutrition Risk in Residential Care

Older adults living in residential care facilities are at increased risk of malnutrition as nutritional status declines as level of dependency and care increases (Gaskill, Black et al. 2008). An international study examined the prevalence of malnutrition among older adults (mean age of 82.3 ± 7.5 years) in five continents using the MNA. This study found that 38.7% of older adults in the hospital setting were malnourished, 13.8% in the residential care setting and 5.8% in the community setting. Additional to this, a further 47.3%, 53.4% and 31.9% of older adults were at risk of malnutrition in the hospital, residential care and community setting, respectively (Kaiser, Bauer et al. 2010).

Furthermore, a systematic review of 37 studies investigating the prevalence of nutritional risk found a higher prevalence of malnutrition compared to Kaiser, Bauer et al. (2010) however, found a similar prevalence rate for those who were at risk of malnutrition among nursing home residents (Bell, Tamura et al. 2013). Conversely, this review included studies from Canada, Asia and Europe whereas Kaiser, Bauer et al. (2010) examined malnutrition among nursing home residents in primarily Europe, South Africa and the US, hence differences in geographical areas may account for varied prevalence rates between studies. Bell, Tamura et al. (2013) reported the MNA was also the most common screening tool used in the majority of studies, with most studies reporting a malnutrition prevalence of 20 to 39% with 47 to 63% of residents classified at "risk of malnutrition". On an international scale, older adults living in residential care have a significantly high proportion of older adults whom are malnourished and at risk of malnutrition. This highlights the importance of identifying the prevalence of malnutrition in this setting, to implement appropriate screening assessments and interventions to reduce the risk of malnutrition and its adverse effects occurring.

In Queensland, Australia, using the Subjective Global Assessment (SGA), a higher prevalence of malnutrition was found among subjects among residential care facilities aged 78 years and over on both audit 1 and 2 (median of 49.2% and 50%, respectively) compared to hospital subjects aged 65 years and over (mean of 34.7 ± 4.0% and 31.4 ± 9.5%, respectively) (Banks, Ash et al. 2007). A strength of this study was the large sample of 2208 acute patients and 839 residents obtained from public hospitals and residential care facilities. In Australia, barriers to adequate treatment and diagnosis of malnutrition among older adults in residential care include: a failure to recognise that malnutrition plays a huge role in disease progression and therapy, lack of staffing skills and knowledge, lack of established evidenced based guidelines, and a shortage of nutrition appointments and services (Banks, Ash et al. 2007). A further study also examined the prevalence of malnutrition among 350 older adults (mean age of 84.2 years) in residential care facilities in

the Queensland, Australia (Gaskill, Black et al. 2008). This study found that 43.1% of residents were moderately malnourished and 6.4% of residents were severely malnourished (Gaskill, Black et al. 2008). Of the residents classified as malnourished, only 17.8% had been seen by a dietitian in the last 6 months and 29.2% were consuming nutritional supplements. This highlights the high level of malnutrition cases of older adults living in residential care that are often overlooked and untreated.

Factors associated with poor nutrition and weight loss in older adults living in residential care are important to determine to form targeted interventions for patients at high risk. A systematic review of 16 studies by Tamura, Bell et al. (2013) reported that dementia, depression, poor functional capacity, swallowing or chewing difficulties, poor dietary intake and older age were factors significantly associated with weight loss, low BMI and inadequate nutrition status among nursing home residents. Malnutrition among nursing home residents has been found to be associated with decreased quality of life, negative clinical outcomes and increased risk of mortality and morbidity (Crogan and Pasvogel 2003, Banks, Ash et al. 2007). The current research surrounding the prevalence of malnutrition among the residential care setting in NZ is limited. Determining the prevalence of malnutrition in this setting can contribute to formulating strategies and interventions to treat malnutrition and improve clinical outcomes in residential care.

2.3.7 Prevalence of Nutrition Risk among Older Adults in NZ

From the studies investigating nutrition risk among older adults in NZ, two of these studies found that 24 to 42% of older adults in the hospital setting were classified as malnourished as shown in **Table 2.3** (Hanger, Smart et al. 1999, Van Lill 2002). Seven of these studies assessed the prevalence of malnutrition in the community setting and found that 31 – 62% of community living older adults were classified as "at high nutrition risk" and 23 – 44% of community living older adults were classified as "at nutrition risk" as shown in **Table 2.4** (Watson, Zhang et al. 2010, Wham, Carr et al. 2011, Wham, Teh et al. 2011, Wham, Teh et al. 2011, McElnay, Marshall et al. 2012, Wham, McLean et al. 2014, Wham, Redwood et al. 2014, Wham, Teh et al. 2015).

Not one of these studies however, has examined the prevalence of malnutrition among NZ older adults living in residential care. This suggests that further research is required to establish and determine the prevalence of nutrition risk among older adults in this setting.

Table 2.3 *Prevalence of nutrition risk among older adults in the hospital setting in New Zealand*

Reference	Sample size	Age	Hospital or Community Setting	Area in NZ	Nutrition Assessment Method	Study Findings
(Hanger, Smart et al. 1999)	66 Older Adults	81.5 years	Hospital	Christchurch	Tricep skinfold thickness, mid upper arm circumference, serum albumin and pre-albumin measurements.	42% of participants were malnourished.
(Van Lill 2002)	71 Older Adults	81 years	Hospital	Auckland	MNA	24% of participants were malnourished, 44% of participants were classified as "at nutrition risk".

Table 2.3 *Prevalence of nutrition risk among older adults in the community setting in New Zealand*

Reference	Sample size	Age	Hospital or Community Setting	Area in NZ	Nutrition Assessment Method	Study Findings
(McElnay, Marshall et al. 2012)	473 older adults Female: 263 Male: 207 Unknown : 30	74 years	Community	Hawkes Bay	SCREEN II	32.8% of participants were classified as "at high nutrition risk", 23.7% of participants were classified as "at nutrition risk".
(Watson, Zhang et al. 2010)	152 Older Adults Female: 95 Male: 57	79.5 years	Community	Christchurch	SCREEN II	31% of participants classified "at high nutrition risk", 23% of participants classified "at nutrition risk".
(Wham, Teh et al. 2011)	108 Older Adults Female: 60 Male: 48	Maori: 76.6 ± 1.8 years Non-Maori: 85.2 ± 0.6 years	Community	North Island	SCREEN II	52% of participants were classified as "at high nutrition risk".
(Wham, Carr et al. 2011)	51 Older Adults Female: 36 Male: 15	82.4 ± 1.7 years	Community	Auckland	SCREEN II	31% of participants were classified as "at high nutrition risk".

(Wham, McLean et al. 2014)	3480 Older Adults Female: 1872 Male: 1600	Maori: 65 years and older Non Maori: 75 years and older	Community	3 DHB's located in NZ	ANSI	62% of participants were classified as either at moderate or high nutrition risk.
(Wham, Redwood et al. 2014)	45 Older Adults Female: 21 Male: 24	85 – 86 years	Community	Bay of Plenty	SCREEN II	40% of participants were "at low risk" of malnutrition, 27% of participants were "at medium risk" of malnutrition and 33% of participants were "at high risk" of malnutrition.
(Wham, Teh et al. 2015)	655 Older Adults Female: 367 Male: 288	Maori: 82.3 ± 2.6 years Non-Maori: 84.6 ± 0.5 years	Community	Bay of Plenty and Lakes Region	SCREEN II	49% of Maori participants were classified as "high nutrition" risk, 35% of non-Maori participants were classified as "at high nutrition risk".

2.4 Factors Affecting Nutritional Health of Older Adults

Individual and lifestyle factors, social and community factors, and socioeconomic, cultural and environmental factors all largely determine nutritional health of older adults.

2.4.1 Social and Community Factors

2.4.1.1 Living Arrangements and Marital Status

Older adults often experience changes in living arrangements such as living alone, living with family or living in a facility that provides additional assistance and support (Ministry of Health 2013). The 2013 census reported that 18.8% of older adults living in residential care were married, 25% of residents did not state their marital status, and a large proportion (60.4%) of the residential care population were widowed or surviving civil union partners (Statistics New Zealand 2013).

An American study by Shahar, Schultz et al. (2001) found that widowhood was associated with increased risk of weight loss, poor appetite, meal enjoyment and ultimately high nutrition risk.

Widowed individuals are at increased nutrition risk due to no assistance provided by a partner for food preparation, and bereavement resulting in poor appetite and ability to self-feed (Shahar, Schultz et al. 2001). Similarly, In NZ, a study by Wham, Teh et al. (2011) found that high nutrition risk was associated with those who lived alone or widowed compared to those who lived with others. Widowed women specifically, who previously cooked for a spouse or partner, may be less motivated to cook and prepare meals if they do not have anyone else to cook for (Locher, Ritchie et al. 2005). This may result in skipping meals and eating less than normal, increasing the risk of malnutrition. Other older adults may have less desire to cook due to limited mobility and poor ability to cook or prepare meals (DiMaria-Ghalili and Amella 2005).

Research indicates that older adults whom eat with others can increase the amount eaten at each meal. Locher, Robinson et al. (2005) reported that older adults consumed a higher caloric intake when eating with others compared to eating alone among a sample of 77 American older adults. De Castro (2002) also found that eating with others was significantly associated with increased meal size. Furthermore, a study in five Dutch nursing homes reported that participants (intervention group) who received a family style meal service over six months reduced the prevalence of malnutrition from 17% to 4%. The prevalence of malnutrition in the control group who ate meals alone increased from 11 to 23%. This suggests that residential care offers an opportunity for older adults to eat with others, routinely encouraging them to increase dietary intake and reduce the risk of developing malnutrition.

2.4.1.2 Support Services

DHB funding provides support services to for older adults to carry out daily tasks including shopping and cooking while remaining living in their own homes and maintaining independence within the community (Ministry of Health 2011). A Norwegian study found that receiving help regularly with daily tasks and poor ability for self-care were strongly associated with higher nutrition risk among community living older adults (Tomstad, Söderhamn et al. 2012). This suggests the importance in identifying community living older adults in need of home support services (Tomstad, Söderhamn et al. 2012). This may assist in providing older adults with the support they need for adequate meal preparation and thereby reducing their risk of malnutrition.

2.4.2 Socioeconomic Factors

2.4.2.2 Income status

The main source of income for older adults is the NZ superannuation and veteran pension, with 90.2% of the population receiving this pension as their primary source of income (Statistics New Zealand 2015). In 2013, the median annual income for older adults was $20,900, with the majority of older adults receiving an annual income in the lower income brackets of $30,000 and below (Statistics New Zealand 2015).

An American study comparing dietary intake and food security among low income and high income older adult populations found that low income adults consumed inadequate caloric intake compared to the high income older adults (Guthrie and Lin 2002). This study also found that low income older adults were more likely to skip meals and snacks compared to the high income older adults. Low income status among the older adult population may often result in meal restriction and consumption of less nutrient dense foods (DiMaria-Ghalili and Amella 2005, Locher, Ritchie et al. 2005). This highlights that lower income status leads to low affordability of food contributing to purchasing and consuming foods that may be low in nutritive value, thus increasing nutrition risk.

2.4.2.3 Education

Education level is correlated with nutritional dietary quality; older adults with a higher education status are more likely to have healthier dietary intakes than older adults with lower education status (McKay, Houser et al. 2006). There is an association between education level and nutrition knowledge as more educated people are more likely to be able to comprehend and understand nutritional information (Parmenter, Waller et al. 2000).

German studies have found that low education level <12 years is significantly correlated with malnutrition in hospitalised older adults (Pirlich, Schütz et al. 2005, Feldblum, German et al. 2007). In contrast, a study in community living older adults in Sweden did not find any significant associations between education level and nutrition risk (Söderhamn, Christensson et al. 2012). The lack of significance in this study compared to German Studies may be as a result of examining this relationship in community living older adults rather than hospitalised older adults. Given 39.1% of the older adult population had no educational qualifications in 2013 (Statistics New Zealand 2013), previous research suggests that low education levels may be linked to lower nutritional knowledge and increased nutritional risk in older adults.

2.4.3 Individual Factors

2.4.3.1 Polypharmacy

Polypharmacy, known as the use of multiple medications, is increasingly common among older adults (Maher, Hanlon et al. 2014). Taking five or more medications has been classed as major polypharmacy (Veehof, Stewart et al. 2000). Martin, Hall et al. (2002) found a high prescribing rate among the NZ older adult population, with a mean of 19.7 medication items being prescribed per annum in older adults across general practices.

Polypharmacy is a rising concern among this age group, as multiple drugs are associated with side effects that can negatively affect nutritional health (Heuberger and Caudell 2011). This includes poor appetite, nausea, weight loss, diarrhoea, changes in taste perception, gastrointestinal problems, reduced saliva production, and changes in serum lipids, glucose regulation, and electrolyte balance (Heuberger 2012, Jyrkkä, Mursu et al. 2012). A study in Finland examined the association between polypharmacy and nutrition risk among 294 community living older adults (Jyrkkä, Enlund et al. 2011). Findings from this study indicated that 50% of the participants whom were taking more than 10 drugs regularly (excessive polypharmacy) were malnourished or at risk of malnutrition at follow up. This highlights that polypharmacy in may be a potential risk factor for malnutrition in older adults and should be carefully assessed upon a residents' admission into residential care to identify those at nutrition risk.

2.4.3.2 Oral Health

Oral health, specifically tooth loss resulting in mastication difficulties, has been identified as a risk factor for malnutrition among older adults (De Marchi, Hugo et al. 2008, Gil-Montoya, Subirá et al. 2008, Saarela, Soini et al. 2014). An American study found edentulism, a common condition affecting many older adults, was associated with poor mastication ability and chewing pain resulting in lower intakes of hard-to-chew foods, dietary fats and micronutrients (Lee, Weyant et al. 2004). These findings demonstrate that edentulism can result in the avoidance of nutrient dense foods leading to poor nutrient intake and nutritional status.

Poor oral health is associated with chewing difficulties, restricted diets, weight loss, poor ability to communicate and decreased quality of life (Petersen, Kandelman et al. 2010). Tooth loss can lead to poor dietary intakes of nutritious foods such as fruits, vegetables and meat due to impaired mastication ability. This results in eating foods low in nutritive value and avoiding foods with fibrous textures (De Marchi, Hugo et al. 2008). This demonstrates that it is important to maintain

adequate oral health with age, as poor oral health is associated with an increased risk of malnutrition.

2.4.3.3 Sensory Changes

Age related chemosensory changes in older adults are associated with an increased risk of poor nutritional status (Murphy 2008). An American study examined the prevalence of olfactory impairment among 2491 older adults aged 53 to 97 years. This study indicated a higher prevalence of olfactory impairment with age (prevalent in 62.5% of older adults aged 80 -97 years) (Murphy, Schubert et al. 2002). Impaired olfactory causes changes in taste and smell perceptions; this may lead to changes in dietary intake and food choice (Rolls 1999). Chemosensory changes can also lead to a loss of appetite increasing the risk of malnutrition. Sensory changes commonly arise from the normal ageing process, however can also be caused by the use of various medications, diseases, malnutrition and other environmental factors. In particular, a wide range of medications can cause alterations or reduced taste perceptions resulting in higher thresholds for certain tastes (sour, sweet and salty) (Schiffman and Graham 2000).

2.4.3.4 Dysphagia

Dysphagia is referred to as "the difficulty or impossibility to swallow liquids, food or medication and can occur during the oropharyngeal phase or the oesophageal phase of swallowing" (Forster, Samaras et al. 2011). Oropharyngeal dysphagia results from the impaired movement of the bolus from the mouth to the oesophagus, whereas oesophageal dysphagia is the poor movement of food through the oesophagus due to weakened oesophageal peristalsis (Sue Eisenstadt 2010).

Dysphagia often arises from advanced neurological disorders, dementia and Parkinson's disease (Jiang, Fu et al. 2016). Dysphagia can also arise from age related muscle mass loss and strength otherwise known as sarcopenia (Namasivayam and Steele 2015). Maeda and Akagi (2015) found that 29% of 224 Japanese hospitalised older adults had both sarcopenia and dysphagia; indicating sarcopenia was an independent risk factor for dysphagia. Dysphagia can increase the risk of aspiration pneumonia, malnutrition, decreased quality of life, poor functional capacity and death (Jiang, Fu et al. 2016). Furthermore, dysphagia is a common condition affecting older adults in residential care facilities. In the US, a review reported that the prevalence of dysphagia was 40 – 60% among older adults living in nursing homes (Tanner 2010).

In particular, dysphagia can result in reduced dietary intake increasing the risk of malnutrition among older adults (Sura, Madhavan et al. 2012). A Japanese study found that of the 24.6% of 874 community living participants regarded as malnourished, 65.6% were at risk of dysphagia, indicating an increased prevalence of dysphagia among individuals at risk of malnutrition

compared to older adults not at risk (Takeuchi, Aida et al. 2014). Another study by Cabre, Serra-Prat et al. (2010) examined the prevalence of dysphagia among 134 hospitalised older adults aged over 70 years in Spain. This study found that 36.8% of older adults regarded as malnourished had dysphagia, indicating a higher prevalence of dysphagia is seen among malnourished individuals. This suggests that dysphagia screening should be performed routinely particularly among malnourished older adults in residential care to diagnose and treat dysphagia appropriately and ultimately treat malnutrition.

2.4.3.5 Screening for Dysphagia

EAT-10 is a validated, self-administered screening tool used to assess the risk and severity of dysphagia (Belafsky, Mouadeb et al. 2008). Belafsky, Mouadeb et al. (2008) found that the EAT -10 tool presented as a validated clinical instrument in detecting and monitoring the severity of dysphagia and the response to treatment.

A study examined the association between the EAT-10 tool and nutritional status of 237 older adults from geriatric health services, acute hospitals and the community in the Tokohu, Japan region (Wakabayashi and Matsushima 2016). Findings from this study indicate an independent association between EAT-10 and nutritional status. The EAT-10 tool demonstrates excellent consistency, reproducibility and validity among the older adult population, across a range of different settings including hospital, residential care and primary care settings (Belafsky, Mouadeb et al. 2008, Kaspar and Ekberg 2012).

2.5 Summary

Nutrition is a key contributor to the health of the older adult population. A variety of different age-related factors however can negatively influence the nutritional status of older adults, therefore increasing the risk of malnutrition among this age group. There is increasing international research highlighting the prevalence of nutrition risk and associated risk factors in age-related residential care, however there have been no studies assessing the nutrition risk of NZ older adults within the residential care setting. With a growing older adult population, determining the prevalence of nutrition risk and associated risk factors is important to identify and design appropriate interventions that can allow older adults to maintain their independence living in the community. Hence, the aim of this research is to determine the prevalence of nutrition risk and associated risk factors among newly admitted older adults into age related residential care facilities within the WDHB region.

Chapter 3: Research Manuscript

*This manuscript is formatted for submission to the Australian and New Zealand Journal of Public Health (**Appendix A**). Additional methodological details are provided in **Appendix A,** results in **Appendix B** and questionnaires in **Appendix C.** The referencing style for the research manuscript has been conformed to be consistent between thesis chapters and to accommodate the ease of reading.*

High prevalence of malnutrition and associated risk factors in older adults newly admitted to residential care

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Abstract:

Objective: To investigate the prevalence of malnutrition and associated risk factors among older adults (aged 65–84 years) admitted into residential care.

Methods: A cross-sectional study was undertaken within Waitemata District Health Board (WDHB) residential care facilities. A questionnaire assessed participant sociodemographic and health characteristics. Anthropometric, body composition and grip strength measures were recorded. The Mini Nutritional Assessment-Short Form assessed nutrition risk, the 10-item Eating Assessment Tool (EAT-10) assessed dysphagia risk, and the Montreal Cognitive Assessment (MoCA) assessed cognition.

Results: The mean age of participants was 78.7 ± 5.0 years. Of the 77 participants, nearly half (45.5%) were malnourished and 49.4% were at nutrition risk. Dysphagia risk was prevalent among 37.7% of participants. Malnourished participants were more likely to require daily help prior to admission (p=0.011) and have slower gait speed (p=0.014). Lower MNA-SF score correlated with lower BMI (r=0.274, p=0.024) and grip strength (r=0.368, p=0.001), and higher dysphagia risk (r=0.248, p=0.029) and medication use (r=-0.213, p=0.043).

Conclusions: Nutrition and dysphagia risk were prevalent within study participants.
Low BMI and grip strength, higher medication use and dysphagia risk are potential risk factors associated with nutrition risk.

Implications for Public Health: Routine malnutrition screening upon residential care admission will identify those at risk to ensure early intervention.

Key words: older adults, residential care, dysphagia, mini nutritional assessment, muscle strength

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Introduction

New Zealand (NZ) has a rapidly growing older adult population (65+ years). Older adults comprised 14.3% of the NZ population in 2013 and are predicted to account for over a quarter (26.7%) of the population by 2063 (Statistics New Zealand 2015). The NZ government have developed policy initiatives to support "Ageing in Place", a concept that encourages older adults to maintain independence and autonomy within the community, and is the preferred option for most older adults (Wiles, Leibing et al. 2011). Despite this, the proportion of older adults transitioning into residential care is growing, with an increase of 14.1% between 2006 to 2013 (Statistics New Zealand 2013).

Social factors including dependency with daily activities, living alone, and social isolation can play a role in increasing nutrition risk among older adults living independently in the community (Ahmed and Haboubi 2010, Tomstad, Söderhamn et al. 2012). In NZ, previous studies have reported the prevalence of malnutrition among community living adults to range from 23 – 44% (Watson, Zhang et al. 2010, Wham, Carr et al. 2011, Wham, Teh et al. 2011, McElnay, Marshall et al. 2012, Wham, McLean et al. 2014, Wham, Redwood et al. 2014). International and Australian studies suggest that the prevalence of malnutrition among older adults in the residential care setting is similar to, or higher than in the community or hospital setting (Banks, Ash et al. 2007, Gaskill, Black et al. 2008). However, there is currently no data published on the prevalence of malnutrition in older adults upon admission into residential care in NZ.

Malnutrition in older adults is associated with poor quality of life, adverse health outcomes, including higher mortality and morbidity, frequent hospital admissions, poor immune function, delayed wound healing, and decreased functional capacity (Chapman 2006, Rasheed and Woods 2013). Typically, malnutrition is associated with a number of age-related physiological changes, resulting in decreased appetite, early satiety, and loss of taste and smell leading to reduced caloric intake and increased nutrition risk (Ahmed and Haboubi 2010, Saka, Kaya et al. 2010). Other risk factors for malnutrition include cognitive impairment, dementia, depression, and polypharmacy (Saka, Kaya et al. 2010, Heuberger and Caudell 2011). These factors not only impact directly on

nutrition status, but also interact in complex and individual ways that can make malnutrition challenging to diagnose and treat.

One example of this complexity is the cyclical relationship between age-related loss of muscle mass and malnutrition (Robinson, Cooper et al. 2012, Tasar, Sahin et al. 2015). The loss of skeletal muscle mass and strength with age, commonly referred to as sarcopenia, results from weight loss, which itself is a consequence of poor food intake (Cruz-Jentoft, Baeyens et al. 2010, Robinson, Cooper et al. 2012). This also results in a subsequent loss of muscle function contributing to impaired functional status (Vandewoude, Alish et al. 2012). Additionally, the loss of muscle strength can result in swallowing difficulties, otherwise known as dysphagia (Namasivayam and Steele 2015). This may reduce food intake further, and lead to a cycle of declining muscle mass and impaired swallowing, resulting in a compromised nutrition status (Serra-Prat, Palomera et al. 2012).

The Mini Nutritional Assessment- Short Form (MNA-SF) is a malnutrition screening tool that has been validated for its use in older adults across multiple settings, including aged-related residential care (Kaiser, Bauer et al. 2009). In the United Kingdom, national guidelines recommend that older adults should be screened for malnutrition upon admission and throughout the duration of stay in residential care (Department of Health 2003). In NZ however, malnutrition screening is not mandatory in residential care facilities. A revised position statement for *'Undernutrition in the Older Person'* by the Australia and New Zealand Society for Geriatric Medicine, suggests that malnutrition screening should be performed in all settings, including residential care. This will help to guide and develop appropriate care plans to prevent and treat malnutrition. As screening is not mandatory in any setting, malnutrition and nutrition risk may be poorly reported in NZ (Australian and New Zealand Society for Geriatric Medicine 2015).

Malnutrition among older adults in all accommodation settings presents a significant public health issue that is a burden to both individuals and government health expenditure if not treated or addressed. Determining the prevalence of nutrition risk among older adults newly admitted into residential care will assist in developing and implementing effective policy initiatives to prevent and treat malnutrition and increase the nutritional health of older adults within the community. To capture the context of malnutrition in residential care in NZ, this study aimed to investigate the prevalence of nutrition risk and associated risk factors among older adults newly admitted to residential care.

Methods

Study Design

A cross-sectional study was undertaken in participants newly admitted to residential care facilities within the WDHB catchment area of Auckland, NZ. The Northern A Regional Ethics Committee of New Zealand (NTX/14/NTA/70) granted ethics approval.

Participant Eligibility

Participants were eligible for this study if they were 65 years or over (55 years if of Maori and Pacific descent), and admitted to age-related residential care within the previous seven days. Those who were unable to give consent, and/or had the presence of a tracheostomy tube, known dysphagia, or were receiving palliative care, were excluded.

Recruitment

Facility managers of sixty-three residential care facilities within the WDHB region were contacted via telephone or by email to identify newly admitted residents who could be invited to participate in the study. Eligible participants were provided with an information sheet by the researchers when visited for the interview. Participants provided written consent by filling out a consent form prior to commencing a face-to-face interview to gather questionnaire information.

Measures

Participant Characteristics

Age, gender, ethnicity, marital status, living arrangement, source of income and highest level of education were collected by a questionnaire administered through a face to face interview.

Dental status was categorised and recorded as dentate (≥ 21 natural teeth remaining), edentulous (<21 natural teeth remaining), or the use of a dental appliance (partial or complete dentures) (Sheiham, Steele et al. 2001, CBG Health Research 2015). Key comorbidities and prescribed medications were obtained from the participant's clinical notes. Participants were asked if they were aware of any current health problems, if they were taking over-the-counter (OTC) medication and/or nutrition supplements, had seen a dietitian in the past year, and if they received subsidised support services and/or daily help with tasks prior to admission.

Anthropometric Measures

Height and weight was measured using a portable stadiometer and Bioelectrical Impedance Analysis (BIA) Tanita Body Composition Analyser scales. For participants unable to stand, calf-circumference and demi-span measurements were recorded. Body Mass Index (BMI) was

calculated using height and weight measurements and categorised according to a cut off value of <23 recommended for older adults (Price, Uauy et al. 2006, Winter, MacInnis et al. 2014).

Demi-span equations to estimate height (Bassey 1986):
Men: Height (cm) = (1.40 x demi-span in cm) + 57.8
Women: Height (cm) = (1.35 x demi-span in cm) + 60.1

Body Composition

Bioelectrical Impedance Analysis (BIA) was used to measure skeletal muscle mass and body fat mass using a Tanita Body Composition Analyser. Participants were excluded from this measurement if they were bedridden, had the presence of a pace maker and/or a metal surgical implant.

Muscle Strength

Muscle strength was obtained by measuring grip strength using a handgrip dynamometer. Measurements were conducted using the second handle position on the Jamar hydraulic handgrip dynamometer (model 5030J1). The final handgrip strength measurement was obtained from an average of three handgrip strength measurements.

Physical Performance

A timed 2.4 metre walk test was used to estimate gait speed and measure lower extremity muscle performance (Penninx, Ferrucci et al. 2000, Bean, Herman et al. 2004). Participants were asked to walk from one cone to the next cone (spaced 2.4 metres apart) three times, and timed using a stopwatch.

Nutrition Risk

The MNA-SF is a validated six item questionnaire consisting of questionnaire items to assess the severity of decline in food intake over the past three months, unintentional weight loss, mobility, psychological stress or acute disease, neuropsychological problems, and BMI and calf circumference (if BMI is unable to be obtained) (Rubenstein, Harker et al. 2001). A score of 12 – 14 (maximum score is 14) identified participants as ‘well- nourished’, a score of 8 – 11 points identified participants as ‘at risk of malnutrition’ and a score of 0-7 points as ‘malnourished’ (Rubenstein, Harker et al. 2001).

Dysphagia Risk

EAT-10 is a validated tool used to measure initial dysphagia risk in older adults. This tool consists of 10 questionnaire items relating to problems associated with swallowing including weight loss or ability to go out for meals, swallowing liquids, solids and medications and pain, coughing or stress when swallowing. Participants gave responses according to the severity of their swallow on a scale of 0 - 4. Participants who obtained an overall score of 3 or greater may indicate dysphagia risk (Belafsky, Mouadeb et al. 2008).

Cognition Status

The MoCA was used to screen for mild cognitive impairment. This test involves sections assessing short-term memory recall, visuospiatal abilities, executive functions, attention, concentration, language and orientation (Nasreddine, Phillips et al. 2005). Participants who scored 26 points or higher, out of a maximum 30 points, were regarded as having normal cognition. Participants who obtained a score of less than 26 points were regarded as cognitively impaired.

Statistical Analysis

Collected data was entered into IBM SPSS package v. 22 (IBM corporation, Chicago, IL, USA) and utilised for statistical analysis. Descriptive statistical analysis was used for the following variables: participant demographic characteristics, setting prior to admission, level of care, anthropometry, body composition, nutrition risk, and health characteristics. Data was treated as normal according to the central limit theorem (Field 2013). For variables with a sample size <30, Kolmogorov- Smirnov tests were used to a test for normality.

Normal data was presented as the mean ± standard deviation, categorical data was reported as counts and percentages, and non-normal data was reported as the geometric mean. Pearson Chi-Square tests were used to analyse differences between categorical data groups. For normal data, independent t-tests were used to compare differences between two groups. For non-normal data, Mann-Whitney tests were used to compare differences between groups. Correlations were tested using the Pearson Coefficient Correlation tests for normal variables, and the Spearman Correlation tests for non-normal variables. A P value of less than 0.05 was considered statistically significant.

Results

Participant Recruitment

Participants were invited to participate in the study, subject to consent from the management of residential care facilities across the WDHB. The recruitment process is shown in **Figure 1.** Of the 63 residential care facilities available, 22 residential care facilities declined to participate in this study. Of the 41 facilities that agreed to participate, 261 participants who were newly admitted to the residential care facilities were invited to take part. 87 of these participants declined to participate, or were excluded due to not meeting the inclusion criteria. A total of 174 participants agreed to participate in this study, with 77 participants aged 65 – 84 years.

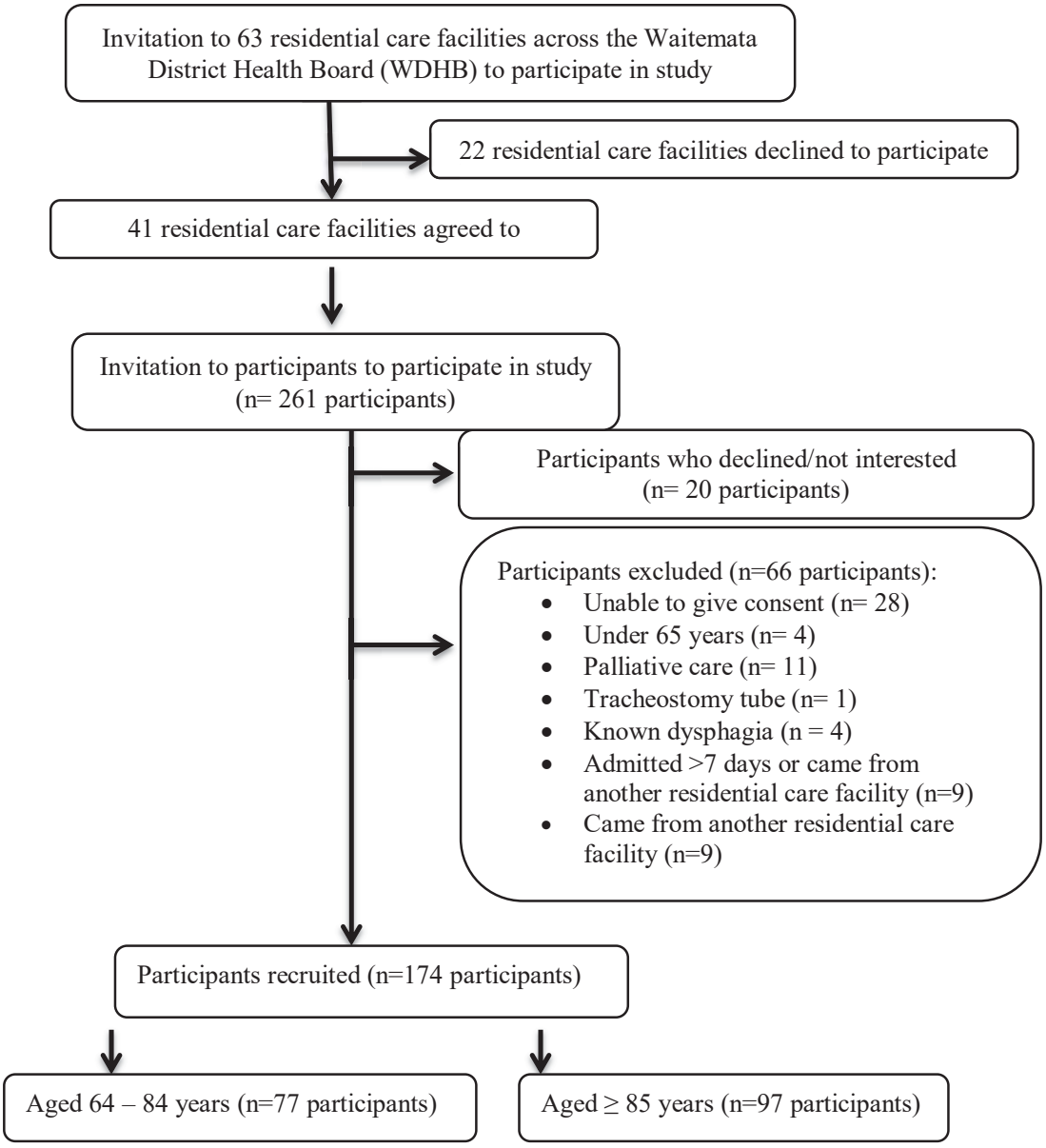

Figure 3.1: *Participant recruitment*

Participant Characteristics

Table 3.1 provides the participant characteristics. The mean age of participants was 78.7 ± 5.0 years (y) (men 79.2 ± 4.3y, women 78.2 ± 5.4y) (range 64 – 84y). Of the 77 participants, 34 (44%) were men and 43 (56%) were women. Two thirds (63.6%) of participants were NZ European, three were Maori, one Pacific, and 24 'other'. Prior to admission into residential care, two thirds (66.2%) of the participants resided in the community, and 33.8% were transferred from a public hospital.

A higher proportion of women were either widowed, divorced or never married compared to men (79.1% vs. 47.1%). Prior to admission, more women than men were living alone. On admission, three quarters (73.5 %) of men received rest home level of care and over half (53.5%) of women received hospital level of care. Three quarters (76.1%) of admissions were permanent and 26% were respite and interim care admissions. Three quarters (74.0%) of participants reported a 'pension only' income. Two thirds (66.2%) of participants reported secondary school as their highest level of education. More men reported a tertiary level of education compared to women (32.4 % vs. 16.3%). More women reported receiving subsidised support services prior to admission compared to men (60.5% vs. 32.4%). Nearly three quarters (71.4%) of participants reported requiring daily help with tasks prior to admission. Over three quarters (79.2%) of participants had not received dietetic input in the past year. Participants had a mean BMI of 24.7 ± 7.2 kg/m^2, and half (50%) had a BMI below 23 kg/m^2.

Nutrition Risk and Health Characteristics

Nutrition risk and health characteristics are provided in **Table 3.1.** Just under half (45.5%) of the participants were malnourished, 49.4% were at risk of malnutrition, and 5.2% had a healthy nutrition status. A higher number of women were malnourished compared to men (53.5% vs. 35.3%). Over a third (37.7%) of the participants were at risk of dysphagia (EAT-10 score ≥ 3). Over half of participants (57.1%) reported using a dental appliance. The majority of participants were cognitively impaired (MoCA score <26), where only 7.7% of the participants were regarded as having normal cognition. A third of participants (32.5%) were unable/declined to complete the MoCA.

Over half of the participants had more than five comorbidities (57.1%), and 38.8% of participants had less than five key comorbidities (mean 5.2 ± 2.1). The most common health conditions were cardiovascular/blood disorders and neurological/mental health conditions, accounting for 74.6% and 61.2% of participant comorbidities respectively.

Over two thirds (71.4%) of participants were taking five or more medications. More men took five or more medications compared to women (76.5% vs. 67.4 %).

Table 3.1: Participant characteristics

Number of Participants, n(%)	Total n= 77 (%)	Men n= 34 (44%)	Women n= 43 (56%)	P-value
Age (years)[a]				
<80 Years	36 (46.7)	15 (44.1)	21 (48.8)	0.680
80 – 84 Years	41 (53.2)	19 (55.9)	22 (51.2)	
Prior setting to admission[a]				
Community	51 (66.2)	26 (76.5)	25 (58.1)	0.091
Hospital	25 (33.8)	8 (23.5)	18 (41.9)	
Ethnicity[a]				
NZ European	49 (63.6)	20 (58.8)	29 (67.4)	0.184
Maori	3 (3.9)	0 (0)	3 (7.0)	
Pacific	1 (1.3)	1 (2.9)	0 (0)	
'Other'	24 (31.2)	13 (38.2)	11 (25.6)	
Marital status[a]				
Married/partnered	27 (35.1)	18 (52.9)	9 (20.9)	**0.003***
Widowed/ divorced/ Never married	50 (64.9)	16 (47.1)	34 (79.1)	
Living arrangements[a]				
Living alone	38 (69.4)	12 (35.3)	26 (60.5)	**0.028***
Living with others	39 (50.6)	22 (64.7)	17 (39.5)	
Type of admission[a]				
Permanent	57 (74.0)	35 (73.5)	32 (74.4)	0.930
Respite/Interim	20 (26.0)	9 (26.5)	23 (53.5)	
Level of care[a]				
Rest home	45 (58.4)	25 (73.5)	40 (46.5)	**0.017***
Hospital	32 (41.6)	9 (26.5)	23 (53.5)	
Sourced Income[a]				
Pension only	60 (77.9)	27 (79.4)	33 (76.7)	0.779
Pension plus other income	17 (22.1)	7 (20.6)	10 (23.3)	
Level of education[a]				
Primary	8 (10.4)	2 (5.9)	6 (14.0)	0.176
Secondary	51 (66.2)	21 (61.8)	30 (69.8)	
Tertiary	18 (23.4)	11 (32.4)	7 (16.3)	
Support services[a]				
Yes	37 (48.1)	11 (32.4)	26 (60.5)	**0.014***
No	40 (59.1)	23 (67.6)	17 (39.5)	
Required daily help with tasks[a]				
Yes	55 (71.4)	25 (73.5)	30 (69.8)	0.717
No	22 (28.6)	9 (26.5)	13 (30.2)	
Received dietetic input[a]				
Yes	16 (20.8)	8 (23.5)	8 (18.6)	0.597
No	61 (79.2)	26 (76.5)	35 (81.4)	
MNA-SF score[a],[b]				
Healthy nutrition status (0 – 7)	4 (5.2)	2 (5.9)	2 (4.7)	0.280
At risk of malnutrition risk (8 - 11)	38 (49.4)	20 (58.8)	18 (41.9)	
Malnourished (12-14)	35 (45.5)	12 (35.3)	23 (53.5)	
Dysphagia risk[a],[c]				
Not at risk of dysphagia (<3)	48 (62.3)	22 (64.7)	26 (60.5)	0.703
At risk of dysphagia (≥ 3)	29 (37.7)	12 (35.3)	17 (39.5)	
Dental status[a]				
Dentate	28 (36.4)	15 (44.1)	13 (30.2)	0.305
Edentulous	5 (6.5)	1 (2.9)	4 (9.3)	

Dental appliance	44 (57.1)	18 (52.9)	26 (60.5)	
MoCA score[a],[d]				
Normal cognitive status (≥ 26)	4 (7.7)	2 (8.0)	2 (7.4)	0.936
Cognitive impairment (< 26)	48 (92.3)	23 (92.0)	25 (92.6)	
Number of key comorbidities[a]				
<5 comorbidities	33 (42.9)	15 (44.1)	18 (41.9)	0.842
≥5 comorbidities	44 (57.1)	19 (55.9)	25 (58.1)	
Number of prescribed medications[a]				
Less than 5 medications	22 (28.6)	8 (23.5)	14 (32.6)	0.384
5 medications or more	55 (71.4)	26 (76.5)	29 (67.4)	
Weight (kg)[e],[f],[g]	68.0 ± 19.2	71.1 ± 18.7	65.5 ± 19.5	0.240
Height (cm)[e],[f]	165.7 ± 10.0	170.7 ± 9.8	161.7 ± 8.2	**<0.001***
BMI (kg/m^2)[e],[f],[h]	24.7 ± 7.2	24.0 ± 5.8	25.4 ± 8.2	0.460
BMI < 23 kg/m^2[a],[i]	33 (50.0)	15 (51.7)	18 (48.6)	
Calf Circumference (cm)[j],[k],[l]	32 (28, 34.5)	33.5 (30.8, 37.5)	29.5 (27.5, 33.5)	0.126
Grip Strength (kg)[e],[h],[m]	15.2 ± 8.8	18.6 ± 10.9	12.6 ± 5.6	**0.007***
Fat mass (kg)[e],[f],[n]	18.7 ± 10.9	16.2 ± 9.5	20.7 ± 11.9	0.299
Muscle mass (kg)[e],[f],[n]	42.7 ± 13.6	47.1 ± 17.9	39.2 ±8.1	0.141
Fat percentage (%)[e],[f],[n]	26.3 ±11.2	20.1 ± 6.9	31.3 ± 11.6	**0.007***
FFM (Kg/m^2) [j],[n],[o]	44.6 (95%CI= 40.5, 49.2)	50.3 (95%CI = 42.4, 59.6)	40.6 (95%CI = 36.6, 45.1)	**0.038***
2.4 m gait speed (m/s)[e],[f],[m]	0.5 ± 0.3	0.5 ± 0.3	0.5 ± 0.2	0.734

BMI, Body Mass Index, FFM, Fat Free Mass, OTC, Over The Counter, * Statistical significance (P<0.05) between gender groups, values reported as n (%) unless otherwise indicated
[a] Pearson chi-square for categorical variables
[b] Established cut-off scores from the MNA-SF (Rubenstein, Harker et al. 2001)
[c] Established cut-off scores from the EAT-10 (Belafsky, Mouadeb et al. 2008)
[d] Established cut-off scores from the MoCA (Nasreddine, Phillips et al. 2005)
[e] Independent t-tests for normal variables
[f] Values reported as mean ± standard deviation
[g] Missing values = 9
[h] Missing values = 11
[i] Cut off values for BMI for older adults (Price, Uauy et al. 2006, Winter, MacInnis et al. 2014).
[j] Mann-Whitney tests for non-normal variables
[k] Missing values = 56
[l] Values reported as median (25th, 75th percentile)
[m] Missing values = 5
[n] Missing values = 50
[o] Values reported as geometric mean (95% Confidence Interval (CI))
[p] Missing values = 35

Table 3.2 provides differences in characteristics, dysphagia risk, anthropometric measures and muscle strength and function by nutrition risk status**.** Given that only four participants had a healthy nutrition status (MNA-SF score 12 – 14), those who had a healthy nutrition status and those at nutrition risk were categorised as one variable (healthy/at risk). Malnourished participants were more likely to receive hospital compared to rest home level of care (67.6% vs. 32.4% p=<0.001). Prior to admission, malnourished participants were significantly more likely to require daily help with activities compared to non-malnourished participants (healthy/at risk) (85.3% vs. 60.5% p=0.011).

The non-malnourished participants (healthy/at risk group) had significantly higher grip strength (p=0.005) and 2.4 m walking speed (p=0.014) than the malnourished participants.

Table 3.2: Differences in characteristics, dysphagia risk, anthropometric measures and muscle strength and function by nutrition risk status

Number of Participants, n(%)	Healthy/at risk n (%) n= 45	Malnourished n (%) n= 32	P-value
Age (years)[a]			
<80 Years	21 (48.8)	15 (44.1)	0.680
80 – 84 Years	22 (51.2)	19 (55.9)	
Level of care[a]			
Rest home	34 (79.1)	11 (32.4)	**<0.001***
Hospital	9 (20.9)	23 (67.6)	
Dysphagia Risk[a],[d]			
Not At Risk	27 (62.8)	21 (61.8)	0.766
At Risk	16 (37.2)	13 (38.2)	
Required daily help with tasks[a]			
Yes	26 (60.5)	29 (85.3)	**0.011***
No	17 (39.5)	5 (14.7)	
Weight (kg)[b],[c],[f]	69.5 ± 18.1	65.9 ± 20.7	0.440
Height (cm)[b],[c]	164.7 ± 10.0	167.0 ± 9.8	0.408
BMI (kg/m^2)[b],[c],[g]	25.7 ± 6.9	23.6 ± 7.6	0.236
BMI <23 kg/ m^2[b],[h]	18 (50.0)	15 (50.0)	1.000
Calf Circumference (cm)[d],[i],[j]	32 (30.2, 35.0)	29 (27.5, 34.5)	0.491
Grip Strength (kg)[b],[c],[k]	17.8 ± 9.5	12.1 ± 6.8	**0.005***
Fat mass (kg)[c],[d],[l]	19.9 ± 11.1	14.5 ± 10.2	0.294
Muscle mass (kg)[b],[c],[l]	44.7 ± 12.0	35.9 ± 17.9	0.169
Fat percentage (%)[b],[c],[l]	28.5 ± 10.7	18.7 ± 10.4	0.058
FFM (kg)[d],[l],[m]	45.6 (95% CI= 40.7, 51.1)	41.6 (95% CI = 32.3, 53.4)	0.414
2.4 m gait speed[b],[c],[n]	0.6 ± 0.3	0.4 ± 0.2	**0.014***

BMI, Body Mass Index, FFM, Fat Free Mass, OTC, Over The Counter, * Statistical significance (P<0.05) between nutrition risk groups, values reported as n (%) unless otherwise indicated
[a] Pearson chi-square for categorical variables
[b] Independent t-tests for normal variables
[c] Values reported as mean ± standard deviation
[d] Mann-Whitney tests for non-normal variables
[e] Established cut-off scores from the EAT-10 (Belafsky, Mouadeb et al. 2008)
[f] Missing values = 9
[g] Missing values = 11
[h] Cut off values for BMI for older adults (Price, Uauy et al. 2006, Winter, MacInnis et al. 2014)
[i] Missing values = 56
[j] Values reported as median (25th, 75th percentile)
[k] Missing values = 5
[l] Missing values =50
[m] Values reported as geometric mean (95% Confidence Interval (CI))
[m] Missing values = 35

Table 3.3 shows the correlation between physical and health characteristics and the nutrition risk score. Lower w**e**ight (r=0.274, p=0.024) and BMI (r=0.317 p=0.010) were correlated with a higher nutrition risk (lower MNA-SF score). MNA-SF score was also positively correlated with grip strength, indicating that a lower nutrition risk (higher MNA-SF score) was significantly associated with higher grip strength (r=0.368, p=0.001). A lower MNA-SF score (higher nutrition risk) was negatively correlated with higher medication use (r=-0.213, p=0.043). An inverse

association was found between MNA-SF score and EAT-10 score (dysphagia risk) (r=-0.248, p=0.029), demonstrating that higher nutrition risk was significantly associated with an increased risk of dysphagia.

Table 3.3: Correlation coefficients between physical and health characteristics and nutrition risk (MNA-SF score)

	Total n= 77	
	Correlation (r)	P-value
Age (years)	-0.186	0.105
Weight (kg)	0.274	**0.024***
BMI (kg/m^2)	0.317	0.010*
Calf circumference (cm)[(a)]	0.194	0.399
Grip strength (kg)	0.368	**0.001***
Fat mass (kg)	0.162	0.419
Muscle mass (kg)	0.320	0.104
Fat percentage (%)	0.223	0.264
FFM (kg)[(a)]	0.236	0.236
2.4 m gait speed (m/s)	0.213	0.177
Number of comorbidities	-0.209	0.069
Number of medications	-0.213	**0.043***
Nutrition supplement use	-0.189	0.100
Dysphagia risk[(b)]	-0.248	**0.029***
Cognition status[(c)]	0.104	0.463

BMI, body mass index, FFM, Fat Free Mass, *Significant correlation (P<0.05)
Pearson correlation coefficient tests used for normal data unless otherwise indicated
[(a)] Spearman correlation tests used for non-normal data
[(b)] EAT-10 score is out of 40
[(c)] MoCA score is out of 26
BMI, body mass index, FFM, Fat Free Mass

Discussion

Among this group of participants newly admitted to residential care facilities, the majority (95%) were malnourished (45%) or at high nutrition risk (49%), using the MNA-SF. A similar prevalence of malnutrition (39%) and nutrition risk (60%) has been reported among nursing homes in Finland, using the full MNA (Suominen, Muurinen et al. 2005). Studies that have investigated the risk of malnutrition within the NZ residential care setting are limited. However, the prevalence of malnutrition found in this study is consistent with the malnutrition prevalence (50%) reported among older adults in Australian residential care facilities using the Subjective Global Assessment (SGA) (Banks, Ash et al. 2007, Gaskill, Black et al. 2008). Increasing age can be a risk factor for poor nutrition status and may explain the high prevalence of malnutrition and nutrition risk found in the present study (Forster and Gariballa 2005).

Half (50%) of the participants in this study had a BMI <23 kg/m^2, a cut off value found to be associated with a higher risk of mortality in older adults in two recent meta-analyses (Price, Uauy et al. 2006, Winter, MacInnis et al. 2014). Lower BMI was associated with higher nutrition risk

(lower MNA-SF score) (r=0.317, p=0.010) in the present study. This finding is not unexpected as the MNA-SF includes BMI within its scoring criteria. This association has also been found among 872 institutionalised older adults (mean age 84.5 years) in Sweden (Saletti, Lindgren et al. 2000). This suggests that routine weighing to detect weight loss and older adults with a BMI <23 may be useful to identify those at increased risk of malnutrition, and who will ultimately require nutrition intervention.

We found no association between lower muscle mass and higher nutrition risk (lower MNA-SF score). However, BIA measures were recorded for only 27 participants due to frail or bedridden participants, or those who had a pace maker and/or metal surgical implants. Previously, a correlation between high nutrition risk (identified using the Short Nutrition Assessment Questionnaire (SNAQ)) and lower muscle mass was reported among older adults newly admitted to hospital in the Netherlands (Pierik, Meskers et al. 2017). The small number of participants with BIA measures may have limited the ability to confirm this association in the present study.

Lower grip strength among the participants correlated with a lower MNA-SF score, indicating higher nutrition risk (r=0.368, p = 0.001). This observation has previously been found among community-living older people aged 75 – 85 years in NZ using the SCREEN II tool (Wham, Teh et al. 2011) and among older adults (mean age 81 years) receiving homecare in Germany using the MNA (Kiesswetter, Pohlhausen et al. 2013). This finding highlights that declines in muscle strength are associated with higher nutrition risk and may lead to poor physical function to perform daily tasks resulting in poor food intake (Hughes, Frontera et al. 2001).

We found that the participants' gait speed was significantly lower in those who were malnourished compared to those who were non-malnourished (healthy/at risk group) (0.6 ± 0.3 m/s vs. 0.4 ± 0.2 m/s, p=0.014). Similar findings have been reported among community living older adults in Japan (Kaburagi, Hirasawa et al. 2011). In the current study, eight participants used a walker and 35 participants were unable to complete the 2.4 m walk test. Of the latter participants, 60% were malnourished. This may suggest that high nutrition risk is associated with slower gait speed, which is a measure of physical performance. This can impact the ability to cook, shop and prepare meals, resulting in poor food intake and increased nutrition risk (Volkert 2011).

The risk of dysphagia was prevalent in over a third of the participants in our study, which was similar to the prevalence (40%) reported among Portuguese nursing home residents (Nogueira and Reis 2013). A higher risk of dysphagia correlated with higher nutrition risk (r=-0.248, p=

0.029) was also reported among nursing home residents (mean age 82 years) in Finland ($p<0.001$) (Suominen, Muurinen et al. 2005). Dysphagia is known to reduce swallowing efficacy leading to poor food intake and an increased risk of malnutrition (Forster, Samaras et al. 2011). Muscles involved in the swallowing process can weaken further as a result of both the ageing process and malnutrition (Serra-Prat, Palomera et al. 2012). This presents a vicious cycle, as dysphagia not only increases the risk of malnutrition, but malnutrition can reduce muscle strength, leading to a further impaired swallow function (Serra-Prat, Palomera et al. 2012). Hence, dysphagia screening in those identified at nutrition risk is of high importance to ensure dysphagia does not go untreated or unrecognised.

Most (84%) of the participants found to be malnourished reported that they required daily help with activities prior to admission; higher than the non-malnourished participants (healthy/at risk group) (60.5%, $p=0.011$). Similarly, among Norwegian older adults living in the community, requiring daily help was more prominent among older adults at nutrition risk (37.5%) compared to those not at risk (8.7%) ($p<0.014$) (Tomstad, Söderhamn et al. 2012). In the present study, two thirds (69.4%) of the participants were living alone prior to admission. Among Swedish community living older adults, both 'living alone' and 'receiving daily help', were found to be predictors of high nutrition risk ($p<0.001$) adults (Söderhamn, Christensson et al. 2012). These factors may impact the ability to acquire, prepare and cook food (Ahmed and Haboubi 2010, Ülger, Halil et al. 2010).

Overall, most (92.3%) participants in this study were found to have a MoCA score of <26 which is indicative of cognitive impairment. However, previous reports suggest that MoCA cut off scores should be based on population and age-related norms (Rossetti, Lacritz et al. 2011, Trzepacz, Hochstetler et al. 2015). The MoCA cut off (<26) may overestimate cognitive impairment, as a cut-off value of 17 or 19 has been suggested to differentiate mild from severe cognitive impairment (Trzepacz, Hochstetler et al. 2015). The high prevalence of cognitive impairment observed in this study may represent overestimations of cognitive impairment and findings should be treated with caution. Although there was no association between cognitive status and nutrition risk observed in the present study, this association has previously been reported among Swedish older adults living in the community and in special housing (nursing homes, sheltered accommodation and group housing) (Fagerström, Palmqvist et al. 2011). In the residential care setting, cognitively impaired older adults often require assistance with feeding and forget to eat thereby resulting in poor food intake and may increase the risk of malnutrition (Lin, Watson et al. 2010). Cognitively impaired older adults are an easily identifiable group and need support in the residential care setting to ensure nutritional requirements are met.

Higher medication use was associated with a lower MNA-SF score (higher nutrition risk) in the current study (r=-0.231, p=0.043). Over two thirds (71.4%) of the study participants were taking five medications or more, classed as major polypharmacy (Veehof, Stewart et al. 2000). Over half (57.1%) the participants had five or more comorbidities and 42% were admitted under hospital level of care. Older adults in residential care are often frail and vulnerable to multiple comorbidities, and higher medication use is predictive of poorer health status (Flaherty, Perry III et al. 2000, Linjakumpu, Hartikainen et al. 2002, Onder, Liperoti et al. 2012). Higher medication use may induce side effects that cause taste changes, poor appetite and nausea, thereby increasing nutrition risk (Heuberger and Caudell 2011). Higher medication use has also been associated with a poorer nutrition status among community living older adults in the US (Heuberger and Caudell 2011). This suggests that polypharmacy may be a potential risk factor for malnutrition in older adults and nutrition screening should be targeted at those using a higher number of medications.

A strength of this study is that it provides a snapshot of the prevalence of nutrition risk among older adults across residential care facilities within the WDHB region. This contributes to the limited body of research surrounding the nutritional health of older adults in the residential care setting in NZ. To the best of our knowledge, this is the first study in NZ to investigate the associations between body composition, muscle strength and function and nutrition risk in older adults within the residential care setting. This study also highlights potential risk factors for malnutrition including low BMI and grip strength, high dysphagia risk and high medication use that should be further investigated in future studies.

Limitations in the present study include that the cross-sectional study design limits the ability for cause-effect relationships to be determined. The sample size was small and therefore may restrict these study findings to be extrapolated to the wider NZ older adult population. Furthermore, participant recruitment was confined within the WDHB region and Maori and Pacific people were underrepresented. This further limits the generalisability of these findings to other NZ DHB regions. Two thirds of participants were not able to take part in BIA measures due to frailty or the presence of an internal metal device, and hydration status was not controlled among those who participated, which may have resulted in inaccurate BIA readings. A total of 25 participants did not complete the MoCA due to visual impairments, hearing deficits, communication barriers, inability to hold a pen, and fatigue, therefore was a further limitation of this study.

In conclusion, the present study found that majority of participants were malnourished or at high nutrition risk. Dysphagia, polypharmacy, and lower BMI and grip strength were significantly associated with a higher nutrition risk (lower MNA-SF score). Malnutrition is a significant public health issue, and is highly prevalent among older adults admitted to residential care facilities. This highlights the importance of performing nutrition risk screening routinely upon a resident's admission, to ensure adequate nutrition interventions are implemented to prevent and treat malnutrition. As highlighted by this study, dysphagia may be a risk factor for malnutrition suggesting that dysphagia screening should also be routinely performed among those identified at nutrition risk. Through adequate screening and assessment, a referral to a dietitian can be made to identify and develop a nutrition care plan and appropriate intervention. Tailored dietetic input may contribute to improving nutrition and health outcomes.

Chapter 4: Conclusion and Recommendations

4.1 Study Summary

Malnutrition is a multi-factorial problem and presents a challenge for vulnerable older adults. This cross-sectional study aimed to investigate the prevalence of nutrition risk among older adults (aged 64 to 84 years) newly admitted into residential care. Findings indicated that malnutrition was prevalent among 45.5% of the participants, with a further 49.4% of participants at nutrition risk. This study highlights the importance of routine screening for malnutrition upon admission into residential care. Screening can identify those at nutrition risk for an early referral to a dietitian for appropriate intervention of a nutrition care plan.

Using the EAT-10, dysphagia was prevalent among over a third (37.1%) of the malnourished participants. A higher EAT-10 score correlated with an increased nutrition risk (lower MNA-SF score). Dysphagia and malnutrition present a viscous cycle, where dysphagia contributes to reduced food intake, thus increasing the risk of malnutrition. Subsequently, malnutrition can result in loss of muscle mass and strength in deglutition. Hence, it is important to implement dysphagia screening among those who have been identified as malnourished for further assessment by a speech language therapist.

Half of the participants had a BMI <23, and a lower BMI was associated with higher nutrition risk. Routine weighing in residential care is important to identify those who may need nutrition intervention to prevent malnutrition and weight loss. Malnourished participants were found to have a significantly lower grip strength and slower gait speed compared to non-malnourished participants (healthy/at risk group). Furthermore, lower grip strength was significantly correlated with increased nutrition risk. Low grip strength and slower gait speed (functional status) are exacerbated by malnourishment and may result in loss of independence leading to the need for a higher level of care. Therefore, older adults with poor muscle strength and functional mobility should be targeted for nutrition screening.

The majority of malnourished participants reported requiring daily help with activities. This highlights that social support may indicate loss of independence with food related activities, such as the ability to acquire and prepare food, which may in turn increase the risk of malnutrition. Most participants were identified as cognitively impaired (92.3%) using the MoCA. Cognitively impaired older adults may be susceptible to high nutrition risk, and are an easily identifiable group. Findings showed a higher number of regular medications positively correlated with a higher nutrition risk. Polypharmacy was found to be prevalent among 78.1% of the malnourished participants. Polypharmacy is a major concern among older adults and should be recognised as a

risk factor when assessing nutrition risk status. These social and health factors can significantly affect nutrition status. As such, nutrition screening to identify these factors upon admission to residential care facilities can highlight older adults who may be vulnerable to nutrition risk.

Overall, the majority (95%) of participants were at nutrition risk upon admission into residential care facilities across the WDHB region. These findings contribute new knowledge to the body of research regarding the nutritional health of older adults in NZ, specifically within the residential care setting. Results also highlight the importance for policy initiatives, to include routine nutrition screening upon admission, and for those who are malnourished, assessment of dysphagia risk. Nutrition risk screening should also be routinely assessed throughout a residents stay in residential care to identify nutrition risk status. This can identify if a dietitian referral and nutrition intervention is needed. Established malnutrition screening processes will allow for dietitians to further assess and develop tailored nutrition treatment plans for those at nutrition risk, and help to increase the nutritional health of residents. Preventing adverse health outcomes related to malnutrition will help reduce individual burden as well as reducing DHB service and health expenditure.

4.2 Study Strengths

This cross-sectional study design provides a snap shot of the prevalence of nutrition risk and associated risk factors among newly admitted older adults in 41 residential care facilities across the WDHB catchment area. Given that research investigating the prevalence of nutrition risk within the residential care setting in NZ is limited, this study contributes to the body of evidence among older adults in this setting.

A NZ registered dietitian and a nutrition research technician provided training on the administration of the MNA-SF, EAT-10 and MoCA screening tools and performing anthropometric, body composition, grip strength and gait speed measures. This was to ensure the student researchers performed measures accurately according to the recommended protocol.

A further strength of this study was the use of the validated screening tool, the MNA-SF. This tool has been validated for use in older adults across a range of different settings; specifically, the residential care setting. The MNA-SF has a high sensitivity, specificity, and diagnostic accuracy.

To ensure the data collected was reliable and accurate, information gathered from cognitively impaired participants was confirmed with a family member, clinical notes, or a registered nurse at the facility.

4.3 Study Limitations

Given the cross-sectional design of this study, causal relationships could not be determined. The four-month data collection period limited the sample size to 77 participants. This therefore restricts the generalisability of the study findings to the wider older adult population. There were few Maori (3.9%) and Pacific (1.3%) participants, which is not representative of the NZ Maori and Pacific older adult population; 5.6% and 2.4%, respectively (Statistics New Zealand 2013). Previous research has found that Maori and Pacific older adults are at increased risk of malnutrition risk compared to non- Maori (McElnay, Marshall et al. 2012, Wham, Teh et al. 2015). Hence, obtaining a more representative sample of the NZ DHB populations will allow these findings to be extrapolated to the wider NZ older adult population.

Body weight measurements were obtained from the clinical notes for patients who were unable to stand. The use of different weighing scales across different facilities may have affected the accuracy of the weights measured. BIA measurements were a limitation because many participants were frail, had the presence of a pacemaker, or a surgical metal implant. BIA measurements however, are subjective to hydration status, timing, body shape, environment and physical exercise. This therefore limited the ability to draw associations between nutrition risk and muscle mass.

Using the MoCA, cognitive impairment was evident among the majority (92.3%) of participants. The MoCA has been validated for its use in identifying mild cognitive impairment in older adults, demonstrating high specificity and sensitivity when compared to the MMSE (Nasreddine, Phillips et al. 2005). Recent studies however, have highlighted that MoCA results should be interpreted with caution. Malek-Ahmadi, Powell et al. (2015) found lower cut-off values are required for those who have a lower education level, as this may result in misjudging cognitive function in older adults. Additionally, the MoCA does not have specific cut-off values to identify if an individual has mild cognitive impairment or dementia. Trzepacz, Hochstetler et al. (2015) suggest the MoCA cut-off value should be lowered to 17 or 19 to identify those with mild cognitive impairment, to avoid misinterpreting impaired cognition in those whom have normal cognitive function. Participants who were unable to hold a pen and were visually impaired, were unable to complete the visuospatial/executive section of the MOCA, therefore obtaining an inaccurate and unreliable score. The MoCA may have also inaccurately identified cognition status among participants who had performance anxiety, hearing deficits, were unable to comprehend instructions due to language barriers, and/or were fatigued whilst completing the test.

4.4 Recommendations for Future Research

1) Recruiting a greater number of participants across residential care facilities in other regions in Auckland and across NZ is a recommendation for future studies. This will allow for study findings to be extrapolated to the broader NZ older residential care population.
2) Further research should focus on a more equal representation of the NZ population in regards to ethnicity. This will provide a more robust representation of the NZ older adult population.
3) Investigating the differences in nutrition status among older adults who are admitted from hospital compared to the community to identify whether the hospital setting influences nutritional status prior to admission into residential care, should be investigated in further research.
4) Future research should investigate other methods of measuring body composition in those who are bedridden or unable to stand.
5) The use of lower cut-off values when using the MoCA warrants further investigation to differentiate those with mild cognitive impairment and those with dementia, to provide a clearer indication of cognition status.
6) Given the high prevalence of nutrition risk identified in this study, future research should aim to investigate nutrition screening processes used upon admission across residential care facilities. Furthermore, investigating follow up procedures that are performed when a resident is identified as malnourished or at malnutrition risk in residential care, may determine if these residents are receiving appropriate nutrition intervention and treatment.
7) Findings from this study indicated that dysphagia, lower BMI, grip strength and gait speed and a higher use of regular medications, are significantly correlated with higher nutrition risk in older adults newly admitted into residential care. These are potential nutrition risk factors to be investigated in future studies within this population.
8) Future research should focus on investigating dysphagia screening processes in residents identified as malnourished upon admission into residential care. The association between dysphagia and malnutrition in the residential care setting among a greater sample size should also be investigated further.

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Appendices:

Appendix A: Manuscript Guidelines and Supplementary Methods

Manuscript Guidelines

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We limit the number of authors for a paper to six in most cases. Justification for a larger number can be provided at submission. Additional contributions short of authorship can be addressed briefly under Acknowledgements. The maximum number of authors for a Letter to the Editor is three.

We are concerned that superficial analyses of databases are being used merely to identify deficits in the health of vulnerable populations. The cumulative effect of these studies is stigmatising and does not benefit the population. We require that such articles generate additional analysis of the source of the deficit and/or policy recommendations for its resolution.

For qualitative papers we recommend the Guidelines developed by *Social Science and Medicine*, available from http://www.journals.elsevier.com/social-science-and-medicine/journal-policies-and-guidelines/guidelines-for-qualitative-papers/. In particular, authors need to justify sample selection and address steps taken against selectivity in the choice of quotations.

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The Abstract must be structured using the headings Objective, Methods, Results, Conclusions, Implications for Public Health. An alternative format may be considered, if authors provide good reasons.

Research Articles reporting original research or systematic reviews of a substantive field should be no longer than 5,000 words, including title, abstract, all references. This word count allows for three figures or tables (each equivalent to 500 words [half a Journal page]). Articles that do not include figures or tables have a word limit of 6,500 words. Authors wishing to include more than three figures or tables of this maximum size must justify their inclusion at the time of submission. A structured abstract must be included (see 'Abstract' for further information).

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Book:
Australian Institute of Health and Welfare. *Australia's Health 2006*. Canberra (AUST): AIHW; 2006.

Website:
Northern Territory Government of Australia [homepage on the Internet]. Darwin (AUST): Department of the Chief Minister, Office of Indigenous Policy, NT Government; 2007 June 15 [cited 2007 Nov 1]. Inquiry into the Protection of Aboriginal Children from Sexual Abuse. Available from: http://www.nt.gov.au/dcm/inquirysaac/media_release.html.

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Author Guidelines updated 26 Jan 2017

Supplementary Methods

Measurement of Calf Circumference

For participants who were unable to give an actual, estimated or self-reported height and weight measurement e.g. bed ridden patients, a calf- circumference measurement was measured due to an undetermined BMI. The MNA-SF user guide (Nestlé Nutrition Institute 2004) states that calf circumference may be used instead of BMI only when weight and height measurements are unobtainable. When measuring the calf circumference in bed bound patients, the participant was required to lie in a supine position with the left knee bent. The tape measure was then wrapped around the participant's calf at the largest diameter to obtain this measurement (Nestlé Nutrition Institute 2004).

Bioelectrical Impedance Analysis (BIA) Measures

Participants who had a pacemaker, or any internal metal devices i.e. surgical metal implants, or who were unable to stand due to frailty, were excluded from this measurement. The BIA scales were placed on a hard floor surface and in an area that was easily accessed by participants. In some cases, BIA scales were placed in a manner that participants could use their walkers or a table for support to step onto the scales. Before participants completed the BIA assessment, they were asked to remove their shoes and any metal accessories i.e. jewellery, watches, hearing aids, glasses etc. Participants were then asked to stand on the two foot pads with bare feet, with one foot placed on each pad. Body fat percentage, fat mass, lean mass and fat-free mass was then calculated through the Tanita body composition height, weight, gender and age specific equation.

Grip Strength

Participants were required to sit upright on a chair with their feet flat on the floor, shoulders adducted, wrists neutrally positioned with thumb facing upwards, elbows flexed at a 90-degree angle and their forearms rested on the arms of the chair. The handgrip dynamometer was positioned in the participant's dominant hand so that the thumb was wrapped around one side of the dynamometer, and the other four fingers on the other side. The participants were encouraged to squeeze as tightly as they were able to. For bed bound participants who were unable to sit in the chair, handgrip strength measurements were obtained with the participant lying at a 30-degree angle on their bed with their elbow supported.

Appendix B: Supplementary Results

MNA-SF Questionnaire Items

Table 3.4 provides a summary of the MNA-SF questionnaire items. Over half of participants whom were classified as malnourished reported a severe decrease in food intake (57.1%). Less than half (42.9%) of participants reported no decrease in food intake. A quarter of participants reported a weight loss of more than 3 kg (26.0%) and one third of participants did not know if they had lost weight (31.2%). Over half (54.3%) of malnourished participants were bed or chair bound and 17.1% of malnourished participants reported they go out. Over two thirds they had suffered from psychological stress/acute disease in the last three months (72.7%). Over half (54.5%) of participants reported no psychological problems, 40.0% of malnourished participants reported having severe dementia or depression compared to 21.1% of participants who were at risk of malnutrition. A higher proportion of malnourished participants had a BMI less than 19 kg/m^2 compared to those at nutrition risk (26.7% vs. 6.1%). Over three quarters (80.0%) of malnourished participants and 33.3% of participants whom were at risk of malnutrition had a calf circumference less than 31 cm.

Table 3.4: Participant MNA-SF questionnaire item scores

MNA-SF items	Total n = 77	Healthy n (%) n= 4 (5.2%)	At Risk n (%) n= 39 (50.6%)	Malnourished n (%) n= 34 (44.2%)
Food intake				
Severe decrease	24 (31.2)	0 (0)	4 (10.5)	20 (57.1)
Moderate decrease	20 (26.0)	1 (25.0)	8 (21.1)	11 (31.4)
No decrease	33 (42.9)	3 (75.0)	26 (68.4)	4 (11.4)
Weight loss				
Weight Loss >3kg	20 (26.0)	0 (0)	6 (15.8)	14 (40.0)
Does Not Know	24 (31.2)	0 (0)	9 (23.7)	15 (42.9)
1 – 3kg Weight Loss	14 (18.2)	0 (0)	9 (23.7)	5 (14.3)
No Weight Loss	19 (24.7)	4 (100)	14 (36.8)	1 (2.9)
Mobility				
Bed or chair bound	24 (31.2)	0 (0)	5 (13.2)	19 (54.3)
Able to get out of Bed but does not go out	17 (22.1)	0 (0)	7 (18.4)	10 (28.6)
Goes out	36 (46.8)	4 (100)	26 (68.4)	6 (17.1)
Psychological Stress/Acute Disease				
Yes	56 (72.7)	0 (0)	25 (65.8)	31 (88.6)
No	21 (27.3)	4 (100)	13 (34.2)	4 (11.4)
Neuropsychological Problem				
Severe Dementia Or Depression	23 (29.9)	1 (25.0)	8 (21.1)	14 (40.0)
Mild Dementia	12 (15.6)	0 (0)	8 (21.1)	4 (11.4)
No Psychological problems	42 (54.5)	3 (75.0)	22 (57.9)	17 (48.6)
Body Mass Index (BMI)				
BMI <19	10 (14.9)	0 (0)	2 (6.1)	8 (26.7)

BMI 19 to <21	10 (14.0)	0 (0)	6 (18.2)	4 (13.3)
BMI 21 to <23	9 (13.4)	1 (25.0)	6 (18.2)	2 (6.7)
BMI <23	38 (56.7)	3 (75.0)	19 (57.6)	16 (53.3)
Calf Circumference				
CC <31 cm	6 (54.5)	0 (0)	2 (33.3)	4 (80.0)
CC ≥ 31 cm	5 (45.5)	0 (0)	4 (66.7)	1 (20.0)

BMI, Body Mass Index, CC, Calf Circumference, MNA-SF, Mini Nutritional Assessment Short Form, values reported as n (%) unless otherwise indicated,

Participant Comorbidities

The most common comorbidities were classed as cardiovascular/blood disorders as shown in **Table 3.5**, prevalent in three quarters of the study population (76.6%). More men had cancer/ other neoplasms compared to women (26.5% vs. 4.7%). A quarter of participants had diabetes/impaired glucose tolerance (24.7%). Over half (59.7%) of participants experienced neurological and/or mental health conditions, with more women experiencing these conditions compared to men (62.8% vs. 55.9%). Over a quarter of the population experienced respiratory (31.2%), gastrointestinal (24.7%) and genitourinary (23.4%) disorders. Just under half of the population had musculoskeletal conditions, with a lower proportion of men experiencing these conditions compared to women (32.4% vs. 58.1%). Just under half (45.5%) of participants experienced a form of skin, sense organ and/or other disorders.

Table 3.5: Participant key comorbidities

	Total n (%)	**Men n (%)**	**Women n (%)**
Cardiovascular/blood disorders	59 (76.6)	28 (82.4)	31 (72.1)
Cancers & other neoplasms	11 (14.3)	9 (26.5)	2 (4.7)
Diabetes/ impaired glucose tolerance	19 (24.7)	6 (17.6)	13 (30.2)
Neurological and Mental Health Conditions	46 (59.7)	19 (55.9)	27 (62.8)
Respiratory disorders	24 (31.2)	7 (20.6)	17 (39.5)
Gastrointestinal	19 (24.7)	7 (20.6)	12 (27.9)
Genitourinary	18 (23.4)	9 (26.5)	9 (20.0)
Musculoskeletal	36 (46.8)	11 (32.4)	25 (58.1)
Injury	12 (15.6)	4 (11.8)	8 (18.6)
Skin, sense organ and other disorders	35 (45.5)	18 (52.9)	17 (39.5)

Values reported as n (%) unless otherwise indicated.

Appendix C: Participant Information Sheet, Consent Form, and Questionnaires (including participant characteristics, physical measures, MNA-SF, EAT-10 and the MoCA)

Appendix C.1: Participant Information Sheet

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA
UNIVERSITY OF NEW ZEALAND

Waitemata District Health Board
Best Care for Everyone

Participant Information Sheet: The Enrich Study

An investigation of nutrition risk among adults recently admitted to a residential care home.

You have been invited to participate in this study, because you have recently been admitted to a residential care home. This study is looking at the nutrition status of adults over 65 years (or over 55years for Maori and Pacific) of age in the Waitemata District Health Board region.

Study Description
The aim of this study is to gain an understanding on the nutrition status and swallowing risk of older adults. We will also look at other possible risk factors of malnutrition including body weight, cognition, muscle mass and strength. This will help in identifying people at risk.

The Research Procedure
If you agree to participate in the study, the following will occur:

1. Once you have signed the consent form, you will complete a questionnaire which includes information about your nutrition, swallowing and cognitive status.
2. Your height, weight, and muscle mass will be measured. We will then measure your strength.

This study will take approximately 60 minutes; however you may withdraw at any time.

Benefits and Risks
It is possible the interviews and measures may identify a problem. If this happens, recommendations will be made for referral to the respective department where appropriate care will be obtained. Side effects may occur although this is extremely unlikely.

Participant's Rights
You do not have to accept this invitation. If you decide to participate, you have the right to:

- Decline to answer any particular question
- Withdraw from the study at any time
- Ask any questions about the study at any time
- Be given a summary of the study findings when it is concluded

Choosing not to participate in this study will in no way affect your current or future care.

Confidentiality
Data collected will only be used for this study. Only investigators of the study will have access to personal information, which will be held securely and treated strictly confidentially. Results of this study may be published or presented at conferences or seminars; however, no individual will be able to be identified. Non-identifiable data from this study may be used in future related studies, which have been given ethical approval from the Ethics Committee. Research data will be stored for a period of ten years (as required by New Zealand law), after which it will be destroyed.

Results:
If requested, you will be offered copies of the publications that arise from this research. However, you should be aware that a significant delay may occur between completion of data collection and completion of the final report. Alternatively, or in addition, you can choose to have the results of the study discussed with you personally by the lead investigator.

Ethics Approval
This study has been reviewed and approved by the Health and Disability Ethics Committee: Northern A, Application 14/NTA/70.

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

- Stacey Senior
  Masters Dietetic student
  021 0381787 or
  stacey.king05@gmail.com
- Idah Chatindiara
  PhD student, Massey University
  02041265744 or
  I.Chatindiara@massey.ac.nz
- Carol Wham PhD, NZ Registered Dietitian
  A/Professor of Nutrition and Dietetics, Massey University,
  c.a.wham@massey.ac.nz
- Dushanka Hettige
  Masters Dietetic student
  027 4583737 or
  hettigedushanka@gmail.com
- Theresa Teresa Stanbrook
  NZRD - Professional Leader-Dietetics- Waitemata DHB
  Teresa.Stanbrook@waitematadhb.govt.nz
- Jacqui Allen FRACS MBChB FRACS ORL HNS,
  Consultant Otolaryngologist, North Shore Hospital, Takapuna
  jeallen@voiceandswallow.co.nz

Appendix C.2: Participant Consent Form

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.	Yes ☐	No ☐
I have been given sufficient time to consider whether or not to participate in this study.	Yes ☐	No ☐
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.	Yes ☐	No ☐
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.	Yes ☐	No ☐
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.	Yes ☐	No ☐
I consent to the research staff collecting and processing my information, including information about my health.	Yes ☐	No ☐
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 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.	Yes ☐	No ☐
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.	Yes ☐	No ☐
I understand the compensation provisions in case of injury during the study.	Yes ☐	No ☐

I consent to have de-identified data collected from this study used in future related studies that have been approved by the Ethics Committee.	Yes ☐	No ☐
I know who to contact if I have any questions about the study in general.	Yes ☐	No ☐
I understand my responsibilities as a study participant.	Yes ☐	No ☐
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:

Appendix C.3: Participant Questionnaire

Student Dietitian Interviewer						**Date**		
Research Assistant						**Time**		
1	**ID number:**			**2**	**NHI number**			
3	**Last name:**				**First Name**			
4	**D.O.B**	Day	Month	Year	**5**	**Age**	Years	Months
6	**Gender**	(1) Male				(2) Female		
7	**Prior setting**	(1) Community				(2) hospital		

Comments:

Demographic:

8. Which of these best describes your ethnicity?

New Zealand European	Maori	Pacific	Other (please specify):
1	2	3	4

Comments:

9. What is your current marital status?

Married/partnered	Widowed	Divorced/separated	Never married
1	2	3	4

Comments:

10. Who lives in your house/unit/apartment with you most of the time?

Living alone	Living with spouse only	Living with others
1	2	3

Comments:

11. Do you receive any income in addition to your pension?

Pension only income	Pension plus other income
1	2

Comments:

12. What is your highest level of education?

Primary	Secondary	Tertiary
1	2	3

Comments:

26. What is your dental status?

Dentate	Edentulous	Dental Appliance
1	2	3

Comments:

Health

38. Have you been told by your doctor that you have any health issues?

Yes	No
1	2

Key co-morbidities (ICD 10 code):	*Comments:*

39. Do you have any other health problems?

Yes	No
1	2

Other health problems:	*Comments:*

40. What medications, prescribed by a doctor, are you regularly taking?

	Medication:	Comment (i.e. dose, etc.)
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		
	Total Number of Prescribed Medications	

41. What over-the-counter (OTC) medications are you regularly taking?

	Medication:	Comment (i.e. dose, etc.)
1.		
2.		
3.		
4.		
5.		

6.		
7.		
8.		
9.		
10.		
	Total Number of OTC Medications	

42. What, if any, nutrition supplements e.g. Complan or vitamin and mineral supplements are you regularly taking?

	Nutrition supplement:	Comments:
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
	Total Number of supplements:	

Support Services:

43. Prior to admission, did you receive any regular subsidised support service?

Yes	No
1	2

Comments: _____

_____

44. **Do you usually need help with daily tasks like shopping, cleaning, cooking?**

Yes	**No**
1	**2**

Comments: _____

45. Have you had any dietetic input within the last year?

Yes	No
1	2

Comments: _____

_____

Appendix C.4: Physical Measures

Physical Assessment:
13. Anthropometric:

Weight (kg)			
Height (cm)		Demispan (cm)	
BMI (kg/m²)		Calf Circumference (cm)	

14. Body Composition
**** IMPORTANT – Are you fitted with a pacemaker or other internal electronic/metal medical device? Yes/No**

Lean Mass			
Fat Mass			
Fat %			
Male		**Female**	
≤ 10.75 kg/m²	> 10.75 kg/m²	≤ 6.75 kg/m²	> 6.75 kg/m²
1	2	1	2

Comments: _____

15. Maximal Grip Strength Test (MGST) – Use dominant hand

Trial 1 =	Trial 2 =	Trial 3 =	
Average Dominant Hand			
Male		**Female**	
≥ 32 kg	< 32 kg	≥ 22 kg	< 22 kg
1	2	1	2

Comments: _____

16. 2.4m Walk Test
Circle one: Used walking stick or frame? (1) Yes (2) No

Trial 1 =		Trial 2 =		Trial 3 =	
Fastest Time (seconds)					
Speed ≤ 1m/s	[0.01 + (speed)(1.052)]		Speed > 1m/s	[0.481 + (speed)(0.581)]	
<4.6m/s	0.47-0.64m/s		0.65-0.82m/s	≥0.83m/s	
1	2		3	4	

Comments: _____

17. Physical activity
How often do you engage in activities that require a low or moderate level of energy such as gardening, cleaning the car, or going for a walk?

More than once a week	Once a week	One to three times a month	Hardly ever or never	
1	2	3	4	

Comments: _____

18. Exhaustion

18a) How often in the last week did you feel that everything you did was an effort?

Rarely or none of the time (<1 day)	Some or little of the time (1 to 2 days)	Moderate amount of the time (3 to 4 days)	Most of the time 5 to 7days	
1	2	3	4	

Comments: _____

18b.) How often in the last week did you feel that you could not get going?

Rarely or none of the time (<1 day)	Some or little of the time (1 to 2 days)	Moderate amount of the time (3 to 4 days)	Most of the time 5 to 7days	
1	2	3	4	

Appendix C.5: Mini Nutritional Assessment – Short Form (MNA)

Mini Nutritional Assessment: (Nestle Nutrition Institution)

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

Severe decrease	Moderate decrease	No decrease	
0	1	2	

20. Involuntary weight loss during the last 3 months?

> 3kg	Does not know	1 - 3 kg	No weight loss	
0	1	2	3	

21. Mobility

Bed or chair bound	Able to get out of bed/chair but doesn't go out	Goes out	
0	1	2	

22. Has suffered psychological stress or acute disease in the past 3 months?

Yes	No	
0	2	

23. Neuropsychological problems

Severe dementia or depression	Mild dementia	No psychological problems	
0	1	2	

24a. Body Mass Index (BMI) _____

BMI < 19	BMI 19 - 20	BMI 21 - 22	BMI ≥ 23	
0	1	2	3	

24b. Calf circumference (CC) in cm (answer only if unable to obtain BMI)

CC < 31 cm	CC ≥ 31 cm	
0	3	

25. MNA-SF score:

Total MNA score (max. 14 points)	**Normal (12-14)**	**At risk of malnutrition (8-11)**	**Malnourished (0-7)**

26. What is your dental status?

Dentate	Edentulous	Dental Appliance
1	2	3

Comments: _____

_____

Appendix C.6: 10 item Eating Assessment Tool (EAT- 10)

27. My swallowing problem has caused me to lose weight

0 No problem	1	2	3	4 Severe problem

28. My swallowing problem interferes with my ability to go out for meals

0 No problem	1	2	3	4 Severe problem

29. Swallowing liquids takes extra effort

0 No problem	1	2	3	4 Severe problem

30. Swallowing solids takes extra effort

0 No problem	1	2	3	4 Severe problem

31. Swallowing pills takes extra effort

0 No problem	1	2	3	4 Severe problem

32. Swallowing is painful

0 No problem	1	2	3	4 Severe problem

33. The pleasure of eating is affected by my swallowing

0 No problem	1	2	3	4 Severe problem

34. When I swallow food sticks in my throat

0 No problem	1	2	3	4 Severe problem

35. I cough when I eat

0 No problem	1	2	3	4 Severe problem

36. Swallowing is stressful

0 No problem	1	2	3	4 Severe problem

37. Total EAT-10 Score

Total EAT-10 Score (max. 40 points)	
Not at risk (<3)	**At risk of swallowing efficiently and safely (≥ 3)**
1	2

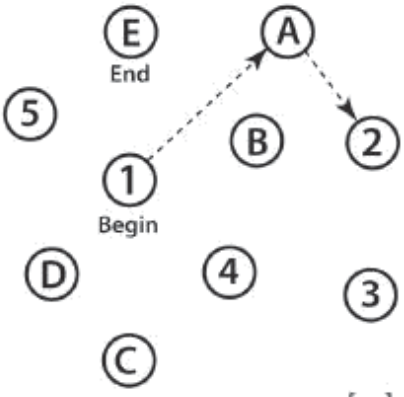
Appendix C.7: Montreal Cognitive Assessment (MOCA)

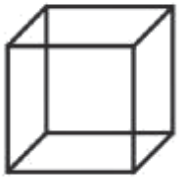
NAME :

MONTREAL COGNITIVE ASSESSMENT (MOCA) Education : Date of birth :

Version 7.1 Original Version Sex : DATE :

VISUOSPATIAL / EXECUTIVE





Copy cube

[ ] [ ]

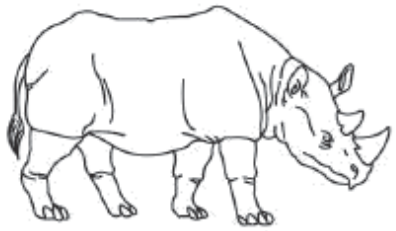
Draw CLOCK (Ten past eleven) (3 points)

[ ] Contour [ ] Numbers [ ] Hands

POINTS ___/5

NAMING

[ ]



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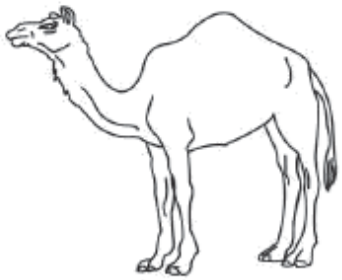

[ ] ___/3

MEMORY Read list of words, subject must repeat them. Do 2 trials, even if 1st trial is successful. Do a recall after 5 minutes.

	FACE	VELVET	CHURCH	DAISY	RED
1st trial					
2nd trial					

No points

ATTENTION Read list of digits (1 digit/ sec.).

Subject has to repeat them in the forward order [ ] 2 1 8 5 4

Subject has to repeat them in the backward order [ ] 7 4 2 ___/2

Read list of letters. The subject must tap with his hand at each letter A. No points if ≥ 2 errors

[ ] F B A C M N A A J K L B A F A K D E A A A J A M O F A A B ___/1

Serial 7 subtraction starting at 100 [ ] 93 [ ] 86 [ ] 79 [ ] 72 [ ] 65

4 or 5 correct subtractions: **3 pts**, 2 or 3 correct: **2 pts**, 1 correct: **1 pt**, 0 correct: **0 pt** ___/3

LANGUAGE Repeat : I only know that John is the one to help today. [ ]

The cat always hid under the couch when dogs were in the room. [ ] ___/2

Fluency / Name maximum number of words in one minute that begin with the letter F [ ] _____ (N ≥ 11 words) ___/1

ABSTRACTION Similarity between e.g. banana - orange = fruit [ ] train – bicycle [ ] watch - ruler ___/2

DELAYED RECALL

	Has to recall words WITH NO CUE	FACE [ ]	VELVET [ ]	CHURCH [ ]	DAISY [ ]	RED [ ]	Points for UNCUED recall only
Optional	Category cue						
	Multiple choice cue						

___/5

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

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Normal ≥ 26 / 30

TOTAL ___/30

Add 1 point if ≤ 12 yr edu

Administered by: _____