Nutrition risk in age-related residential care: prevalence and associated factors in adults of advanced age

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Abstract

Background: The New Zealand population is rapidly ageing. Adults of advanced age (≥85 years) are one of the fastest growing population groups with numbers expected to double by 2036. Increasing longevity is associated with reduced mobility, health loss, cognitive decline, and nutritional vulnerability. This often results in increased care requirements and movement into age-related residential care (ARRC). Overseas research indicates an increased prevalence of malnutrition in ARRC residents. Malnutrition in older adults is associated with increased morbidity and mortality, and consequently increased cost of health care. This study aims to establish the prevalence of nutrition risk and associated factors among adults of advanced age recently admitted to ARRC within the Waitemata District Health Board (WDHB) region of Auckland, New Zealand.

Methods:

A total of 97 participants aged ≥85 years were recruited within five days of admission to WDHB ARRC facilities. Sociodemographic and health characteristics of participants were determined during a single 60-minute interview. Standardised measures were used to measure body composition, grip strength and gait speed. Nutrition risk was assessed using the Mini Nutritional Assessment-Short Form (MNA-SF), dysphagia risk using the 10-Item Eating Assessment Tool (EAT-10) and cognitive status using the Montreal Cognitive Assessment (MoCA).

Results:

Of the 97 participants (mean age 90.9 ± 3.8 years), half (50.5%) were malnourished, 40.2% at nutrition risk and a third (37.1%) were at dysphagia risk. Malnourished participants were more likely to be ≥90 years ($p = 0.019$), admitted to ARRC on a permanent basis ($p = 0.016$), at dysphagia risk ($p = 0.015$), have a BMI <23 ($p = 0.022$), lower fat mass ($p = 0.005$), and fewer comorbidities ($p = 0.030$). The MNA-SF score was inversely correlated with age ($r = -0.225$, $p = 0.027$) and positively correlated with BMI ($r = 0.499$, $p = <0.001$) and fat mass ($r = 0.765$, $p = <0.001$).

Conclusion:

A high prevalence of malnutrition and dysphagia risk was discovered within this study population. Residents aged ≥90 years with low BMI are at greatest nutrition risk and are an easily identifiable group. Early screening and intervention is recommended upon admission to ARRC.

Key words: Aged, anthropometric measures, deglutition disorders, malnutrition, mini nutritional assessment, rest home

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Dedication

This work is dedicated to the memory of my beautiful Nana, Noeline King (1938 – 2017), whose strength and determination inspired me to meet challenges head on and come out the other side still smiling.

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Abbreviations

ARRC	Age-related Residential Care
BIA	Bioelectrical Impedance Analysis
BMI	Body Mass Index
Cm	Centimetre
COPD	Chronic Obstructive Pulmonary Disorder
DHB	District Health Board
EAT-10	10-Item Eating Assessment Tool
ESPEN	European Society for Parenteral and Enteral Nutrition
HDEC	Health and Disability Ethics Committee
Kg	Kilogram
LILACS NZ	Life and Living in Advanced Age: A Cohort Study in New Zealand
m	Metre
MCI	Mild Cognitive Impairment
MMSE	Mini Mental State Examination
MNA	Mini Nutritional Assessment
MNA-SF	Mini Nutritional Assessment-Short Form
MoCA	Montreal Cognitive Assessment
MST	Malnutrition Screening Tool
MUST	Malnutrition Universal Screening Tool
NZANS 2008/09	New Zealand Adult Nutrition Survey 2008/09
SD	Standard Deviation
SGA	Subjective Global Assessment
WDHB	Waitemata District Health Board
WHO	World Health Organisation
y	Years

Chapter 1: Introduction

1.1 Background

The population of New Zealand is progressively ageing as a result of declining fertility and increasing life expectancy (Cornwall and Davey 2004). In New Zealand, older adults are considered those aged ≥65 years. This age group currently comprises ~14% of the New Zealand population, but is expected to grow to 22% by 2034 (Office for Senior Citizens 2015). Similarly, the population of adults of advanced age (≥85 years) contributed to 1.7% of the New Zealand population in 2013, but is expected to comprise 3.6% of the population by the year 2036 (Environmental Health Indicators New Zealand 2017). The speed with which the population of older New Zealanders is growing highlights the importance of ensuring the maintenance of health and wellbeing during the latter years of life. Good health allows older adults to enjoy a high quality of life, however the increased risk of health problems and disability associated with increasing age can jeopardize this resulting in the need for a higher level of care. Age-related residential care (ARRC) facilities play an integral role in the care of dependent older adults during the latter years of life. Currently, over 31,000 older adults live within ARRC facilities in New Zealand (Office for Senior Citizens 2015). As the population of older New Zealanders continues to grow, so too may the need for older adults who lose their independence to require an increased level of care, consequently increasing the demand for health services and ARRC support.

Ageing is associated with diminished physiological, functional, and metabolic processes. Changes in body composition occur with advancing age to favour the deposition of body fat and the progressive decline of lean muscle mass (Chen, Bai et al. 2007). Lower levels of muscle mass result in reduced muscular strength, which has the capacity to impair physical activity and functionality in the older adult, thereby increasing the risk of disease and disability (Drewnowski and Evans 2001, Landi, Onder et al. 2014, Legrand, Vaes et al.

2014). The prevalence of chronic illness increases with age and is the principal cause of health loss and mortality in older adults (Ministry of Health 2016). Similarly, neurodegenerative processes associated with ageing may lead to cognitive decline or dementia, ultimately reducing an individual's autonomy and independence (World Health Organization 2016). Finally, health loss, disability and impaired functionality in combination with changes in social or living situations can lead to older adults becoming isolated, putting this population at an increased risk of developing depression (Drewnowski and Evans 2001).

The health loss associated with ageing leads older adults to require more support from health services than younger people, a phenomenon that combined with the ageing population places increasing pressure on the health care sector (Ministry of Health 2002, Office for Senior Citizens 2015). To combat this the New Zealand government has introduced two key policies: the Positive Ageing Strategy (2001) and the Healthy Ageing Strategy (2016) (Dalziel 2001, Ministry of Health 2016). The vision of these policies is to reduce the burden of age-related health problems and enable older adults to continue living independently within their own homes with sufficient support to encourage good health and quality of life throughout the latter years of life.

The nutritional state of older adults is positively associated with health outcomes and quality of life (Gaskill, Black et al. 2008). Changes in body composition as a result of ageing may affect the nutrient requirements of older adults. Lower levels of lean muscle mass reduce the basal metabolic rate of older adults leading to reduced energy requirements with age (Borden, Conner et al. 2012). Reduced energy requirements in combination with the impaired digestive and metabolic efficiency associated with ageing can compromise the adequacy of nutrient intake for healthy ageing (Drewnowski and Evans 2001). Inadequate energy intake may place older adults at increased nutrition risk, which if not addressed may result in malnutrition.

Malnutrition is defined as chronic under-nutrition as a result of inadequate energy and/or protein intake that results in significant weight loss and muscle wasting (Nieuwenhuizen, Weenen et al. 2010). Malnutrition poses a significant

threat to the health and wellbeing of older adults. Malnutrition is associated with increased risk of morbidity and mortality, resulting in an increased rate of hospitalisation and cost of health care (Allard, Aghdassi et al. 2004, Merrell, Philpin et al. 2012). Factors associated with increased nutrition risk include loss of a spouse, social isolation, chronic illness, polypharmacy, impaired dentition, dysphagia, and cognitive impairment (Sheiham, Steele et al. 2001, Jyrkkä, Enlund et al. 2011, O'Sullivan and Ashton 2012, Donini, Scardella et al. 2013, Wham, Teh et al. 2015, Wakabayashi and Matsushima 2016). Many of these factors are experienced with advancing age, demonstrating the importance of identifying older adults at increased nutritional risk in the community.

Validated screening tools measure the incidence of factors or behaviours associated with nutrition risk. The mini nutritional assessment-short form (MNA-SF) specifically developed for older populations, investigates decline in food intake, weight loss, mobility, psychological stress/acute illness, neuropsychological problems, and weight status to identify nutrition risk (Rubenstein, Harker et al. 2001). The MNA-SF has been validated for use within the ARRC setting and has been touted as the screening tool of choice for detecting malnutrition in older adults by the European Society for Parenteral and Enteral Nutrition (ESPEN) (Rubenstein, Harker et al. 2001).

In summary, older adults are exposed to many social and health factors that predispose the development of nutrition risk and explain the high prevalence of malnutrition within this population, particularly within an ARRC facility. Additionally, the biological effects of ageing in combination with the rapidly ageing population of New Zealand will continue to place increasing demand on the health care sector. Identifying the prevalence of nutrition risk and associated risk factors specific to the New Zealand population of older adults upon admission to an ARRC facility is important to determine future strategies for supporting healthy ageing in the community. Targeting those at risk may help support Ageing in Place.

The purpose of this study was to determine the prevalence of nutrition risk and dysphagia among older adults recently admitted to ARRC facilities in the

Waitemata DHB of New Zealand. This study also investigated the relationship between nutrition risk and associated sociodemographic, anthropometric, and health risk factors relevant for the population of older adults. The results of this study will provide an understanding of the prevalence of nutrition risk in older adults upon admission to ARRC. This data can then be used to support community-based initiatives to encourage Healthy Ageing and Ageing in Place. Routine malnutrition screening for all older New Zealanders upon admission to ARRC facilities is an important first step. A follow up nutrition care plan can then be implemented to improve nutrition status.

1.2 Aim and Objectives

1.2.1 Aim

The aim of this study was to establish the prevalence of nutrition risk and associated sociodemographic, anthropometric, and health factors among adults of advanced age (aged ≥85 years) that have recently been admitted to age-related residential care facilities within the Waitemata DHB area.

1.2.2 Objectives

1. To determine the prevalence of nutrition risk using the Mini Nutritional Assessment-Short Form (MNA-SF).
2. To determine the prevalence of dysphagia risk using the Eating Assessment Tool -10 (EAT-10).
3. To assess the anthropometric measures body composition and muscle mass using bioelectrical impedance analysis (BIA) scales.
4. To assess muscular strength using a handgrip dynamometer and gait speed using a 2.4m self-paced walk test.
5. To determine social and health factors associated with nutrition risk.

1.3 Thesis Structure

This thesis is structured into four chapters. Chapter one has presented an introduction and background to the significance of determining nutrition risk in advanced aged residents of ARRC facilities. Chapter two reviews the current literature on malnutrition and associated risk factors in older adults, particularly those within ARRC. Chapter three contains the research manuscript, prepared according to manuscript requirements of the Nutrition and Dietetics Journal (see **Appendix A**), detailing the methodology, results and discussion of the findings of this study. Chapter four concludes this thesis with a summary of the study and recommendations for further research.

1.4 Researchers' Contribution

Table 1.1 Research team and areas of contribution

Contributors	Research Contribution
Stacey Senior	Principal researcher – Thesis author Recruited and interviewed participants, data input and analysis, interpretation of results, authored thesis manuscript
Dushanka Hettige	Associate researcher Provided assistance with recruitment, data collection and data input
Idah Chatindiara	Associate researcher Provided assistance with recruitment and data collection
A/Prof Carol Wham	Academic supervisor – Study designer Provided assistance with thesis structure, interpretation of results, revision of final draft and approval of final thesis manuscript
Dr Marilize Richter	Academic co-supervisor Provided assistance with statistical analysis, interpretation of results, revision of final thesis draft
Dr Jacqueline Allen	Professional supervisor – Study designer and ethics application Provided assistance with recruitment of Waitemata DHB ARRC facilities
PC Tong	Provided equipment training prior to data collection

Chapter 2: Literature Review

2.1 Ageing in New Zealand

New Zealand, like many developed countries, is experiencing population ageing, characterised by declining fertility and increasing life expectancy (Cornwall and Davey 2004). Older adults aged ≥65 years currently make up ~14% of the New Zealand population, with this number projected to increase to 22% by 2034 (Office for Senior Citizens 2015). Additionally, adults of advanced age (≥85 years) made up 1.7% of the New Zealand population in 2013, and are expected to make up 3.6% of the population by 2036 (Environmental Health Indicators New Zealand 2017). These statistics demonstrate the rapid growth of the population of older adults, showcasing them as one of the fastest growing population groups within New Zealand.

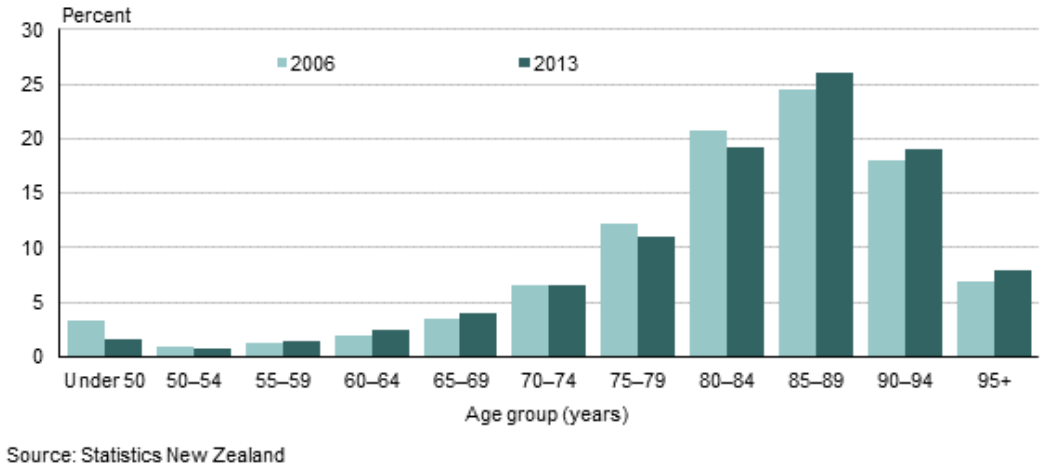
The ethnic composition of older New Zealanders is also rapidly changing (Ministry of Health 2016). Between 2016 and 2026 the population of older Maori adults is anticipated to increase by 79%, older Pacific adults by 63%, and older Asian adults by 125% (Ministry of Health 2016). Increased ethnic diversity requires an increased cultural awareness and consideration of how older New Zealanders experience ageing on an individual level to provide culturally appropriate personalised care for the older adult.

How people experience ageing is only partially related to chronological age, with greater influence attributed to genetic factors, upbringing, lifestyle choices, and the local environment (Ministry of Health 2016). These factors contribute to the heterogeneity of older adults as a population. When in good health older adults can enjoy a high quality of life, however, increasing age is associated with increased risk of health problems and disability. Supporting older adults living with chronic health conditions encourages participation in society and increases feelings of self-worth, promoting health and wellbeing in old age (Ministry of Health 2016). This concept is known as ‘Healthy Ageing’ and is

defined by the Ministry of Health as the action of enhancing and preserving functional capacity in older people to facilitate health and wellbeing (Ministry of Health 2016). Healthy ageing is not simply focused on the prevention of disease and disability, but includes values integral to ‘Ageing in Place’ - enabling the continuation of independent living in a safe and healthy environment during the latter years of life (Dalziel 2001). As the population of older New Zealanders continues to grow, the concept of Healthy Ageing is set to become an ever-significant part in creating sustainable health care.

While some older adults are able to maintain both physical and mental capacity as well as an independent lifestyle well into the latter years of life, others may experience diminished health and progressive disability resulting in loss of independence and the need for a higher level of care. Over 31,000 older adults currently live in age-related residential care (ARRC) facilities within New Zealand, an increase of more than 14% since 2006 (Statistics New Zealand 2013, Office for Senior Citizens 2015). The majority of older adults living in ARRC are aged ≥80 years, with the largest proportion of residents within the 85-89 year age group (Figure 2.1.) (Statistics New Zealand 2013). Over 60% of older New Zealanders in ARRC are widowed, reflecting the impact that loss of a spouse with advancing age has on the maintenance of independence during old age (Statistics New Zealand 2013). Additionally, over 92% of ARRC residents within New Zealand identify as European ethnicity, with much smaller numbers of Maori, Pacific, and Asian ethnicities (Statistics New Zealand 2013). This lack of cultural diversity in the ARRC population may reflect cultural differences in attitudes regarding care of the elderly, with collectivist cultures such as Maori, Pacific and Asian ethnicities more likely to care for their elderly within the family home.

Figure 2.1 Age group of people in residential care for older people – 2006 and 2013 Censuses (Statistics New Zealand 2013)



Source: Statistics New Zealand

Residents of ARRC experience different health conditions, care requirements, and rates of mortality than adults of a similar age who continue to live independently within the community (Stow 2016). A New Zealand study of short-term mortality rates in residents of ARRC emphasizes this increased mortality, with as many as 12.6% of residents dying within the first six months of admission (Connolly, Broad et al. 2014). In combination with the rapidly ageing population of New Zealand, this highlights the increasingly integral role of ARRC facilities in supporting the health and wellbeing of older New Zealanders.

2.2 Changes in Body Composition and Functionality with Ageing

The ageing process is associated with significant changes in the composition of the body, specifically, a decrease in muscle mass and increase in fat mass (Chen, Bai et al. 2007). This age-related loss of muscle is known as sarcopenia. Sarcopenia results from a combination of factors including reduced physical activity, protein and/or vitamin D deficiency, impaired protein metabolism, hormonal changes with ageing, and genetic predisposition (Brownie 2006, Thomas 2007). The rate of muscle loss associated with ageing is reported to be 1-2% per year after the age of 50, with approximately 30% of muscle mass lost

between the ages of 20-80 years of age (Frontera, Hughes et al. 2000, Hughes, Frontera et al. 2002). Lower levels of muscle mass are associated with reduced muscle strength, however, it is unclear if reduced muscle strength is the cause or result of low levels of muscle mass (Drewnowski and Evans 2001, Landi, Onder et al. 2014).

Muscle strength is an integral component in the maintenance of physical function, mobility and independence during old age (Goodpaster, Park et al. 2006). Muscular strength has been suggested to decline at a faster rate with ageing than muscle mass, highlighting the importance of muscle quality over mass (Delmonico, Harris et al. 2009). In older adults, loss of muscular strength may present gradually as daily tasks become harder until performance is impaired to the point where execution of the task is no longer possible (Hughes, Frontera et al. 2001). Impaired muscle strength affecting physical performance is also associated with increased health risk in older adults. A study in Belgium investigating this phenomenon in older adults aged ≥80 years found that those with lower levels of muscle strength were at an increased risk of hospitalisation and mortality (Legrand, Vaes et al. 2014). Measures of muscular strength in older adults may, therefore, identify older adults at increased health risk who may benefit from targeted intervention or additional support.

Declining muscle mass and strength with advancing age has a significant effect on the functional capacity of older adults. Balance, postural control, mobility, stability, and endurance are all factors associated with muscle mass and strength, and directly influence the functional capacity of older adults (Lusardi, Pellecchia et al. 2003). Impaired functionality increases the likelihood of falls in older adults, often resulting in hospitalisation, disability, frailty and increased dependency. Functional capacity declines progressively with increasing age, with adults of advanced age exhibiting significantly lower levels of functional capacity than their younger peers (Smee, Anson et al. 2012). The maintenance of muscle mass and strength is therefore an important factor in the continued functionality of older adults, particularly in adults of advanced age, to support healthy ageing and Ageing in Place.

2.3 Frailty in Older Adults

Changes in muscle mass, strength and function may contribute to the development of frailty in older adults. Frailty is a medical condition in which a combination of factors including reduced strength, impaired functional capacity, and fatigue increase the vulnerability of the older adult, leading to poor recovery after a stressor event (Clegg, Young et al. 2013, Morley, von Haehling et al. 2014). The five key phenotypes of frailty include recent weight loss, frequent exhaustion, physical inactivity, slow gait speed, and weak muscular strength (Clegg, Young et al. 2013). The presence of three or more of the above phenotypes confirms the presence of frailty within older adults (Fried, Tangen et al. 2001). Frailty is associated with serious health consequences that can significantly impair quality of life and threaten independence. Older adults who are frail have an increased risk of falls, disability, hospitalisation, institutionalisation and mortality (Fried, Tangen et al. 2001, Clegg, Young et al. 2013). Alarmingly, frailty is highly prevalent within the population of older adults. A study to investigate the prevalence of frailty in independent-living older adults aged ≥65 years in the United States discovered that 15% of older adults were frail, and a further 45% discovered to be pre-frail, with the rate of frailty increasing with age and dependency (Bandeen-Roche, Seplaki et al. 2015). These findings are supported by a study of frailty within nursing home residents in Albacete, Spain. Higher rates of frailty were discovered within this population with almost 70% of residents characterised as frail and a further 28% pre-frail (González-Vaca, de la Rica-Escuín et al. 2014). These results highlight the significant prevalence of frailty within all older adults, but especially within residents of ARRC, thus emphasising the vulnerability of this population.

2.4 Health Loss of Older Adults

2.4.1 Loss of Sensory Function

Ageing is associated with the deterioration of the sensory organs affecting taste, smell, vision and hearing. Of these, hearing and vision are the most commonly recognised sensory losses with age. The prevalence of both hearing and vision disabilities increase with advancing age. In New Zealand, hearing disabilities affect 12.6% of women and 22.3% of men aged 65-74 years, and 24.1% of women and 35.1% of men aged ≥75 years (Ministry of Health 2007). Similarly, vision disabilities affect 4.5% of women and 4.0% of men aged 65-74 years, and 14.0% of women and 9.9% of men aged ≥75 years (Ministry of Health 2007). Although all of the sensory losses associated with ageing have the capacity to influence quality of life in older adults, vision and hearing disabilities pose the greatest risk to health and safety. An American study to investigate the implications for health and functionality of older adults (aged ≥70 years) with vision and hearing disabilities discovered that these sensory losses increase the incidence of comorbidities, falls and activity limitations in older adults (Crews and Campbell 2004). These findings may translate to impaired functional capacity and increased dependence, leading older adults to require a higher level of care. Vision and hearing loss, therefore, can have a profound affect on the health of older adults, increasing the risk of health loss and cost of health care associated with ageing.

2.4.2 Chronic Illness

Within New Zealand, the major causes of health loss in older adults are coronary heart disease, dementia, stroke, chronic obstructive pulmonary disorder (COPD), age-related hearing loss, diabetes, colorectal cancer, lung cancer, and injuries resulting from falls (Ministry of Health 2016). Chronic illness is also the principal cause of death in older New Zealanders, particularly ischaemic heart disease, stroke and COPD (Ministry of Health 2007). Similar patterns of health loss and mortality are reflected globally with chronic illnesses contributing to 70% of all deaths, 80% of which are due to cardiovascular diseases, cancer, respiratory diseases and diabetes (World Health Organization

2017). The increasing global prevalence of health loss and mortality attributed to chronic illness reflects the unhealthy lifestyles prevalent in modern society in combination with and ageing population, resulting in a significant barrier to the maintenance of healthy ageing.

Chronic illnesses affect a greater proportion of older adults with advancing age (Ministry of Health 2007). Data on the New Zealand population of older adults suggest that while 30% of adults aged 50-64 years have no chronic illness, only 12% of adults aged 75-84 years experience this same level of health (Ministry of Health 2007). Additionally, the number of chronic illnesses experienced by older adults increases with age, with those aged >75 years three to four times more likely to experience ≥4 chronic illnesses than those aged 50-64 years (Ministry of Health 2007). The causes of health loss also differ between age groups of older adults. Older adults aged 65-74 years experience a greater prevalence of high cholesterol, whereas those aged 75-84 years are more likely to experience hypertension (Ministry of Health 2007). Bone and joint conditions such as arthritis and osteoporosis are twice as common in adults aged ≥65 years than their younger counterparts, and the rate of prevalence and mortality for all cancers increases significantly with age (Ministry of Health 2007). These trends emphasize the biological impact that ageing has on the body and highlight the increased rate of health decline that is commonly experienced during the later years of life.

2.4.3 Depression

Loss of health, mobility and functionality can lead to older adults becoming isolated and experiencing higher rates of loneliness and depression (Drewnowski and Evans 2001). Because of these factors, depression is common in old age and is especially prevalent in older adults living within ARRC (Smoliner, Norman et al. 2009). A Dutch study of 350 residents within ARRC (aged 94 years ± 8.3) investigated the prevalence and risk factors for depression within this population. A high prevalence was discovered with 46.2%

of residents affected by depression, suggesting the rate of depression may be three to four times higher in older adults within ARRC than elderly living within the community (Jongenelis, Pot et al. 2004). Furthermore, the suffering associated with depression can lead to impaired perception of health, increased use of health care services, and ultimately, increased health care costs (World Health Organization 2016). These factors highlight the importance of assessing the mental health of older adults, particularly those within ARRC, to ensure that depressive symptoms are identified and managed effectively to promote the health and wellbeing of the older adult.

2.4.4 Dementia

Neurological changes in the structure and function of the brain occur with ageing and can result in impaired cognitive function and the development of dementia. Dementia is characterised by memory loss and changes in thought patterns and behaviour which eventually impair activities of daily living and result in the need for a higher level of care to maintain the health and safety of the older adult (World Health Organization 2016). Dementia poses a significant health issue within the population of older adults worldwide. Although not considered part of the normal ageing process dementia is positively associated with advancing age, with the incidence of dementia suggested to double every five years from the age of 65 (Corrada, Brookmeyer et al. 2010). Dementia currently affects 50,000 New Zealanders, however, population ageing indicates that this number is expected to increase to 78,000 by 2026 (Ministry of Health 2014). Aside from age, factors which have been associated with an increased risk of dementia include family history, female gender, low level of education, low body weight in later life, and vascular conditions such as hypertension, hyperlipidaemia and diabetes (Doruk, Naharci et al. 2010).

2.4.5 Cost of Health Loss of Older Adults in New Zealand

Although older adults make up only 15% of the New Zealand population, they utilise approximately 42% of all health care services, and this figure is expected to reach 50% within the next ten years (Ministry of Health 2016). Over recent years DHB expenditure on health services for older adults has increased more than any other area, with the majority of this spending going into ARRC facilities (Ministry of Health 2016). These figures demonstrate the burden that health loss creates not only within the life of the older adult, but also within the broader health and financial sectors of government. The implications of this health burden may lead to an inequitable distribution of the health care budget resulting in other health services missing out, or conversely, the inability of the government to continue to support the health of older adults at the same level as the population ages and health care needs of older adults continue to increase. Both of these scenarios highlight the dire consequences of health loss on population ageing without preventative intervention to improve the health of older adults at an earlier stage.

2.5 Nutrition for Healthy Ageing

Maintaining optimal nutrition during the latter years of life is important to promote the health and wellbeing of older adults (Donini, Scardella et al. 2013, Suominen, Jyvakorpi et al. 2014). A French study of community living adults aged ≥65 years investigated the relationship between diet and mortality. After a 10-year follow up period this study discovered a lower mortality rate among older adults who ate a diverse diet rich in fruit, vegetables and fish (Letois, Mura et al. 2016). This highlights the importance of dietary quality and diversity on improving the survival rates of older adults.

Despite this, processes associated with ageing may reduce an older adults' ability to consume a diverse and healthful diet. In general, older adults eat smaller meals more slowly, which can lead to reduced energy intake (Ministry of Health 2013). The physiological changes associated with ageing also affect the digestive system, resulting in decreased stomach capacity, impaired nutrient

absorption and decreased gut motility (Brownie 2006, Ministry of Health 2013). Additionally, age-related changes in sensory organs can affect the visual and aromatic appeal of foods (Ministry of Health 2013). These physiological effects of ageing lead to an impaired appetite and reduced food intake, a phenomenon known as ‘anorexia of ageing’ (Ministry of Health 2013).

Food and nutrition guidelines have been developed to encourage healthy ageing in older New Zealanders. Key themes within these guidelines focus on the importance of weight maintenance and daily exercise, eating a diverse diet rich in fruits, vegetables, wholegrain cereals, lean proteins and dairy products, and encouraging social interaction during meal times (Ministry of Health 2013). For older adults who experience an impaired appetite affecting food intake, the addition of energy and protein rich snacks between meals is recommended to achieve a healthy weight (Ministry of Health 2013). These guidelines differ from the Eating and Activity Guidelines for New Zealand Adults (Ministry of Health 2015) as they acknowledge the broader social aspects associated with optimal nutrition for healthy ageing, such as promoting regular meals throughout the day and the importance of eating with other people.

2.5.1 Changes in Energy and Nutrient Requirements with Ageing

The physiological and body composition changes associated with ageing significantly influence the macro- and micronutrient requirements of older adults.

Energy

Energy requirements decline with age due to a reduction in basal metabolic rate as a result of decreased lean body mass and physical inactivity (Borden, Conner et al. 2012). Although reduced, it is important that energy requirements are met to maintain the physiologic and metabolic processes of the body, support tissue synthesis for repair, and prevent the development of negative energy balance and malnutrition (University of Otago and Ministry of Health

2011, Borden, Conner et al. 2012). Research indicates however, that many older adults have difficulty meeting daily energy requirements. An American study reviewed existing cohort and cross-sectional data about nutritional habits of older adults to investigate how diet changes with age. This review concludes that between the ages of 25-70 years energy intake is reduced by up to 1200kcal/day for men and 800kcal/day for women (Wakimoto and Block 2001). Furthermore, 10% of men and women aged 80 years were found to have an energy intake of less than 890kcal/day and 750kcal/day respectively (Wakimoto and Block 2001). Similar findings are reflected within the New Zealand population. Analysis of the New Zealand Adult Nutrition Survey 2008/09 indicates a reduction of energy intake between adults aged 19-71+ years of 950kcal/day for men and 580kcal/day for women (University of Otago and Ministry of Health 2011). In addition, the Life and Living in Advanced Age: A cohort study in New Zealand (LILACS NZ) discovered a mean energy intake in octogenarians of 1890kcal/day for men and 1500kcal/day for women (Wham, Teh et al. 2016).Comparison of this data with the average energy requirements for older adults of 2000kcal/day for men and 1830kcal/day for women suggests that older New Zealanders may not be meeting the necessary energy requirements for weight maintenance and therefore may be at increased nutrition risk (National Health and Medical Research Council and Ministry of Health 2006).

Reduced energy intake can also affect the quality of the diet as a whole, and influence the intake of other nutrients important for healthy ageing such as protein and micronutrients (Drewnowski and Evans 2001, Brownie 2006).

Protein

Protein is a nutrient of great importance for the nutritional adequacy of older adults. Consuming inadequate amounts of protein has been related to impaired immune function, slow rate of healing, and increased rate of muscle loss in older adults (Ministry of Health 2013, Paddon-Jones and Leidy 2014). Alterations in protein utilisation associated with ageing means that even when

the same amount of protein is consumed, older adults are unable to produce the same amount of muscle mass as younger adults (Suominen, Jyvakorpi et al. 2014). This highlights the need for increased protein requirements with age.

Increasing protein requirements by 25% for adults aged ≥70 years has been proven to provide additional health benefits to the older adult (Paddon-Jones and Leidy 2014). As a result, current protein recommendations for older adults stand at 1-1.2g/kg of bodyweight for the general older population, but may be as high as 2g/kg for older adults experiencing serious illness, injury or malnutrition (Ministry of Health 2013, Suominen, Jyvakorpi et al. 2014).

Although protein requirements increase with age, protein intake is frequently reduced in older adults due to a combination of mechanical and metabolic changes to eating and digestion (Paddon-Jones, Short et al. 2008). This concept is reflected in data from the NZANS 2008/09. Analysis of this survey discovered that adults aged >65 years had lower protein intakes than their younger peers, with older women and men consuming 11g and 25g less protein per day respectively (Ministry of Health 2013). Similar findings have been reported by the LILACS NZ study, which discovered protein intake in New Zealand octogenarians of 0.98g/kg and 0.91g/kg for men and women respectively (Wham, Teh et al. 2016). Collectively, these findings highlight the increased nutritional vulnerability of older adults when it comes to protein intake.

Micronutrients

Adequate intake of micronutrients such as calcium, vitamin D, iron and zinc, is especially important for older adults to maintain good health and functional capacity.

Reduced digestive and metabolic efficiency as a result of ageing means that older adults have increased requirements for the micronutrients that are affected by these changes (Drewnowski and Evans 2001). Requirements for calcium, a micronutrient essential for supporting bone health, increase with age

due a reduction in the amount of dietary calcium able to be absorbed by the body and the increased risk of fractures with falls during older age (Borden, Conner et al. 2012). Despite this, results of the LILACS NZ study indicate a high proportion of older adults (aged 80-90 years) aren't meeting the nutrient reference values for calcium (Wham, Teh et al. 2016). This trend is especially apparent within the older Maori population, where more than 93% of women and over 91% of men aren't meeting calcium requirements (Wham, Teh et al. 2016). These findings suggest that many older New Zealanders may be at an increased risk of fractures and poor bone health due to inadequate calcium intake.

Micronutrient sufficiency during old age can also be affected by changes in dietary habits. Iron is a vital nutrient for energy and immunity in older adults, with inadequate intake associated with an increased risk of iron deficiency anaemia which in turn increases the risk of frailty, falls, and cognitive impairment (Borden, Conner et al. 2012). Although iron requirements do not increase with age, New Zealanders aged >71 years have been found to have lower iron intake when compared to the rest of the population (University of Otago and Ministry of Health 2011). This may be due to reduced intake or avoidance of meat, which although a rich source of iron, can be fibrous and difficult for older adults to safely chew with missing teeth or dentures. Similarly, zinc requirements do not increase with age although zinc is known to have an important role in immunity and wound healing. The NZANS 2008/09 demonstrates a low intake of zinc within adults aged >71 years when compared to all other age groups (University of Otago and Ministry of Health 2011). Additionally, 90% of men aged >71 years consume less than the recommended daily intake of zinc (University of Otago and Ministry of Health 2011). Again, these findings may be attributed to a reduced intake or avoidance of zinc rich foods such as meat, nuts and whole-grains due to masticatory difficulties.

Finally, changes in lifestyle factors can also affect micronutrient sufficiency. Lower levels of Vitamin D, an important nutrient with roles in bone health and muscle function, are common in older adults particularly those in ARRC, those with limited mobility, and those with darker skin tones (Ministry of Health 2013).

The synthesis of Vitamin D within the skin during sun exposure slows with ageing, therefore lifestyle changes that limit sunlight exposure increase the risk of older adults developing vitamin D deficiency (Ministry of Health 2013, Suominen, Jyvakorpi et al. 2014). More than one third of New Zealanders aged ≥75 years have insufficient levels of vitamin D (Ministry of Health 2013). As a result regular vitamin D supplementation is common within this population (Ministry of Health 2013).

These findings demonstrate the great impact that the ageing process has on the nutritional adequacy of the older adult's diet and the increased risk of health implications that may result.

2.6 Malnutrition in Older Adults

In contrast to other age groups, under-nutrition rather than over-nutrition is a key concern in older adults (Leslie, Lean et al. 2006). Malnutrition is defined as chronic under-nutrition due to an insufficient intake of energy and/or protein resulting in significant weight loss and muscle wasting (Nieuwenhuizen, Weenen et al. 2010, López-Contreras, Torralba et al. 2012). In older adults, malnutrition is associated with an increased rate of hospitalisation, increased cost of health care, and increased risk of morbidity and mortality (Allard, Aghdassi et al. 2004, Merrell, Philpin et al. 2012). These consequences demonstrate the significant threat that malnutrition poses to the health and wellbeing of older adults, as well as being a substantial obstacle to the public health concept of Ageing in Place.

Malnutrition is a common occurrence within the population of older adults, however prevalence rates differ between settings.

Older adults living independently within the community have lower rates of malnutrition when compared to acute and ARRC settings. In Italy, a study of 718 older adults (age 78.2 years ±8) investigated the prevalence of malnutrition

and associated risk factors between community living older adults and residents of ARRC. Community living older adults experienced low levels of malnutrition (14.5% of women, 2% of men), however, malnutrition was prevalent amongst residents of ARRC (42.5% of women, 30.8% of men) (Donini, Scardella et al. 2013). This may be explained by the better health and functionality of older adults who remain in independent living situations within the community, and are therefore more likely to maintain a higher level of nutrition. In New Zealand, the prevalence of malnutrition within community living octogenarians was found to be higher than the above figures, with approximately half of Maori and over one third of non-Maori being identified as high nutrition risk (Wham, Teh et al. 2015). This indicates the importance of screening for nutrition risk within community living older adults in New Zealand to address nutritional issues before functionality is impaired and a higher level of care is required.

In the hospital, the rate of malnutrition in older adults has been suggested to increase as events leading to hospitalisation and the disease process itself influence the nutritional state of the older adult. A study between New Zealand and Australia investigated the nutritional status and food intake of adults (age 84.6 years ±18) in acute care wards of hospitals. This study revealed a high prevalence of malnutrition, with up to 32% of adults in acute care settings qualifying as malnourished (Agarwal, Ferguson et al. 2011). Similar results have been discovered in overseas studies focusing specifically the nutrition status of hospitalised older adults (aged ≥65 years), with more than one quarter of the participants discovered to be malnourished (Dorner, Luger et al. 2014). Older adults who are identified as malnourished during a hospital stay may be at an increased risk of institutionalisation on discharge if the deconditioning associated with malnutrition impairs the ability of the older adult to safely perform activities of daily living. This fact in combination with the high prevalence of malnutrition in older adults in the acute care setting highlights the increased health and nutrition burden many older adults may have upon admission to ARRC facilities.

Global research suggests that nutrition risk and the prevalence of malnutrition in older adults is highest within ARRC. A study in Finland investigated the

nutritional status and associated risk factors for malnutrition in residents of ARRC (mean age 82 years). This study discovered 60% of residents were at increased nutrition risk, with a further 29% of residents identified as malnourished (Suominen, Muurinen et al. 2005). Similar findings have been reported in a study of ARRC facilities within Australia. Approximately half of all residents within this study (age 84.2 years ±8.7) were discovered to be malnourished (Gaskill, Black et al. 2008). Older adults at increased nutrition risk are more likely to be female, have reduced functional capacity, cognitive impairment, dysphagia and poor food intake (Suominen, Muurinen et al. 2005). These health issues identified as risk factors for malnutrition lead the older adult to require an increased level of care, which may explain the increased prevalence of nutrition risk and malnutrition within residents of ARRC. Although overseas studies indicate a high level of nutrition risk and malnutrition within the ARRC setting, there is limited data about the prevalence of malnutrition in ARRC within New Zealand.

The severity of the outcomes associated with malnutrition in older adults, in combination with the increased risk of malnutrition with ageing and dependency demonstrates the importance of malnutrition screening for all older adults, especially for those within ARRC. Additionally, differences in the prevalence of malnutrition between different countries and within different settings may also be influenced by the choice of malnutrition screening tool used in each study.

2.6.1 Malnutrition Screening Tools Used in ARRC

Nutrition risk is identified using validated screening tools that measure the incidence of specific factors or behaviours that increase an individual's risk of developing malnutrition. Measures frequently involve the use of anthropometric markers such as BMI, calf or mid upper arm circumference, in combination with questions to determine unintentional weight loss, satiety and appetite, and medical/neuropsychological conditions that may affect nutritional intake (Dent, Visvanathan et al. 2012). Commonly used malnutrition screening tools in ARRC

include the Malnutrition Screening Tool (MST), the Malnutrition Universal Screening Tool (MUST), and the Mini Nutritional Assessment-Short Form (MNA-SF).

Malnutrition Screening Tool (MST)

The Malnutrition Screening Tool (MST) determines individuals at risk of malnutrition via two questions about recent unintentional weight loss and appetite (Ferguson, Capra et al. 1999). The MST is scored between 0-5 with a score ≥2 indicative of increased malnutrition risk. Although originally designed for use in adults within the acute hospital setting, this tool has also been validated for use in older adults within ARRC (Ferguson, Capra et al. 1999, Isenring, Bauer et al. 2009).

Malnutrition Universal Screening Tool (MUST)

The Malnutrition Universal Screening Tool (MUST) is composed of three parts to determine risk of malnutrition: weight status/BMI, recent unintended weight loss, and recent acute illness/no nutritional intake (Elia 2003). Scoring of the MUST ranges from 0-6 where 0 indicates low risk of malnutrition, 1 indicates a medium risk, and ≥2 indicates high risk of malnutrition. The MUST has been validated for the nutritional screening of adults in hospitals, ARRC, and community settings (Elia 2003, Anthony 2008).

Mini Nutritional Assessment-Short Form (MNA-SF)

The Mini Nutritional Assessment-Short Form (MNA-SF) was developed specifically for use in older populations (Rubenstein, Harker et al. 2001). The MNA-SF reduces the 18 questions of the original Mini Nutritional Assessment (MNA) tool to six questions investigating decline in food intake, weight loss, mobility, psychological stress/acute illness, neuropsychological problems and BMI/calf-circumference (Rubenstein, Harker et al. 2001). The MNA-SF is scored

from 0-14 where ≥12 indicates normal nutrition status, 8-11 indicates risk of malnutrition, and ≤7 indicates presence of malnutrition. The MNA-SF has been validated for use in community and ARRC settings, and is recommended by the European Society for Parenteral and Enteral Nutrition (ESPEN) as the screening tool of choice for detecting malnutrition in older adults (Rubenstein, Harker et al. 2001, Isenring, Banks et al. 2012).

2.7 Factors Affecting Nutrition Risk in Older Adults

2.7.1 Sociodemographic Factors

Sociodemographic factors such as marital status, living arrangement, income, and education may affect food choice and availability, and may therefore influence the nutritional status of older adults (Donini, Scardella et al. 2013).

Marital Status & Living Arrangement

Marital status and living arrangement are indices of social environment and are influential factors for the nutritional status and health of the older adult. Marriage elicits a protective effect on the nutritional status and functional capacity of older adults, especially in older men (Drewnowski and Evans 2001, Locher, Ritchie et al. 2005). The LILACS NZ study investigated the association between health and social factors on nutrition risk in a sample of 655 community living octogenarians. This study concluded that older adults who are married or live with a spouse/others are less likely to be at high nutrition risk than their widowed counterparts or those who live alone (Wham, Teh et al. 2015). These findings are supported by an American study on the effect of widowhood on nutrition in the elderly, which reports that widowhood is associated with decreased food intake and an increased prevalence of weight loss (Shahar, Schultz et al. 2001). The reasons for reduced food intake and weight loss after the loss of a spouse differ between genders. Men who are widowed may experience increased nutrition risk due to a lack of knowledge about how to

shop for, prepare and cook healthy meals (Locher, Ritchie et al. 2005). Similarly, women who are widowed may experience increased nutrition risk due to the loss of additional financial resources or lack of purpose without having someone to cook and care for, and may therefore skip meals or eat more simple, unbalanced meals (Locher, Ritchie et al. 2005).

Loss of a spouse can also lead to changes in social or living situations. Older adults who live alone are at an increased risk of developing malnutrition (O'Sullivan and Ashton 2012). Older adults may experience higher rates of depression and loneliness due to the social isolation associated with living alone, especially if functionality or mobility becomes impaired, often resulting in reduced appetite and nutritional intake (Nieuwenhuizen, Weenen et al. 2010, O'Sullivan and Ashton 2012). Many studies have shown that independent living older adults who live alone generally eat less than those who live and eat with other people (Brownie 2006). This highlights the importance of considering the social factors associated with eating when targeting nutrition risk in older adults.

Income

Economic situation may change with age as older adults move from financial independence during years of employment through to increased financial dependence after retirement. Income, or economic status, has been highlighted as a key determinant of health throughout a lifetime, but is especially important during old age (O'Sullivan and Ashton 2012). Disparities between the income required to maintain a healthy lifestyle and the current income of older adults in New Zealand may present a substantial obstacle to achieving healthy ageing strategies (O'Sullivan and Ashton 2012). Over 90% of New Zealanders aged ≥65 years receive the government funded New Zealand Superannuation pension, with approximately 60% of older adults dependent on this pension for the provision of more than 85% of their total income (O'Sullivan and Ashton 2012). Additionally, almost half of New Zealanders aged ≥65 years have a low income, earning less than 60% of the median income in New Zealand

(O'Sullivan and Ashton 2012). These figures indicate the increased levels of financial dependency experienced by older adults within New Zealand.

Additionally, nutritional disparities exist between low and high income populations (Guthrie and Lin 2002). Low income may affect an individual's sense of food security and promote the development of nutrition risk, especially in older adults who may be financially dependent upon pension payments. Food security, defined as the ability to acquire adequate amounts of safe and nutritionally sufficient foods, is essential for the maintenance of nutritional wellbeing and to support healthy ageing (University of Otago and Ministry of Health 2011). Changes in financial situations experienced in old age reduce the older adult's ability to obtain enough healthy food to maintain nutritional adequacy (Nieuwenhuizen, Weenen et al. 2010, Donini, Scardella et al. 2013). This is manifested in a reduction of food quality, quantity, and variety, leading to nutritional imbalance and increased nutrition risk (Donini, Scardella et al. 2013).

Despite the high prevalence of older New Zealanders earning low levels of income, results of the NZANS 2008/09 report a higher level of food security within this population when compared to younger populations (University of Otago and Ministry of Health 2011). Although contrary to what might be expected due to the aforementioned relationship between low income and nutrition risk, this finding is not uncommon. A US study by Guthrie and Lin (2002) also discovered higher levels of food security in the older adults (>60 years old) when compared to the rest of the population. This phenomenon may be explained by differences in attitude and perception of food security between different age groups (Guthrie and Lin 2002). Previous life experiences lived by the current generation of elderly such as war, economic depression, and food shortages may explain these differences and the resiliency of older adults when resources are scarce.

Education

Low levels of education can influence the nutritional status of older adults if it reduces the ability to make healthful food decisions (Donini, Scardella et al. 2013). The concept of health literacy is important for older people to be able to understand the information given to them about nutrition and health so they can act upon it in a safe way (Borden, Conner et al. 2012). Dietary intake and food habits differ among older adults with varying levels of education (Timpini, Facchi et al. 2011). Older adults with fewer years of education have been shown to be more likely to experience weight loss and are at greater risk of malnutrition than those with higher levels of education (Alibhai, Greenwood et al. 2005, Timpini, Facchi et al. 2011). An Italian study of nutrition risk in community-living elderly established low levels of education to be an independent risk factor for the development of malnutrition. This study discovered that 16.3% of participants with <5 years of education were at risk of malnutrition, compared to only 6.7% of participants with ≥5 of education (Timpini, Facchi et al. 2011). Although these figures highlight a trend towards higher levels of malnutrition in older adults with less education, the cross-sectional design of this study cannot establish low education as a causative factor for malnutrition. Additionally by categorising education into only two groups (<5 years vs. ≥5 years of education), this research does not identify whether nutrition risk decreases with increasing levels of education.

Wham, McLean et al. (2014) also investigated the relationship between education and nutrition status by identifying differing levels of nutrition risk between different levels of education. This study, conducted on community living older adults in New Zealand, clearly identifies an inverse relationship between education and nutrition risk with 66% of primary educated participants at moderate/high nutrition risk compared to 63% of secondary and 59% of tertiary educated participants. These figures highlight the importance of malnutrition screening in older adults who have lower levels of education.

2.7.2 Health Factors

Chronic Illness

Older adults commonly experience multiple comorbidities due to the effects of ageing on the body (Brownie 2006). Loss of health, mobility and functionality as a result of chronic illness leads to reduced independence and may compromise the ability of older adults to maintain nutritional integrity (Brownie 2006). Metabolic processes associated with chronic illness may result in inflammation, hyper-catabolism and greater nutrient losses, thereby amplifying nutrition risk (Donini, Scardella et al. 2013). Similarly, the symptoms experienced with chronic disease such as pain, anorexia and fatigue may affect the quality and quantity of food eaten leading to unintended weight loss and malnutrition.

Polypharmacy

Increased incidence of chronic illness in the elderly is associated with an increased number of prescription medications required for treatment, which may result in polypharmacy (Heuberger and Caudell 2011). Polypharmacy can be defined as the regular use of more than six to nine medications, however disagreement exists within the literature on the exact number of medications required to qualify as polypharmacy (Jyrkkä, Enlund et al. 2011, Maher, Hanlon et al. 2014).

Declining health with age means that polypharmacy is common within the elderly population, as up to two thirds of older adults report using at least one medication on a daily basis (Heuberger and Caudell 2011, Maher, Hanlon et al. 2014). Polypharmacy in older adults is associated with many negative health effects including drug interactions, impaired functional capacity, cognitive decline and increased nutrition risk (Chen, Bai et al. 2007, Heuberger and Caudell 2011, Jyrkkä, Enlund et al. 2011, Maher, Hanlon et al. 2014). Although these negative health effects of polypharmacy may impair nutritional status themselves, the side effects of multiple medications also contribute to increased nutritional risk. Common side effects of medications including nausea, loss of

appetite, reduced salivary function and taste changes may reduce food intake resulting in unintended weight loss and malnutrition (Heuberger and Caudell 2011, Jyrkkä, Enlund et al. 2011). A Finnish study by Jyrkkä, Enlund et al. (2011) investigated the relationship between polypharmacy and nutrition status in a sample of 294 older adults (aged ≥75 years). As many as 50% of older adults who regularly use more than 10 medications were found to be malnourished or at risk of developing malnutrition (Jyrkkä, Enlund et al. 2011). The severity of the implications of malnutrition within the older adult in combination with the extensive prevalence of nutrition risk due to excessive polypharmacy highlights the importance of addressing these issues, especially within the vulnerable population of ARRC residents.

Dentition

The dental status of older adults plays an integral role in the ability to chew and safely swallow food, and therefore impacts food choice and dietary quality (Nowjack-Raymer and Sheiham 2007, Heuberger and Caudell 2011). Tooth loss is associated with reduced food intake, especially of protein foods which tend to be fibrous and require greater chewing capacity (Sheiham, Steele et al. 2001). As ageing is associated with increased prevalence of tooth loss, this highlights a further avenue through which older adults are predisposed to nutrition risk.

Establishing a cut-off point for the minimum number of teeth required before nutritional quality is impaired is difficult, however research indicates that adults with ≥21 teeth have the functional capacity to consume a high quality diet to allow for optimum nutrition (Sheiham, Steele et al. 2001, CBG Health Research 2015). Although the use of dentures in edentulous older adults may increase chewing capacity, those who wear dentures continue to be at higher nutrition risk than those who have been able to retain ≥21 of their natural teeth (Sheiham, Steele et al. 2001, Nowjack-Raymer and Sheiham 2007).

Analysis of the 2012 New Zealand Older People's Health Survey discovered that only 35% of older adults in ARRC were functionally dentate using the above criteria of ≥21 natural teeth remaining (CBG Health Research 2015). Over half of residents had no natural teeth remaining, and of these only 74% used a full set of dentures (CBG Health Research 2015). These statistics highlight the poor oral health of older New Zealanders within ARRC and the relevance of investigating the association between dentition and nutrition risk within this population.

Dysphagia

Dysphagia, or impaired swallowing, is a disorder commonly experienced by older adults (Belafsky, Mouadeb et al. 2008). Changes in muscle mass and function with age affect the physiology of swallowing by slowing the swallowing process and increasing the chance of swallowed matter entering the upper airway, resulting in an inefficient or unsafe swallow (Sura, Madhavan et al. 2012). Similarly, health conditions associated with the ageing process such as neurologic or neuromuscular disorders, respiratory conditions, head and neck cancers, or the side effects of medications may contribute to the development of dysphagia (Sura, Madhavan et al. 2012, Wakabayashi and Matsushima 2016). Additional risk factors for dysphagia include old age, impaired cognitive capacity, and polypharmacy (Park, Han et al. 2013). These are common characteristics of ARRC residents and thus insinuate an increased frequency of dysphagia within this setting.

Dysphagia presents a significant health care issue in older adults within ARRC and is associated with increased risk of morbidity and mortality (Sura, Madhavan et al. 2012, Park, Han et al. 2013). A study in South Korea investigated the prevalence of dysphagia and associated risk factors in 395 older adults in ARRC (aged ≥65 years). This study discovered a high prevalence of dysphagia with >57% of the sample qualifying as dysphagic (Park, Han et al. 2013). Dysphagia is characterised by increased effort when swallowing, frequent coughing while eating, pain or discomfort when

swallowing, and increased stress or anxiety at meal times (Belafsky, Mouadeb et al. 2008, Park, Han et al. 2013). As a result, nutritional complications are a notable complication of dysphagia. These symptoms often lead older adults to modify their diet to avoid problematic foods, resulting in reduced food intake and increased nutrition risk (Sura, Madhavan et al. 2012, Wakabayashi and Matsushima 2016). Malnutrition can also lead to the development of dysphagia via the loss of muscle associated with deconditioning (Sura, Madhavan et al. 2012, Wakabayashi and Matsushima 2016). The cyclical relationship between malnutrition and dysphagia in combination with the dire consequences of both illustrates the importance of identifying older adults who may be at risk of developing dysphagia.

In response to the need for a quick and reliable screening tool to identify dysphagia risk, Belafsky, Mouadeb et al. (2008) created the 10-item Eating Assessment Tool (EAT-10). The EAT-10 is composed of 10 statements about swallowing which are rated on the subjective experience of the individual on a scale of 0 representing no problem to 4 representing a severe problem. The scores are summed with a final score of ≥3 indicative of increased risk of dysphagia. The EAT-10 screening tool has been validated for use within a range of populations at risk for developing dysphagia, including older adults within ARRC (Belafsky, Mouadeb et al. 2008, Wakabayashi and Matsushima 2016).

2.7.3 Cognitive Factors

Depression

Depression is a significant factor in the development of malnutrition in older adults (Chen, Bai et al. 2007). Depression has been associated with indifference towards food, lack of appetite, reduced food intake and weight loss (Smoliner, Norman et al. 2009, Donini, Scardella et al. 2013). Losses associated with ageing including loss of social role and independence are common in older adults experiencing depression and may manifest as anorexia

(Donini, Scardella et al. 2013). Similarly, depression may impair an older adult's capacity to cook and eat meals, and has been associated with taste changes (Ministry of Health 2013).

A study of older adults within ARRC facilities in Berlin (age 84.6 years ±9.1) investigated the relationship between nutritional status and depression. This study revealed a modest association and complex relationship between nutritional status and depression in residents of ARRC (Smoliner, Norman et al. 2009). Smoliner, Norman et al. (2009) explain that due to the nature of both conditions, it cannot be determined whether depression is the reason for, or the result of increased nutritional risk. These findings emphasize the importance of screening for and treating both depression and malnutrition within residents of ARRC to support healthy ageing.

Cognitive Impairment

Cognitive impairment in older adults affects all aspects of daily life, including nutrition status. Erratic eating behaviour, forgetting to eat, safety issues with food preparation, and trouble self-feeding all increase nutrition risk in the older adult (Sura, Madhavan et al. 2012, Ministry of Health 2013). An Italian study by Donini, Scardella et al. (2013) investigated this relationship. This study found a high prevalence of malnutrition in older adults who were cognitively impaired (Donini, Scardella et al. 2013). This association has also been demonstrated in many other studies (Suominen, Muurinen et al. 2005, Verbrugghe, Beeckman et al. 2013, Malara, Sgro et al. 2014). The universal prevalence of malnutrition within cognitively impaired adults suggests a complex cyclical reciprocal relationship between these conditions. Cognitive impairment has been associated with reduced food intake and malnutrition, however nutritional deficiencies in protein, vitamin D and B12 have also been linked to increased rates of cognitive decline (Malara, Sgro et al. 2014, Zwaluw, Rest et al. 2014, de van der Scheuren, Lonterman-Monasch et al. 2016). This relationship highlights the importance of optimal nutrition in later life to ensure the maintenance of both nutritional status and cognitive function.

The Montreal Cognitive Assessment (MoCA) was created in response to the need for an easily administered screening tool to identify those with mild cognitive impairment (MCI) that may not otherwise be detected using the Mini-Mental State Examination (MMSE) (Nasreddine, Phillips et al. 2005). The MoCA is composed of 30 questions examining cognitive function in domains frequently affected by MCI including visuospatial/executive, naming, memory, attention, language, abstraction, delayed recall and orientation. Scores in each domain are summed and an additional point is added for individuals with <12 years of education to counter the effect of education on cognition. Scores of <26 indicate the presence of MCI. The MOCA has been validated for use within the population of older adults (Nasreddine, Phillips et al. 2005).

2.8 Summary

The rapidly ageing population of New Zealand predicts increasing numbers of older adults requiring a higher level of care, such as that provided by ARRC facilities. Residents of ARRC experience unique health and nutrition considerations that predispose this population to an increased prevalence of nutrition risk and malnutrition. Despite an increasing amount of international literature on the nutrition status of older adults within ARRC, research has yet to be performed within the New Zealand population. This study, therefore, proposes to establish the prevalence of nutrition risk in adults of advanced age within ARRC in New Zealand. The results of this study will identify key factors associated with nutrition risk to form the basis of nutrition and health interventions aimed at supporting healthy ageing and encouraging Ageing in Place for all older New Zealanders.

Chapter 3: Research Study Manuscript

*The following manuscript is prepared according to the author guidelines for Nutrition and Dietetics (**Appendix A**). Additional results can be found in **Appendix B** and questionnaires used in research can be found in **Appendix C**.*

Malnutrition and dysphagia in newly admitted rest home residents of advanced age

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3.1 Abstract

Aim

To establish the prevalence of nutrition risk and associated risk factors among adults of advanced age recently admitted to age-related residential care (ARRC).

Methods

A cross-sectional study was conducted among participants aged ≥85 years within five days of admission to ARRC within the Waitemata District Health Board region of Auckland, New Zealand. A 60-minute interview established sociodemographic and health characteristics of participants. Body composition, grip strength and gait speed were recorded using standardised measures. Nutrition risk was determined using the Mini Nutritional Assessment-Short Form (MNA-SF), dysphagia risk using the 10-Item Eating Assessment Tool (EAT-10) and cognitive status using the Montreal Cognitive Assessment (MoCA).

Results

Among 97 participants (mean age 90.9 ± 3.8 years), half (50.5%) were malnourished, 40.2% at nutrition risk and a third (37.1%) were at risk of dysphagia. Malnourished vs. well-nourished/at risk participants were more likely to be ≥90 years ($p = 0.019$), admitted to ARRC on a permanent basis ($p = 0.016$), at dysphagia risk ($p = 0.015$), have a BMI <23 ($p = 0.022$), lower fat mass ($p = 0.005$), and fewer comorbidities ($p = 0.030$). The MNA-SF score was

inversely correlated with age (r = -0.225, p = 0.027) and positively correlated with BMI (r = 0.499, p = <0.001) and fat mass (r = 0.765, p = <0.001).

Conclusions

Malnutrition and dysphagia risk are prevalent at early admission to ARRC, especially among those ≥90 years with low BMI who are an easily identifiable group. Early screening and intervention is critical upon admission to ARRC.

Key Words: Aged, anthropometric measures, deglutition disorders, malnutrition, mini nutritional assessment, rest home

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3.2 Introduction

New Zealand, like many developed countries, is experiencing population ageing. The population of older adults aged ≥85 years contributed to 1.7% of the New Zealand population in 2013 and is expected to make up 3.6% of the population by the year 2036 (Environmental Health Indicators New Zealand 2017). This highlights adults of advanced age as one of the fastest growing population groups in New Zealand (Office for Senior Citizens 2015). Advanced age is associated with changes in physiological, functional and metabolic processes within the body. Body composition changes to favour fat deposition and the reduction of lean muscle mass (Chen, Bai et al. 2007) resulting in loss of muscular strength and functionality (Goodpaster, Park et al. 2006), thus contributing to the development of frailty and health loss (Clegg, Young et al. 2013). This loss of muscle mass and strength may also result in an inefficient or unsafe swallow, increasing the risk of dysphagia (Sura, Madhavan et al. 2012). This may lead older adults to modify their diet resulting in reduced food intake

and increased nutrition risk, which if unresolved can lead to malnutrition (Sura, Madhavan et al. 2012).

Malnutrition is a considerable threat to the health, wellbeing and independence of older adults. Key risk factors for malnutrition such as social isolation (O'Sullivan and Ashton 2012), impaired dentition (Sheiham, Steele et al. 2001), dysphagia (Sura, Madhavan et al. 2012), chronic illness (Donini, Scardella et al. 2013) and cognitive impairment (Suominen, Muurinen et al. 2005) may be experienced in advanced age. Malnutrition increases the risk of morbidity and mortality in vulnerable older adults, which may lead to an increased rate of hospitalisation, institutionalisation and cost of health care (Allard, Aghdassi et al. 2004, Merrell, Philpin et al. 2012). Older adults at risk of developing malnutrition can be identified using validated nutrition screening tools. The Mini-Nutritional Assessment-Short Form (MNA-SF), specifically designed for use in older adults, investigates the factors and behaviours associated with nutrition risk and has been validated for use within the age-related residential care (ARRC) setting (Rubenstein, Harker et al. 2001). Identification of nutrition risk in older adults allows for the development of a nutrition care plan to address physical and health factors contributing to malnutrition and prevent further health loss.

In New Zealand the prevalence of malnutrition has been identified in older adults within community and hospital settings. New Zealand studies among community living older adults have discovered the prevalence of high nutrition risk to range from 31% to 49% (Wham, Carr et al. 2011, McElnay, Marshall et al. 2012, Wham, McLean et al. 2014, Wham, Teh et al. 2015). Similarly, the prevalence of malnutrition in hospitalised older adults has been suggested to range from 24% to 28.4% (Van Lill 2002, Popman, Richter et al. 2017).

Despite the high prevalence of malnutrition in older adults within community and hospital settings in New Zealand, the prevalence of malnutrition upon admission to ARRC facilities is unknown. Identifying the prevalence of nutrition risk and associated risk factors specific to the population of older adults upon admission to an ARRC facility is integral to establishing effective strategies to target those

at risk and support healthy ageing in the community. To achieve this, this study aimed to establish the prevalence of nutrition risk and associated risk factors among adults of advanced age recently admitted to ARRC facilities.

3.3 Methods

3.3.1 Study Design and Participant Eligibility

A prospective non-randomised cross-sectional observational study was conducted among participants aged ≥85 years, within five days of admission to ARRC facilities in the Waitemata District Health Board (WDHB) region of Auckland, New Zealand. Residents were excluded if they were unable to consent, had existing swallowing or malabsorptive disorders, cancer of the larynx, had psychiatric eating disorders, or were under palliative care. The Health and Disability Ethics Committee (HDEC) granted ethical approval for this study (reference 14/NTA/70/AM01).

Eligible participants were provided with a detailed study outline, informed that participation was voluntary, data would be de-identified and confidential, and that withdrawal from the study was accepted at any stage without this affecting their medical care. Written consent was attained before enrolment into the study.

3.3.2 Measures

Trained researchers collected data during a single 60-minute structured interview performed at the ARRC facility using a custom designed questionnaire, standardised assessment tools and anthropometric measures. Sociodemographic characteristics of the participant were documented including age, gender, prior setting, admission type, level of care, ethnicity, education level, marital status, primary income and support service requirement and use.

Anthropometric Measures

Weight and body composition were measured using calibrated bioelectrical impedance analysis (BIA) scales (Tanita Body Composition Analyser Sc-330, Wedderburn, Sydney, Australia). When unable to obtain a weight, calf circumference was measured to the nearest 0.1cm using a non-stretch tape measure (Lufkin Executive Thinline, W606PM 6mm x 2m, Maryland, USA) according to instructions within the MNA-SF user guide (Nestlé Nutrition Institute 2004). Height was measured using a portable stadiometre (Seca 213, Hamburg, Germany), or calculated to within 0.5cm using demi-span measurements (Bassey 1986). Body mass index (BMI) was calculated using the participant's weight and height to determine weight status according to the World Health Organisation (WHO) international BMI classification (World Health Organization 2003).

Muscular Strength and Performance

Muscular strength was determined by measuring handgrip strength of the participant's dominant hand using a Jamar handgrip dynamometer (model 5030J1) set in the second position. Gender-specific cut-off values (men: <32 Kg, women: <22 Kg) identified low muscular strength (Bahat, Tufan et al. 2016). Mobility was evaluated by calculating normal gait speed (m/s) with a self-paced 2.4 metre walk test. A cut-off value of ≤1 m/s represented slow gait speed (Cesari, Kritchevsky et al. 2005).

Health Characteristics

Comorbidities, prescription medications and nutritional supplements were recorded from clinical notes. Self-reported dental status was documented as dentate (≥21 natural teeth), edentulous (<21 natural teeth), or dental appliance (partial/complete dentures used) (Sheiham, Steele et al. 2001, CBG Health Research 2015).

Nutrition Risk

Nutrition risk was identified using the MNA-SF tool, which consists of six questions determining food intake and involuntary weight loss, mobility, psychological stress or acute disease, neuropsychological issues, and BMI/calf circumference (Kaiser, Bauer et al. 2009). The MNA-SF has been validated for

use in older adults (Kaiser, Bauer et al. 2009). Scoring of the questionnaire ranges from 0 to 14, with scores of 8-11 indicating nutrition risk and scores ≤7 identifying malnutrition (Kaiser, Bauer et al. 2009).

Dysphagia Risk

Dysphagia risk was assessed using the validated EAT-10 questionnaire, which consists of ten questions investigating swallowing difficulty with different textures, weight loss and stress associated with swallowing difficulty, and pain when swallowing (Belafsky, Mouadeb et al. 2008). Scoring of the questionnaire ranges from 0 to 40, with scores of ≥3 indicative of dysphagia risk (Belafsky, Mouadeb et al. 2008).

Cognitive Assessment

The Montreal Cognitive Assessment (MoCA) was used to determine the cognitive status of participants (Nasreddine, Phillips et al. 2005). The MoCA measures cognitive function in areas including visuospatial/executive, naming, memory, attention, language, abstraction, delayed recall and orientation (Nasreddine, Phillips et al. 2005). This 30-point assessment tool is validated for use in older adults as a measure of cognitive status, with scores of ≤26 indicating cognitive impairment (Nasreddine, Phillips et al. 2005).

Statistical Analysis

Data was collated into Microsoft Excel workbooks with participants assigned individual identification codes for identity protection. Results were analysed using SPSS Version 23 (IBM Corporation, New York, US). Descriptive statistics were used for sociodemographic, anthropometric and frailty measures, nutrition and dysphagia risk. Normality was established using Kolmogorov-Smirnov and Shapiro-Wilk tests. Normally distributed data was presented as mean (± standard deviation, SD), non-normally distributed data presented as median (25^{th}, 75^{th} percentiles) or geometric mean (95% confidence interval), and categorical data presented as frequencies. Independent t-tests determined differences between groups of normally distributed data, Mann Whitney tests were used for groups of non-normally distributed data, and Pearson's chi-square was used for groups of categorical data. Pearson's Coefficient

Correlation tests established correlation between normally distributed data, and Spearman's Correlation tests established correlation for non-normally distributed data. Significance was established where $p < 0.05$.

3.4 Results

The sociodemographic, health and physical characteristics of the participants are presented in Table 3.1. There were 97 participants, 35 (36.1%) men. The mean age of participants was 90.9 years (± 3.8) and over half (55.7%) were ≥90 years. Although most participants had been admitted into ARRC on a permanent basis (75.3%), a quarter was admitted for respite care. Two thirds (64.9%) of participants had been admitted from community living situations with the remainder (35.1%) from hospital.

The MNA-SF identified half (50.5%) of the participants as malnourished, 40.2% at nutrition risk and 9.3% well-nourished. Among the 76 participants who completed weight and height measures, the mean BMI was 21.9 ± 4.3 Kg/m^2 and 49 (64.5%) had a BMI <23 (Winter, MacInnis et al. 2014).

One third (37.1%) of participants were at risk of dysphagia (EAT-10 score >3) and all 67 participants who completed the MoCA were identified as cognitively impaired (score <26). One third (30.9%) of participants were unable to complete the MoCA due to vision impairment, functional disability, or fatigue.

The mean grip strength of the participants was 11.3 ± 8.3 Kg and mean gait speed was 0.4m/s (95% CI = 0.3, 0.6).

Table 3.1 Sociodemographic, health and physical characteristics of participants

		Total n (%)	Men n (%)	Women n (%)
		97 (100.0)	35 (36.1)	62 (63.9)
Age (years)[a]		90.9 ± 3.8	91.0 ± 4.1	90.9 ± 3.6
85-89 years		43 (44.3)	17 (48.6)	26 (41.9)
≥90 years		54 (55.7)	18 (51.4)	36 (58.1)
Prior setting	Community	63 (64.9)	21 (60.0)	42 (67.7)
	Hospital	34 (35.1)	14 (40.0)	20 (32.3)
Admission Type	Permanent	73 (75.3)	27 (77.1)	46 (74.2)
	Respite/ interim	24 (24.7)	8 (22.9)	16 (25.8)
Level of Care	Rest Home	53 (54.6)	18 (51.4)	35 (56.5)
	Hospital	44 (45.4)	17 (48.6)	27 (43.5)
Ethnicity	NZ European	62 (63.9)	21 (60.0)	41 (66.1)
	Maori	1 (1.0)	0 (0.0)	1 (1.6)
	Pacific	0 (0.0)	0 (0.0)	0 (0.0)
	Other	34 (35.1)	14 (40.0)	20 (32.3)
Marital Status	Married/ partnered	32 (33.0)	20 (57.1)	12 (19.4)
	Widowed/ separated/ never married	65 (67.0)	15 (42.9)	50 (80.6)
Living Arrangement	Living alone	52 (53.6)	13 (37.1)	39 (62.9)
	Living with spouse/ others	45 (46.2)	22 (62.9)	23 (37.1)
Source of Income	Pension only	71 (74.0)	21 (60.0)	50 (82.0)
	Pension plus other income	25 (26.0)	14 (40.0)	11 (18.0)
Level of Education	Primary	21 (21.6)	8 (22.9)	13 (21.0)
	Secondary	53 (54.6)	14 (40.0)	39 (62.9)
	Tertiary	23 (23.7)	13 (37.1)	10 (16.1)
Requires assistance with daily tasks		71 (74.0)	29 (82.9)	42 (68.9)
Comorbidities	<5	28 (28.9)	9 (25.7)	19 (30.6)
	≥5	69 (71.1)	26 (74.3)	43 (69.4)
Prescribed Medications	<5	32 (33.0)	11 (31.4)	21 (33.9)
	≥5	65 (67.0)	24 (68.6)	41 (66.1)
Dental Status	Dentate (≥21 natural teeth)	22 (22.7)	8 (22.9)	14 (22.6)
	Edentulous (<21 natural teeth)	7 (7.2)	5 (14.3)	2 (3.2)
	Dental appliance	68 (70.1)	22 (62.9)	46 (74.2)
Dysphagia Risk[a]		3.0 ± 4.3	3.5 ± 4.5	2.8 ± 4.3
At risk (EAT-10 score ≥3)[d]		36 (37.1)	14 (40.0)	22 (35.5)
Cognitive Score (MoCA) (n=67)[a]		14.28 ± 5.3	14.0 ± 5.2	14.4 ± 5.4
Cognitive Impairment (MoCA score <26)[e]		67 (100.0)	23 (100.0)	44 (100.0)
Weight (Kg) (n=78)[a]		58.9 ± 14.5	66.8 ± 12.0	54.7 ± 14.0
Height (cm) (n=95)[a]		162.2 ± 19.4	167.5 ± 30.4	159.3 ± 7.7
Calf circumference (cm) (n=37)[a]		31.7 ± 4.2	31.2 ± 4.0	32.1 ± 4.4
BMI (Kg/m^2) (n=76)[a]		21.9 ± 4.3	22.9 ± 4.2	21.4 ± 4.4
BMI <23[a]		49 (64.5)	16 (61.5)	33 (66.0)
Fat mass (Kg) (n=17)[c]		11.8 (9.4, 15.8)	13.6 (9.4, 16.4)	9.8 (9.3, 13.9)
Muscle mass (Kg) (n=17)[b]		39.8 (35.2, 45.0)	46.2 (35.1, 61.0)	37.3 (32.3, 43.0)
Fat free mass (Kg) (n=17)[b]		42.0 (37.1, 47.4)	48.7 (37.0, 64.1)	39.3 (34.0, 45.3)
Grip strength (Kg) (n=89)[a]		11.3 ± 8.3	17.1 ± 8.8	7.9 ± 5.7
Gait speed (m/s) (n=31)[b]		0.4 (0.3, 0.6)	0.3 (0.2, 0.6)	0.5 (0.3, 0.7)
MNA-SF Score[a]		7.4 ± 3.3	7.1 ± 3.4	7.6 ± 3.2
Well-nourished (12-14)[f]		9 (9.3)	3 (8.6)	6 (9.7)
At risk (8-11)[f]		39 (40.2)	12 (34.3)	27 (43.5)
Malnourished (0-7)[f]		49 (50.5)	20 (57.1)	29 (46.8)

EAT-10, 10-Item Eating Assessment Tool; MoCA, Montreal Cognitive Assessment; MNA-SF, Mini Nutrition Assessment-Short Form.
All values reported as n (%) unless otherwise indicated.
(a) Values reported as mean ± SD.
(b) Values reported as geometric mean (95% CI).
(c) Values reported as median (25th, 75th centile).
(d) Recognised cut-off values for dysphagia risk as per the EAT-10 (Belafsky, Mouadeb et al. 2008).

(e) Recognised cut-off values for cognitive function as per the MoCA (Nasreddine, Phillips et al. 2005).
(f) Recognised cut-off values for MNA-SF (Rubenstein, Harker et al. 2001).

Table 3.2 shows the characteristics of participants by nutrition risk status (well-nourished/at risk and malnourished). Participants who were malnourished were more likely to be ≥90 years (p = 0.019), admitted to ARRC on a permanent basis (p = 0.016), at risk of dysphagia (p = 0.015), a low BMI <23 (p = 0.022), lower fat mass (p = 0.005), and have fewer comorbidities (p = 0.030).

Table 3.2 Characteristics of well-nourished/at risk and malnourished participants

	Well-nourished/ At risk n = 48 (49.5)	**Malnourished** n = 49 (50.5)	***p- value***
Age (years) (n = 88) [(a)]	90.2 ± 3.7	91.6 ± 3.7	0.057
85-89 years	27 (56.3)	16 (32.7)	**0.019 ***
≥90 years	21 (43.8)	33 (67.3)	
Admission Type			
Permanent	31 (64.6)	42 (85.7)	**0.016 ***
Respite/interim	17 (35.4)	7 (14.3)	
Level of Care			
Rest Home	31 (64.6)	22 (44.9)	0.052
Hospital	17 (35.4)	27 (55.1)	
Comorbidities			
<5	9 (18.8)	19 (38.8)	**0.030 ***
≥5	39 (81.3)	30 (61.2)	
Dysphagia Risk [(a)(d)]	2.3 ± 4.1	3.7 ± 4.5	0.113
At risk (EAT-10 score ≥3)	12 (25.0)	24 (49.0)	**0.015 ***
Weight (Kg) (n = 78) [(a)]	61.2 ± 13.7	56.2 ± 15.1	0.125
Height (cm) (n = 95) [(a)]	161.9 ± 9.2	162.5 ± 25.7	0.886
Calf circumference (cm) (n = 37) [(a)]	33.2 ± 3.6	30.7 ± 4.4	0.082
BMI (Kg/m^2) (n = 76)[(a)]	23.0 ± 3.8	20.7 ± 4.6	**0.019 ***
BMI <23 (Kg/m^2)	21 (52.5)	28 (77.8)	**0.022 ***
Fat mass (Kg) (n = 17) [(c)]	14.6 (12.9, 20.9)	9.5 (7.4, 10.8)	**0.005 ***
Muscle mass (Kg) (n = 17) [(b)]	40.8 (34.6, 48.1)	38.4 (28.9, 51.0)	0.386
Fat free mass (Kg) (n = 17) [(b)]	43.0 (36.4, 50.7)	40.4 (30.4, 53.7)	0.386
Grip strength (Kg) (n = 89) [(a)]	12.2 ± 7.6	10.4 ± 8.9	0.303
Gait speed (m/s) (n = 31) [(b)]	0.5 (0.3, 0.8)	0.4 (0.2, 0.6)	0.081

EAT-10, 10-Item Eating Assessment Tool; MoCA, Montreal Cognitive Assessment.
Normally distributed data differences between groups tested with Pearson chi-square and independent t-tests. Non-normally distributed data transformed into geometric mean (95% CI) normality tested using Shapiro-Wilk test and Mann Whitney test for correlation. All values reported as n (%) unless otherwise indicated.

(a) Values reported as mean ± SD.
(b) Values reported as geometric mean (95% CI).
(c) Values reported as median (25th, 75th centile).
(d) Recognised cut-off values for dysphagia risk as per the EAT-10 (Belafsky, Mouadeb et al. 2008).
(e) Recognised cut-off values for cognitive function as per the MoCA (Nasreddine, Phillips et al. 2005).

** Significant difference (p <0.05)*

The MNA-SF score was inversely correlated with age (r = -0.225, p = 0.027) (Table 3.3) and positively correlated with BMI (r = 0.499, p = <0.001) and fat mass (r = 0.765, p = <0.001).

Table 3.3 Correlation between MNA-SF score and participant characteristics

	Total n = 97	
	Correlation	***p-value***
Age (years) [(a)]	-0.225	**0.027 ***
BMI (Kg/m^2) [(a)]	0.499	**<0.001 ***
Fat mass (Kg) [(b)]	0.765	**<0.001 ***
Muscle mass (Kg) [(b)]	0.296	0.248
Fat free mass (Kg) [(b)]	0.296	0.248
Grip strength (Kg) [(a)]	0.204	0.055
Gait speed (m/s) [(b)]	0.142	0.445
Comorbidities [(a)]	0.041	0.693
Prescribed medications [(a)]	-0.022	0.829
Dysphagia risk (EAT-10 score) [(a)]	-0.105	0.305
Cognitive status (MoCA score) [(a)]	0.010	0.935

MNA-SF, Mini Nutrition Assessment-Short Form.
(a) Normal data tested using Pearson's correlation (r)
(b) Non-normal data tested using Spearman's correlation
** Significant difference (p <0.05).*

3.5 Discussion

Half of the study participants recently admitted to an ARRC facility were identified to be malnourished using the MNA-SF. Although literature on the nutrition risk status of older adults in residential care in New Zealand is scarce, this finding is similar to prevalence reported elsewhere. In Australia, half of ARRC residents mean age of 84.2 years were also found to be malnourished using the Subjective Global Assessment (SGA) (Gaskill, Black et al. 2008). Similarly, a high prevalence of malnutrition was identified in octogenarian men (30.8%) and women (42.5%) living in ARRC facilities in Italy (Donini, Scardella et al. 2013). A Finnish study of 2114 ARRC residents, mean age 82 years, found 60% of residents to be at increased nutrition risk and 29% identified as malnourished using the MNA (Suominen, Muurinen et al. 2005). In the current study, participant age was inversely correlated with the MNA-SF score (r = -0.225, p = 0.027) supporting the evidence that advanced age is a significant risk factor for nutrition risk (Meijers, Schols et al. 2008, Wham, McLean et al. 2014), therefore explaining the above correlation.

The mean BMI of participants in this study was 21.9 ± 4.3 kg/m^2 and although this meets the WHO definition of a healthy weight range (BMI 18.5 – 24.9) (World Health Organization 2003), more recent research has suggested this range may not be suitable for application in older adults (Winter, MacInnis et al. 2014). A reverse j-shaped association between BMI and mortality has been recognised in older adults, indicating the protective value of increased weight for better health outcomes in advanced age (Locher, Roth et al. 2007). A BMI of <23.0 is associated with increased mortality and may be a more appropriate cut-off for determining underweight older adults (Winter, MacInnis et al. 2014). Using this cut-off, almost two thirds (64.6%) of study participants would be classified as underweight (BMI of <23.0). Lower BMI was associated with increased nutrition risk (lower MNA-SF score) in the current study (r = 0.499, *p* = <0.001). This is expected as BMI is an integral measure of nutrition risk within the MNA-SF, however these results highlight the importance of nutritional screening in older adults with a low body weight.

Over one third (37.1%) of the study participants were at risk of dysphagia as determined by EAT-10. These findings are comparable to the prevalence of dysphagia in a Japanese study of nursing home residents (mean age 82 years) where 43% of participants had an EAT-10 score of >3, consistent with dysphagia risk (Wakabayashi and Matsushima 2016). Participants at increased dysphagia risk in the current study were also more likely to be malnourished (49%) than those who were well-nourished/at nutrition risk (25%). These findings are consistent with a number of other studies identifying a link between dysphagia and increased nutrition risk (Park, Han et al. 2013, Wakabayashi and Matsushima 2016, Wham, Fraser et al. 2017). Reduced muscle mass, comorbidities and impaired cognition, all characteristics common in residents of ARRC facilities, contribute to the development of dysphagia, which in turn increases nutrition risk (Sura, Madhavan et al. 2012, Park, Han et al. 2013, Wakabayashi and Matsushima 2016). This high prevalence of dysphagia risk demonstrates a need for dysphagia screening upon admission to ARRC to ensure early nutrition intervention.

All 67 participants who completed the MoCA scored less than 26 points and were classified as cognitively impaired (Nasreddine, Phillips et al. 2005). Although previous research suggests an increased prevalence of malnutrition in cognitively impaired older adults (Suominen, Muurinen et al. 2005, Donini, Scardella et al. 2013, Verbrugghe, Beeckman et al. 2013), this was not able to established in the current study. Cognitive impairment affects nutrition status through erratic eating behaviour, forgetting to eat and issues with self-feeding, resulting in reduced food intake and malnutrition (Sura, Madhavan et al. 2012). Nutrient deficiencies associated with malnutrition may too increase the rate of cognitive decline in older adults (de van der Scheuren, Lonterman-Monasch et al. 2016). The high prevalence of cognitive impairment in this study may be reflective of the advanced age of participants and may have facilitated the requirement for an increased level of care as provided within ARRC. This finding highlights the importance of early identification and treatment of malnutrition upon admission to improve quality of life of cognitively impaired residents.

Although previous studies have identified an increased prevalence of malnutrition with increasing comorbidity in older residents (Meijers, Schols et al. 2008, Donini, Scardella et al. 2013), we found malnourished participants had fewer comorbidities than their well-nourished/at nutrition risk counterparts. A potential explanation may be the increase in mortality associated with both malnutrition and increasing morbidity, reflecting the inability of the advanced age body to overcome both conditions (Chan, Lim et al. 2010).

This is the first New Zealand study to investigate the prevalence of nutrition risk and associated risk factors among newly admitted ARRC residents of advanced age. A further strength of the current study includes the use of the popular MNA-SF malnutrition-screening tool, which allows the results of this study to be compared to existing research. Additionally, the sociodemographic characteristics of participants within this study are representative of the population of ARRC residents within New Zealand (Statistics New Zealand 2013).

This study also has several limitations. The cross-sectional design limits conclusions of causality between nutrition risk and causative factors, instead reporting only associations. Secondly, only 67 participants were able to complete the MoCA due to the large number of participants with visual or functional disabilities and all were cognitively impaired. Although the MoCA has been validated for use in older populations, recent research suggests an overestimation of cognitive impairment in adults of advanced age and suggests the addition of age-specific cut-off values (Oren, Yogev-Seligmann et al. 2015). Additionally, differences in environmental conditions and participant hydration status reduced the accuracy of body composition data recorded using bioelectrical impedance analysis. Finally, generalisability of the results of this study is limited due to the small sample size.

In conclusion, a high prevalence of malnutrition was identified among adults of advanced age recently admitted to ARRC facilities. Dysphagia risk and cognitive impairment, both important factors in nutrition risk, were highly prevalent within this sample. Screening for nutrition risk and associated factors upon admission to ARRC facilities provides early identification of nutritionally vulnerable older adults and early intervention to improve nutrition status and quality of life.

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Conflict of Interest

The authors have no conflicts of interest to declare.

Authorship

SS collected the data. SS and MR analysed the data. CW and JA designed the study. All authors contributed to manuscript preparation. All authors are in agreement with the manuscript and declare that the content has not been published elsewhere.

Chapter 4: Conclusion and Recommendations

4.1 Overview and Achievement of Aims

Overseas research has identified a high prevalence of nutrition risk among ARRC residents especially among those of advanced age. The principal aim of this study was to determine the prevalence of nutrition risk among adults of advanced age upon admission to ARRC facilities within the Waitemata DHB region of New Zealand using the MNA-SF screening tool. Half (50.5%) of the study participants were found to be malnourished, and a further 40.2% were identified at nutrition risk.

Nutrition risk in adults of advanced age is multifactorial. Identifying factors associated with increased nutrition risk in older adults upon admission to an ARRC facility enables the development of strategies to reduce the impact of nutrition risk on the health and independence of older adults, thereby supporting the concept of Healthy Ageing. The implementation of nutrition and dysphagia risk screening of older adults within the community, combined with dietetic referral and input, will enable nutritionally vulnerable older adults to maintain a healthy nutrition status while continuing to live independently.

Dysphagia risk (determined using the EAT-10 screening tool) was prevalent among more than a third (37.1%) of the participants, particularly among those who were malnourished (49%). This showcases the cyclical relationship between malnutrition and dysphagia: inadequate oral intake related to dysphagia increases the risk of malnutrition, whilst muscular deconditioning associated with malnutrition increases dysphagia risk.

BMI and fat mass were positively correlated with the MNA-SF score indicating that lower body mass and fat mass were associated with increased nutrition risk. Additionally, two thirds of participants (64.5%) had a BMI <23 Kg/m^2 suggesting a low body weight for older adults. Preventing loss of body mass

and fat mass is an integral part of the prevention of nutrition risk in adults of advanced age.

Low levels of muscle strength (grip strength) and muscle function (2.4m gait speed) were identified among the participants. Limited mobility meant that less than one third of participants were able to complete walk test measures. Although significant associations between muscle strength, muscle function and nutrition risk were unable to be established, reduced functional capacity as a result of impaired muscle strength is known to limit the nutritional independence of older adults.

In this study, advancing age significantly correlated with the MNA-SF score (increased nutrition risk). Malnourished participants were more likely to be ≥90 years old, admitted to ARRC facilities on a permanent vs. temporary basis and have less comorbidity. An intricate relationship exists between nutrition status, morbidity and mortality. Although malnutrition may increase morbidity and vice versa, the lower level of morbidity found within malnourished residents in this study may reflect the inability of the advanced age body to overcome malnutrition in addition to multi-morbidity. Furthermore, all residents within the current sample were cognitively impaired highlighting the increased vulnerability of this population, however no significant association between cognitive status and nutrition risk as measured by the MNA-SF was established.

4.2 New Knowledge and Recommendations for Practice

The results of this study indicate a high prevalence of nutrition risk and malnutrition among adults of advanced age recently admitted to ARRC facilities. Older adults who were ≥90 years, with a low BMI <23, and with swallowing difficulties were at greatest risk of malnutrition and should be targeted for nutrition risk screening upon admission to ARRC facilities. This will allow for early identification of nutritionally vulnerable older adults who would benefit from dietetic intervention. Additionally, the body weight of residents should be recorded upon admission to ARRC facilities and regularly thereafter for the early identification of weight loss to allow for additional nutrition support as

needed. Nutrition care plans to address nutrition risk in residents should be developed by a registered dietitian to allow ARRC staff to identify the correct pathway for appropriate nutrition intervention.

4.3 Strengths

This is the first study in New Zealand to provide a snapshot of the prevalence of nutrition risk and associated risk factors among adults of advanced age upon early admission to ARRC. This study reveals a high prevalence of nutrition risk in newly admitted ARRC residents and supports the results of a pilot study where higher nutrition risk was found in participants newly admitted to ARRC compared to hospital or community living situations (Wham, Fraser et al. 2017). The current study adds to the literature on nutrition risk in older adults and demonstrates the importance of early nutrition screening in older adults of advanced age upon admission to ARRC.

According to the 2013 census (Statistics New Zealand 2013), the sociodemographic characteristics of this study population were closely representative of the population of ARRC residents in New Zealand. Half of residents were ≥90 years (50.9% nationally, 55.7% in the current sample), two thirds of residents were women (68.1% nationally, 63.9% in the current sample), and over half of residents were widowed/unmarried prior to admission (60.4% nationally, 67.0% in the current sample).

An additional strength was the use of the MNA-SF for nutrition risk assessment, developed specifically for use in older populations and validated within the ARRC setting (Rubenstein, Harker et al. 2001, Isenring, Banks et al. 2012). The MNA-SF is commonly used in research thus allowing the results of this study to be compared to other research. Furthermore, the reduced number of questionnaire items compared to the full version of the MNA allows for quick and easy administration ensuring low participant burden.

4.4 Limitations

The cross-sectional design of this study limits conclusions of causality between nutrition risk and causative factors, instead reporting only associations. Time restraints limited data collection to a six-month period, which combined with the slow rate of new admissions to the 41 ARRC facilities involved with the study, resulted in a final sample of 97 participants. This small sample size limits the generalisability of the study results.

Many participants had visual or functional disabilities and only 67 participants completed the MoCA, all of whom were identified to have some degree of cognitive impairment. Disabilities are common among adults of advanced age, especially in residents of ARRC facilities who require a higher level of care. Recent research suggests the MoCA overestimates cognitive impairment in adults of advanced age, and it has been proposed the addition of age-specific cut-off values may provide a more representative cognitive assessment (Oren, Yogev-Seligmann et al. 2015).

Only 17 participants completed body composition measures due to being bed-bound or unable to balance unsupported on the BIA scales. Many participants were also excluded from BIA assessment due to presence of internal metal devices (i.e. a pacemaker or metal joint replacement). Differences in environmental conditions, participant hydration status and positioning on the scales prevent the standardisation of BIA measures, reducing the accuracy of the data recorded and potentially overestimating muscle mass (Beaudart, Reginster et al. 2015). Therefore, BIA measures should be interpreted with caution.

4.5 Recommendations for Further Research

This study provides important findings about the high level of nutrition risk and dysphagia in adults of advanced age newly admitted to ARRC. Recommendations for further research in this area include:

1. Allowing for a longer data collection period to recruit a larger sample and increase the generalisability of the results of nutrition risk assessment in adults of advanced age newly admitted to ARRC.

2. Investigating nutrition risk in early admission ARRC residents of advanced age in other DHBs in New Zealand to identify geographic differences between sample populations.

3. The use of age-specific cut-off values to interpret the MoCA in adults of advanced age or use of other appropriate validated cognitive screening tools suitable for older adults with visual or functional disabilities.

4. Investigating alternative measures of body composition to overcome physical limitations associated with reduced mobility in advanced age.

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Appendices

Appendix A Manuscript Requirements for Nutrition and Dietetics Journal

4. PREPARATION OF THE MANUSCRIPT

Format

The main text file should be prepared using Microsoft Word, doubled-spaced. The top, bottom and side margins should be 30 mm.

Style

Manuscripts should follow the style of the Vancouver agreement detailed in the International Committee of Medical Journal Editors' revised 'Uniform Requirements for Manuscripts Submitted to Biomedical Journals: Writing and Editing for Biomedical Publication', as presented at http://www.ICMJE.org/.

Spelling. The journal uses Australian spelling and authors should therefore follow the latest edition of the *Macquarie Dictionary*.

Units. Measurements must be given in SI or SI-derived units. Please go to the Bureau International des Poids et Mesures (BIPM) website at http://www.bipm.fr for more information about SI units.

Abbreviations. Abbreviations should be used sparingly – only where they ease the reader's task by reducing repetition of long, technical terms. Initially use the word in full, followed by the abbreviation in parentheses. Thereafter use the abbreviation only.
The following abbreviations can be used without definition: ACT, ADP, AIDS, ATP, CI, CV, df, DNA, EDTA, EGTA, e.g., GDP, GTP, HDL, HEPES, HIV, HPLC, i.e., LDL, NAD, NADH, NADP, NADPH, NS, NSW, NT, RNA, SA, SE, SEE, SEM, SD, tris, VLDL, vol : vol, wt : vol, UK, USA, WA.

Trade names. Drugs should be referred to by their generic names. If proprietary drugs have been used in the study, refer to these by their generic name, mentioning the proprietary name, and the name and location of the manufacturer, in parentheses.
Names of vitamins and related compounds should be those recommended by the International Union of Nutritional Sciences Committee on Nomenclature (reprinted in J Nutr 1990; 120: 12–19). Generic names, however, may be used where appropriate, e.g. vitamin A deficiency. Authors using RDIs, RDAs, RNIs, NRV or similar dietary allowances to estimate nutrient adequacy should specify and cite the authority for the cutoff point used.

Parts of the Manuscript

The manuscript should be submitted in separate files: title page; main text file; figures.

Title page

The title page should contain:
(i) A short informative title that contains the major key words. The title should not contain abbreviations.
(ii) The full names of the authors and each author's highest abbreviated qualification(s) and APD or NZRD status,
(iii) The addresses of the author's affiliated institutions at which the work was carried out and the author's position title
(iv) An authorship declaration
(v) The full postal and email address, plus telephone numbers, of the author to whom correspondence about the manuscript should be sent
(vi) Funding and Conflicts of interest statements
(vii) A short running title (less than 50 characters)
(viii) word count, excluding title page, abstract, references, figures and tables
The present address of any author, if different from that where the work was carried out, should be supplied in a footnote.

Authors are requested to provide the following in the title page. On acceptance these will need to be added at proof stage.

Authorship Declaration

The contribution of each author should be stated. The statement must also acknowledge that all authors are in agreement with the manuscript and declare that the content has not been published elsewhere.

Funding statement

All sources of financial grants and other funding must be disclosed.

Conflicts of Interest statement

This must include a frank declaration of the authors' industrial links and affiliations.
The absence of funding or a conflict of interest must also be stated.

Main text file

The Main Text file should be presented in the following order: (i) title abstract and key words, (iii) text, (iv) references, (v) appendices, (vi) figure legends, (vii) tables (each table complete with title and footnotes) and (viii) figure legends. Footnotes to the text are not allowed and any such material should be incorporated into the text as parenthetical matter.

Abstract and key words

All articles (original research, reviews) require a structured abstract that states in 250 words or fewer the purpose, basic procedures for conducting the analysis, main findings and principal conclusions of the study. Divide the abstract with the headings: Aim, Methods, Results, Conclusions. The abstract should contain full sentences and not contain abbreviations or references.

Between three and six key words, for the purposes of indexing, should be supplied below the abstract, in alphabetical order. It is preferable that they are taken from those recommended by the US National Library of Medicine's Medical Subject Headings (MeSH) browser list at http:/www.nlm.nih.gov/mesh/meshhome.html.

Text

All manuscripts should use the following headings to divide the sections of the manuscript: Introduction, Methods, Results, Discussion. Subheadings should not be used in these sections. Ethics approval must be stated in the methods section.

References

References follow the Vancouver style, i.e. numbered sequentially as they occur in the text and ordered numerically in the reference list.
• All citations mentioned in the text, tables or figures must be listed in the reference list.
• In the text, references should be cited using superscript Arabic numerals in the order in which they appear. The number should be placed directly after full-stops, commas or words with no space before the number.
• If cited in tables or figure legends, number according to the first identification of the table or figure in the text.
• In the reference list, cite the names of all authors when there are six or fewer; when seven or more, list the first three followed by *et al.*
• Do not use *ibid.* or *op cit.*
• Reference to unpublished data and personal communications should not appear in the list but

should be cited in the text only (e.g. Smith A, 2000, unpublished data).
• Names of journals should be abbreviated in the style used in *Index Medicus*.
• Authors are responsible for the accuracy of the references.
• Authors can read more about the Vancouver reference style at:
http://authorservices.wiley.com/reference_text.asp?site=1#vancouver

Journal article
1 Dunstan DW, Zimmet PZ, Welborn TA et al. The Australian diabetes, obesity and lifestyle study (AusDiab) – Methods and response rates. *Diab Res Clin Pract* 2002; **57**: 119–29.

Book
2 Cashel K, Jefferson S. *The core food groups: The scientific basis for developing nutrition education tools*. Canberra: National Health and Medical Research Council, 1995.

Chapter in a book
3 Bischoff SC, Sellge G. Immune mechanisms in food-induced disease. In: Metcalfe DD, Sampson HA, Simon RA, editors. *Food Allergy: Adverse reactions to foods and food additives*. Oxford: Blackwell, 2003; 14–37.

Publication available online
4 Rutihauser IHE. Getting it right: How to use the data from the 1995 National Nutrition Survey. Canberra: Commonwealth Department of Health and Aged Care; 2000. (Available from: http://www.sph.uq.edu.au/NUTRITION/monitoring/publications.htm, accessed 4 May 2005).

Online article not yet published in an issue
An online article that has not yet been published in an issue (therefore has no volume, issue or page numbers) can be cited by its Digital Object Identifier (DOI). The DOI will remain valid and allow an article to be tracked even after its allocation to an issue.
5 Brand-Miller J. Glycaemic index and glycaemic load: crunch time? *Nutrition and Dietetics* doi: 10.1111/j.1747-0080.2009.01356x

Tables and statistics

Tables should be self-contained and complement, but not duplicate, information contained in the text. Number tables consecutively in the text in Arabic numerals. Type tables on a separate page with the legend above. Legends should be concise but comprehensive – the table, legend and footnotes (including statistical tests) must be understandable without reference to the text. Vertical lines should not be used to separate columns. Column headings should be brief, with units of measurement in parentheses; all abbreviations must be defined in footnotes. Footnote symbols: $^{(a)}$, $^{(b)}$, $^{(c)}$, onwards should be used and *, **, *** should be reserved for *P*-values. Statistical measures such as SD or SEM should be identified in the headings. After statistical testing, the value of the test statistic should be reported. Give the actual *P*-value, to two significant digits, whether or not the value is statistically significant. *P*-values less than 0.001 should be reported as $P<0.001$ rather than $P=0.000$. Abbreviations used in the text must be redefined in tables and figures with a few exceptions: ANOVA (analysis of variance), BMI (body mass index), F (female), M (male).

Appendices

These should be placed at the end of the paper, numbered in Roman numerals and referred to in the text. If written by a person other than the author of the main text, the writer's name should be included below the title.

Figure legends

Type figure legends on a separate page. Legends should be concise but comprehensive – the figure and its legend must be understandable without reference to the text. Include definitions of any symbols used and define/explain all abbreviations and units of measurement.

Figures

All illustrations (line drawings and photographs) are classified as figures. Figures should be cited in consecutive order in the text using Arabic numerals.

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Appendix B Supplementary Results

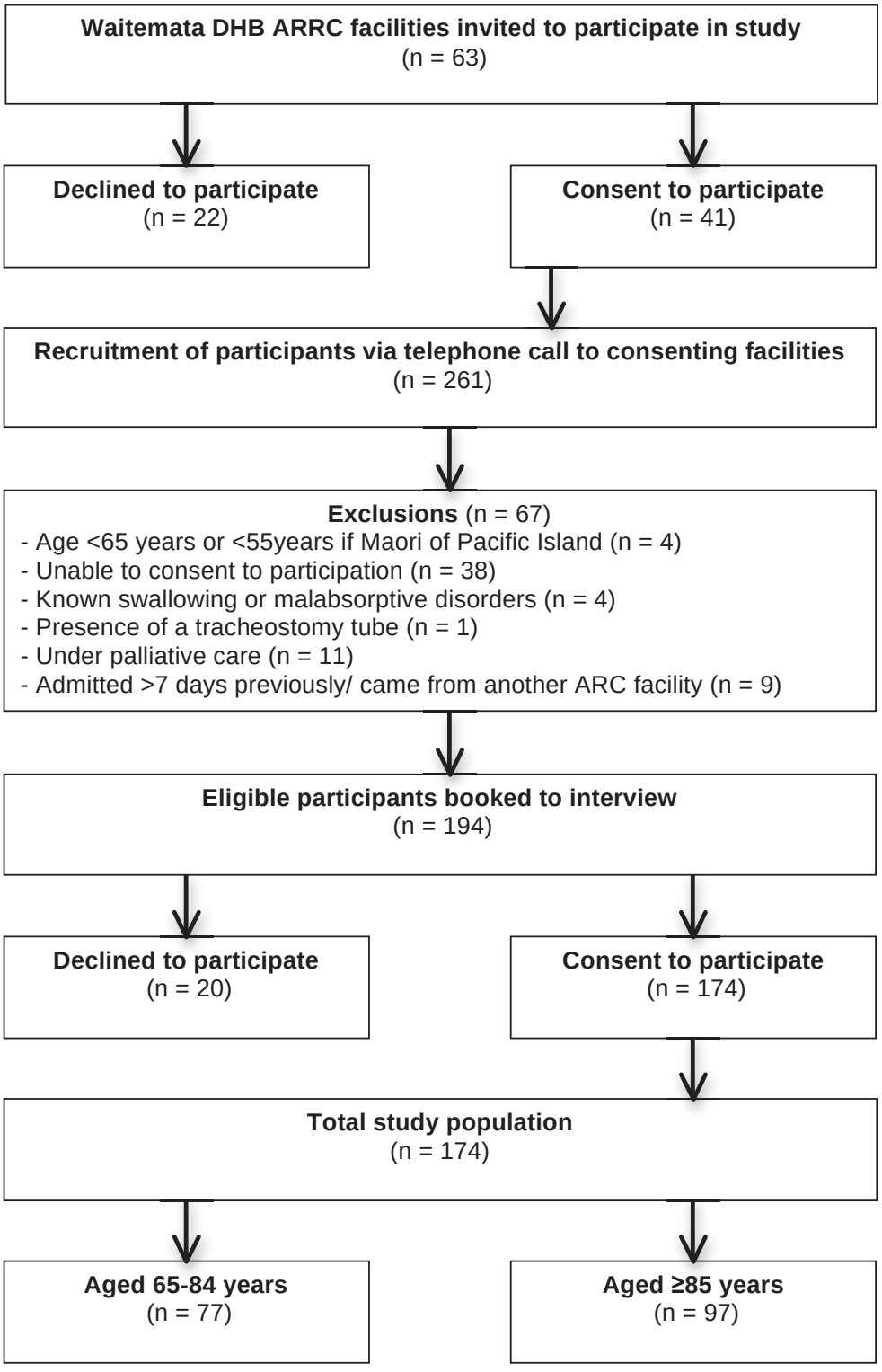


Figure 3.1 Participant flow chart

Table 3.4 Participant comorbidities

	Total n (%) n = 97 (100.0)	**Men n (%)** n = 35 (36.1)	**Women n (%)** n = 62 (63.9)
Cardiovascular/vascular conditions	82 (84.5)	31 (88.6)	51 (82.3)
Cancers & other neoplasms	21 (21.6)	10 (28.6)	11 (17.7)
Diabetes/ impaired glucose tolerance	16 (16.5)	5 (14.3)	11 (17.7)
Neurological/neuropsychiatric conditions	48 (49.5)	13 (37.1)	35 (56.5)
Respiratory conditions	21 (21.6)	9 (25.7)	12 (19.4)
Gastrointestinal conditions	25 (25.8)	9 (25.7)	16 (25.8)
Genitourinary conditions	30 (30.9)	13 (37.1)	17 (27.4)
Musculoskeletal conditions	50 (51.5)	16 (45.7)	34 (54.8)
Injury	24 (24.7)	7 (20.0)	17 (27.4)
Sensory, skin and other conditions	62 (63.9)	21 (60.0)	41 (66.1)

All values reported as n (%) unless otherwise indicated.

Most participants in the current study experienced cardiovascular/vascular conditions (84.5%). Sensory, skin and other conditions (63.9%) and musculoskeletal conditions (51.5%) were also prevalent within this sample.

Table 3.5 Support services and dietetic input received by participants

	Total n (%) n = 97 (100.0)	**Men n (%)** n = 35 (36.1)	**Women n (%)** n = 62 (63.9)	***p***
Receives regular subsidised support services	61 (62.9)	22 (62.9)	39 (62.9)	0.996
Not receiving regular subsidised support services	36 (37.1)	13 (37.1)	23 (37.1)	
Requires assistance with daily tasks	71 (74.0)	29 (82.9)	42 (68.9)	0.132
Does not require assistance with daily tasks	25 (26.0)	6 (17.1)	19 (31.1)	
Received dietetic input	20 (20.6)	9 (25.7)	11 (17.7)	0.351
Has not received dietetic input	77 (79.4)	26 (74.3)	51 (82.3)	

All values reported as n (%) unless otherwise indicated. Differences between groups identified using Pearson's Chi test.

** Significant difference (p <0.05)*

Almost three quarters (74.0%) of participants require assistance with daily tasks, and 62.9% receive regular subsidised support services. Additionally, the majority of participants (79.4%) have not received dietetic input.

Table 3.6 Participant MNA-SF item responses by nutrition risk status

	Total n (%) n = 97 (100)	**Well-nourished n (%)** n = 9 (9.3)	**At risk n (%)** n = 39 (40.2)	**Malnourished n (%)** n = 49 (50.5)
Food intake				
Severe decrease	25 (25.8)	0 (0.0)	3 (7.7)	22 (44.9)
Moderate decrease	34 (35.1)	1 (11.1)	13 (33.3)	20 (40.8)
No decrease	38 (39.2)	8 (88.9)	23 (59.0)	7 (14.3)
Involuntary weight loss				
Weight loss >3kg	24 (24.7)	0 (0.0)	1 (2.6)	23 (46.9)
Does not know	35 (36.1)	1 (11.1)	14 (35.9)	20 (40.8)
1-3kg weight loss	16 (16.5)	1 (11.1)	9 (23.1)	6 (12.2)
No weight loss	22 (22.7)	7 (77.8)	15 (38.5)	0 (0.0)
Mobility				
Bed/chair bound	22 (22.7)	0 (0.0)	5 (12.8)	17 (34.7)
Does not go out	34 (35.1)	3 (33.3)	9 (23.1)	22 (44.9)
Goes out	41 (42.3)	6 (66.7)	25 (64.1)	10 (20.4)
Psychological stress/acute disease				
Yes	65 (67.0)	2 (22.2)	21 (53.8)	42 (85.7)
No	32 (33.0)	7 (77.8)	18 (46.2)	7 (14.3)
Neuropsychological problem				
Dementia/depression	19 (19.6)	0 (0.0)	4 (10.3)	15 (30.6)
Mild dementia	16 (16.5)	0 (0.0)	6 (15.4)	10 (20.4)
No psychological problems	62 (63.9)	9 (100.0)	29 (74.4)	24 (49.0)
Body Mass Index (BMI)				
BMI <19	22 (28.9)	0 (0.0)	6 (17.1)	16 (47.1)
BMI 19 to 20	9 (11.8)	1 (14.3)	6 (17.1)	2 (5.9)
BMI 21 to 22	17 (22.4)	0 (0.0)	9 (25.7)	8 (23.5)
BMI ≥23	28 (36.8)	6 (85.7)	14 (40.0)	8 (23.5)
Calf Circumference (CC)				
CC <31cm	11 (52.4)	0 (0.0)	0 (0.0)	11 (73.3)
CC ≥31cm	10 (47.6)	2 (100.0)	4 (100.0)	4 (26.7)

MNA-SF, Mini Nutrition Assessment-Short Form.

All values reported as n (%) unless otherwise indicated.

Almost half (44.9%) of malnourished participants reported a severe decrease in food intake and 46.9% reported involuntary weight loss >3kg. Two thirds (67.0%) of participants reported experiencing recent psychological stress/acute disease and 63.9% reported having no psychological problems. Over one quarter (28.9%) of participants who completed BMI measures had a BMI <19 and half (52.4%) of participants who completed measures of calf circumference had a calf circumference <31cm.

Appendix C Questionnaires used in Research

Appendix i Information Sheet

Participant Information Sheet

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.senior05@gmail.com

- Dushanka Hettige
  Masters Dietetic student
  027 4583737 or
  hettigedushanka@gmail.com

- Idah Chatindiara
  PhD student, Massey University
  02041265744 or
  I.Chatindiara@massey.ac.nz

- Theresa Teresa Stanbrook
  NZRD - Professional Leader-Dietetics- Waitemata DHB
  Teresa.Stanbrook@waitematadhb.govt.nz

- Carol Wham PhD, NZ Registered Dietitian
  A/Professor of Nutrition and Dietetics,
  Massey University,
  c.a.wham@massey.ac.nz

- Jacqui Allen FRACS MBChB FRACS ORL HNS,
  Consultant Otolaryngologist,
  North Shore Hospital, Takapuna
  jeallen@voiceandswallow.co.nz

Appendix ii Participant Consent Form

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	Yes ☐	No ☐

on this study.		
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 iii Demographic, Physical Assessment, Health & Support Service 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:

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 1 =	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 1 =	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	

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 iv Mini Nutritional Assessment-Short Form (MNA-SF)(Nestlé Nutrition Institute 2004)

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)**

Appendix v 10-Item Eating Assessment Tool (EAT-10)(Belafsky, Mouadeb et al. 2008)

To what extent do you experience the following problems? Rate from 1-4

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	

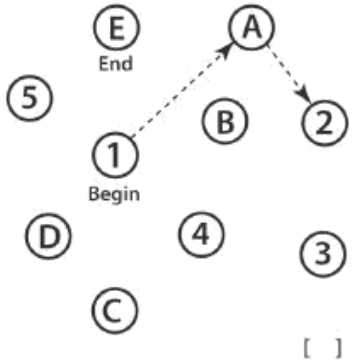
(max. 40 points)		
Not at risk(<3)		At risk of swallowing efficiently and safely (≥ 3)
1		**2**

Appendix vi Montreal Cognitive Assessment (MOCA)(Nasreddine, Phillips et al. 2005)

MONTREAL COGNITIVE ASSESSMENT (MOCA)
Version 7.1 Original Version

NAME :
Education : Date of birth :
Sex : DATE :

VISUOSPATIAL / EXECUTIVE



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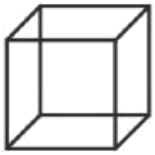


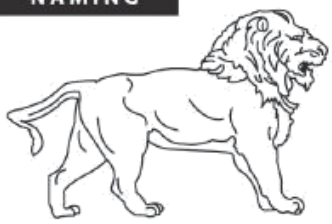
[ ] [ ]

Draw CLOCK (Ten past eleven) (3 points)

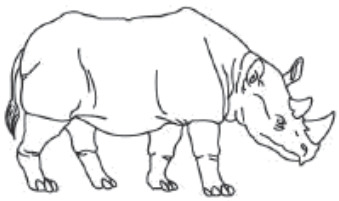
[ ] Contour [ ] Numbers [ ] Hands

POINTS ___/5

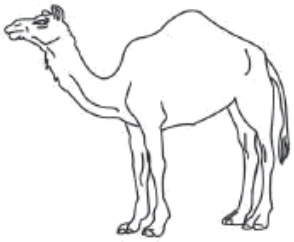
NAMING



[ ]



[ ]



[ ] ___/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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TOTAL ___/30
Add 1 point if ≤ 12 yr edu

Administered by: _____