Assessment of nutrition risk using the Mini-Nutritional Assessment Short-Form and biomarkers (prealbumin) in community-living older adults within Auckland

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Abstract

Background: The global population is ageing with New Zealand currently experiencing a large growth in those aged 65 years and older. Increasing age is associated with increasing use of health and disability support services. Vulnerable older adults are at high risk of malnutrition and may be high users of these services. With global ageing creating more economic and social pressures on countries, it is important that nutritional well-being, a key determinant of good health and healthy ageing, is maintained throughout life to sustain functional health and quality-of-life in older adults. Assessing nutrition status will help determine those at nutrition risk.

Aim: To determine the prevalence of nutrition risk in community-living older adults enrolled with The Henderson Medical Centre, a general practice in West Auckland; to determine the prevalence of dysphagia risk; and to assess the potential of prealbumin (PAB) in conjunction with C-reactive protein (CRP) as biomarkers of nutrition risk.

Method: Patients enrolled with Henderson Medical Centre were recruited into this cross-sectional study over a three-month period. Nutrition risk was determined by the Mini Nutritional Assessment Short-Form (MNA-SF), dysphagia risk by the 10-Item Eating Assessment Tool (EAT-10), and cognitive function by the Montreal Cognitive Assessment tool (MoCA). Demographic, living situation, co-morbidities, number of medications, and support services information was collected through a face-to-face interview. Serum PAB and CRP were measured and their relationship with the MNA-SF analysed.

Results: Two hundred participants, mean age 80.9±4.5 years, were recruited. Women comprised 55.5%. Two participants were categorised by the MNA-SF as malnourished and 12% categorised as at risk of malnutrition. Dysphagia risk was observed in 7.5%. 131 participants received a blood test, with a mean PAB value of 0.27±0.06g/L and mean CRP value 4.66 ±11.81mg/L. 85% of participants had a normal PAB and CRP value. No significant association was found between serum PAB values and nutrition risk status when compared.

Conclusion: One in seven community-living older adults were categorised as at risk of malnutrition. Our study found a low prevalence of nutrition and dysphagia risk indicating a generally 'well' study population. PAB and CRP did not significantly correlate with the MNA-

SF scores in this population. The results highlight the need for further studies investigating the use of PAB and CRP as nutrition biomarkers in community-living older adults.

Key words: older adults, community-living, nutrition risk, dysphagia, prealbumin, C-reactive protein

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Abbreviations

ADE	Adverse Drug Event
ANSI	Australian Nutrition Screening Initiative
AT&R	Assessment, Treatment & Rehabilitation
BMI	Body Mass Index
BMR	Basal Metabolic Rate
BRIGHT	Brief Risk Identification Geriatric Health Tool
CC	Calf circumference
CHD	Coronary Heart Disease
cm	Centimetres
CRP	C-Reactive Protein
CVD	Cardiovascular Disease
DALY	Disability-adjusted life year
DHB	District Health Board
EAT-10	10 Item Eating Assessment Tool
HDEC	Health and Disability Ethics Committee
HOPS	Health of Older People Strategy
IADL	Instrumental Activities of Daily Living
ICD-10	International Statistical Classification of Diseasesand Related Health Problems, 10th revision
kg	Kilograms
LiLACS NZ	Life and Living in Advanced Age, a Cohort Study in New Zealand
m	Metres
MCI	Mild Cognitive Impairment
MDADI	MD Anderson Dysphagia Inventory
MMSE	Mini-Mental State Examination
MNA	Mini Nutritional Assessment
MNA-SF	Mini Nutritional Assessment Short Form

MoCA	Montreal Cognitive Assessment
MoH	Ministry of Health
MUST	Malnutrition Universal Screening Tool
NHMRC	Nation Health and Medical Research Council
NRV	Nutrient Reference Values
NZ	New Zealand
NZANS	New Zealand Adult Nutrition Survey
NZBD	New Zealand Burden of Diseases, Injuries and Risk Factors Study
NZHS	New Zealand Health Survey
OECD	Organisation for Economic Co-operation and Development
PAB	Prealbumin
PEM	Protein-Energy Malnutrition
RBP	Retinol Binding Protein
RD	Registered Dietitian
SCREEN II	Seniors in the community: risk evaluation for eating and nutrition, Version II
SNAQ	Short Nutritional Assessment Questionnaire
SWAL-QOL	Swallowing Quality of Life
VFS	Videofluoroscopy
WDHB	Waitemata District Health Board
WHO	World Health Organisation

Chapter 1: Introduction

1.1 Overview

The New Zealand population is ageing. Soon there will be more people aged 65 years and older than under the age of 15. By 2015, 25 percent of the population will be aged 65 years and older (Statistics New Zealand, 2014). Good health is critical to and influences happiness and well-being and is comprised of two dimensions: how long people live and their quality of life (Ministry of Social Development, 2010).

Increasing age is associated with increasing use of health and disability support services due to older people requiring more health care, with more than 80 percent of health care costs occurring after 65 years of age, and 90 percent of support services for older adults received by adults 75 years and older. With the rapid growth in number and proportion of the aged population, the demand for such services is only going to increase in the future regardless of older people staying healthier for longer (Dyson, 2001).

A key concern is therefore the growing economic and social pressures on health care, society and governments. A major challenge facing governments with ageing populations is to ensure positive ageing in place: keeping older adults well, maintaining independence and with a good quality of life, in order to retain functional capacity and reduce the risk of early disability (Dyson, 2001; Watson, Zhang, & Wilkinson, 2010).

Nutrition risk and malnutrition is highly associated with poorer health status and adverse clinical outcomes, such as impaired muscle and respiratory function, poor wound healing, and increased morbidity, mortality, and institutionalisation. Malnutrition largely goes undetected and undertreated and is both a cause and consequence of disease (Saunders & Smith, 2010). Malnutrition affects every domain of a person's well-being and is an important, highly associated risk factor for development and severity of frailty in older people (D. Harris & Haboubi, 2005; Thomas et al., 2002). Additionally, it increases healthcare costs on society (Kaiser, Bandinelli, & Lunenfeld, 2010; The Dietitians Association of Australia, 2009).

Within New Zealand, there are limited data on the nutritional status and prevalence of nutrition risk and malnutrition among community-living older adults (Watson et al., 2010). Various studies have found high nutrition risk in community-living older adults to range from 31-52 percent, and those at moderate nutrition risk to range from 23 to 27 percent (McElnay et al., 2012; Watson et al., 2010; C. Wham, Carr, & Heller, 2011; C. Wham, Teh, Robinson, & Kerse, 2011; C. A. Wham & Bowden, 2011; C. A. Wham, Mclean, et al., 2014; C. A. Wham, Redwood, & Kerse, 2014; C. A. Wham et al., 2015).

The Mini Nutritional Assessment Short Form (MNA-SF) is ideal for use in the community as a nutrition risk screening tool. The MNA-SF is simple to administer, and has been developed and validated for older adults, allowing for quick identification of those that are malnourished and at risk of malnutrition. Additionally, a simple, rapid and reliable laboratory test that responds to protein-energy malnutrition, such as prealbumin in conjunction with C-reactive protein, has potential to be more efficient than nutrition risk screening and more effective in evaluating inflammation (Gallagher, Charlette, Coble Voss, Finn, & McCamish, 1996; Saka et al., 2011; Shenkin, 2006).

Nutrition plays a central role in influencing whether we age well (Khaw, 2008). As malnutrition is not a consequence of ageing, it is therefore important to determine the prevalence of nutrition risk, identify the factors affecting nutritional status and address these issues.

1.2 Significance of Research

The purpose of this research is to gain a snapshot of the current prevalence of nutrition risk and malnutrition in older adults living independently in the community within a defined area of the Auckland region. Considering the New Zealand population is ageing, there is a need for a quick, simple and valid method of nutrition risk screening in older adults in a setting where a full nutritional assessment is challenging to obtain. This study aims to add to the current body of evidence to aid policy development on attaining successful ageing in the community and optimal and efficient screening for nutrition risk.

1.3 Aims and Objectives

1.3.1 Aims

The aim of this study was to determine the prevalence of nutrition risk status in community-living older adults enrolled with a general practice within the Auckland region.

1.3.2 Objectives

This study has three main 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 10-item Eating Assessment Tool (EAT-10).
3. To assess the potential of prealbumin (PAB) in conjunction with C-reactive protein (CRP) as a biomarker of nutrition risk.

1.4 Structure of the Thesis

This thesis is composed of six chapters, starting with an introduction to the importance of the research in Chapter 1. Chapter 2 provides a review of the current literature in order to understand factors influencing the health of older people and current measures of nutrition status. The procedures used in this study are outlined in Chapter 3. Chapter 4 presents the results of this study for prevalence of nutrition and dysphagia risk amongst the participants and of serum PAB and CRP values. The results and findings of this study are discussed in Chapter 5 in relation to previous research and future requirements, and reflects on the strengths and limitations of the study. Chapter 6 lastly provides a summary of the study, recommendations for ideal nutrition and dysphagia risk screening, and proposed future research. A full list of references and appendices are found at the end of this thesis.

Chapter 2: Literature Review

2.1 The Ageing Population

A transition to lower birth and death rates is causing the New Zealand population to age. In 2011, the first of the baby-boom generation (those born between 1950 and the early 1970s) moved into the older ages, signifying the start of the projected large growth in those aged 65 years and older. The median age of the New Zealand population has increased from 26 years in 1971 to 37 years in 2009 - this is expected to increase to 46 years by 2051 (Statistics New Zealand, 2014). Population growth within New Zealand will slow as the population ages and the gap between the number of births and deaths reduces. By the 2020's, there will be more people aged 65 years and older than there will be under the age of 15 (Ministry of Health, 2002a; Statistics New Zealand, 2014). It is predicted that the 65+ age group will increase from 13 percent of the population in 2010 to 22 percent of the population by 2031 and 25 percent by 2051. The older population itself is ageing too; by the 2050s, one in four people aged 65+ will be 85+, compared to one in eight in 2014 (Statistics New Zealand, 2014).

2.1.1 Ethnic Diversity

There will be increasing ethnic diversity in the older ages resulting in the needs of the older population becoming more diverse. The proportions of Māori and Pacific people aged 65 years and older in the population are estimated to increase by 270 percent and 400 percent respectively. By 2021, the Māori and Pacific populations aged 65+ are projected to increase from 20,000 in 2001 to 56,000, and from 9,000 to 26,000 respectively. The Asian ethnic group will experience the fastest growth reaching 56,000 in 2021 from 11,000 in 2001 (Statistics New Zealand, 2006).

2.1.2 Life Expectancy

Life expectancy of New Zealanders at birth in 2012-14 was 79.5 years for men and 83.2 years for women. However, Maori and Pacific ethnic groups continue to experience higher fertility and mortality rates than Asian and European ethnic groups. Maori life expectancy is significantly lower than that of non-Maori, with 2012-14 life expectancy of females of Maori ethnicity being 77.1 years and 70.4 years for males of Maori ethnicity. This is compared with 83.9 years for non-Maori females and 80.3 years for non-Maori males (Statistics New Zealand, 2015b).

Despite assumed lower death rates and the increase in life expectancy, death rates will continue to rise as more people reach older ages where most deaths occur. The rapidly growing and ageing older population will thus impact on the demand for health and support services, as older people are the highest users of health and disability support services (Dyson, 2001).

2.1.3 Positive Ageing in Place

The New Zealand Positive Aging Strategy Action Plan was developed and implemented in 2001/02 by the Ministry of Health and includes the key health action 'Health of Older People Strategy' (HOPS). The aim of the strategy is to create a society where older adults can positively age, are highly valued, and recognised as integral members of families and communities. The strategy promotes participation in health care decisions to have more control over their lives, and participation in and contribution to social, family, whanau and community life (Dyson, 2001). Overall, it comprises ten goals which provide a framework for the changes needed to be made to provide the required health and support services for the older population (Ministry of Health, 2002b). The ten goals for older people include: ensuring a secure and adequate income; equal access to health services and culturally appropriate services across rural and non-rural communities; affordable and appropriate housing and transport options; ensuring safe, secure and positive attitudes towards ageing in the community; ensuring continued employment opportunities for older people; and increasing opportunities for personal growth and participation in the community (Office for Senior Citizens, 2015).

This strategy draws upon the United Nations Principles for Older Persons (United Nations Human Rights Office of the High Commissioner, 1991), work undertaken by the World Health Organization (WHO) and the Organization for Economic Co-operation and Development (OECD), and other nation's policies regarding health care needs of ageing populations, most notably Australia, the United Kingdom and Canada (Ministry of Health, 2002b; World Health Organization, 2002).

A meaningful life to older people focuses on "having a sense of purpose or motivation and a feeling of significance" (Koopman-Boyden, Cameron, Davey, & Richardson, 2014). Barriers to participating in education, training and employment (reducing economic standard of living) can further reduce people's ability to participate in other areas of life, including

family life, socialisation, participating in community activities and recreation and leisure pursuits. This can lead to frustration and isolation (Ministry of Social Development, 2010). With numerous health inequalities present between New Zealand European and other ethnic groups, it is further important that culturally appropriate services are provided for the growing populations, including Māori, Pacific and Asian older adults.

The concept of 'ageing in place' - meaning the ability to make choices in later life about where to live and receiving the support needed to do so - is a key focus of the New Zealand government. Older adults are high users of health and disability support services and use more as they age – adults 75 years and older receive 90 percent of support services for older adults. The demand for such services is likely to increase in the future with the rapid growth in number and proportion of the aged population, regardless of older people staying healthier for longer (Dyson, 2001). Older adults want to be free from pain, suffering and injury or illness-related incapacitation; this is where ageing in place aims to keep older adults healthy and in their own homes to maximise social wellbeing (Ministry of Social Development, 2010). Essentially, it is helping older adults maintain autonomy and independence.

2.2 Physical Health and Function of Older Adults

2.2.1 Healthcare Costs and Ageing

Advancing age is associated with degenerative processes, leading to a decline in physical and cognitive function, and age-associated social and lifestyle changes. It can become difficult to separate changes associated with healthy ageing from ill-health (Khaw, 2008; Ministry of Health, 2013a). Increasing age is associated with increasing health costs due to older people requiring more health care, with the majority of health costs occurring within the last few years of life - more than 80 percent of health care costs occur after 65 years of age (New Zealand Treasury, 2012; Te Pou, 2011). The proportion of people to have seen a health care worker from their usual primary health care provider about their own health generally increases with age. The 2006/07 New Zealand Health Survey found the proportion of the population who had seen a GP in the last 12 months was highest for adults over 65 years of age and children under 5 years (Ministry of Health, 2008).

In 2012, approximately 25 percent of spending by the New Zealand Government was directed towards 13 percent of the population aged 65 years and older. It is estimated that $4.678 billion (approximately 36%) of health spending is towards services for those aged over 65 (Ministry of Social Development & Office for Senior Citizens, 2012). Additionally, it is estimated that the average person aged 65 years or older currently costs the public health system around five times as much as the average person under 65 years in New Zealand (New Zealand Treasury, 2012). In 2012/2013, the Government spent $928 million on aged residential care, an increase of $184 million than that spent four years earlier. Furthermore, the 2013 Budget provided an additional $11.3 million per year for aged residential care subsidies (New Zealand Government, 2013).

Global ageing of the population will create more economic and social pressures on countries. Thus, a major challenge facing governments with ageing populations is to ensure positive ageing in place: keeping older adults well, maintaining independence and with a good quality of life, in order to retain functional capacity and reduce the risk of early disability (Dyson, 2001; Watson et al., 2010).

Good health is critical to and influences happiness and well-being. It is comprised of two dimensions: how long people live and their quality of life (Ministry of Social Development, 2010). Good health enables people to participate in a greater range of social activities and allows more choices in life. Life expectancy in New Zealand has increased by approximately 11 years over the last half century, largely due to advances in medical treatment and delayed onset of disease from improved healthier lifestyles (Te Pou, 2011). However, older adults are experiencing a greater burden of chronic, non-communicable diseases than ever before, namely due to increasing life expectancy and an accumulation of exposures to risk factors (Ministry of Health, 2013a). The growing number and proportion of older people comprising the population means diseases and disorders commonly associated with ageing and older people will have a greater impact on society, such as cardiovascular disease, some cancers, and type 2 diabetes which are seen to peak at this period (Ministry of Health, 1997; World Health Organization & Food and Agriculture Organization of the United States, 2003) .

2.2.2 Chronic Diseases and Health Loss in Older Adults

In 2013, the Ministry of Health published The New Zealand Burden of Diseases, Injuries and Risk Factors Study (NZBD) (Ministry of Health, 2013b), a report based on fatal and non-fatal data from 2006 analysing how much healthy life is lost due to early death, illness or disability. 'Health loss' describes the gap between the current population's state of health and that of an ideal population free from ill health and disability; health loss is estimated using the measure disability-adjusted life years (DALY). This was the first of its kind to be published in New Zealand and compares to the WHO *Global Burden of Disease* published in 2010. *Health Loss in New Zealand* allows identification of areas for health gain, whilst helping guide healthy policy, planning and provision of services.

The leading causes of health loss in 2006 for the population as a whole at the condition group level were cancers (17.5%) and vascular and blood disorders (17.5%), followed by mental disorders (11%), musculoskeletal disorders (9%) and injury (8%). For those aged 65-74 years, cancers and vascular disorders were the leading causes of health loss at 29 and 24 percent respectively, followed by musculoskeletal disorders at 11 percent. Adults aged 75 years and over experienced their majority of health loss from vascular disorders (35%) which overtakes cancer (18%). Neurological conditions ranked third at 10 percent (Figure 3) (Ministry of Health, 2013b).

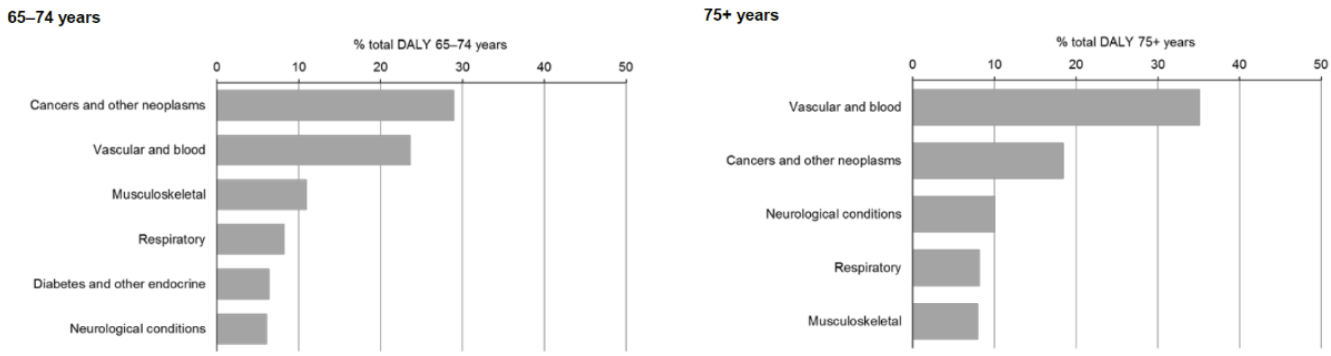

Figure 1: DALYs, by leading condition group and age group for 2006 (Ministry of Health, 2013b)

As discussed previously, Māori experience greater inequalities as a whole compared to non-Māori. They also sustain greater health loss in most condition groups. Vascular disorders were the major cause of excess burden in Māori at 26 percent, whilst cancers (15%), mental illness (12%), injury (11%), and diabetes and other endocrine disorders (9%) followed (Ministry of Health, 2013b).

Despite only making up 12 percent of the population, older adults aged 65+ sustained over one-third (37%) of total health loss in 2006 (Ministry of Health, 2013b).

2.2.2.1 Cancers

Cancer is a leading cause of death in New Zealand and fundamentally a disease of ageing - the prevalence and incidence increases with age. In 2006, cancers were the leading cause of health loss for older adults aged 65-74 years (29%), and second largest cause (18%) for those aged 75 years and older. All-cancer mortality rates are nearly seven and twelve times higher for females and males respectively aged 85 years and over than among those aged 50-64 years, whilst all-cancer mortality rates are twice as high for Māori than for non- Māori (Ministry of Health, 2013b).

Cancer incidence may increase in older adults due to a variety of factors, including age-related changes in the immune system and hormones, accumulation of genetic mutations, carcinogen exposure over the lifetime, and the development of cancers after a long latency period (Ministry of Health, 2013a). Food, nutrition, obesity and physical activity can influence fundamental cellular process with the potential to promote or inhibit cancer development and progression (Ministry of Health, 2013a). Dietary factors are estimated to account for 30 percent of cancers (World Health Organization & Food and Agriculture Organization of the United States, 2003). Consuming a healthy diet, participating in physical activity, maintaining a healthy weight, and most importantly, not smoking tobacco will all aid in reducing the global burden of cancer over time (Ministry of Health, 2013a; World Health Organization & Food and Agriculture Organization of the United States, 2003).

2.2.2.2 Cardiovascular Disease

Cardiovascular diseases (CVD) affect the heart and circulatory system, and include coronary heart disease (CHD), stroke, hypertensive disease, and peripheral vascular disease (Ministry of Health, 2013a). CVD is a leading cause of death in older New Zealand adults. In 2005, coronary heart disease accounted for 21 percent of all deaths for New Zealand adults, and was the leading cause of death in all age categories over 65 years. Stroke was the third leading cause of death in non-Māori, and was the second cause of death for men and women aged over 75 years (Ministry of Health, 2013a).

The prevalence of stoke and diagnosis of CHD increases with age, with stroke being the most common cause of disability in older New Zealanders. Function and disability are the main outcomes associated with recovery post-ischaemic stroke – they are highly disabling and limit the ability to carry out activities of daily living (Cornwall & Davey, 2004). In 2006/07 Māori women were twice as likely to be diagnosed with CHD than non- Māori (Ministry of Health, 2013a).

High intake of saturated fats, salt and refined carbohydrates, as well as below recommended intake of fruits and vegetables are unhealthy lifestyle dietary choices further associated with increased risk for CVD (Ministry of Health, 2008; World Health Organization & Food and Agriculture Organization of the United States, 2003).

2.2.2.3 Neurological disorders

Neurological conditions are the third leading cause of health loss in older New Zealand adults, contributing 6.8 percent (Ministry of Health, 2013b). Neurological conditions include dementia (Alzheimer's disease and vascular are predominant), Parkinson's disease, migraine, insomnia, epilepsy, multiple sclerosis, motor neuron disease, muscular dystrophy and intellectual impairment. The process of ageing is commonly associated with a decline in cognitive function. Dementia goes above and beyond normal ageing processes, resulting in significant loss of memory and reduction of intellectual function, often encompassed with personality changes and eventual interference with daily living; It is one of the major causes of disability in the elderly (Jorm, 1994).

Worldwide, the rate of dementia is doubling every 20 years (Alzheimers New Zealand, 2010). In 2011, 48,182 of New Zealander's (1.1%) were living with dementia, an increase of 18 percent since 2008. It is estimated 74,000 New Zealander's will have dementia by 2026, and over 146,000 by 2050. In 2006, dementia accounted for 1.8 percent of health loss, a burden that is expected to increase as the population rapidly ages (Ministry of Health, 2013b).

Changes in cognitive function and mental health can affect the autonomy and independence of an older person, with malnutrition commonly associated with neurological conditions. Neurological changes can have a negative impact on nutritional status with issues including refusing or forgetting meals, unfavourable eating behaviours, appetite changes, dyspraxia

and self-feeding difficulties, swallowing difficulties, safety issues in food preparation whereby unintended harm to themselves could occur, and inability to prepare food appropriately (Keller et al., 2008; Ministry of Health, 1997). Malnutrition can lead to death and institutionalisation, thus increasing health loss (Keller et al., 2008).

2.2.2.4 Musculoskeletal disorders

Musculoskeletal conditions are associated with high rates of disability and primary health care use, though associated with low mortality, they were the fifth leading cause of health loss in older New Zealand adults (Ministry of Health, 2013b).

Osteoporosis commonly occurs in older adults and is associated with low bone density due to low bone formation, excessive bone resorption, or both, resulting in less dense, porous, fragile and brittle bones. This increases the risk of fractures and resulting disability and reduced physical functionality (Ministry of Health, 2013a).

2.2.3 Functional Health and Ageing

Changes in body composition occur with age. A decline in skeletal muscle mass is experienced by one to two percent per year after 50 years of age, further accelerating after 80 years of age (Ministry of Health, 2013a). Men experience a more gradual decline in loss of muscle mass, whilst post-menopausal women will observe a sudden drop. Loss of muscle mass compromises muscle strength, leading to a decline in physical functional capacity, impaired mobility and balance, and greater risk of falls, fractures and mortality (Houston et al., 2008; Ministry of Health, 2013a; Rolland et al., 2008). This age-related decline in muscle mass is described by the term ‘sarcopenia’.

An increased risk for decline in functional status is associated with reduced physical activity, contributing to a decline in basal metabolic rate (Stuck et al., 1999). Though physical activity and ensuring good nutrition can slow the loss of and even improve muscle mass and strength, age-related sarcopenia is not reversible (Ministry of Health, 2013a). It is therefore important to ensure older adults eat well with a variety of foods and adequate protein intake to slow the loss of muscle mass, associated functional decline, and subsequent poorer nutritional status.

2.3 Nutrition and Ageing

2.3.1 The Importance of Nutritional Well-Being

Nutritional well-being is a major determinant of good health, healthy ageing, and quality-of-life. It is associated with health promotion, prevention of dietary deficiency disease, and avoiding malnutrition secondary to another disease (Amarantos, Martinez, & Dwyer, 2001). Good nutrition is further associated with supporting physical function, reducing risk of chronic disease, supporting mental health, and preventing disability (Ministry of Health, 2013a). As the population continues to age, it is vastly important to maintain functional health and quality of life in older adults - nutrition plays a central role in influencing healthy ageing (Khaw, 2008).

2.3.2 Dietary Advice for Older Adults

Nutritional recommendations for the New Zealand population are based on the Nutrient Reference Values for Australia and New Zealand (NRVs) (National Health and Medical Research Council & Ministry of Health, 2005). The NRVs include two categories of older adults: 51-70 years and adults >70 years of age, however the nutritional requirements of older adults are not well defined. Based on the recommendations, older adults show increased requirements for a variety of nutrients, including protein, calcium, vitamin D, and vitamin B6. On the contrary, adults have reduced energy requirements in older age (National Health and Medical Research Council & Ministry of Health, 2005). The Ministry of Health developed *The Food and Nutrition Guidelines for Health Older People (Ministry of Health, 2013a)*, a publication outlining up-to-date food and nutrition related advice for older people, recognising the burden of chronic disease and factors affecting frailty in older people.

An adapted description of each food group with indication of nutrients provided and advice on the recommended number of servings per day is found in Table 1.

Table 1: Advice on servings and nutrients of the four food groups for health older people

Food Group	Nutrients provided	Recommended Servings Per Day
Vegetables and Fruit (includes fresh, frozen, canned and dried)	• Carbohydrates • Dietary fibre • Vitamins: Folate, vitamin A (mostly in yellow & green vegetables) and vitamin C (dark-green leafy vegetables, most fruit, potatoes) • Minerals: magnesium, potassium	Eat at least 5 servings per day: • At least 3 servings of vegetables • At least 2 servings of fruit
Breads & Cereals (includes breakfast cereals, breads, grains, rice and pasta), preferably wholegrain	• Carbohydrates • Dietary fibre • Vitamins: all B group (except B_{12}), E • Minerals (particularly wholegrain): magnesium, calcium, iron, zinc and selenium	At least 6 (chose wholegrain)
Milk & Milk Products (includes milk, cheese, yoghurt, and ice-cream) and alternatives	• Protein • Fats: higher in saturated especially in full-fat products. • Vitamins: riboflavin, B_{12}, A, D • Minerals: rich in calcium, phosphorus, zinc and iodine	At least 3 (choose low-fat or reduced-fat options)
Meats, Meat Products and alternatives (includes seafood, eggs, nuts and seeds, and legumes)	• Protein • Fats: mostly unsaturated in seafood, nuts and seeds; mostly saturated and cholesterol in meats • Vitamins: B_{12}, niacin, thiamin • Minerals: Iron, zinc, magnesium, potassium copper, phosphorus and selenium • Iodine (mostly in seafood and eggs) • Fibre (in legumes, nuts and seeds)	At least 1

(Ministry of Health, 2013a)

2.3.2.1 Energy

Energy requirements vary widely due to gender, body size and level of physical activity. Adequate energy is required to sustain metabolic processes, physiological functions, muscular activity, heat production, growth, and synthesis of new tissues (Ministry of Health, 2013a; National Health and Medical Research Council & Ministry of Health, 2005). Energy

requirements are recognised to decrease with age in older adults due to an age-related loss of lean body mass and fall in basal metabolic rate (Chernoff, 2004; Ministry of Health, 2013a; World Health Organization, 2015).

Studies have shown a dysregulation of food intake in older adults, resulting in a loss of body mass when approaching 70 years of age (Morley & Thomas, 1999). Physiological changes in appetite, taste and smell, as well as ill-fitting dentures may contribute to older people experiencing difficulty eating enough foods to meet their energy and nutrient requirements (Ministry of Health, 2013a).

2.3.2.2 Protein

Adequate protein intake is essential to build and repair tissue, in hormone, enzyme and antibody synthesis, and for other body functions. Inadequate protein intake in older adults is associated with increased skin fragility, reduced immune function, poor rates of healing, and longer recovery from illness (Chernoff, 2004; Ministry of Health, 2013a). Muscle protein formation may be stimulated by higher availability of protein, thus it is important that adequate protein intake is maintained (Ministry of Health, 2013a). Ensuring adequate dietary protein intake for this population group is essential to optimise health status, prevent protein-energy malnutrition, and reduce the effects of age-related sarcopenia.

2.3.2.3 Micronutrients

Deficiencies of micronutrient (vitamins and minerals) are often common in older adults due to a number of factors such as reduced food intake, lack of dietary variety, and also age-related physiological decline in efficient absorption and metabolism of foods (World Health Organization, 2015).

In particular, older adults have been identified as at greater risk of vitamin D deficiency due to thinning of skin, reduced skin production and decreased exposure to sunlight (Ahmed & Haboubi, 2010). They are at an increased risk of fractures and osteoporosis with ageing secondary to reduced calcium absorption and resorption of bone minerals occurring more rapidly than bone formation with age (Brown, McNeill, Radwan, & Willingale, 2007). There is an increased calcium requirement for people over 70 years (National Health and Medical Research Council & Ministry of Health, 2005), and an adequate intake of calcium rich foods is vital for bone health.

2.3.3 Dietary Trends in Older Adults

The New Zealand Health Survey 2014/15 (NZHS) reported 78 percent of adults aged 75+ ate at least three servings of vegetables per day, and 64 percent ate at least two servings of fruit per day. This means 22 percent and 36 percent are not able to meet the recommended serves. Women aged 75+ are more likely to meet the fruit intake than men (75% and 66% respectively). The NZHS14/15 has shown a decreasing trend in adults meeting the recommended three servings of vegetables and two of fruits since 2006/07, at 43 percent and 40 percent respectively (Ministry of Health, 2015).

2.4 Malnutrition

Malnutrition is a major health problem both internationally and within New Zealand which largely goes unrecognised. It is a cause and a consequence of ill health across many patient groups and healthcare settings, interfering with patients' ability to benefit from health treatment. Malnutrition affects every domain of a person's well-being, and additionally, it increases healthcare costs on society (The Dietitians Association of Australia, 2009).

Malnutrition can be defined as a state in which a deficiency or excess (or imbalance) of energy, protein, vitamins and minerals causes measurable adverse effects on body tissue, function or clinical outcome (British Association for Parenteral and Enteral Nutrition, 2016; National Institute for Health and Care Excellance, 2006). Malnutrition, as defined, can encompass both under-nutrition and over-nutrition (obesity).

2.4.1 Over-Nutrition in Older Adults

The increasing prevalence of over-nutrition, synonymous with overweight and obesity, are now the major nutritional disorders affecting developed countries with the resulting health consequences contributing to the lack of recognition of under-nutrition (Kopelman & J., 2002). It is a disease in its own right and is causally related to morbidity, impaired quality of life, premature death, increased healthcare use and costs (Arterburn, Crane, & Sullivan, 2004; Villareal, Apovian, Kushner, & Klein, 2005). Obesity is linked to a number of chronic diseases and health conditions, for example: type 2 diabetes mellitus, cardiovascular disease, dyslipidaemia, hypertension, osteoarthritis, obstructive sleep apnoea, certain

cancers (e.g. kidney and uterine), mobility issues, gallstones and depression (Kopelman & J., 2002; Ministry of Health, 2015).

Morbid obesity rates are continuing to grow. In the 2014/15 New Zealand Health Survey 31% of adults (three in ten adults) were obese, with Māori 1.7 times more likely to be obese than non- Māori. Obesity rates are seen to increase with age, peaking in the 65-74 years age group at 37 percent, but trends downward with advancing age to 25 percent in 75+ years. (Ministry of Health, 2015). This decline can be attributed to a number of changes that occur with ageing: older adults tend to have a lower usual daily energy intake than younger adults (University of Otago & Ministry of Health, 2011), and a decline in fat-free mass and fat mass during older age compared to younger adults (fat-free mass peaks around 20 years of age and fat-mass around 60-70 years) (Villareal et al., 2005).

Ageing is also accompanied with hormonal changes that can enhance fat deposition, reduction of fat-free mass, and energy balance (Villareal et al., 2005). Older adults therefore generally eat less as they age, but also expend less energy due to body tissue changes, chronic disease and functional incapacity (Ministry of Health, 2013a).

2.4.2 Under-Nutrition in Older Adults

Under-nutrition is highly prevalent amongst older adults, as discussed in Section 2.4.4. Rather than over-nutrition, under-nutrition is a major cause for concern as its relationship to morbidity and mortality is stronger than that of obesity (D. Harris & Haboubi, 2005). Malnutrition is both a cause and consequence of disease, largely going undetected and undertreated (Saunders & Smith, 2010). Under-nutrition, here on synonymous with malnutrition, can not only cause and contribute to illness, but will affect the course of medical treatment and duration of recovery (Kopelman & J., 2002). It is associated with a number of adverse clinical outcomes, including increased length of hospitalisation, prolonged rehabilitation, postoperative complications, infection, pressure ulcers, poor wound healing, impaired muscle and respiratory function, as well as increased mortality and institutionalisation (D. Harris & Haboubi, 2005; Thomas et al., 2002). Additionally, malnutrition is an important risk factor for development and severity of frailty in older people, and increased healthcare costs (Kaiser, Bandinelli, et al., 2010).

Many of these adverse outcomes were first observed by Ancel Keys and colleagues during the now infamous Minnesota Starvation Experiment of World War II (Kalm & Semba, 2005). As well as negatively affecting mind and body, malnutrition can lead to poorer health, neurological deficits, loss of independence, reduced quality-of-life, and earlier mortality (Sullivan & Walls, 1998).

Under-nutrition aetiology is multifactorial. Most adult malnutrition is associated with disease and may be as a result of reduced dietary intake, reduced absorption of nutrients, increased losses or requirements, and increased energy expenditure (in diseased states) (Saunders & Smith, 2010). However ageing is associated with a number of factors that can affect nutritional status, including reduced lean body mass, cytokine and hormonal changes, delayed gastric emptying and altered gastric distension, and diminished sense of smell and taste (Ahmed & Haboubi, 2010).

Clinical malnutrition is preceded by a state of nutrition risk. Older adults who are nutritionally depleted due to chronic conditions are placed at an increased risk of subsequent hospitalisation (Feldblum et al., 2009). As malnutrition is not a consequence of ageing, it is therefore important to identify the factors affecting nutritional status and address these issues.

2.4.3 Factors Affecting Nutritional Status

2.4.3.1 Polypharmacy

Polypharmacy, defined as the use of multiple drugs most commonly five or more, is increasingly prevalent in older adults (Maher, Hanlon, & Hajjar, 2014; Scott, Anderson, Freeman, & Stowasser, 2014). The Health Quality and Safety Commission New Zealand (2016) found on average, 45 percent of adults 75+ and 57 percent of those aged 85+ were prescribed five long-term medications, compared to 26 percent of adults aged 65 to 74. Studies have shown polypharmacy to be associated with medication non-adherence, an increased risk of adverse drug events (ADEs), drug-interactions, delirium and urinary incontinence. Drug-drug interactions are a common cause of preventable ADEs, which can lead to hospitalisation and contribute to increased health care costs. It is also associated with a reduced functional capacity with diminished ability to perform Instrumental Activities

of Daily Living (IADLs), for example cooking, shopping and managing and taking medications, potentially leading to poorer nutritional status (Maher et al., 2014; Scott et al., 2014).

2.4.3.2 Dental Status

Oral health status and nutritional status in older adults can go hand-in-hand. Poor dentition and ill-fitting dentures can affect chewing status and limit the type and quantity of food older adults eat. Older adults may resort to texture-modified diets if they experience reduced pain and ease of chewing with softer or puree foods. These foods requiring an extended cooking time can be of poorer nutritional quality and contribute to risk of malnutrition (Brodeur, Laurin, Vallee, & Lachapelle, 1993; Brownie, 2006; Chauncey, Muench, Kapur, & Wayler, 1984; Marcenes, Steele, Sheiham, & Walls, 2003).

Edentulousness (tooth loss) is an independent risk factor for weight loss and can create communication issues in older people. It is also highly linked to socioeconomic status – studies have shown people with low income and/or education are more likely to be edentulous than those of higher income and/or education (Petersen & Yamamoto, 2005). Maintaining good oral health and functional dentition in the older ages is important in order to avoid dietary restrictions and maintain adequate nutritional status.

2.4.3.3 Dysphagia

Age-related changes in swallow function and age-related diseases are risk factors for dysphagia in older adults. Increasing life expectancy in conjunction with the increase in population growth of older adults and subsequent increased acute and chronic ailments means a greater number of elderly are experiencing impaired swallowing (Hudson, Daubert, & Mills, 2000). Dysphagia, any disruption in the swallowing process, is associated with morbidity and mortality, contributing negatively to health status, most notably increasing risk of malnutrition, dehydration, and pneumonia (Sura, Madhavan, Carnaby, & Crary, 2012).

The aetiology can be attributed to age-related changes in swallowing and/or muscle function, or as a secondary disorder following a primary diagnosis causing the dysphagia, such as stoke, trauma, acute disease, or surgery (Hudson et al., 2000). Age-related changes associated with the mastication and swallowing process include decreased salivary flow, increased motor response time required for chewing, impaired pharyngeal peristalsis, and

upper oesophageal sphincter opening. With ageing comes a loss of muscle mass and connective tissue elasticity, resulting in a loss of strength and range of motion. Overall, older adults may require more time to effectively chew and moisten foods to form a bolus, with a transit of the bolus occurring more slowly. This can contribute to increased frequency of swallowed material entering the upper airway and greater post-swallow residue (Hudson et al., 2000; Sura et al., 2012).

The incidence of stroke and dementia increases with increasing age. Neurological diseases (e.g. stroke, dementia), progressive diseases (e.g. Parkinson's, age-related changes) and cancers of the head and neck are some of the more common disease categories that may contribute to dysphagia. Dementia is associated with self-feeding impairments related to cognitive impairment, weakness and other motor deficits, loss of appetite and food avoidance, leading to weight loss and increased dependency for feeding (Hudson et al., 2000; Sura et al., 2012).

Dysphagia in community-living adults can often go underdiagnosed and missed as they are often considered independent and generally not requiring skilled care in their daily lives. Undetected dysphagia can present clinically silent, resulting in an increased risk of dysphagia-related health morbidities (Madhavan, Lagorio, Crary, Dahl, & Carnaby, 2016; Wakabayashi & Matsushima, 2016). Furthermore, community-living older adults may not seek immediate medical intervention for declining swallow function, but instead may self-modify their diets or reduce dietary intake of certain foods unintentionally placing themselves at risk for declining nutritional intake and contributing to malnutrition (Madhavan et al., 2016). In contrast, malnutrition can contribute to dysphagia through loss of muscle mass and reduced functional capacity leading to increased frailty. Thus, a vicious cycle can be created through the effects of malnutrition on dysphagia and vice versa, suggesting that dysphagia can contribute to and trigger the frailty process in older adults (Serra-Prat et al., 2012; Sura et al., 2012).

The gold standard for diagnosis of dysphagia is videofluoroscopy (VFS), however this is a timely procedure and is not feasible to conduct in every older adult. Screening tools should ideally be quick, easy to administer, and validated in an elderly population (Kaspar & Ekberg, 2012). Several clinical screening tools have been developed to assess those at risk, such as

the SWAL-QOL, the 10-item Eating Assessment Tool (EAT-10), and the M. D. Anderson Dysphagia Inventory (MDADI). However, not all of these are appropriate for use in community-living older adults. The SWAL-QOL consists of 44 items and is timely for patients to complete and clinicians to score, thus it is not considered a quick and easy screening tool for clinical use. The MDADI has been developed specifically for head and neck cancer patients and is also not considered appropriate for use in the greater older adult population. These two screening tools are not appropriate for use in the general older adult population due to their timely process and specificity towards a subset of dysphagic patients. The EAT-10 however, consists of ten items and is considered quicker for use in clinical settings as it can be self-administered (Belafsky et al., 2008).

The ten items covered by the tool include: weight loss; eating in social situations; difficulties swallowing liquids, solids and tablets; pain, food sticking, coughing, and stress when swallowing; and self-perceived pleasure of eating when swallowing. The EAT-10 asks patients to rate the extent of their dysphagia symptoms on a scale from zero to four (zero being no problem and four being a severe problem). Patients can score a maximum of 30 points, with a score $\geq$3 considered at risk of swallowing safely and efficiently. The simplicity, ease of administration and scoring makes the EAT-10 an attractive tool for quick identification of patients at risk of swallowing difficulties (Belafsky et al., 2008; Kaspar & Ekberg, 2012).

2.4.3.4 Cognitive Function and Ageing

A decline in cognitive function is experienced with age. Mild cognitive impairment (MCI) is an intermediate clinical state between the normal ageing-associated cognitive decline and dementia - MCI precedes and commonly leads to dementia (Nasreddine, 2010). Cognitive function, mental impairment, dementia and Alzheimer's can negatively impact an older person by way of affecting autonomy and independence (Ministry of Health, 2013a). A recent review for risk factors of malnutrition by Moreira et al. (2016) found cognitive decline and dementia to be significant risk factors for malnutrition. Impaired cognitive function can affect a person's nutrition status by their refusal and/or forgetting of meals and poor or inconsistent eating habits (Ministry of Health, 2002a).

In 2001, approximately 70 percent of people with dementia were cared for in their own homes, usually by one carer (Ministry of Health, 2002a). The ageing population is expected to bring about an increased incidence of dementia among the New Zealand population, thus there is a need for early detection of cognitive impairment in order to slow functional decline and prevent nutritional deficiencies.

There are several screening tools available for detecting dementia, including the Mini-Mental State Examination (MMSE) and the Montreal Cognitive Assessment (MoCA). The MMSE is one of the most widely used by physicians, however it does have difficulty detecting MCI – most individuals clinically assessed as meeting the MCI criteria may also score >26 on the MMSE, the range for normal older individuals (Nasreddine, 2010). The MoCA was therefore developed as a tool to assist the diagnosis of MCI in those scoring normal on the MMSE. The MocA assesses different cognitive domains covering visuospatial skills and executive functions, conceptual thinking, calculations, attention and concentration, language, memory, and orientation to date, place and city. Patients can score a total of 30 points: scoring below 26 indicates mild cognitive impairment (MCI) whilst 26 or above is considered normal cognitive function. Though it is difficult to differentiate levels of cognitive impairment, the MoCA can be useful in detecting MCI and mild Alzheimer's (Nasreddine, 2010).

2.4.3.5 Living Situation and Marital Status

Living situation and marital status can influence nutritional status. Living alone is associated with increased nutritional risk for both men and women (American Dietetic Association, 2000). The Living Standards of Older New Zealander's survey found 53 percent of older people lived in single-person households with the majority widowed (76%) (Barrett, Twitchin, Kletchko, & Ryan, 2006). Eating in the company of others can directly impact food quality and quantity, with a shared meal shown to increase the meal size by up to 46 percent more than when eaten alone (de Castro, 2002). Studies have shown that older adults living independently and alone may eat less and be at a higher risk of reduced nutritional status. Men have been observed to be more vulnerable than women to the impact of eating alone with significantly lower intakes (Brownie, 2006). However, older women are more likely to be widowed and live alone due to their higher life expectancy

than men. Depression secondary to social isolation and bereavement can reduce motivation to eat or prepare adequate meals (Kamp, Wellman, & Russell, 2010).

In a New Zealand based study by C. Wham, Teh, et al. (2011) in community-living older adults, 46 percent were found to live alone with 53 percent widowed. Those who were widowed were more likely to be at nutrition risk than those who were married/partnered, divorced/separated or never married. Participants at less nutrition risk lived with others. Older people living with others feel better, are healthier and have a higher life expectancy than those without partners (Barrett et al., 2006). There is a need to identify older adults living alone in the community and/or widowed who may be at higher risk of poorer nutritional status.

2.4.3.6 Income and Education

Socioeconomic status is closely related to health and nutritional status. Those on lower incomes have a higher prevalence of health and secondary functional problems (Barrett et al., 2006). Income can affect nutritionally adequate food choices to maintain a healthy diet and suitable transport to access shops. Older adults have lower than average incomes, with low-income older people observed to eat less fruit, vegetables, milk, meat and meat products than higher-income adults (Bowman, 2007).

Higher education level is associated with better functional status (Stuck et al., 1999). A lack of food and nutrition related knowledge and cooking skills can limit dietary variety and reduce dietary adequacy, increasing risk of poorer nutritional status.

2.4.3.7 Support Services

The incidence of disability increases with age. Approximately 45 percent of older adults in New Zealand aged 65 and over have some form of physical, sensory or intellectual disability (Te Pou, 2011). Rates of disability in the community are lower than for those in residential aged care. Older adults in the community are more likely to have either no disability or mild disability, whilst those in aged care are more likely to have a severe disability (Ministry of Health, 2002a). Support services for older adults include needs assessment and service co-ordination, assessment, treatment and rehabilitation services (AT&R), home support services (e.g. personal cares, household management) and other ongoing support services.

For people aged 85 years and over, 61% of health expenditure is accounted for by disability support services (New Zealand Treasury, 2012).

2.4.4 Nutrition Risk in Community-Living Older Adults

Studies in developed countries have found the prevalence of malnutrition in community-living older adults to range from approximately 2 to 10 percent (Bauer, Kaiser, Anthony, Guigoz, & Sierber, 2008; Jensen, Kita, Fish, Heydt & Frey, 1997; Kaiser, Bauer, et al., 2010). Nutrition risk precedes malnutrition and is more common, ranging from 25 to 65 percent (Guigoz, Vellas, & Garry, 1996). The United Kingdom Royal College of Physicians found 12.4 percent of community-living adults over 65 years of age were at high or medium risk of malnutrition (D. Harris & Haboubi, 2005), whilst a Belgium study estimates up to 65 percent of elderly patients are protein-energy undernourished at the time of hospital admission, or experience a decline in nutrition status during hospitalisation (Pepersack, 2005). In Australia, several studies have reported malnutrition prevalence in community-living elderly to range between 4-38% (Craven, Pelly, Lovell, Ferguson, & Isenring, 2016; Rist, Miles, & Karimi, 2012; Winter, Flanagan, McNaughton, & Nowson, 2013).

In an audit investigating nutritional status of older people, 24 percent of older adults admitted to Middlemore Hospital, New Zealand were malnourished and a further 44 percent were at risk of malnutrition (Van Lill, 2002). Furthermore, 42 percent of people 65 years or older admitted to Christchurch Hospital in New Zealand in 1996 with a femur fracture had at least two indicators of protein-energy malnutrition (PEM) upon admission; two-thirds of these patients were living independently in their own homes at the time of injury (Hanger, Smart, Merrilees, & Frampton, 1999).

Within New Zealand, there are limited data on the nutritional status and prevalence of nutrition risk and malnutrition among community-living older adults (Watson et al., 2010). Currently there are eight studies that have investigated nutrition risk in community-living older adults, with high nutrition risk ranging from 31-52% as shown in Table 2 (McElnay et al., 2012; Watson et al., 2010; C. Wham, Carr, et al., 2011; C. Wham, Teh, et al., 2011; C. A. Wham & Bowden, 2011; C. A. Wham, Mclean, et al., 2014; C. A. Wham, Redwood, et al., 2014). The differing nutrition screening tools utilised are explained in further detail in Table 3 later in this review.

In the first study by Watson et al. (2010), 152 community-living older adults aged 70+ in Christchurch were sampled. Participants were screened for nutrition risk using the Seniors in the Community Risk Evaluation for Eating and Nutrition tool (SCREEN II). Participants either lived alone (56.6%) or with one other person. Nutrition risk was present in 23 percent of participants, with 31 percent at high risk of malnutrition. As participants were a convenience sample and not randomised into the study these results cannot be extrapolated to the wider population of Christchurch community-living older adults.

The second study was conducted by C. Wham, Carr, et al. (2011) on Auckland's North Shore. Participants were community-living older adults aged 80-85 years. The study screened the 51 participants for nutrition risk using SCREEN II. A third (31%) of participants was at high risk of malnutrition, with 82 percent of participants living alone. As a small convenience sample of older people who lived in North Shore City was recruited into the study the results are not representative of older New Zealanders.

In the third study by the same author C. A. Wham and Bowden (2011), 12 men aged 75 to 89 years who lived alone in Auckland were assessed for nutrition risk, again using the SCREEN II tool. Half of the participants were assessed to be at high nutritional risk, with SCREEN II scores ranging from 44-56. This sample of men had a self-selection bias and is thus not representative of the New Zealand population. Furthermore, the study design does not allow the demonstration of cause and effect relationships in factors related to nutrition risk.

The fourth study, the feasibility study for Life and Living in Advanced Age, a Cohort Study in New Zealand (LiLACS NZ) again by the same author C. Wham, Teh, et al. (2011), investigated nutrition risk across three North Island locations in 108 community-living older adults aged 75 to 85 years. The SCREEN II tool was again utilised. 52 percent were assessed to be at high nutrition risk, with the mean SCREEN II score (range 29-58) found to be higher in older people living with others. Due to the small sample size, the results are not representative of the region where participants were recruited from. The cross-sectional design does not allow comment of causality in factors related to nutrition risk.

A New Zealand North Island study by different researchers (McElnay et al., 2012) investigated nutrition risk in 473 community-living Maori and non-Maori older adults in the Hawkes Bay region, 56.5 percent were at nutritional risk and 32.8 percent of the participants assessed to be at high risk using the SCREEN II tool. Furthermore, older Maori were 5.2 times more likely to be at nutritional risk than non-Maori, whilst older people living alone were 3.5 times more likely to be at nutritional risk than those living with others similar to the findings of C. Wham, Teh, et al. (2011). However, due to the small numbers of Maori participants in this study within the Hawke's Bay region, the results should be interpreted with caution.

The final three studies were also conducted by the same author C. A. Wham, Mclean, et al. (2014), C. A. Wham, Redwood, et al. (2014), and C. A. Wham et al. (2015) The first investigated factors associated with nutrition risk in three District Health Board (DHB) regions in New Zealand as part of the Brief Risk Identification Geriatric Health Tool (BRIGHT) trial. This found 35 percent of the 3,480 participants 65 years and older to be at high nutritional risk (ANSI score 0-3) and 27 percent at moderate risk (ANSI score 4-5). This study had the largest sample size, however as above, the cross-sectional design does not enable cause and effect relationships for factors related to nutrition risk.

The second study aimed to validate the SCREEN II in 45 community-living older adults involved in LiLACS NZ aged 85-86 years in the Bay of Plenty region. Thirty-three percent of participants were identified at high nutrition risk and 60 percent at any risk (SCREEN II score range 36-60). Again, the findings of this study are limited by the small sample size.

The final study, the baseline assessment for LiLACS NZ, investigated health and social factors associated with nutrition risk in Maori and non-Maori community-living older adults. In this study 255 Maori and 400 non-Maori participants were recruited from two locations in the North Island. Half (49%) of Maori (SCREEN II range 21-60) and 38 percent of non-Maori participants (SCREEN II range 20-63) were assessed to be at high nutrition risk. However, these rates could be underestimated as those fully participating were more able.

Table 2: Prevalence of nutrition risk in studies investigating New Zealand community-living older adults.

Reference	Number of participants	Age (years)	Location	Nutrition Screening Tool	Nutrition Risk Prevalence
Watson et al. (2010)	n = 152 37.5% men	[1]79.5	Christchurch	SCREEN II	At risk = 23% High risk = 31%
C. Wham, Carr, et al. (2011)	n = 51 29.4% men	[1]82.4 (1.7)	North Shore, Auckland	SCREEN II	High risk = 31%
C. A. Wham and Bowden (2011)	n = 12 100% men	Range = 79-87	Auckland	SCREEN II	High risk = 50%
C. Wham, Teh, et al. (2011) *LiLACS NZ feasibility study*	n = 108 (n=33 Maori; n=79 non-Maori) 44% men	[1]Maori = 76.6 (1.8) Non-Maori = 85.2 (0.6)	North Island	SCREEN II	High risk = 52%
McElnay et al. (2012)	n = 473 (n=40 Maori, n=433 non-Maori) 43.8% men	[1]74	Hawkes Bay	SCREEN II	At risk = 23.7% High risk = 32.8%
C. A. Wham, Mclean, et al. (2014) *BRIGHT trial*	n = 3480	Inclusion age >75 (non-Maori) & >65 (Maori)	60 General Practices in 3 main NZ centres	ANSI	Low risk = 38% Moderate risk = 27% High risk= 35%
C. A. Wham, Redwood, et al. (2014) *LiLACS NZ*	n = 45 53% men	Range = 85-86	Bay of Plenty	SCREEN II	Low risk = 40% Medium risk = 27% High risk = 33%
C. A. Wham et al. (2015) *LiLACS NZ*	n = 655 (n= 255 Maori; n= 400 non-Maori) 44% men	[1]Maori = 82.8 (2.6) Non-Maori = 84.6 (0.5)	Bay of Plenty and Lakes DHB	SCREEN II	High risk = 49% (Maori) & 38% (non-Maori)

[1]Reported as mean (SD)
SD = standard deviation

2.5 Malnutrition assessment

A comprehensive nutritional status assessment to target protein-energy malnutrition in older adults is complex, with no definitive gold standard criterion available or universally accepted index of nutritional status (Gallagher et al., 1996; Keller, Goy, & Kane, 2005). Currently, a detailed nutrition assessment will evaluate food intake, recent weight loss (or other changes in body composition), signs of and risk factors for malnutrition, and biochemical data (Saka et al., 2011). However, many validated protein-energy malnutrition (PEM) screening tools require accurate measurements of recent bodyweight changes which is not always possible, especially in bedridden patients or those experiencing a decline in cognitive function (Shenkin, 2006).

Nutrition risk screening is a means of quickly and efficiently identifying older adults at high risk of poor nutrition or who are currently nutritionally impaired (Edington, 1999). Nutritional screening occurs in various forms, including validated screening tools for example, the Mini-Nutritional Assessment (MNA) and Malnutrition Universal Screening Tool (MUST), and biochemical markers including albumin, prealbumin, transferrin, and retinol binding protein. The nutrition screening process should be quick and simple, and acceptable to patients and healthcare workers. Furthermore, it must have good sensitivity (D. Harris & Haboubi, 2005). The aim of nutrition screening is to look for characteristics associated with nutritional problems in order for nutrition assessment and intervention to occur effectively and efficiently to prevent further progression into a malnourished state (D. Harris & Haboubi, 2005; Rubenstein, Harker, Salva, Guigoz, & Vellas, 2001).

2.5.1 Malnutrition Screening Tools

There is currently no gold standard for detection of malnutrition in community-living older adults – it remains underdiagnosed and under treated. Dietetic resources are limited in the community setting, thus a simple, valid and cost effective method to detect nutrition risk prior to progression of malnutrition in older adults is required (C. A. Wham, Redwood, et al., 2014).

Anthropometric measurements have limited value for determining the nutritional status of a patient when used alone, as dehydration or oedema can affect weight and subsequently BMI, and changes in skinfold thickness and mid-upper arm circumference (Saka et al., 2011).

A summary of the current screening tools suitable for use in the community can be found in Table 3. The MNA-SF was determined as the most appropriate for use in this study as it has been validated in older adults (Kaiser et al., 2009), and is easy and quick to administer.

2.5.1.1 Mini Nutritional Assessment (MNA)

When Guigo, Vellas, and Garry started developing the Mini Nutritional Assessment (MNA) in the 1990s, there was no validated screening tool available at the time for assessing nutrition status in the elderly (Bauer et al., 2008). The MNA was developed and validated specifically for use in a free-living and clinically relevant elderly population (Guigoz et al., 1996; Hudgens & Langkamp-Henken, 2004; Kaiser et al., 2009). The purpose is to detect the presence of undernutrition and risk of developing undernutrition among older adults in home-care programmes, nursing homes and hospitals (Kondrup, Allison, Elia, Vellas, & Plauth, 2003).

The MNA is composed of 18 items, taking 10-15 minutes to administer. The items covered are included in Table 3. Patient scoring allows categorisation as normal nutritional status; at risk for malnutrition, indicating further assessment is required (for example biological markers albumin and CRP); and malnourished, indicating nutrition intervention is immediately required (Guigoz et al., 1996).

The MNA is attractive for use in subacute care to determine undernourishment as measurements of biochemical markers (albumin, cholesterol) are not required, however a health professional must administer it (Thomas et al., 2002). The MNA is thought to be more likely to identify risk of developing undernutrition and undernutrition at an early stage as it includes physical and mental aspects that frequently affect the nutritional status of older adults, in conjunction with a dietary questionnaire (Kondrup et al., 2003). The MNA has shown high sensitivity and specificity at 96 percent and 98 percent respectively in detecting undernourished individuals and is easy to administer when compared to nutritional assessment including anthropometric, clinical, biological and dietary parameters, serving as the nutritional “gold standard” (Vellas et al., 1999).

However, whilst the MNA covers numerous anthropometric, dietary, clinical and subjective indices, it takes longer to administer than other validated screening tools. The MNA was therefore shortened into the MNA-SF, a more practical tool for use in a variety of settings.

2.5.1.2 Mini Nutritional Assessment – Short Form (MNA-SF)

Due to time constraints associated with administering the full MNA, Rubenstein and colleagues developed a shortened version: Mini Nutritional Assessment – Short-Form (MNA-SF) (Table 3). The MNA-SF correlated well to the full MNA (Pearson's r = 0.969), and is just as good as the MNA in predicting serum albumin (Kaiser et al., 2009; Rubenstein et al., 2001). The MNA-SF is more rapidly administered taking less than five minutes and allows quicker identification of those requiring further nutritional assessment.

The MNA-SF is comprised of six items, covering BMI (or calf circumference if BMI is unavailable), recent weight loss, stress or acute disease, mobility, neuropsychological problems, and appetite loss/eating difficulty. These six items were identified from the full MNA as they had high sensitive and specificity, highest diagnostic accuracy relative to clinical nutritional status, minimal examination time, and lowest amount of "don't know" answers (Bauer et al., 2008). Similarly to the MNA, scores are summed with a maximum score of 14, and indicate individuals as 'malnourished' (score 0-7), 'at risk of malnutrition' (score 8-11), or 'normal nutrition status' (score 12-14).

Table 3: Nutrition screening tools available for community-living older adults

Tool (reference)	Country of Origin	Format & Nutrition Screening Items	Population group	Risk Categories
Mini Nutritional Assessment – short form (MNA-SF) Rubenstein et al. (2001)	Switzerland	6-item tool: Anthropometry (BMI, weight loss), stress or acute disease, mobility, neuropsychological problems, appetite loss/eating difficulty	Older adults	Maximum score = 14 12-14 = Normal nutrition status 8-11 = At risk of malnutrition <7 = Malnourished
Mini Nutritional Assessment (MNA) Guigoz et al. (1996)	Switzerland	18-item tool: Anthropometry (BMI, weight loss, arm/calf circumference), lifestyle, medication, mobility, dietary assessment (number of meals daily, food/fluid intake, feeding mode), subjective assessment (self-perception of health/nutrition)	Older adults	Maximum score = 30 ≥24 = Normal nutrition status 17-23.5 = At risk of malnutrition <17 = Malnourished
Seniors in the Community: Risk Evaluation for Eating and Nutrition (SCREEN II) Keller et al. (2005)	Canada	14 item questionnaire: Weight change, food intake/risk factors (meal frequency, dietary restriction, appetite, chewing/swallowing/shopping difficulties, meal replacement, eating along, meal preparation)	Older adults	Maximum score = 64 <49 = High nutrition risk 50-53 = Medium nutrition risk >53 = Low nutrition risk
DETERMINE checklist The Nutrition Screening Initiative Barrocas, White, Gomez, and Smithwick (1996)	USA	10 item checklist: Disease, eating poorly, tooth loss or pain, economic hardship, reduced social contact, multiple medications, involuntary weight loss or gain, needing assistance	Older adults	Maximum score = 21 0-2 = Low nutritional risk 3-5 = Moderate nutritional risk >6 = High nutritional risk

		in self-care, and elderly (>80 years)		
Malnutrition Universal Screening Tool (MUST) Stratton et al. (2004)	UK	BMI, history of unexplained weight loss, acute illness effect	Older Adults Community and hospital	0 = Low risk 1 = Medium risk ≥2 = High risk
Short Nutritional Assessment Questionnaire 65+ (SNAQ 65+) Wijnhoven et al. (2012)	Netherlands	Recent weight loss, mid-upper arm circumference, appetite and physical functionality	Older adults in the community aged 65+ or 65-	1. Undernourished 2. At risk of undernutrition 3. Not undernourished
Australian Nutrition Screening Initiative (ANSI) Lipski (1996)	Australia	10-item checklist: Quantity/quality of food intake, fruit, vegetable and dairy intake, alcohol intake, chewing/swallowing difficulties, financial and living situation, polypharmacy, unintentional weight loss, activities of daily living.	Older adults	Maximum score = 21 0-2 = Good nutritional health 3-5 = Moderate nutrition risk ≥6 = High nutrition risk

2.5.2 Laboratory Measures of Malnutrition Risk

Nutrition assessment methods should be sensitive, specific, and relatively inexpensive; thus, a simple, rapid and reliable laboratory test has potential to be more effective for nutrition risk screening (Gallagher et al., 1996; Saka et al., 2011; Shenkin, 2006). Serum hepatic protein and lipid levels have previously been identified as useful indicators of severity of illness as they can assist in identifying those most likely to develop malnutrition whilst providing an objective dimension (Omran & Morley, 2000). PAB has become the preferred marker with literature finding it to correlate well with patient nutrition status in a range of clinical settings (F. K. Beck & Rosenthal, 2002).

The concentrations of many plasma proteins increase during inflammatory states, largely in response to inflammation-associated cytokines. These are termed 'positive acute phase proteins', whilst those that decrease significantly under the same circumstances are termed 'negative acute phase proteins' (Samols, Agrawal, & Kusner, 2001). Plasma proteins synthesised by the liver (hepatic proteins) are commonly used as nutritional biochemical markers – these include albumin, PAB, transferrin, and retinol-binding protein (D. Harris & Haboubi, 2005). However biochemical parameters as indicators of nutritional status are often confounded by comorbid conditions and may not independently reflect nutritional status, thus they have limitations in their usefulness (D. Harris & Haboubi, 2005; Thomas et al., 2002). A single measurement of one biochemical marker is not always of value as it will lack specificity and sensitivity to detect modifications of nutritional status (Paillaud et al., 2005).

2.5.2.1 Albumin

Historically, serum albumin levels have been most widely used as an indicator of malnutrition in clinical practice, with levels being a consistent predictor of mortality and other outcomes (for example, perioperative complications) in older adults. Serum albumin has a half-life of 17 to 19 days, with its main role being maintenance of colloidal osmotic pressure. (F. K. Beck & Rosenthal, 2002; Doweiko & Nompleggi, 1990; D. Harris & Haboubi, 2005; Mahan, Escott-Stump, & Raymond, 2012; Salva & Pera, 2001; Thomas et al., 2002).

Albumin is a relatively small molecule, yet it accounts for the majority of hepatic protein production with normal serum albumin levels 3.5 to 5.0 g/dL. Hepatic synthetic capacity of

albumin depends upon the quantity and quality of nutrients, route of intake and ratio of protein and energy intake. Calorie deprivation decreases hepatic synthesis of albumin as much as 50 percent within the first 24 hours, persisting as long as the deficiency continues (Doweiko & Nompleggi, 1990).

2.5.2.2 Limitations of albumin

Serum albumin is affected by hepatic failure and systemic inflammatory response following injury, infection or inflammation, thus reduced serum albumin may not reflect nutritional status. Cytokines released during acute illness or inflammation, such as tumor necrosis factor α, interleukin 2, and interleukin 6 inhibit albumin production and facilitate albumin transport from intravascular to extravascular space (Salva & Pera, 2001; Thomas et al., 2002). Hepatic failure will further alter albumin synthesis by the liver, gastrointestinal and cardiac diseases can increase albumin losses through the gut, whilst renal diseases can lead to albuminuria. Wounds ranging from ulcers to major trauma, burns and peritonitis can cause high losses through the open surface (Klein et al., 1997; Paillaud et al., 2005). Furthermore, the longer half-life of albumin and large body pool size means it does not respond to short-term dietary changes in protein and energy intake and is a relatively insensitive measure of acute changes in nutritional status (Delliere & Cynober, 2016; Doweiko & Nompleggi, 1990; D. Harris & Haboubi, 2005; Klein et al., 1997). Once the body pool has been depleted, it typically takes 14 days to return to normal (F. K. Beck & Rosenthal, 2002). Reduced serum albumin can furthermore promote oedema as the water in the plasma moves to the interstitial compartment (Mahan et al., 2012). Therefore, albumin would perform better as an indicator of chronic malnutrition.

2.5.2.3 Prealbumin

Prealbumin (PAB), also known as transthyretin, is a negative acute-phase hepatic plasma protein previously used as a biochemical marker of protein-energy malnutrition (Dennis et al., 2008; Fuhrman, Charney, & Mueller, 2004; Salva & Pera, 2001). It has the shortest biological half-life of all serum proteins at approximately one to two days, thus it is a more suitable indicator to evaluate acute protein malnutrition (Hrnciarikova et al., 2009)., and exists in a relatively small pool signifying PAB sensitivity to changes in protein-energy status. Therefore, serum level concentrations can reflect recent changes in dietary intake rather than overall nutritional status

(Shenkin, 2006). PAB is a transport protein for vitamin A and thyroid hormones (thyroxine), which circulates as a retinol-binding-PAB complex. It is synthesized by hepatocytes to be released into circulation, and eventually partially catabolised by the kidneys (Fuhrman et al., 2004; Klein et al., 1997; Robinson et al., 2003).

Several studies have been undertaken to determine the effectiveness of PAB as an indicator of nutritional risk and response to nutrition care in hospitalised patients. Mears (1995) found PAB to be a sensitive measure of nutritional status when used in conjunction with a diagnosis by a Registered Dietitian (RD) and with medical and nutrition history. Based on their findings of earlier assessment and intervention of PEM, and reduced length of hospital stay, PAB was included into the Leonard Chabert Medical Centre's (Louisiana, USA) nutrition screening and monitoring program. Furthermore, PAB screening is thought to have contributed to savings of over US$600,000/year for this hospital, mainly attributed to the decreased length of stay. Dennis et al. (2008) found a strong positive correlation in hospitalised patients between average daily protein and energy intake, and changing serum levels of PAB during hospitalisation. In a study by Robinson et al. (2003), the authors found there was a similar probability of a hospitalised patient being diagnosed as normal nutritional status or malnourished when using standard nutrition screening protocols and PAB assessment. Only PAB was statistically significant as a predictor of dietitian nutrition assessment compared to albumin and retinol-binding protein. Low serum PAB concentration can therefore be regarded as a sign identifying patients at-risk of malnutrition, requiring further assessment and monitoring, and for whom nutritional support may be needed as part of the treatment plan (Saka et al., 2011; Shenkin, 2006). PAB has potential to be a feasible, reliable and quick tool for identification of at-risk individuals, more so in settings where a full and detailed nutritional assessment may be challenging to obtain (F. K. Beck & Rosenthal, 2002; Devoto et al., 2006).

2.5.2.4 Limitations of prealbumin

PAB has low specificity as a nutrition indicator when there is ongoing inflammation during the disease process as its levels typically remain supressed until the inflammation resolves. Many diseases that affect older adults can affect serum PAB concentrations, and as a consequence, mitigating recommendations for the routine use of PAB serum levels as a marker of nutritional

status (Dennis et al., 2008; Pepersack, 2005). Levels of PAB may decrease in inflammatory states (in response to infection, injury or trauma) independent of individual nutritional status, and increase with recovery from the same conditions.

PAB levels are also influenced in response to cytokine and hormone infusions (for example, corticosteroids), renal or hepatic dysfunction, and changes in patient hydration status (Fuhrman et al., 2004; Klein et al., 1997; Robinson et al., 2003). Acute renal failure can negatively affect serum PAB concentration as a result of reduced catabolism of PAB and retinol-binding protein by the kidneys. Low levels are further found in association with poorly controlled cardiovascular disease, end-stage liver disease, and impaired zinc status as zinc is required for PAB synthesis and secretion (Mahan et al., 2012). One of the functions of PAB is acting as a transport protein for thyroxine; in hyperthyroid states, PAB levels also increase as the PAB molecules are saturated with thyroxine, and vice versa in hypothyroid states (Bharadwaj et al., 2016). Hydration status can decrease PAB levels - resuscitation fluids and fluid overload can dilute serum PAB and give a false indicator of low serum levels. In contrast, high dose corticosteroid therapy is associate with elevated PAB concentrations (Dennis et al., 2008). The degree of injury or illness can further negatively impact nutritional status if appetite, gastrointestinal motility and hemodynamic stability are affected (Fuhrman et al., 2004). Therefore, PAB and CRP are often collected together as CRP is also a marker of inflammation used to assess an inverse correlation with serum PAB levels. CRP may thus help distinguish between depressed PAB levels, secondary to acute illnesses versus depressed PAB levels, secondary to malnutrition (Robinson et al., 2003).

PAB is not a routinely used marker of nutritional status amongst older adults, especially amongst the community-living population. It is therefore not known how strongly change in PAB concentration correlates with nutrient intake in older community-living adults. PAB is a potentially important marker for assessing nutritional risk and recent changes in protein-energy intake in older adults, however its specificity as a nutritional indicator in community living older adults needs to be determined (Dennis et al., 2008).

2.5.2.5 Transferrin

Transferrin is a globulin protein required for binding and transport of ferric iron to bone marrow for haemoglobin production (Mahan et al., 2012; Spiekerman, 1995). Transferrin has an average half-life of eight days, shorter than albumin by nine days but longer than PAB (Salva & Pera, 2001). Transferrin is a more sensitive indicator of early PEM than albumin due to its shorter half-life and smaller body pool (D. Harris & Haboubi, 2005; Spiekerman, 1995).

2.5.2.6 Limitations of transferrin

Transferrin as an indicator of nutritional status is highly dependent on iron levels. Thus Iron deficiency and anaemia, which could be related to the nutritional derangements, will increase its levels in proportion to the deficiency resulting in inaccuracies (Bharadwaj et al., 2016; Delliere & Cynober, 2016; Salva & Pera, 2001; Spiekerman, 1995). Transferrin use is unreliable in conditions including iron-deficiency, hypoxaemia, chronic infection and hepatic disease (D. Harris & Haboubi, 2005). Acute hepatitis is associated with increased levels, whilst liver disease, nephrotic syndrome, neoplastic disease and other protein-losing states are associated with decreased levels. Furthermore, its usefulness as a diagnostic tool of nutrition risk status is unreliable as a wide range of values have been reported during studies (Spiekerman, 1995).

2.5.2.7 Retinol Binding Protein (RBP)

RBP mainly exists as part of the retinol-circulating complex existing in a 1:1 molar ratio with retinol and PAB. RBP and has an average plasma half-life of 12 hours and has previously been used in monitoring short-term changes in nutritional status (Bharadwaj et al., 2016; de Pee & Dary, 2002; Salva & Pera, 2001; Spiekerman, 1995). It has a small body pool size, and reportedly responds quickly to changes in protein and energy intake.

2.5.2.8 Limitations of RBP

Due to current varied and insufficient consistent data, a cut-off has not been reliably proposed or specified (de Pee & Dary, 2002). Likewise with the previously discussed hepatic proteins, RBP binding to retinol is also influenced by liver disease, chronic renal failure, acutely stressful situations, and the presence and degree of acute-phase response (de Pee & Dary, 2002). RBP is also dependent on adequate protein, vitamin A (retinol) and zinc status for proper functioning,

as it incorporates the molecules into the complex. Therefore, any abnormalities in the levels of these micronutrients will affect serum RBP levels (Bharadwaj et al., 2016; Mahan et al., 2012). Furthermore, though RBP provides the same information as PAB, the cost of assaying is greater and RBP is more sensitive to renal failure (Delliere & Cynober, 2016). Though RBP has a much shorter half-life than PAB (12 hours versus 2 days), RBP is excreted in the urine and its levels increase more significantly than PAB in renal failure due to its reduced catabolism in the renal tubules (Spiekerman, 1995). Considering kidney function shows a downward trend with advancing age, RBP may not be the most reliable indicator of nutritional status in older adults.

2.5.2.9 C-reactive protein (CRP)

Whilst the other proteins (PAB, albumin, transferrin and retinol-binding protein) are all negative acute phase proteins, CRP is a positive acute phase protein and likewise, a marker of inflammation. It can increase as much as 1,000-fold during inflammation, sepsis and infection (Fuhrman et al., 2004; Spiekerman, 1995). CRP levels rise more rapidly than any other acute-phase proteins, typically 4-6 hours before changes are seen in other protein (Spiekerman, 1995). CRP is not considered a marker of nutritional status, however it is routinely used in conjunction with PAB as it can aid distinguishing between low PAB levels secondary to acute illness versus secondary to malnutrition (Omran & Morley, 2000; Robinson et al., 2003).

2.5.2.10 Nutrition risk screening utilising biomarkers

Sergi et al. (2006) investigated the role of visceral proteins in detecting malnutrition in elderly patients and concluded, in accordance with a previous study by Finucane et al. (1988), that transferrin did not show any relationship with free-fat mass and did not allow one to distinguish healthy participants from those of poorer nutritional status. Furthermore, Sergi et al. (2006) observed a significant reduction in mean PAB and RBP values in underweight participants, and showed a higher correlation with fat-free mass than albumin. Shetty, Jung, Watrasiewic, and James (1979) found that obese subjects instigated on a low energy and/or protein diet had reduced plasma protein levels (PAB and RBP) with a rapid turnover rate, whilst PAB was observed to be a more sensitive marker than albumin for protein-malnutrition in a groups of health conscious Parisian elderly (Cals et al., 1994). Conversely, Dennis et al. (2008) observed PAB to have limited value as a nutritional marker in older recuperative care patients with

present inflammation indicated by high cytokine and CRP levels. The results of studies investigating plasma proteins as indicators of nutrition status can have conflicting results when comparing between those investigating acute changes in nutrition status and those investigating chronic malnutrition, and more so when comparing between seemingly healthy subjects with little to no present inflammation, and hospitalised patients with high inflammation biomarker values.

2.6 Summary

The limited number of New Zealand studies show nutrition risk is prevalent amongst community-living older adults. However, due to the small sample size in many of these studies, more cross-sectional studies are required with larger sample size in order to determine the true prevalence of malnutrition and nutrition risk in a representative sample of New Zealand community-living older adults. No biochemical marker on its own offers a satisfactory nutrition screening test. The negative acute phase hepatic proteins PAB, albumin and transferrin may be used as indicators of inflammation presence and processes that could accelerate nutritional depletion and thus warrant further investigations prior to exacerbation and subsequent hospital admission. With the current rapidly ageing New Zealand population and increasing number living in their own homes, it is important to identify those at nutritional risk and provide interventions before such hospitalisations occur. However, biochemical markers should be utilised in conjunction with clinical judgement and related measures (e.g. anthropometry, subjective) by a nutrition health professional.

3.0 Methodology

3.1 Study Design

This study was a cross-sectional, observational design to identify and assess nutrition risk prevalence in a non-randomized, convenience sample of community-living older adults enrolled with a community general practice. The research also aimed to assess the potential use of PAB, in conjunction with CRP, as biomarkers of nutrition risk status. Face-to-face interviews were conducted with the participants to complete a questionnaire and integrated validated screening tools. Participant recruitment was conducted between June 2016 and September 2016.

3.2 Participants and Setting

The participants of this study were older adults living independently within their own homes in the community and enrolled in the Henderson Medical Centre in West Auckland between June 2016 and September 2016.

3.3 Participant Recruitment and Consent

A database of participants aged ≥75 years enrolled in the Henderson Medical Centre was provided for the research. Maori and Pacific ethnicities had a lower age inclusion criteria (≥65 years) to account for health disparities and lower life expectancy compared to non-Maori and non-Pacific.

Eligible participants were contacted by telephone by a student researcher and invited to participate in the study. An information form (Appendix B) was read to the participant's over the phone. Upon verbally agreeing to participate in the study, a time was scheduled for a one-off face-to-face interview in the participant's own home. A hard-copy of the information form was taken to the interview, explained and left with the participant. Participants' were provided adequate time to go through the information form and ask any questions. Participants were informed that they could decline the invitation to the study, withdraw from the study at any stage, decline to answer specific questions, and could contact the researchers at any time about the study. They were also informed that the current study would in no way affect their current

and ongoing healthcare. Adverse effects were explained to the participants, in that they would be unlikely to experience any apart from some bruising and discomfort at the site of blood withdrawal. Written consent to participate and provide a blood sample (Appendix C) was gained from the participants at the time of visit. Those who declined to participate were advised they would not receive any further contact from the researchers. The inclusion and exclusion criteria for the study are detailed as follows:

3.3.1 Inclusion Criteria:

1. Older adults living in the community enrolled with the general practice involved;
    a. ≥65 years of age (Māori and Pacific Island ethnicities) or
    b. ≥75 years of age (all other ethnicities)
2. Must be willing and cognitively able to provide informed consent;

3.3.2 Exclusion Criteria:

1. Unwilling or unable to provide reasonable informed consent;
2. Diagnosed physiological impairments that may affect nutrition e.g.:
    a. Tumor in the voicebox
    b. Zenker diverticulum
    c. Malabsorption or metabolic syndrome affecting digestion
    d. Presence of a fistula (leak between the throat and the skin)
3. Diagnosed psychiatric illness affecting nutrition e.g. Anorexia nervosa
4. Palliative care and/or who may not survive the next two years.

Those that did not meet the inclusion criteria, were too ill to participate, or were unable to provide reasonable reliable information and informed consent were excluded from the study at time of interview.

3.4 Ethical Approval

Ethical review and approval for this study was obtained from Northern A Health and Disability Ethics Committee (HDEC) (Application 14/NTA/70), WDHB Ethics Committee, Maori Research Committee for the WDHB, and Massey University Northern Human Ethics Committee.

Participants were informed all documents containing personal information would be stored in a locked filing cabinet, with all electronic data stored and password protected in a secure building only the researcher could access. Participants were further informed that all personal and identifiable information would be removed upon publication of results, and all study data would be kept for a period of ten years (as per New Zealand law), after which time it would be securely destroyed.

3.5 Study Questionnaire

The one-off face-to-face interview administering the study questionnaire was conducted in English. The questionnaire (Appendix D) was comprised of two sections: the first section involved collecting personal and demographic information, whilst the second section was comprised of three integrated validated screening tools. In order of administration, the tools included were: 1) the Mini Nutritional Assessment®-Short Form (MNA®-SF) (Appendix E); 2) the 10-item Eating Assessment Tool (EAT-10) (Appendix F); and 3) the Montreal Cognitive Assessment (MoCA) (Appendix G). The researcher was trained by a New Zealand Registered Dietitian in the administration of the tools. Anthropometric data was collected at the end of the questionnaire. The interview took approximately 45-75 minutes to complete.

3.5.1 Sociodemographic Characteristics

This section was comprised of six items to determine: age (in years); ethnicity; current marital status; social living situation; income; and education level.

Ethnicity was based on four ethnic groups: New Zealand European, Maori, Pacific, or Other (participants were asked to specify). Multiple ethnic groups could be selected if participants identified as belonging to more than one. Current marital status was based on four categories: married/partnered, widowed, divorced/separated, or never married. Living situation was based on participants living alone, with their spouse only, or with others (participants were asked to elaborate on how many and who). Income was determined from whether participants received income in addition to their pension. Examples of other income sources included

wages/salary/commission, self-employment, investment interest, rent, or other pensions (e.g. received from overseas) (Statistics New Zealand, 2013). If participants provided information on type of income, this was recorded in the comments section. Highest level of education was based on attending primary school, secondary school, or tertiary institution. It was noted if participants received ≤12 years education as per the MoCA protocol (Nasreddine, 2010).

3.5.2 Health Characteristics

Health characteristics were based on participants' responses to six items: health issues and key co-morbidities, regular prescribed and over-the-counter medications, current nutritional supplements, dentition status, and support services.

Participants were asked to list any known health issues and any current prescribed, over-the-counter medications, and nutritional supplements they may be taking regularly. These were noted with frequency of dosage recorded. In addition to participant-reported information, participant medical information was accessed through the medical database at North Shore Hospital, (Concerto) and through the general practice database. The information included key co-morbidities, and number and type of prescription medications at the time of interview.

Dentition status was identified from: dentate, edentulous, or dental appliance. Edentulous was defined as missing one or more teeth.

Participants were asked if they received subsidised support services and if they required assistance with daily tasks (e.g. shopping, cleaning and cooking) - hours and frequency were recorded. Finally, participants were asked if they had received input from a dietitian in the past, with details of what, when and how often noted.

3.5.3 Mini Nutritional Assessment®-Short Form (MNA®-SF)

The validated MNA®-SF was used to assess and identify participants who were malnourished or at risk of malnutrition (Kaiser et al., 2009; Nestle Nutrition Institute, n.d.) (Appendix E). Screening items in the MNA®-SF included a recent decline in food intake, involuntary weight loss, and psychological stress or acute disease. Participants were also asked about

neuropsychological problems and current mobility. The MNA®-SF incorporates BMI and calf-circumference (CC only if BMI is unable to be obtained); individuals with a BMI <19kg/m^2 are identified as 'at risk of malnutrition'. Participants could score a maximum of 14 points, with those scoring 0-7 identified as malnourished. Those who scored 8-11 points were identified as at risk of malnutrition, and those scoring 12-14 points were identified as having normal nutrition status.

3.5.4 10-Item Eating Assessment Tool (EAT-10)

The validated 10-item Eating Assessment Tool was used to measure and assess any swallowing difficulties participants might have experienced (Belafsky et al., 2008) (Appendix F). The EAT-10 includes questions regarding dysphagia symptoms: weight loss; eating in social situations; difficulties swallowing liquids, solids and tablets; pain, food sticking, coughing, and stress when swallowing; and self-perceived pleasure of eating when swallowing. Participants were asked to rank each item on a scale from 0 (no problem) to 4 (severe problem). Participants scoring less than three points were identified as 'not at risk', whilst those scoring three points or higher were identified as 'at risk of swallowing efficiently and safely'.

3.5.5 Montreal Cognitive Assessment (MoCA)

The validated Montreal Cognitive Assessment was used to assess and screen participants for mild cognitive impairment (Nasreddine, 2010). The researcher was trained by a New Zealand Registered Dietitian in administering the MoCA (Appendix G). The MoCA assesses different cognitive domains covering visuospatial skills and executive functions, conceptual thinking, calculations, attention and concentration, language, memory, and orientation to date, place and city. Participants could score a maximum of 30 points: 26 or above was considered normal cognitive function, whilst scoring below 26 indicated mild cognitive impairment (MCI).

3.5.6 Anthropometric

Anthropometric data included five items: weight, height, demispan, calf circumference, and Body Mass Index (BMI). Comments were recorded on the questionnaire if measurements were unable to be obtained.

3.5.6.1 Weight

Body mass (weight, kg) was measured using the Body Composition Analyzer, SC-330 (Tanita, Japan), recorded to the nearest 0.1 kg. Participants were asked to remove any heavy outer clothing, shoes and socks, and ensure empty pockets before recording their weight, in accordance with the MNA-SF user guide instructions (Nestle Nutrition Institute, n.d.).

3.5.6.2 Height

Standing height (m) was measured and recorded using a portable stadiometer (Secca CE0123), in accordance with the MNA-SF user guide (Nestle Nutrition Institute, n.d.). The stadiometer was set up on an even and firm surface, supported against a wall. Participants were measured with shoes removed, standing up as straight as possible with heels together and buttocks and shoulders against the stadiometer. Participants were asked to look straight ahead, keeping their head upright and aligned with arms hanging freely. The stadiometer measure was lowered until making contact with the top of the head. Height was recorded to the nearest 0.1cm.

Demi-span was measured if standing height was unable to be obtained safely (Nestle Nutrition Institute). Participants were asked to extend their left arm horizontally in line with shoulders, with the arm flat and wrist straight. A tape measure (Lufkin Executive Thinline measuring tape) was used to measure the distance from the participant's mid-sternal notch to the web between the middle and ring fingers on their extended arm. Height was then calculated using the following predictive equations:

Females

(1.35 x demi-span in cm) + 60.1 = height in cm

Males

(1.40 x demi-span in cm) + 57.8 = height in cm

3.5.6.3 Body Mass Index

The participant's recorded height was input into the Body Composition Analyzer SC-330 (Tanita, Japan) and Body Mass Index (BMI) output recorded to the nearest 0.1 kg/m^2. BMI is calculated using the participant's measured weight (kg) and height (m), input into the formula as follows:

$$\text{BMI (kg/m}^2\text{)} = \frac{\text{weight (kg)}}{\text{height (m)}^2}$$

BMI was classified as per the World Health Organization (WHO) international classification (World Health Organization, 2006):

Table 4: WHO International Classification of adult BMI

Classification	BMI (kg/m^2)
Underweight	<18.50
Normal range	18.50-24.9
Pre-obesity	25.0-29.9
Obesity Class I	30.0-34.9
Obesity Class II	35.0-39.9
Obesity Class III	>40.0

3.5.6.4 Calf-circumference

Participants were asked to sit with weight evenly distributed and their left calf exposed. CC was measured to the nearest 0.1cm at the widest point using a tape measure (Lufkin Executive Thinline tape measure). Additional measurements were taken above and below to ensure the widest point was recorded (Nestle Nutrition Institute, n.d.).

3.6 Blood sampling procedures

Fasting blood samples were collected to analyse serum levels of PAB and CRP. Upon providing consent, participants' names were provided to medical staff at the general practice after time of interview to arrange the appropriate laboratory request test form. Forms were collected by the research student and posted to the participants. Participants were instructed that blood samples could be collected at a Labtest laboratory at their convenience when undergoing a routine blood test or as an additional blood test.

Blood samples were required to be collected under fasting conditions. The participant must have fasted for >10 hours but <16 hours; this included no smoking, eating any food (including chewing gum), or drinking fluids other than plain water (Labtests, 2015). Collection of samples occurred via venepuncture by a trained Labtest's phlebotomist, with processing of samples and analysis occurring according to Canterbury Health Laboratories procedures. Serum PAB and CRP

levels were determined by rate nephelometry for a quantitative measurement (Canterbury Health Laboratories, 2013a, 2013b).

The PAB reference range for healthy adults is 0.2-0.4g/L (Canterbury Health Laboratories, 2013b). Participant PAB results were grouped into two categories as is similar to previous studies (Robinson et al., 2003): <20 mg/dL, considered a malnourished/abnormal PAB value; and ≥20 mg/dL, considered a well-nourished/normal PAB value.

Normal concentrations of CRP range from ≤2 mg/L to 10 mg/L, with a normal reference value <5 mg/L (Canterbury Health Laboratories, 2013a); due to this range, a clinically significant value was defined as >10 mg/L (Samols et al., 2001; Stenvinkel, Barany, Chung, Lindholm, & Heimburger, 2002).

3.7 Statistical Analysis

All data recorded on the study questionnaire was coded, with coded questionnaire items and biomarker results then entered into a Microsoft Excel data template spreadsheet. This was imported into IBM SPSS version 22 software (IBM Corporation) which was used for the statistical analysis. Due to the large sample size, data was assumed to be normally distributed and homogenous (central limit theorem), and presented as mean ± standard deviation (Field, 2009). Categorical data was expressed as counts and percentages. Independent T-tests were used to compare means for continuous scale data, whilst Pearson Chi-Square was used to compare categorical data and counts. Where the Pearson Chi-Squared test was invalid due to cell counts being less than five, Fisher's Exact test was used. A p value <0.05 was considered statistically significant.

The affected variables were regrouped where Pearson Chi-Squared and Fisher's Exact Test were invalid: marital status recoded into 'currently married/partnered' and 'not currently married/partnered'; living situation recoded into 'living alone' and 'living with others' (spouse and/or others), income recoded to exclude two participants not receiving a pension, key comorbidities recoded into '<5 key comorbidities' and '≥5 key comorbidities', and dental status regrouped into 'dentate' and 'edentulous and/or utilising dental appliance'. Finally, MNA score

was regrouped into two categories: scores ≤11 being at risk of malnutrition and/or malnourished, and score ≥12 being of normal nutrition status.

BMI values from the MNA-SF results were grouped according to New Zealand Ministry of Health and WHO cut-off points, where a BMI of <18.5 kg/m^2 is classified as 'underweight', 18.5-24.9 kg/m^2 'normal', and BMI ≥25.0 kg/m^2 as 'overweight/obese' (World Health Organization, 2006). The number of medications currently or regularly taken was grouped into two categories: <5 current/regular medications, or ≥5 current/regular medications. This classification is based on the definition of polypharmacy, accepted as ≥5 current or regular medications (Scott et al., 2014). Key co-morbidities were grouped into health conditions that are the leading cause of health loss in people ≥65 years of age. These groupings were according to those published within the reports by Dyson (2001) and Ministry of Health (2008).

Chapter 4: Results

4.1 Participant Recruitment

Two hundred participants (89 men and 111 women) enrolled with Henderson Medical Centre were recruited for the current study between June 2016 and August 2016, shown in Figure 2.

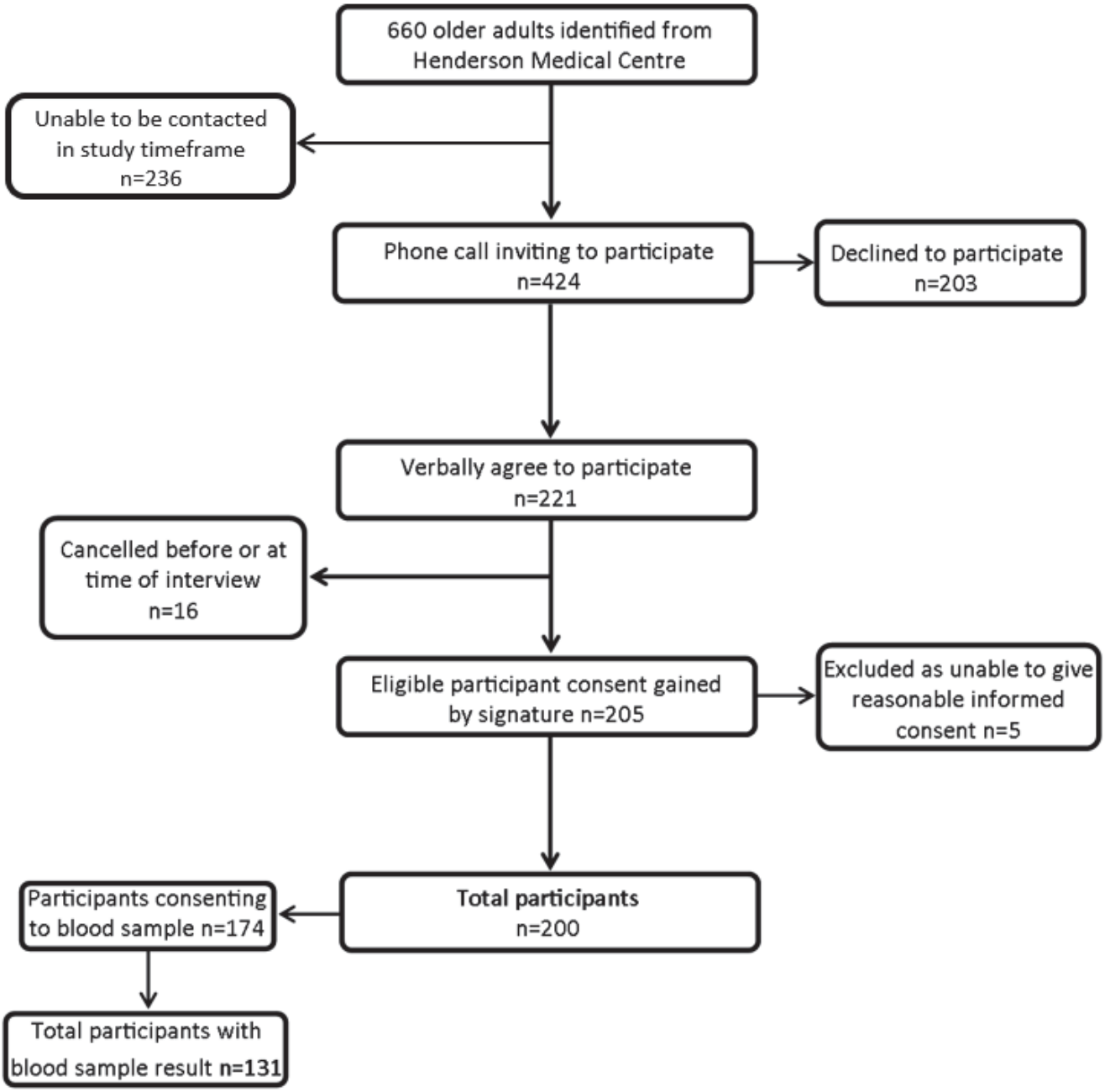

Figure 2: Study design detailing participant recruitment and final participant number.

4.2 Participant Characteristics

Participant characteristics are presented in Table 4.1. The mean age of participants was 80.9 years (±4.5), with a range from 71 to 94 years. Half of the participants (52.5%) were aged ≥80 years, with 5.5 percent of the participants ≥90 years. One participant aged <75 years identified as Maori.

The majority of participants were of New Zealand European descent (69.5%). The remaining 61 participants (30.5%) identified as 'Other' ethnicity – this included Dutch (n=23), British (n=18), Scottish (n=4), Australian (n=3), South African (n=2), and Maori (n=2). The remaining nine participants identified as Pacific, Swiss, Italian, Finnish, German, Croatian, Estonian, German/Samoan, and Scottish/Yugoslavian origin.

Over half of the participants were married or partnered (57.5%), with a similar frequency living with one or more people (60%). The remaining 40 percent of participants lived alone. The majority of participants (77.5%) had received a secondary school education.

Half of the participants received a pension only (45%) income whilst the other half received the pension plus other income (54%). Two participants reported they did not receive a pension as they were not born in New Zealand and thus were not eligible, however they had a partner/spouse working and earning an income.

The mean BMI of participants was 27.4kg/m^2, with most participants above the normal BMI range. Table 5 provides the participant characteristics.

Table 5: Participant characteristics

	Total n (%) n=200	**Men n (%)** n=89 (44.5)	**Women n (%)** n=111 (55.5)
Age (years)[‡]	80.9 ± 4.5	81.5 ± 4.6	80.6 ± 4.4
70-79 Years	95 (47.5)	40 (45.0)	55 (49.6)
80-84.9 Years	68 (34.0)	30 (33.7)	38 (34.2)
85-89.9 Years	26 (13.0)	13 (14.6)	13 (11.7)
≥90 Years	11 (5.5)	6 (6.7)	5 (4.5)
Range	71 - 94	71.7 – 93.8	75.0 – 94.6
Ethnicity			
New Zealand European	139 (69.5)	59 (66.3)	80 (72.1)
Maori	2 (1.0)	2 (2.2)	0 (0)
Other	59 (29.5)	28 (31.5)	31 (27.9)
Marital status			
Married/Partnered	115 (57.5)	64 (72.0)	51 (46.0)
Widowed	66 (33.0)	19 (21.3)	47 (42.3)
Divorced/Separated	16 (8.0)	4 (4.5)	12 (10.8)
Never Married	3 (1.5)	2 (2.2)	1 (0.9)
Living situation			
Living Alone	80 (40.0)	25 (28.0)	55 (49.6)
Living with Spouse/Partner only	95 (47.5)	53 (59.6)	42 (37.8)
Living with Others	25 (12.5)	11 (12.4)	14 (12.6)
Income			
Pension Only Income	90 (45.0)	27 (30.3)	63 (56.8)
Pension Plus Other Income	108 (54.0)	61 (68.6)	47 (42.3)
Do Not Receive Pension	2 (1.0)	1 (1.1)	1 (0.9)
Highest education			
Primary	9 (4.5)	7 (7.9)	2 (1.8)
Secondary	154 (77.5)	56 (62.9)	98 (88.3)
Tertiary	37 (18.5)	26 (29.2)	11 (9.9)
Weight (kg)[‡1]	74.1 ± 17.1	79.9 ± 15.9	69.5 ± 16.6
Height (cm)[‡]	164.2 ± 9.2	171.6 ± 6.5	158.3 ± 6.3
BMI (kg/m^2)[‡1]	27.4 ± 5.5	27.0 ± 4.6	27.7 ± 6.2
Underweight <18.5kg/m^2	6 (3)	2 (2.2)	4 (3.6)
Normal 18.5-24.9kg/m^2	55 (27.5)	25 (28.1)	30 (27.3)
Pre-obesity ≥25-29.9kg/m^2	89 (44.5)	43 (48.3)	46 (41.8)
Obesity Class I 30-34.99kg/m^2	35 (17.5)	15 (16.9)	20 (18.2)
Obesity Class II 35-39.99kg/m^2	9 (4.5)	3 (3.4)	6 (5.5)
Obesity Class III ≥40kg/m^2	5 (2.5)	1 (1.1)	4 (3.6)

SD = standard deviation; BMI = Body Mass Index

Values reported as frequencies: count (percentage) unless otherwise indicated

[‡]Values reported as mean ± SD

[1]Missing data (n=199); Calf-circumference recorded in place of BMI (n=1)

4.3 Health Characteristics

4.3.1 Key Co-morbidities

Tables 6 outlines the key co-morbidities (less than or equal to five or more) for the participants by gender. The mean number of key comorbidities was 3.9 ± 2.4, ranging from 0-12 conditions. Eight percent of participants (n=16) had no key comorbidities. The majority of participants (n=183) had at least one condition - 54% had between 1-4 conditions and 37.5% had between 5-10 conditions. One participant had 12 conditions. There was no significant difference between men and women.

Table 6: Participant key co-morbidities

	Total n (%) n=200	**Men n (%)** n=89	**Women n (%)** n=111	***P***
< 5 Key Comorbidities	124 (62.0)	52 (58.4)	72 (64.9)	0.351
≥ 5 Key Comorbidities	76 (38.0)	37 (41.6)	39 (35.1)	

Values reported as frequency: count (percentage)

Table 7 shows the participants health conditions, grouped as per the New Zealand Burden of Diseases study and ICD-10 code (Ministry of Health, 2013). Vascular and blood disorders (hypertension, heart failure, angina etc.) and diabetes and other endocrine disorders (dyslipidaemia, hypothyroidism etc.) were the most common health conditions in 80 percent and 58 percent of participants.

Table 7: Key co-morbidities experienced by participants

	Total n (%) n=184	**Men** n=83 (45.1)	**Women** n=101 (54.9)
Vascular & Blood Disorders	147 (79.9)	72 (86.7)	75 (74.3)
Diabetes & Other Endocrine Disorders	107 (58.2)	46 (55.4)	61 (60.4)
Musculoskeletal Disorders	89 (45.1)	33 (39.8)	50 (49.5)
Gastrointestinal Disorders	58 (31.5)	26 (31.3)	32 (31.7)
Respiratory Disorders	38 (20.7)	13 (15.7)	25 (24.8)
Sense Organ Disorders	33 (17.9)	13 (15.7)	20 (19.8)
Genitourinary Disorders	24 (13.0)	17 (20.5)	7 (6.9)
Neurological Conditions	24 (13.0)	10 (12.0)	12 (11.9)
Cancers & Other Neoplasms	22 (12.0)	9 (10.8)	13 (12.9)
Other	22 (11.9)	13 (15.7)	9 (8.9)
Mental Conditions	14 (7.6)	4 (4.8)	10 (9.9)
Infections	8 (4.3)	2 (2.4)	6 (5.9)
Skin Disorders	2 (1.1)	0 (0.0)	2 (1.9)
Injury	1 (0.5)	0 (0.0)	1 (0.9)

All values reported as frequency: count (percentage)

4.3.2 Medications

Table 8 outlines the number of regular prescribed medications by gender. The mean number of regular prescribed medications was 4.9 (range, 0-14). Over half of the participants (57%) were prescribed ≥5 medications. No significant difference was found between number of regular prescribed medications and gender.

Table 8: Prescribed medications

	Total n (%) n=200	**Men n (%)** n=89	**Women n (%)** n=111	***P***
No regular prescribed medications	20 (10)	8 (9)	12 (10.8)	
< 5 Medications	66 (33)	25 (28.1)	41 (36.9)	0.196
≥ 5 Medications	114 (57)	56 (62.9)	58 (52.3)	

All values reported as frequency: count (percentage)

Over-the-counter medications were reported to be taken by 15 (7.5%) participants. Of these, 14 participants were taking one medication and the remaining participant taking two. The medications recorded included: Panadol, Neurofen, Omeprazole, Gaviscon, Cough Liquid, Mucinex, sleeping tablets, nasal spray, and tear drops.

4.3.3 Nutritional Supplements

4.3.3.1 Prescribed Nutritional Supplements

Over one-third of total participants (37%) were prescribed nutritional supplements from their General Practitioner (range, 1-3 prescribed). Of these participants, 61 were prescribed one nutritional supplement, 10 prescribed two supplements, and three participants prescribed three nutritional supplements.

Cholecalciferol was the most common prescribed nutritional supplement for 42 participants and more commonly prescribed to women (Table 9). Hydroxocobalamin (vitamin B12 injections) and multivitamins were the second most commonly prescribed supplement. Women were more likely to be prescribed nutritional supplements than men ($P < 0.001$).

Table 9: Prescribed nutritional supplements

	Total n (%)	Men	Women	*P*
Total n prescribed	74	19	55	<0.001
Cholecalciferol	42 (21.0)	8	34	
Hydroxocobalamin	19 (9.5)	8	11	
Multivitamin	18 (9.0)	6	12	
Iron	5 (2.5)	3	2	
Folic Acid	3 (1.5)	0	3	
Calcium	2 (1.0)	0	2	
Occuvit	1 (0.5)	0	1	

Values reported as frequency: count (percentage)

4.3.3.2 Over-the-Counter Nutritional Supplements

Over half of the participants (n=106, 53%) reported regularly taking over-the-counter nutritional supplements (range, 1-18). Half (n=52) took one supplement daily. Two participants reported taking ≥10 supplements regularly, with one reporting 10 and one reporting 18. Of the 67 different supplements reported by participants, the five most common were fish oil capsules (n=37), magnesium (n=25), glucosamine (or glucosamine containing chondroitin) (n=22), multivitamins (n=21), and vitamin C (n=16).

4.3.4 Dental Status

Over half of the participants (56.5%) had some form of dental appliance, and 41% of participants were dentate (Table 10). Five participants (2.5%) were classed as edentulous, with some degree of tooth loss (at least one tooth missing). No significant difference was found in dental status between genders.

Table 10: Participant dental status

	Total n (%)	Men n (%)	Women n (%)
	n=200	n=89	n=111
Dentate	82 (41.0)	36 (40.4)	46 (41.4)
Edentulous/Dental Appliance	118 (59.0)	53 (52.5)	65 (65.5)

Values reported as frequency: count (percentage)

4.3.5 Support Services

The majority of participants (79.5%) did not receive regular subsidised support services, and 85.5% of participants did not require assistance with daily tasks (Table 11). No significant differences were found between genders.

Table 11: Support services received by participants

	Total n (%) n=200	**Men n (%)** n=89	**Women n (%)** n=111
Receives Regular Subsidised Support Services	41 (20.5)	16 (18.0)	25 (22.5)
Not Receiving Regular Subsidised Support Services	159 (79.5)	73 (82.0)	86 (77.5)
Requires Assistance with Daily Tasks	29 (14.5)	9 (10.1)	20 (18.0)
Does Not Require Assistance with Daily Tasks	171 (85.5)	80 (89.9)	91 (82.0)

Values reported as frequency: count (percentage)

4.4 Dysphagia Risk

The mean EAT-10 score was 0.6 ± 1.7, ranging from 0-10. There were 15 participants (7.5%) with dysphagia risk (score ≥3). Most participants were not at risk (92.5%), with 155 (83.4%) of those scoring zero (Table 12). No significant differences were found in dysphagia risk between genders.

Table 12: Participant EAT-10 scores to assess dysphagia risk

	Total	**Men**	**Women**
	n=200	n=89	n=111
At Risk (score ≥3)	15 (7.5)	6 (6.7)	9 (8.1)
Not At Risk (score <3)	185 (92.5)	83 (93.3)	102 (91.9)

EAT-10 = 10-item Eating Assessment Tool
Recognised cut-offs for swallowing difficulties as per the EAT-10 (Belafsky et al., 2008)

4.5 Cognitive Status

There were 175 participants who completed the Montreal Cognitive Assessment (MoCA). Twenty-five participants had an incomplete MoCA (declined to continue the assessment or declined to answer specific questions within the assessment).

Table 13 illustrates completed MoCA scores. The mean MoCA score was 22.7±4.1 (range, 10-30). Two-thirds of the participants (63%) scored <26 indicative of mild cognitive impairment. Participants were significantly more likely to score <26 than score ≥26 (*P*=0.006). No significant differences were found in MoCA scores between genders.

Table 13: Participant MoCA scores

	Total n (%)	**Men n (%)**	**Women n (%)**	***P***
	n=175	n=79	n=96	
MoCA score[‡]	22.7 ± 4.1	22.3 ± 3.6	23.0 ± 4.4	0.223[1]
Normal Cognitive Status (score ≥26)	49 (28.0)	14 (17.7)	35 (36.5)	0.006[2*]
Mild Cognitive Impairment (score <26)	126 (72.0)	65 (82.3)	61 (63.5)	

MoCA = Montreal Cognitive Assessment
Values reported as frequency: count (percentage) unless otherwise indicated
[‡]Values reported as mean ± SD
[1]Comparison between means determined by independent t-tests
[2]Comparison between categories determined by Pearson Chi-Square
*Statistically significant at the 0.05 level
Recognised cut-offs to detect mild cognitive impairment as per the MoCA (Nasreddine et al., 2005)

4.6 Nutrition Risk Status

Table 14 shows participants' nutrition risk status by MNA-SF score. The mean MNA-SF score was 13.1 (±1.5) (range, 6-14). Two participants were found to be malnourished and 24 (12%) at-risk of malnutrition. The majority of participants (87%) were of normal nutrition status. No significant differences were found between mean MNA score and gender. More women (n=17) were in the 'at risk' group than men (n=7). The MNA-SF item scores are presented in Appendix H.

Table 14: MNA-SF participant scores by gender

MNA-SF score	Total n=200	Men n=89	Women n=111
Malnourished (score 0-7)	2 (1.0)	2 (2.2)	0 (0.0)
At Risk of Malnutrition (score 8-11)	24 (12.0)	7 (7.9)	17 (15.3)
Normal Nutrition Status (score 12-14)	174 (87.0)	80 (89.9)	94 (84.7)

MNA-SF = Mini Nutritional Assessment - Short-Form
Values reported as frequency: count (percentage)
Recognised cut-offs for nutritional status as per the MNA-SF (Kaiser et al., 2009)

4.6.1 Nutrition Risk by Participant Characteristics

Table 15 shows the sociodemographic, health and social factors by those at/not at nutrition risk. Due to the small number of participants classified as 'malnourished', the MNA-SF scores were categorised using the cut-offs of 'at nutrition risk' being less than 12 points (n=26, 13.0%), with normal nutrition status being 12 points or greater (n=174, 87.0%) (Rubenstein et al., 2001; Kaiser et al., 2009).

4.6.1.1 Associations between participants' nutrition risk status and sociodemographic, health and social support factors

Significant associations were observed for cognitive function (*P*=0.036) and support services (*P*=0.015) between those at risk of malnutrition and those of normal nutrition status. Only 25.2 percent of participants of normal nutrition status were of normal cognitive function compared to 45.8 percent of those at risk of malnutrition, whilst 38.5 percent of those at-risk received support services compared to 17.8 percent of participants of normal nutrition status. BMI was significantly lower in participants at risk of malnutrition compared to those of normal nutrition status (23.6kg/m^2 and 27.9kg/m^2 respectively, *P*=0.007). No other significant differences were found for other risk factor variables between nutrition status groups.

Table 15: Associations between participant nutrition risk status, sociodemographic, health and social support factors

	Total n (%) n = 200	MNA score ≥12 n = 174	MNA score <12 n= 26	*P*
Age[‡]				
70-79y	95 (47.5)	82 (47.1)	13 (50.0)	0.784[4]
≥80y	105 (52.5)	92 (52.9)	13 (50.0)	
Gender				
Men	89 (44.5)	80 (46.0)	9 (34.6)	0.277[4]
Women	111 (55.5)	94 (54.0)	17 (65.4)	
Marital Status				
Married/Partnered	115 (57.5)	101 (58.0)	14 (53.8)	0.686[4]
Not currently married/partnered	85 (42.5)	73 (42.0)	12 (46.2)	
Living Situation				
Living alone	80 (40.0)	69 (39.7)	11 (42.3)	0.797[4]
Living with others	120 (60.0)	105 (60.3)	15 (57.7)	
Income[1]				
Pension only income	90 (45.0)	77 (44.3)	13 (50.0)	0.617[4]
Pension plus other income	108 (54.0)	95 (54.6)	13 (50.0)	
Highest Education				
Primary	9 (4.5)	8 (4.6)	1 (3.8)	
Secondary	154 (77.0)	133 (76.4)	21 (80.8)	
Tertiary	37 (18.5)	33 (19.0)	4 (15.4)	
Health Conditions				
<5 Key co-morbidities	124 (62.0)	111 (63.8)	13 (50.0)	0.177[4]
≥5 Key co-morbidities	76 (38.0)	63 (36.2)	13 (50.0)	
Regular Prescribed Medications				
<5 Medications	86 (43.0)	71 (40.8)	15 (57.7)	0.105[4]
≥5 Medications	114 (57.0)	103 (59.2)	11 (42.3)	
Prescribed Nutrition Medications				
Prescribed	74 (37.0)	66 (37.9)	8 (30.8)	0.480[4]
Not prescribed	126 (63.0)	108 (62.1)	18 (69.2)	
Over-The-Counter Nutrition Supplements				
Taking nutrition supplements	106 (53.0)	95 (54.6)	11 (42.3)	0.242[4]
Not taking	94 (47.0)	79 (45.4)	15 (57.7)	
Dental Status[3]				
Dentate	82 (41.0)	70 (40.2)	12 (46.2)	
Edentulous and/or dental appliance	118 (59.0)	104 (59.8)	14 (53.8)	0.567[4]

Dysphagia Risk Status (EAT-10)				
Not At Risk	185 (92.5)	162 (93.1)	23 (88.5)	0.420[5]
At Risk	15 (7.5)	12 (6.9)	3 (11.5)	
[3]Cognitive Function (MoCA)				
Normal	49 (28.0)	38 (25.2)	11 (45.8)	0.036[4*]
Below Normal	126 (72.0)	113 (74.8)	13 (54.2)	
Support Services				
Receiving Regular Support Services	41 (20.5)	31 (17.8)	10 (38.5)	0.015[4*]
Not Receiving Support Services	159 (79.5)	143 (82.2)	16 (61.5)	
Daily Task Assistance				
Requires Assistance	29 (14.5)	25 (14.4)	4 (15.4)	1.000[5]
Does Not Require Assistance	171 (85.5)	149 (85.6)	22 (84.6)	
[2]BMI (kg/m^2)	27.4 ± 5.5	27.9 ± 4.9	23.6 ± 7.5	0.007[6*]
Underweight (<18.50)	6 (3.0)	0 (0.0)	6 (23.1)	
Normal (18.50-24.99)	55 (27.6)	42 (24.3)	13 (50.0)	
Overweight/obese (≥25.00)	138 (69.0)	131 (75.7)	7 (26.9)	

EAT-10 = 10-Item Eating Assessment Tool; MoCA = Montreal Cognitive Assessment; BMI = Body Mass Index; SD = standard deviation

Values reported as frequencies: count (percentage) unless otherwise indicated

[‡]Values reported as mean ± SD

[1]Missing data (n=198)

[2]Missing data (n=199)

[3]Missing data (n=175)

[4]Significance determined by Pearson Chi-Square

[5]Significance determined by Fishers Exact Test

[6]Significance determined by Independent t-tests

[*]Significant association/difference between groups (p<0.05)

4.7 Nutrition Biomarkers

4.7.1 Prealbumin

Of the 200 participants, 131 completed blood tests as shown in Figure 1. The mean serum PAB value was 0.27 g/L, with values ranging from 0.10-0.49g/L (Table 16). No significant difference was found between serum PAB value and gender.

Table 16: Participant PAB values

	Total n=131	**Men** n=60	**Women** n=71	***P***
PAB[‡] (g/L)	0.27 ± 0.06	0.26 ± 0.07	0.27 ± 0.06	0.531

PAB = prealbumin
[‡]Values reported as mean ± SD
Normal prealbumin (PAB) reference range: 0.2-0.4g/L

Nine participants had abnormal serum PAB results, whilst 116 participants had a PAB value within the normal reference range (Table 17). Of these 116, seven participants were found to have a borderline PAB value of 0.2g/L.

Table 17: Categorised PAB values by gender

PAB (g/L)		**Total** n=131	**Men** n=60	**Women** n=71
Abnormal	<0.20	9 (6.9)	6 (10.0)	3 (4.25)
Normal	0.20-0.39	116 (88.5)	51 (85.0)	65 (91.5)
	≥0.40	6 (4.6)	3 (5.0)	3 (4.25)

PAB = prealbumin
Values reported as frequencies: count (percentage)

4.7.2 C-reactive Protein

Table 18 shows the laboratory values of CRP for all participants. CRP values ranged from <1-121 mg/L. No significant difference was found between serum CRP value and gender. The majority of participants (n=118, 90%) had a normal CRP value within the reference range (<10mg/L). The remaining 13 participants (10%) had CRP values ≥10mg/L indicating the presence of mild to acute inflammation (Table 19).

Table 18: Participant CRP protein values

	Total	Men	Women	*P*
	n=131	n=60	n=71	
CRP (mg/L)	4.66 ± 11.81	5.83 ± 16.75	3.68 ± 4.48	0.299

CRP = C-reactive protein
Values reported as mean ± SD

Table 19: Categorised CRP values by gender

CRP (mg/L)		Total	Men	Women
		n=131	n=60	n=71
Normal	<10	118 (59.0)	54 (90.0)	64 (90.1)
Abnormal	≥10	13 (6.5)	6 (10.0)	7 (9.9)

CRP = C-reactive protein
Values reported as frequencies: count (percentage)
Normal CRP reference range = <10mg/L

4.7.3 Nutrition Risk and Biomarkers

Table 20 shows the prevalence of normal and abnormal CRP values, of those with normal and abnormal PAB values within both 'normal nutrition' risk status and those with 'at-risk of malnutrition' status categories. One participant had an abnormal PAB value and at-risk of malnutrition with no inflammation present. The remaining eight participants (6.2%) with an abnormal PAB value had a normal nutrition status as assessed by the MNA-SF – two of these participants had inflammation. The two participants found to be malnourished (Table 14) by the MNA-SF did not have a completed blood test.

Table 20: Prevalence of normal and abnormal CRP values, of those with normal and abnormal PAB values, within both 'normal nutrition' risk status and those with 'at-risk of malnutrition' status categories according to MNA-SF score

	MNA-SF Score			
	At-risk <12		Normal ≥12	
	PAB (g/L)			
	Abnormal <0.2	Normal ≥0.2	Abnormal <0.2	Normal ≥0.2
CRP (mg/L)				
Normal <10	1 (0.8)	14 (10.7)	6 (4.6)	97 (74.0)
Inflammation ≥10	0 (0.0)	2 (1.5)	2 (1.5)	9 (6.9)
Total	1	16	8	106

All values reported as frequency: count (percentage)

The relationship between nutrition status and PAB and CRP, for all participants is presented in Table 21. No significant difference was found between mean nutrition biomarker values and nutrition risk status. There was no significant correlation between PAB and total MNA-SF score or between CRP and total MNA-SF score. There was a small and significant correlation between PAB and CRP (r=1.262, *P*=0.003).

Table 21: Correlation between PAB, CRP and MNA-SF nutrition risk group

	MNA-SF Normal (score ≥12)	**MNA-SF At-risk** (score <12)		**Pearson Correlation Coefficient**	
	Mean ± SD	*Mean* ± SD	P*	r	*P*
PAB (g/L)	0.27 ± 0.07	0.25 ± 0.04	0.394	.092	0.299
CRP (mg/L)	4.77 ± 12.42	3.94 ± 6.49	0.788	-.113	0.200

*Independent T-tests
Pearson correlation coefficient performed by serum PAB and serum CRP vs total MNA-SF score for continuous data.
SD = standard deviation; MNA-SF = Mini Nutritional Assessment Short Form; PAB = Prealbumin; CRP = C-reactive protein

No statistically significant association was found between those with 'normal' and 'at-risk' nutrition status and those with 'abnormal' and 'normal' PAB values (*P*=1.00), and remained not significant even after adjustment for CRP.

A binomial logistic regression was applied to determine if serum PAB and CRP values predicted change in nutrition status (assessed by the MNA-SF scores). The model (Table 22) was not statistically significant, $X^2(8)=6.428$, *P*=0.599, $R^2=0.033$. No statistically significant correlation was found for the predictor variables (age, gender, serum PAB or serum CRP) with those at-risk or of normal nutrition status as assessed by the MNA-SF.

Table 22: Binomial logistic regression predicting likelihood of nutrition status assessed by the MNA-SF based on PAB and CRP values

	B	Standard Error	*P*	Odds Ratio	95% C.I. for EXP(B)	
					Lower	Upper
Age	0.041	0.069	0.554	1.041	0.910	1.191
Gender*	0.477	0.549	0.385	1.612	0.550	4.726
PAB	5.086	4.931	0.302	161.821	0.010	2548744.646
CRP	0.011	0.032	0.734	1.011	0.950	1.076
Constant	-2.921	5.742	0.611	0.054		

* Gender is for females compared to males

5.0 Discussion

The aim of this study was to determine the prevalence of nutrition and dysphagia risk in community-living older adults, and to assess the potential of PAB in conjunction with CRP as biomarkers of nutrition risk. To our knowledge, this is the only study which has investigated the potential of PAB, in conjunction with CRP, as a nutrition biomarker in community-living older adults within New Zealand.

Overall, using the MNA-SF, two participants (1%) were found to be malnourished and 24 participants (12%) were at-risk of malnutrition. Most of the participants were of healthy nutrition status. As nutritional well-being is a key determinant of good health and healthy ageing, it is apparent this study population of older adults do not demonstrate a high prevalence of nutrition risk. The individuals who consented to participate therefore may not be representative of the general older New Zealand population living at home. Similarly, Winter et al. (2013) in Australia found among 225 older participants attending a community General Practice (mean age 81.3 years), 17 percent were categorized as at risk using the MNA-SF, and only one participant was assessed to be malnourished. In a population of 250 older Australian recipients of publicly funded home care services, Visvanathan et al. (2003) found 4.8 percent were malnourished. The current study thus found similar rates of malnutrition to Visvanathan et al. (2003) and Winter et al. (2013). In a UK study among elderly living in sheltered accommodation (n=100), 17% were found to be at risk of malnutrition using the MNA (D. G. Harris, Davies, Ward, & Haboubi, 2008). A systematic review of studies which have investigated nutrition risk using the MNA (n=14149, 21 studies) found a mean 2 percent of community-living older adults to be malnourished (range 0-8%) and 24 percent at risk of malnutrition (range 8-76%) (Guigoz, 2006) which bears resemblance to the current study.

In contrast, other studies which have investigated nutrition risk in community-living older adults have observed a higher prevalence of nutrition risk. A retrospective pooled analysis of previous international studies utilising the full MNA (n=964, 88% female) categorized 5.8 percent of participants as malnourished, 32.9 percent at-risk of malnutrition, and 62.4 percent as well-

nourished (Kaiser, Bauer, et al., 2010). A Danish study involving 171 participants found 21.6 percent at-risk of undernutrition and 78.4 percent well-nourished (A. M. Beck, Ovesen, & Osler, 1998). Although these studies utilised the full version of the MNA, the MNA-SF is strongly correlated (r=.945) (Rubenstein et al., 2001), hence these studies provide evidence of a high prevalence of nutrition risk. In New Zealand, a Christchurch based study of 152 participants, mean age 79.5 years, found 23 percent of community-living participants were at nutrition risk and 31 percent at high nutrition risk using Seniors in the Community: Risk Evaluation for Eating and Nutrition, version II (SCREEN II) (Watson et al., 2010).

The participants mean BMI in this study was 27.4kg/m^2. One-quarter of the participants (24.5%) were obese (BMI $\geq$30kg/m^2), whilst three percent of participants were underweight (BMI <18.5kg/m^2) in accordance with the WHO classification (World Health Organization, 2006). Similarly to the current study, Soini, Routasalo, and Lagstrom (2004) found in 178 elderly home-care patients aged 75-94 years, the mean BMI was 27.4kg/m^2; one-third were obese and six percent were underweight. The current study found participants at risk of malnutrition had a significantly lower mean BMI (23.6kg/m^2) than those of normal nutrition status (27.9kg/m^2) ($P <$ 0.05). This is not unexpected as BMI is a component within the MNA-SF tool. In this study, approximately one-quarter of participants at risk of malnutrition were overweight or obese. In Australia, Winter et al. (2013) similarly found one-third of participants at nutrition risk to be overweight or obese. This does highlight that risk of malnutrition can be present in participants with a normal and overweight or obese BMI, and indicates that BMI on its own is not a useful indicator of malnutrition.

Although BMI cut-off values have not been clearly defined in the elderly, meta-analyses suggests that mortality and morbidity associated with overweight and obesity only increases with a BMI greater than 30kg/m^2 (in the absence of obesity related health conditions), a higher BMI in the elderly than in the young and middle-aged (Flicker et al., 2010; Janssen & Mark, 2007; Landi et al., 1999; Mathus-Vliegen, 2012). Thus, data suggests being moderately

overweight may confer a survival advantage in elderly compared to those who are underweight or obese.

As evidenced, the prevalence of malnutrition and nutrition risk amongst community-living older adults varies widely. This may largely be attributed to variability in nutrition risk factors amongst study populations such as prevalence of those receiving home care services and living alone, frequency of GP visits, and number of health conditions and comorbidities.

A Finnish study (Soini et al., 2004) found 3 percent of frail elderly home-care patients to be malnourished and 48 percent at risk of malnutrition. Similarly, Visvanathan et al. (2003) found 38.4 percent of elderly home-care recipients were at risk of malnutrition. Our study most likely observed a lower prevalence of those at risk than those by Visvanathan et al. (2003) and Soini et al. (2004) as all participants in the two studies were receiving home care services. Individuals receiving home care services generally have some form of moderate to severe functional limitation, with the services allowing them to remain at home. Good nutrition is associated with supporting physical function and preventing disability, therefore identifying individuals receiving home care services may be a viable way to identify those most at risk of malnutrition.

The current study found 11 participants (42%) at nutrition risk lived alone. In comparison to other New Zealand studies, Watson et al. (2010) found 71 percent and 75 percent of participants at nutrition risk and at high nutrition risk respectively lived alone, and C. Wham, Teh, et al. (2011) found 60 percent of participants at significant risk of malnutrition lived alone. Living with others places older people at lower risk of malnutrition, most likely because eating in the presence of others and with others can increase food intake during meals (Locher, Robinson, Roth, Ritchie, & Burgio, 2005). However, this study did not observe a significant association between those living alone and being at risk of malnutrition.

Overall, the study found 15 participants (7.5%) to be at risk of dysphagia. Twelve percent of participants at risk of malnutrition were found to be at risk of dysphagia, compared to seven

percent of participants of normal nutrition status at risk of dysphagia. However, this was not significantly different.

The highest dysphagia risk factor scores in the EAT-10 tool were for 'swallowing pills takes extra effort', 'when I swallow food sticks in my throat' and 'I cough when I eat'. These findings were not investigated further, however, such factors can unintentionally place individuals at risk for declining nutritional intake, as instead of seeking clinical attention, they may instead self-modify their diet or reduce dietary intake of certain foods (Madhavan et al., 2016). Furthermore, insecurities about eating if coughing or food sticking in the throat is experienced can be humiliating, especially if in public, whilst also producing a sudden awareness of almost being suffocated, and feeling close to death (Jacobsson, Axelsson, Osterlind, & Norberg, 2000; Martin, 1991).

The prevalence of dysphagia risk is similar to previous studies. Kawashima, Motohashi, and Fujishima (2004) reported 7.5 to 12.7 percent of older people living at home choking while eating using a dysphagia screening questionnaire. A higher prevalence was found in a U.S based study by Roy, Stemple, Merrill, and Thomas (2007), in which a third (33%) of participants reported a current swallowing problem. Roy et al. (2007) did not use a validated screening tool to assess dysphagia prevalence, instead using an interview questionnaire in conjunction with the M.D. Anderson Dysphagia Inventory (MDADI). The questionnaire included symptoms, signs, practices and patterns in swallowing history, whilst the MDADI was used to assess the effects of swallowing dysfunction on quality of life. A systematic review found the mean prevalence of dysphagia to be 15 percent among community-living older adults across six studies (n=2834) (Madhavan et al., 2016). However, as Madhavan et al. (2016) noted, many dysphagia studies have utilised differing diagnostic tools, ranging from non-validated assessment tools to a water swallow screen and videofluroscopy. A lack of standardisation thus impacts on the true prevalence of dysphagia in community-living older adults.

This study found eight percent of women were at risk of dysphagia compared to 6.7% of men. These findings are in contrast with literature where dysphagia has been observed to be greater in men than in women (Yang, Kim, Lim, & P, 2013). Men experience a greater age-related decline in absolute muscle strength across all muscle groups and including the tongue muscle, compared to women which may explain impaired bolus propulsion. Though gender differences were not significantly different in this study, they should be considered when investigating dysphagia prevalence in future studies.

Within this study of the 131 participants with a blood result, nine (6.9%) were found to have a PAB value <0.2g/L (mean 0.16±0.04g/L), below the normal reference range (0.2-0.4g/L), considered at risk of malnutrition. Thirteen participants (6.5%) were found to have a CRP value ≥10mg/L (mean 24.9±8.6mg/L), considered above the normal reference range (<10mg/L) indicating the presence of acute inflammation. The findings are similar to a study by Cals et al. (1994) investigating nutritional status in free-living Parisian health-conscious older adults, in which the authors found a median PAB value of 0.28g/L and median CRP value of 2mg/L across the 193 participants. The authors concluded the CRP values were similar to those of younger adults, suggesting the participants were free of acute inflammatory conditions indicating that ageing did not have an effect on inflammatory markers.

Seventeen participants within this study with blood test results were at-risk of malnutrition as classified by the MNA-SF. Of these, only one participant at risk of malnutrition had a PAB value less than 0.2g/L for whom the CRP value was within the normal range. Although the MNA-SF categorised the 17 participants at-risk of malnutrition, their biochemistry, specifically a PAB value within the normal range, indicated that there had been no recent changes in protein-energy intake. Overall, 74 percent of the participants had a normal PAB value, normal CRP value and were found to be of normal nutrition status as assessed by the MNA-SF.

Little research has focused on investigating serum PAB and CRP in community-living older adults as markers of nutrition status. A study investigating CRP, serum lipids and serum proteins in 101

hospitalised geriatric patients by Hrnciarikova et al. (2009) found the participants to have a mean PAB 0.17g/L and mean CRP 41.18mg/L. Nine percent had acute inflammation and normal nutrition status, 29 percent were malnourished without acute inflammation, and 33 percent were malnourished with acute inflammation. Higher rates of malnutrition and acute inflammation were found by Hrnciarikova et al. (2009) than in the current study, most possibly due to all participants being hospitalised.

Studies investigating nutritional status in older adults have shown a strong correlation between PAB and CRP, indicating an inverse relationship between the two variables (Devoto et al., 2006; Hrnciarikova et al., 2009; Pepersack, 2005). This can produce false positive results as PAB synthesis is depressed by proinflammatory cytokines, inferring it necessary to evaluate in relation to CRP (Shenkin, 2006). This relationship was not observed in the present study, most likely due to the majority of participants deemed of good health with PAB and CRP values within the normal reference range indicating no present inflammation. Furthermore, the studies by Devoto et al. (2006), Hrnciarikova et al. (2009) and Pepersack (2005) were all conducted in hospitalised geriatric patients, thus higher CRP values in conjunction with lower PAB values would be expected due to the higher prevalence of inflammatory conditions and comorbidities present. Additionally, the medical centre has much higher than average consultation fees for a GP, at $42.50 for enrolled, funded adults (Henderson Medical Centre, 2012). This is compared to $37.14, the national average cost of a GP visit for adults in 2014 (Statistics New Zealand, 2015a). Socioeconomic status is closely related to health and nutritional status; it could be probably that the study population were of a higher socioeconomic status, thus able to afford the higher than average cost to see their GP and therefore be of better health and nutrition status than those of a lower socioeconomic status.

Despite strong correlation coefficients observed between the MNA and PAB and CRP concentrations in a previous study by Vellas et al. (2000), this was not observed in the current study. Furthermore, this study found that PAB below the reference range did not predict nutrition risk as in previous studies (Robinson et al., 2003; Saka et al., 2011). This is possibly due

to the majority of participants (91.5%) reporting no recent decrease in food intake in the MNA-SF (Appendix H). PAB is known to respond to protein-energy malnutrition, hence its basis as a biomarker of nutrition status. The shorter half-life and smaller body pool of PAB allows it to theoretically be a more reliable indicator of acute changes in nutritional status compared to albumin (Bharadwaj et al., 2016). The high prevalence of participants reporting no recent change in food intake may explain the weak and non-significant correlations observed between serum PAB and CRP levels and the MNA-SF. Participants who had blood tests were sufficiently mobile to travel to a laboratory facility and could be regarded to have good functional health.

5.1 Strengths of the Study

Among 200 community-living older adults, this study provided primary findings on the prevalence of nutrition and dysphagia risk, and the use of PAB in conjunction with CRP as nutritional biomarkers. To our knowledge, this is the only study which has investigated the potential of PAB as a nutrition biomarker in community-living older adults within New Zealand. Furthermore, there are very few studies investigating dysphagia prevalence in community-living older adults within New Zealand. This study adds to and builds on the small body of research investigating nutrition and dysphagia risk in older New Zealand adults.

The MNA-SF is a validated and reliable nutrition risk screening tool for older adults and is used extensively within community-living older adults internationally. The MNA-SF was quick to administer taking less than ten minutes and aided in reducing response burden. The researcher was trained by a New Zealand Registered Dietitian in appropriate administration of the MNA-SF per the MNA-SF protocol.

This study found there was a high participation rate and high compliance with the elective blood sample component of data collection. Of the 200 participants, 87 percent consented to a blood sample; 75 percent of those consenting had blood sample results available by the end of data collection. High participation may be due to the requirement for routine three-monthly blood tests, thus allowing participants to have the blood sample drawn at the same time.

5.2 Limitations of the Study

The observational cross-sectional design of this study means it is not possible to discern causation or reverse causation between malnutrition, dysphagia, cognitive function and nutritional biomarkers in community-living older adults. The data thus only allows associations to be observed - more longitudinal and intervention studies are required to determine causation.

The sample of participants recruited was a convenience sample and not randomised, with the sample size further restricted by the short timeframe available for participant recruitment and data collection. A large number declined to participate (n=203), some due to poor health. However, participant's exclusion was largely due to inability to gain informed consent secondary to suspected severe dementia/cognitive impairment. Studies suggest malnutrition is associated with cognitive impairment, therefore potentially underestimating nutrition risk in these study participants (Isaia et al., 2011; Lee et al., 2009).

The one percent sample of participants considered malnourished did not allow for statistical comparisons to be drawn between nutrition status groups. A major limitation of the study was reliance on participants to comply with the blood sample and a delay of up to two weeks on posted laboratory request forms reaching participants following the interview. Overall, this did not allow the nutrition biomarkers to accurately reflect nutrition risk at the time participants were initially visited.

A lack of ethnic diversity was evidenced within this study with New Zealand European's over-represented and Maori and Pacific under-represented. This contrasts with the ethnic distribution suggested of the West Auckland region, with census data estimating proportion of Maori at 15.9 percent and Pacific peoples at 19.5 percent, though also estimating a lower proportion of Maori and Pacific people aged >65 years at 3.7% compared to New Zealand as a whole at 5.4% (Auckland Council, 2014).

Vision impairments (e.g. macular degeneration, cataracts), difficulty holding a pen and writing, and participants declining to answer questions led to some incomplete MoCA scores and scores not accurately reflecting participants' cognitive function. Subsections in the MoCA could allow for further classification of cognitive function if participants score <26 (impaired cognitive function).

This sub-sample of the population is not reflective of the New Zealand older adult population. Participants were sampled primarily from West Auckland as those enrolled with Henderson Medical Centre, thus limiting the representativeness of the sample across New Zealand. Future studies would do well to sample from multiple GP clinics around Auckland and New Zealand to better represent the population of community-living older adults.

6.0 Conclusion and Recommendations

6.1 Study Findings

This cross-sectional observational study is one of the first investigating the prevalence of nutrition and dysphagia risk and assessing the potential use of prealbumin in conjunction with C-reactive protein as nutritional biomarkers in community-living older adults within New Zealand. Nutrition and dysphagia risk prevalence was observed to be low with two participants (1%) found to be malnourished and 24 participants (12%) found to be at risk of malnutrition as assessed by the MNA-SF. Fifteen participants (7.5%) were found to be at risk of dysphagia as assessed by the EAT-10. Dysphagia risk was not observed to contribute to nutrition risk. The majority of the participants had normal PAB and CRP. No significant correlations were observed between PAB, CRP values and nutrition risk status. These blood sample results were unsurprising considering most participants reported no recent decrease in food intake as part of the MNA-SF. Overall, this study population was in good health.

6.2 Recommendations for Future Research

The findings of this study highlight the need for future nutrition risk screening in community-living older adults to capture the higher risk population, such as the frail elderly, those too ill to participate, and older adults with severe cognitive impairment, Parkinson's disease, and other health conditions that are associated with decreased nutritional status. Considering the New Zealand population is ageing, it is recommended that older adults are routinely screened through their primary care provider with regular weights recorded to identify those that this study could not reach. The MNA-SF and EAT-10 are quick, reliable and easy to administer screening tools for nutrition and dysphagia risk, thus providing a valid and effective process of nutrition risk assessment. These tools are ideal to use in a general practice setting where nutrition intervention may be readily available, especially considering risk of malnutrition is multifactorial and requires an interdisciplinary health care approach to adequately address the most important factors.

Overall, this sample of community-living older adults within the Auckland region could be considered a relatively healthy population. As these results are unable to be extrapolated to the

New Zealand population, further studies investigating nutrition risk in community-living older adults should be undertaken in other regions to gain a greater understanding of the true prevalence. Further investigations are also required to identify the relationship between PAB and CRP values, and nutrition risk status to assess their potential as nutritional biomarkers.

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Appendices

Appendix A: Health and Disability Ethics Committee Study Approval

Health and Disability Ethics Committees

Health and Disability Ethics Committees
Ministry of Health
C/- MEDSAFE, Level 6, Deloitte House
10 Brandon Street
PO Box 5013
Wellington
6011

0800 4 ETHICS
hdecs@moh.govt.nz

30 June 2014

Dr Jacqueline Allen
PO Box 99743
Newmarket
Auckland
Auckland 1149

Dear Dr Allen

Re:	Ethics ref:	14/NTA/70
	Study title:	Multidimensional Nutritional Analysis of Waitemata DHB Elderly Population

I am pleased to advise that this application has been *approved* by the Northern A Health and Disability Ethics Committee. This decision was made through the HDEC-Expedited Review pathway.

Conditions of HDEC approval

HDEC approval for this study is subject to the following conditions being met prior to the commencement of the study in New Zealand. It is your responsibility, and that of the study's sponsor, to ensure that these conditions are met. No further review by the Northern A Health and Disability Ethics Committee is required.

Standard conditions:

1. Before the study commences at *any* locality in New Zealand, all relevant regulatory approvals must be obtained.

2. Before the study commences at *a given* locality in New Zealand, it must be authorised by that locality in Online Forms. Locality authorisation confirms that the locality is suitable for the safe and effective conduct of the study, and that local research governance issues have been addressed.

After HDEC review

Please refer to the *Standard Operating Procedures for Health and Disability Ethics Committees* (available on www.ethics.health.govt.nz) for HDEC requirements relating to amendments and other post-approval processes.

Your **next progress report** is due by 27 June 2015.

Please don't hesitate to contact the HDEC secretariat for further information. We wish you all the best for your study.

Yours sincerely,

Dr Brian Fergus
Chairperson
Northern A Health and Disability Ethics Committee

Encl: appendix A: documents submitted
appendix B: statement of compliance and list of members

Appendix B: Participant Study Information

Participant Information Sheet

You are invited to take part in a study to understand about nutrition risk in older adults who live in their own homes.

Why is the study important?

This study will help us to identify the level of nutrition risk and swallowing risk in older adults. This is important to help guide any needs for support to older adults to retain their independence and stay living in their own homes. This study has been ethically reviewed and approved by the Northern A Health and Disability Ethics Committee.

What will my participation involve?

- A one-off interview in your own home, taking approximately 60-90 minutes. This will involve completing a short questionnaire and measurements including your weight, height, muscle mass, hand grip strength, and physical ability.
- Providing consent for a fasting blood sample to measure blood components that may be able to detect nutrition risk (serum prealbumin and C-reactive protein). You will be sent the blood test forms from your doctor if you agree to take part. Once you are fully satisfied that you understand what is involved in participating in the research you will be required to sign a consent form (copy attached).

You may like to discuss your intentions with healthcare professionals of your choice, and/or family members. You may ask questions, clarify areas you do not understand, or voice concerns with the researchers at any time

Will choosing not to participate affect my healthcare in anyway?

Our research is not part of routine patient care. If you decide not to participate, your current or future healthcare will not be affected in any way.

What are the possible benefits and risks to participating?

If the research identifies a nutritional health issue you will be offered appropriate treatment.

You may experience slight discomfort or bruising at the site of blood draw. In the extremely unlikely event you experience additional side effects during participation in this study, please contact your GP and advise the researchers immediately. We do not know all the side effects that may occur.

What are your rights?

You are under no obligation to accept this invitation, however if you decide to participate, you may:

- Decline to answer one or more particular questions

- Withdraw from the study at any time
- Ask questions regarding the study at any time
- Be withdrawn from the study should any harmful effects occur.
- On conclusion of the study, you may request a summary of the research findings from the researchers. There may be a delay in conclusion of the study and provision of the findings.

What will happen to my personal details when the study finishes?
All data collected during this research including personal information, will be de-identified to protect confidentiality, and stored securely for a period of ten years (as required by New Zealand law). After this time it will be destroyed. Access will only be available to lead and co-researchers. Blood samples collected during this research will be disposed of after testing.

In the event study results are published or presented at scientific conferences or seminars, non-identifiable information will be used. Non-identifiable data may be used in related future studies which have been approved by the Ethics Committee.

Who should I contact if I have questions, concerns or complaints during my participation in the study?
If at any stage you have questions, concerns or complaints regarding this study, please contact the following researchers:

Vicki Williams
Dietetic Masters Student,
Massey University
Phone: (09) 414 4314 or 021 414 431
Email: vicki.williams1@xtra.co.nz

Emily Sycamore
Dietetic Masters Student,
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Appendix C: Participant Informed Consent Form

Consent Form

Nutrition and swallowing risk in independent older adults

Participant Declaration of Consent:

The study has been explained to me in detail. In addition, I have read the accompanying information sheet which I can keep to refer to at any time during the duration of the study. Adequate time has been provided to enable me to fully consider participation in this study. A full list of researchers involved and contact details has been provided so I may discuss the study in more detail and obtain supplementary information, as and when necessary.

I understand I can ask questions or withdraw at any stage during the duration of this study.

I consent to providing a blood sample to test for nutrition risk (serum prealbumin and C-reactive protein) Please circle: YES / NO

Participant's name:

Signature: **Date:**

Research Declaration of Explanation:

A verbal explanation of the study has been provided to the participant. The participant has been provided with and will retain a copy of an information sheet for future reference. All questions asked by the participant have been answered, and it is believed the participant understands what is required of them to participate in the study. Informed written consent has been received by eligible patients to participate in the research.

Researcher's name:

Signature: **Date:**

Appendix D: Study Questionnaire

Questionnaire

Student Dietitian Interviewer						**Date**		
Research Assistant						**Time**		
1	**ID number:**				**2**	**NHI number**		
3	**Last name:**				**4**	**First Name**		
5	**D.O.B**	Day	Month	Year	**6**	**Age**	Years	Months

Demographic:

7. Which of these best describes your ethnicity?

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

Comments: _____

8. What is your current marital status?

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

Comments: _____

9. 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: _____

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

Pension only income	Pension plus other income
1	2

Comments: _____

11. What is your highest level of education?

Primary	Secondary	Tertiary
1	2	3

Comments: _____

Health

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

Yes	No
1	2

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

13. Do you feel you have health problems other than those discussed with your doctor?

Yes	No
1	2

Other health problems:	*Comments:*

14. 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		

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

	Medication:	Comment (i.e. dose, etc.)
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
Total Number of OTC Medications		

16. 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	

17. What is your dental status?

Dentate	Edentulous	Dental Appliance
1	2	3

Comments: _____

Support Services:

18. Do you receive any regular subsidised support service?

Yes	No
1	2

Number of Hours	Frequency (per week)	Service Description

Comments: _____

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

Yes	No
1	2

Comments: _____

20. Have you previously had any dietetic input?

Yes	No
1	2

Comments: _____

Mini Nutritional Assessment: (Nestle Nutrition Institution)

21. 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	

22. Involuntary weight loss during the last 3 months?

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

23. Mobility

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

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

Yes	No	
0	2	

25. Neuropsychological problems

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

26a. Body Mass Index (BMI) $\frac{\textbf{weight in kg}}{\textbf{height in m}^2}$

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

26b. Calf circumference (CC) in cm (answer only if unable to obtain BMI)

CC < 31 cm	CC ≥ 31 cm	
0	3	

27. MNA-SF score:

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

10-Item Eating Assessment Tool:

28. My swallowing problem has caused me to lose weight

0 No problem	1	2	3	4 Severe problem

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

0 No problem	1	2	3	4 Severe problem

30. Swallowing liquids takes extra effort

0 No problem	1	2	3	4 Severe problem

31. Swallowing solids takes extra effort

0 No problem	1	2	3	4 Severe problem

32. Swallowing pills takes extra effort

0 No problem	1	2	3	4 Severe problem

33. Swallowing is painful

0 No problem	1	2	3	4 Severe problem

34. The pleasure of eating is affected by my swallowing

0 No problem	1	2	3	4 Severe problem

35. When I swallow food sticks in my throat

0 No problem	1	2	3	4 Severe problem

36. I cough when I eat

0 No problem	1	2	3	4 Severe problem

37. Swallowing is stressful

0 No problem	1	2	3	4 Severe problem

38. 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

Montreal Cognitive Assessment:

39. MoCA Score

Total MoCA Score (max. 30 points) * Add 1 point if ≤ 12y education	
Normal ≥ 26	Cognitive Impairment <26
1	2

Participant Assessment: (Interviewer to answer 46 and 47)

How well do you rate:

40. The reliability of the respondent's responses?

Very poor	Poor	Neither poor nor good	Good	Very good
1	2	3	4	5

41. The participant's understanding of the questions

Very poor	Poor	Neither poor nor good	Good	Very good
1	2	3	4	5

Comments (required if answer is 1 or 2): _____

_____

Blood Assessment:

42. Serum prealbumin

Result (mg/L)	
<20mg/L = malnourished/abnormal	≥20mg/L = well-nourished/normal
1	2

43. Serum C-reactive protein

Result (mg/L)	
>10mg/L = elevated/abnormal	≤10mg/L = normal
1	2

Comments:_____

_____

Physical Assessment:

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

44. Anthropometric:

Weight (kg)			
Height (cm)		Demispan (cm)	
Height² (m^2)		Calf Circumference (cm)	
BMI (kg/m^2)			

45. Body Composition

Muscle Mass (kg)		Fat Mass (kg)		Fat (%)	
FFM (kg)		**Height squared (m^2)**			
FFMI (kg/m^2)					
Male (FFMI)		**Female (FFMI)**			

≤ 10.75 kg/m²	> 10.75 kg/m²	≤ 6.75 kg/m²	> 6.75 kg/m²
1	2	1	2

Comments:_____

46. Grip Strength – Use dominant hand (Allow a 15 second rest between trials)

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

Comments:_____

47. 2.4m Walk Test (allow for a 10 second interval between walks)

Trial 1					
Trial 2					
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:_____

48. 5TSTS Test

Time (seconds)			
75 - 79 years		80 + years	
≤ 12.6 sec	> 12.6 sec	≤ 14.8 sec	> 14.8 sec
1	2	1	2

Comments:_____

Appendix E: Mini Nutritional Assessment – Short Form (MNA-SF)

Mini Nutritional Assessment

MNA®

Nestlé Nutrition Institute

Last name: First name:

Sex: Age: Weight, kg: Height, cm: Date:

Complete the screen by filling in the boxes with the appropriate numbers. Total the numbers for the final screening score.

Screening

A Has food intake declined over the past 3 months due to loss of appetite, digestive problems, chewing or swallowing difficulties?
0 = severe decrease in food intake
1 = moderate decrease in food intake
2 = no decrease in food intake ☐

B Weight loss during the last 3 months
0 = weight loss greater than 3 kg (6.6 lbs)
1 = does not know
2 = weight loss between 1 and 3 kg (2.2 and 6.6 lbs)
3 = no weight loss ☐

C Mobility
0 = bed or chair bound
1 = able to get out of bed / chair but does not go out
2 = goes out ☐

D Has suffered psychological stress or acute disease in the past 3 months?
0 = yes 2 = no ☐

E Neuropsychological problems
0 = severe dementia or depression
1 = mild dementia
2 = no psychological problems ☐

F1 Body Mass Index (BMI) (weight in kg) / (height in m)^2 ☐
0 = BMI less than 19
1 = BMI 19 to less than 21
2 = BMI 21 to less than 23
3 = BMI 23 or greater ☐

IF BMI IS NOT AVAILABLE, REPLACE QUESTION F1 WITH QUESTION F2.
DO NOT ANSWER QUESTION F2 IF QUESTION F1 IS ALREADY COMPLETED.

F2 Calf circumference (CC) in cm
0 = CC less than 31
3 = CC 31 or greater ☐

Screening score (max. 14 points) ☐☐

12-14 points: ☐ Normal nutritional status
8-11 points: ☐ At risk of malnutrition
0-7 points: ☐ Malnourished

Save Print Reset

Ref. Vellas B, Villars H, Abellan G, et al. *Overview of the MNA® - Its History and Challenges.* J Nutr Health Aging 2006;10:456-465.
Rubenstein LZ, Harker JO, Salva A, Guigoz Y, Vellas B. *Screening for Undernutrition in Geriatric Practice: Developing the Short-Form Mini Nutritional Assessment (MNA-SF).* J. Geront 2001;56A: M366-377.
Guigoz Y. *The Mini-Nutritional Assessment (MNA®) Review of the Literature - What does it tell us?* J Nutr Health Aging 2006; 10:466-487.
Kaiser MJ, Bauer JM, Ramsch C, et al. *Validation of the Mini Nutritional Assessment Short-Form (MNA®-SF): A practical tool for identification of nutritional status.* J Nutr Health Aging 2009; 13:782-788.

For more information: www.mna-elderly.com

Appendix F: 10-Item Eating Assessment Tool (EAT-10)

EAT-10:
A Swallowing Screening Tool

Nestlé Nutrition Institute

LAST NAME | FIRST NAME | SEX | AGE | DATE

OBJECTIVE:

EAT-10 helps to measure swallowing difficulties.
It may be important for you to talk with your physician about treatment options for symptoms.

A. INSTRUCTIONS:

Answer each question by writing the number of points in the boxes.
To what extent do you experience the following problems?

1 My swallowing problem has caused me to lose weight.
0 = no problem
1
2
3
4 = severe problem

2 My swallowing problem interferes with my ability to go out for meals.
0 = no problem
1
2
3
4 = severe problem

3 Swallowing liquids takes extra effort.
0 = no problem
1
2
3
4 = severe problem

4 Swallowing solids takes extra effort.
0 = no problem
1
2
3
4 = severe problem

5 Swallowing pills takes extra effort.
0 = no problem
1
2
3
4 = severe problem

6 Swallowing is painful.
0 = no problem
1
2
3
4 = severe problem

7 The pleasure of eating is affected by my swallowing.
0 = no problem
1
2
3
4 = severe problem

8 When I swallow food sticks in my throat.
0 = no problem
1
2
3
4 = severe problem

9 I cough when I eat.
0 = no problem
1
2
3
4 = severe problem

10 Swallowing is stressful.
0 = no problem
1
2
3
4 = severe problem

B. SCORING:

Add up the number of points and write your total score in the boxes.
Total Score (max. 40 points)

C. WHAT TO DO NEXT:

If the EAT-10 score is 3 or higher, you may have problems swallowing efficiently and safely. We recommend discussing the EAT-10 results with a physician.

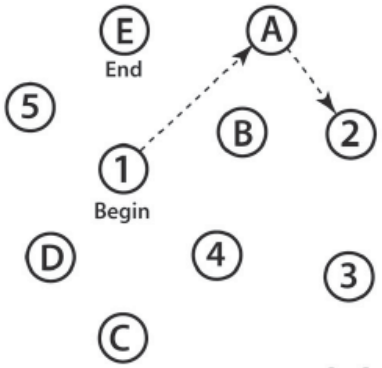
Reference: The validity and reliability of EAT-10 has been determined.
Belafsky PC, Mouadeb DA, Rees CJ, Pryor JC, Postma GN, Allen J, Leonard RJ. Validity and Reliability of the Eating Assessment Tool (EAT-10). Annals of Otology Rhinology & Laryngology 2008;117(12):919-924.

Appendix G: Montreal Cognitive Assessment (MoCA)

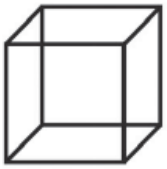
MONTREAL COGNITIVE ASSESSMENT (MOCA)
Version 7.1 Original Version

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

VISUOSPATIAL / EXECUTIVE — POINTS



Copy cube



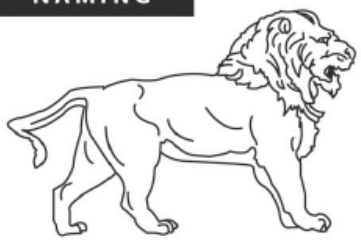
[ ] [ ]

Draw CLOCK (Ten past eleven)
(3 points)

[ ] Contour [ ] Numbers [ ] Hands

__/5

NAMING



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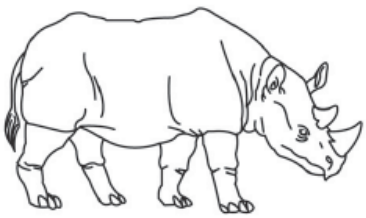
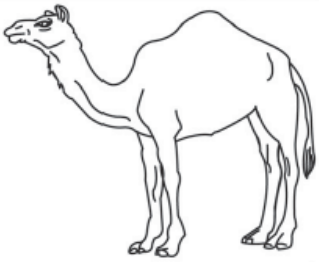


[ ]



[ ]

__/3

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

	FACE	VELVET	CHURCH	DAISY	RED
1st trial					
2nd trial					

No points

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

Subject has to repeat them in the forward order [ ] 2 1 8 5 4
Subject has to repeat them in the backward order [ ] 7 4 2

__/2

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

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

__/1

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

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

__/3

LANGUAGE Repeat : I only know that John is the one to help today. [ ]
The cat always hid under the couch when dogs were in the room. [ ]

__/2

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

__/1

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

__/2

DELAYED RECALL

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

__/5

ORIENTATION [ ] Date [ ] Month [ ] Year [ ] Day [ ] Place [ ] City

__/6

© Z.Nasreddine MD www.mocatest.org Normal ≥ 26 / 30

TOTAL __/30

Add 1 point if ≤ 12 yr edu

Administered by: _____

Appendix H: Participant MNA-SF item scores by nutrition status category

	Total n (%) n = 200	Normal n (%) n = 174	At Risk n (%) n= 24	Malnourished n (%) n = 2
A. Food Intake				
No Decrease	183 (91.5)	165 (94.8)	17 (70.8)	1 (50.0)
Moderate Decrease	17 (8.5)	9 (5.2)	7 (29.2)	1 (50.0)
Severe Decrease	0 (NA)	0 (NA)	0 (NA)	0 (NA)
B. Weight Loss				
No Weight Loss	186 (93.0)	170 (97.7)	14 (58.3)	2 (100.0)
1-3kg Weight Loss	4 (2.0)	3 (1.7)	1 (4.2)	0 (NA)
Does Not Know	6 (3.0)	1 (6.0)	5 (20.8)	0 (NA)
Weight Loss >3kg	4 (2.0)	0 (NA)	4 (16.7)	0 (NA)
C. Mobility				
Goes Out	192 (96.0)	170 (97.7)	21 (87.5)	1 (50.0)
Able to get Out of Bed/Chair but Does Not Go Out	8 (4.0)	4 (2.3)	3 (12.5)	1 (50.0)
Bed/Chair Bound	0 (NA)	0 (NA)	0 (NA)	0 (NA)
D. Psychological Stress/Acute Disease				
Yes	28 (14.0)	14 (8.0)	12 (50.0)	2 (100.0)
No	172 (86.0)	160 (92.0)	12 (50.0)	0 (NA)
E. Neuropsychological Problem				
No Psychological Problems	190 (95.0)	169 (97.1)	21 (87.5)	0 (NA)
Mild Dementia	1 (5.0)	0 (NA)	1 (4.2)	0 (NA)
Severe Dementia/Depression	9 (4.5)	5 (2.9)	2 (8.3)	2 (100.0)
F1. Body Mass Index (kg/m^2)[2,3]				
BMI <19	8 (4.0)	0 (NA)	7 (29.2)	1 (50.0)
BMI 19 to <21	11 (5.5)	7 (4.0)	3 (12.5)	1 (50.0)
BMI 21 to <23	15 (7.5)	10 (5.7)	5 (20.8)	0 (NA)
BMI ≥23	165 (82.5)	156 (89.7)	9 (37.5)	0 (NA)
F2. Calf Circumference (cm)[2,3]				
< 31	0 (NA)	0 (NA)	0 (NA)	0 (NA)
≥ 31	1	1 (0.6)	0 (NA)	0 (NA)

[1]All values reported as frequency: count (percentage)

[2]Recognised BMI and CC cut-offs for MNA-SF (Nestle Nutrition Institute, n.d.)

[3]Missing values (BMI n=199, CC n=1)