Validation of the nutrition screening tool

'Seniors in the Community: Risk Evaluation for Eating and Nutrition,

version II'

among people in advanced age.

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Table of Contributions	
Planning for NZ photographic atlas	Dr. Carol Wham (LiLACS lead investigator) and Kristy Redwood (Masters candidate)
Formatting of NZ photographic atlas and MPR forms	Kristy Redwood
Baseline SCREEN II administration	LiLACS NZ interviewers
Follow - up SCREEN II administration	Kristy Redwood
Recruitment for validation study	Kristy Redwood and LiLACS project co-ordinator
Twenty-four hour dietary recall x 2 – weekdays	LiLACS NZ nurses
Twenty-four hour dietary recall x1 – weekend	Kristy Redwood
Quality checking of 24 hour recalls	Kristy Redwood, Dr. Carol Wham
Dietitian's nutrition risk rating assessment	Kristy Redwood
Physical assessment (including anthropometrics)	LiLACS NZ nurses
Dietary analysis (Foodworks)	Kristy Redwood

Abstract

Background:

This study aims to determine the validity of the nutrition screening tool 'Seniors in the Community: Risk Evaluation for Eating and Nutrition' (SCREEN II) among adults of advanced age in Life and Living in Advanced Age: a cohort study in New Zealand (LiLACS NZ). SCREEN II is widely used in Canada and has been found to be valid and reliable amongst well community living older people. As the LiLACS NZ participants are considerably older than those recruited in Canada it was important to validate the SCREEN II tool among participants in advanced age and in the New Zealand setting.

Methods:

Forty–five people, 85-86 years, were recruited on the basis of their baseline nutrition risk score. SCREEN II consists of 14 items with a total summed score ranging from 0 to 64. Equal proportions of participants were recruited at low (>54), medium (50-53) and high risk (<50). One year later participants completed a follow up SCREEN II assessment and underwent a dietitian's nutrition risk rating assessment. The assessment included a medical history, anthropometric measures and a dietary assessment using three 24 hour multiple pass recalls. Using clinical judgement the dietitian ranked participants from low risk (score of 1) to high risk (score of 10). A Spearman's correlation determined the association between the SCREEN II score and the dietitian's risk score. Receiver operating characteristic (ROC) curves were completed to determine sensitivity and specificity of cut-offs.

Results:

There was no change in nutrition risk over the year. Participants who lived alone (p=0.02), were women (p=0.03), widowed (p=0.01), former or current smokers (p=0.03), took multiple medications (polypharmacy) (p=0.03), had depressive symptoms (p=0.02) were significantly more likely to be at nutrition risk. SCREEN II was significantly correlated with the dietitian's risk rating (r= -0.73, p<0.01). A new cut-off of <49 was established for high nutrition risk based on ROC curves and was associated with high sensitivity 90% and specificity 86%.

Conclusion:

SCREEN II appears to be a valid tool for the identification of nutrition risk in community-living older adults 85 years and older using a cut-off of <49 for high nutrition risk.

Key Words: SCREEN II, nutrition, screening tool, advanced age, older adults

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1.0 Introduction

Older adults aged 85 years-plus are the fastest growing age group of the New Zealand population with a projected growth rate of 13% (of the 65-plus population) in 2009, to 25% by 2061 (Ashley-Jones 2009). People in advanced age are the highest consumers of the health and disability expenditure (Ministry of Health 2006). The challenge of providing adequate health services within the available funding constraints already exists and as the older population continues to grow, there will be an ever increasing demand on health resources (Ministry of Health 2006). *The New Zealand Positive Ageing Strategy* and the *Health of Older People Strategy* have a focus of improving the health, promoting quality of life and independence, and reducing inequalities for older people (Dalziel 2001). The growth of the older population in conjunction with the government strategies demonstrates a need to understand the factors which could lead to maintenance of health and independence with age.

Health and nutrition status are interrelated (Keller 2007). Good health is essential to aging well and good nutrition is a key determinant of health. Food is not only critical to physiological wellbeing, but also contributes to the social, cultural and psychological quality of life in older people (American Dietetic Association 2005). Malnutrition leads to many adverse consequences and is associated with increased morbidity and mortality (Visvanathan 2003). Older people are more prone than any other age group to develop malnutrition (Payette, Gray-Donald et al. 1995). New Zealand based studies report between 30% - 50% of community living older adults are at high nutrition risk (Watson, Zhang et al. 2010; Wham, Teh et al. 2011), with higher rates found in adults of advanced age (Wham, Teh et al. 2011). The international prevalence of nutrition risk for community living older people ranges from 6 – 52% depending on the method of classification (Visvanathan 2003; Keller, Goy et al. 2005; Kaiser, Bauer et al. 2010).

The detection of malnutrition in older adults can be difficult due to the wide range of health issues, functional abilities, economic constraints and social issues affecting the nutrition status of this age group (Ülger, Halil et al. 2010). Currently no gold standard for the detection of malnutrition exists and consequently it is under-diagnosed and under treated (Phillips, Foley et al. 2010). A registered dietitian or qualified nutritionist have the expertise required to assess and detect malnutrition, however dietetic resources are limited in the community setting. A rapid, simple and cost effective method for identifying nutrition risk in this age group is required. A nutrition screening tool fulfils these requirements and allows health professionals to reliably detect nutrition risk prior to the development of overt malnutrition. However, for a screening tool to be effective it must be valid to the population group and setting of its intended use (Elia, Zellipour et al. 2005).

More than 20 screening tools have been developed to detect nutrition risk in older populations (Green and Watson 2006). A recent review by Phillips et al. found only three tools that had undergone appropriate

validity and/or reliability testing and were suitable for use in community dwelling older adults. These tools included the Mini-Nutritional Assessment Short Form (MNA-SF), Malnutrition Universal Screening Tool (MUST) and Seniors in the Community: Risk Evaluation for Eating and Nutrition version II (SCREEN II) (Phillips, Foley et al. 2010). There is limited New Zealand based data on the use of nutrition screening tools in older people and little is known worldwide about nutrition screening in advanced age.

SCREEN II was the nutrition screening tool selected for use in 'Life and Living in Advanced Age: A cohort study' (LiLACS NZ). The purpose of the LiLACS NZ study is to: establish what life is like in advanced age; determine what is important to ongoing wellbeing; and to record the pathways of health and living of 1000 participants, non-Maori (85 + years) and Maori (80 – 90 years). As nutrition is essential to aging successfully it is necessary that the nutritional status of the LiLACS participants is captured accurately. SCREEN II is a nutrition screening tool that was developed specifically for community living older people, and has shown to be valid and reliable amongst Canadian older people (55 years-plus) (Keller, Goy et al. 2005). The aim of this study is to validate SCREEN II in an older sub-set of participants (85 years) enrolled in LiLACS NZ. All LiLACS NZ participants completed SCREEN II at baseline. Twelve months later participants were recruited into the validation study on the basis of their baseline SCREEN II nutrition risk status. SCREEN II will be validated against the criterion of a registered dietitian's nutrition risk assessment which includes anthropometric, medical and dietary risk factor data. The assessment also includes a comprehensive dietary analysis based on three, twenty four hour, multiple pass recalls (MPR). Changes in participants' nutrition risk status from baseline to follow-up will be evaluated. Once validated, SCREEN II will enhance the reliability of LiLACS NZ findings which seek to identify the relationship between nutrition risk status in advanced age and the trajectories of health outcomes.

2.0 Literature Review

2.1 Older People in New Zealand

New Zealand is an aging population; people aged over 65 years are growing by number and proportion. Population forecasts state that older people will grow from thirteen percent of the population in 2009 to twenty five percent by 2051 (Statistics New Zealand 2007). Adults in advanced age (85-plus years) are the fastest growing segment of the population. This trend is attributable to increases in life expectancy, sub-replacement fertility, and the ageing of the 'baby boomers'. For the first time in history there will be more older people than children under the age of 14 years (Ashley-Jones 2009). Depicted below (Figure 2.1) is the projected paralleling of the population over the next 50 years with a widening peak for those in advanced age (Statistics New Zealand 2009).
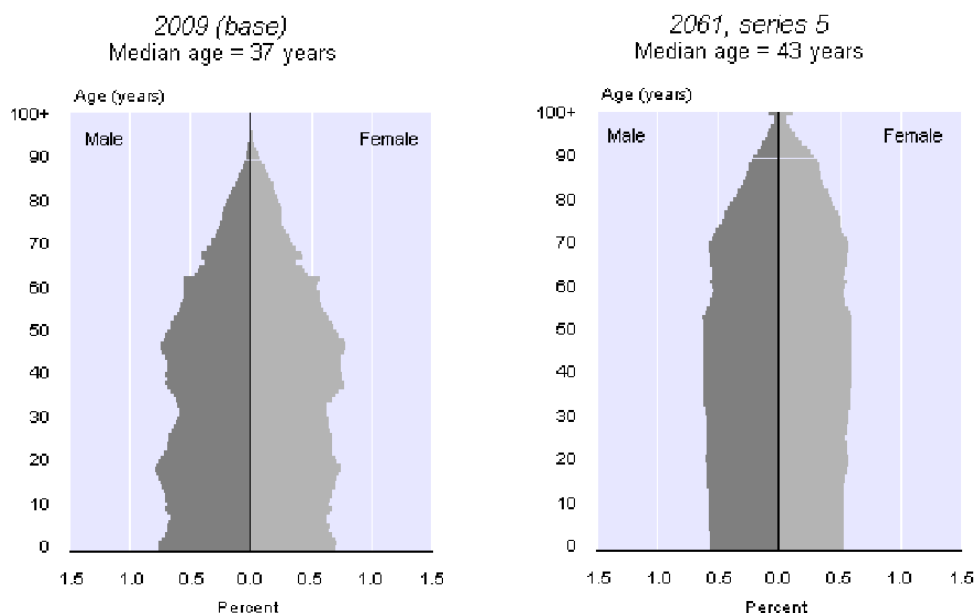
Figure 2.1: Population age pyramid projections from 2009 – 2061 (Statistics New Zealand 2009).

Life expectancies are increasing, between 1996 and 2006 life expectancy increased 3.6 years for men (to 81.7 years) and 2.6 years for women (to 85 years) (Ministry of Health and Statistics New Zealand 2009). However the number of years of full health is not increasing at the same rate, resulting in more years of poor health and dependency at the end of life. The current 'healthy life expectancy', or years of full health, is 77 years for men and 79 years for women (Wang 2007). This disparity between life expectancy and years of healthy life greatly increases the demands on the health care system (Wang 2007; Ministry of Health and Statistics New Zealand 2009).

Numerous frame works have been produced both nationally and internationally to promote healthy aging. In 1991 The United Nations released five guiding principles for older people: independence, participation, care, self–fulfilment and dignity (United Nations 1991). The World Health Organisation (WHO) then released *Active Ageing: a policy framework* (World Health Organisation 2002) to aid the development of healthy and active aging action plans. Active aging was defined as 'the process of optimising opportunities for populations and individuals for health, participation and security in order to enhance quality of life as people age' (World Health Organisation 2002). In 2001, *The New Zealand Positive Aging Strategy* was released which aimed to improve community participation opportunities for older people. *The Positive Aging Strategy* listed the 'Aging in Place' policy as one of its top priorities (Dalziel 2001). The 'Aging in Place' policy places emphasis on enabling older people to age positively in the community by establishing a safe and secure home environment which is supported by a wide variety of home based services (Dalziel 2001). Residential or institutional care is not desirable in older age and can reflect a negative view of aging (Cutler 2011). The 'Aging in Place' policy recognised that older people prefer to remain in their own homes for as long as possible (Ministry of Social Development 2000). Supporting research has found that living in your own home is associated with better health and quality of life outcomes (if adequate supports services are provided) compared to those living in institutions (Richmond, Moor et al. 1997; Cutler 2011).

To plan for the future and successfully execute *The Positive Aging Strategy* and the 'Aging in Place' policy there is a need to better understand the factors that influence health and the quality of life of older people (Ministry of Health 2010). Nutritional status is a major determinant of health and well-being (American Dietetic Association 2005) and needs to be considered when addressing the health concerns of older people.

2.2   Health of Older People

Successful aging is defined as the ability to maintain three key behaviours: low risk of disease and disease related disability, high mental and physical function and an active engagement in life (American Dietetic Association 2005). Most people over the age of 65 years are considered healthy, however health declines with age. Adults in advanced age experience a higher prevalence of chronic illness, disability and dependence than younger age groups (Wang 2007). Key determinants of health for older people include: physiological (e.g. disease and disability), social (e.g. living situations) and psychological (e.g. dementia and depression) factors (Ministry of Health 2010) . These determinants of health also affect the nutrition status of older people.

2.2.1   Chronic diseases and conditions of older people

Almost three-quarters of New Zealanders over the age of 85 years have more than one chronic condition and less than ten percent have no chronic conditions (Wang 2007). Chronic conditions and diseases are the five leading causes of death of adults in advanced age, these include: ischaemic heart disease, stroke, chronic obstructive pulmonary disease, prostate cancer (men) and organic psychotic conditions (women)

(Wang 2007). Type II diabetes and arthritis are also common causes of morbidity for older people (Ministry of Health 2010). Chronic disease increases the risk of frailty and impacts on all aspects of life including mobility and functional capacity, independence, and quality of life (Ministry of Health 2010).

Chronic disease and poor nutrition have a bidirectional relationship (Keller 2007). Chronic disease can affect metabolism (increase or decrease), nutrient absorption and excretion, appetite, and lead to difficulty with activities of daily living (ADLS) and mobility (ability to prepare food) (Nowson 2007). The root causes of many chronic diseases are the dietary and lifestyle choices made over a lifetime (Morley 2007; Ministry of Health 2010). Even after the age of 65 years risk factors for chronic conditions remain modifiable. Physical activity, balanced nutrition and the avoidance of tobacco products can result in more 'healthy' years and a decrease in mortality and morbidity risk (WHO and FAO 2003; American Dietetic Association 2005; Morley 2007).

2.2.2 Functional health

The maintenance of functional health is important for independence, quality of life and decreased morbidity and mortality in older people (Stuck, Walthert et al. 1999; Payette 2005). Levels of dependency (Keller and Hedley 2002; Sharkey 2002) and disability affect more than two–thirds of New Zealanders over the age of 75 years (Controller and Auditor - General 2011). Functional health impacts nutritional status. Older people who are dependent have difficulty completing basic activities such as food procurement and preparation (Salvà and Pera 2001; Sharkey 2002) which can result in increased consumption of convenience, easy to chew, less nutritious foods (Payette, Gray-Donald et al. 1995; Sharkey 2002; Bartali, Salvini et al. 2003; Saka, Kaya et al. 2010). Poor nutritional status can lead to weight loss, especially loss of lean body mass (sarcopenia) (St-Arnaud-McKenzie, Payette et al. 2010; Malafarina, Úriz-Otano et al. 2012), frailty (Payette 2005), increased falls risk (Baumgartner, Koehler et al. 1998) and exacerbate functional impairment.

Sarcopenia

Sarcopenia is the loss of muscle mass associated with aging, however, to date there is no accepted definition or reference values available to diagnose sarcopenia. A review by Bijlsma et al. states that sarcopenia can be defined as the loss of muscle mass (including mass from skeletal and organ tissue), but not the loss of muscle strength (Bijlsma, Meskers et al. 2012). Baumgartner et al. defined sarcopenia as appendicular muscle mass two standard deviations below the mean for healthy young adults (Baumgartner, Koehler et al. 1998). Using varying definitions of sarcopenia, studies show that 53 - 58% of participants over the age of 80 years are sarcopenic compared to 13 - 24% of participants younger than 70 years (Baumgartner, Koehler et al. 1998; Morley, Baumgartner et al. 2001; Hairi, Cumming et al. 2010).

The causes of sarcopenia in community dwelling elderly are multi-factorial and include hormonal changes, sedentary lifestyle, smoking, disuse atrophy, poor health, poor nutrition, genetics, (Harris 1997; Baumgartner, Koehler et al. 1998; Morley, Baumgartner et al. 2001; Bales and Ritchie 2002) and an age

associated increase in catabolic cytokines (Roubenoff, Parise et al. 2003). Sarcopenia is associated with impaired mobility and functional dependence (Hurley, Bartlett et al. 1997; Hairi, Cumming et al. 2010) and a three to four fold increase in disability (independent of age, sex, obesity, ethnicity, social economic status, morbidity and health behaviours) (Baumgartner, Koehler et al. 1998). Older people with sarcopenia have a higher incidence of infections, pressure ulcers, institutionalisation, poor quality of life (Malafarina, Úriz-Otano et al. 2012) and increased mortality risk (Roubenoff, Parise et al. 2003). People with sarcopenic obesity, or a high fat mass and low muscle mass, are more susceptible to mobility and disability problems than those with obesity or sarcopenia alone (Malafarina, Úriz-Otano et al. 2012).

Treatment of sarcopenia or muscle mass wasting can be challenging in older adults. Resistance exercise is proven to slow or reverse sarcopenia, however, this is not always feasible for older people due to other health conditions and functional limitations (Morley, Baumgartner et al. 2001; Hairi, Cumming et al. 2010; Malafarina, Úriz-Otano et al. 2012). There is some evidence to suggest that consuming over 0.8g/day and up to 2.0g/day of animal protein can help protect or potentially gain lean body mass in healthy older people (De Souza Genaro and Martini 2010), nevertheless there is not enough conclusive evidence to suggest that sarcopenia is reversible, especially in those who are already frail (Morley, Baumgartner et al. 2001; Malafarina, Úriz-Otano et al. 2012).

Falls, related fractures and osteoporosis

In New Zealand approximately half of older people in their eighties experience one fall a year (ACC 2003). Over 80% of all hospital admissions for adults over 75 years are falls related (ACC 2005). Falls are the leading cause of death due to unintentional injury for both Maori and non-Maori women and non-Maori men over 65 years (Wang 2007). Older people who are prone to falls usually have a loss of strength and mobility, failing eyesight, polypharmacy, or cognitive impairment (Connor, Langley et al. 2006). Falls decrease independence in older people as the fear of falling can be incapacitating and lead to severe restrictions in activity and social isolation (ACC 2005). The results of a meta-analysis of four New Zealand based fall prevention studies in 1000 older people (65 - 97 years) demonstrated a 35% reduction in falls and injuries after the implementation of an individualised exercise program. Participants aged 80 and older benefited significantly more from the program than those aged 65 to 79 years (Robertson, Campbell et al. 2002). Older adults have an age associated loss of bone mineral density which increases the fracture risk after a fall (Zhang 2007; Ministry of Health 2010). Hip fractures in older people result in pain, rapid loss of physical function, deformity and hospitalisation (ACC 2005; Zhang 2007; Ministry of Health 2010) and are significantly associated with excess mortality, morbidity and social service expenditure (Zhang 2007).

Vitamin D and calcium are involved in bone metabolism and an insufficiency has been attributed to an increase risk of falls and fractures (Zhang 2007). Low serum levels of vitamin D are associated with muscle weakness and atrophy (particularly in fast twitch muscle fibres), increased postural sway, impaired

psychomotor function and increased bone turnover (Scragg and Bartley 2007). Poor calcium intake is associated with a low bone mineral density and increased risk of osteoporosis (Ministry of Health 2010). Older New Zealanders have lower than expected serum levels of the precursor for vitamin D, 25-hydroxyvitamin D (25(OH)D) (Scragg and Bartley 2007) and mean intakes of dietary calcium for people over 70 years are reported to be at only 55% of RDI (University of Otago and Ministry of Health 2011).

 Dietary supplementation with a combination of calcium and vitamin D (greater than 700 IU) significantly reduces hip fracture risk in older people [OR 0.18, 95%CI 0.06 - 0.58], however, only if baseline 25OHD levels were below 50nmol/L (Zhang 2007). A meta-analysis looking at the effect of vitamin D supplementation on falls found a reduction in falls risk by 22% with an absolute risk reduction of 7% (the treatment of 15 people prevents one fall) (Bischoff-Ferrari, Dawson-Hughes et al. 2004). Dietary supplementation in combination with fall prevention exercise programs may help older people to avoid the negative consequences of falls and fractures on independence and quality of life.

Physical Activity

Physical activity begins to decline from 65 years in women and from 75 year in men (Wang 2007). Sixty percent of women and 37% of men over the age of 85 years report sedentary behaviour (Ministry of Health 2010). A lack of physical activity is independently associated with an increased risk of functional decline (Stuck, Walthert et al. 1999), frailty and mortality (de Groot, Verheijden et al. 2004). Partaking in regular physical activity of thirty minutes duration on at least five days of the week substantially reduces all cause mortality (de Groot, Verheijden et al. 2004; Ministry of Health 2010). Resistance exercise (with a focus on balance and stability) has increased benefits and is better tolerated than aerobic exercise in older people (ACC 2003). Benefits of exercise include: maintenance of independence and quality of life, preservation of lean body mass, maintenance of bone mineral density (Stuck, Walthert et al. 1999), improvements in balance and strength, increases in appetite, improvements in cardiovascular and metabolic function (Ministry of Health 2010) and management of arthritis (American Dietetic Association 2005). Physiological benefits include reduced brain atrophy, improved memory and lesser levels of depression (Morley 2007). These benefits are also observed in adults over 80 years old (ACC 2003).

Frailty

 A person who is frail will meet three of the five following criteria: weight loss of 10 lbs (5.5 kgs), self-reported exhaustion, weak grip strength, slow walking speed (or decreased mobility), and low physical activity (Fried, Tangen et al. 2001). Frailty is associated with increased morbidity and mortality (Fried, Tangen et al. 2001; Hubbard, Lang et al. 2010). A New Zealand study of 2931 community dwelling adults (65 years-plus) found prevalence of frailty to be 8.1%, with a higher prevalence in participants who were older (>84 years), Maori (Maori 11.5%, non Maori 8%), female (women 9%, men 7%) and lived alone (Barrett,

Twitchin et al. 2006). Poor nutrition status is consistently associated with the development of frailty in older people (Payette 2005).

2.2.3   Mental health of older people

Cognitive function, mood disorders, mental health impairment, including dementia and Alzheimer's have negative impacts on all aspects of life including nutrition status (Ministry of Health 2010).

Depression

Internationally, depression and mood disorders are reported to affect between 16% (Roberts, Kaplan et al. 1997; Ávila-Funes, Gray-Donald et al. 2008) and 30% of the very old (85 years-plus) (Roberts, Kaplan et al. 1997). Rates of depression in older New Zealanders appear to be lower, although they may be under-reported. Between 3% and 12% of people aged 65-plus self-reported at least one depressive symptom and 3% to 8% received treatment for issues related to depression (self-reported). Depression rates were twice as high for those living alone compared to those who did not (Statistics New Zealand 2004). The higher prevalence of depression often reported in older adults is likely attributed to health impairments and a poor perception of health rather than aging itself (Roberts, Kaplan et al. 1997).

Depression is linked to frailty, deterioration of social networks, and poorer health outcomes (Morley and Morley 1995; Ministry of Health 2010). It is also an independent risk factor for malnutrition (Callen and Wells 2005; Saka, Kaya et al. 2010) and is suggested to be the second ranked cause of weight loss and anorexia in older people only after unexplained weight loss (Thompson and Morris 1991; Morley and Morley 1995; Morley 1997; Wilson, Vaswani et al. 1998). Ninety percent of older people who are depressed report weight loss versus only 60% of younger adults (Blazer, Bachar et al. 1987). Kivela et al. (as cited in Morley and Morley 1995) found the following gastrointestinal disturbances in depressed older men: diarrhoea 20%, constipation 30%, stomach pain 37%, nausea 27%, vomiting 10%, loss of appetite 22% and weakness 61% (Morley and Morley 1995). However, it was unknown whether the gastrointestinal symptoms were caused by depression or the underlying physical disease states (Pulska, Pahkala et al. 2000). Older adults with unexplained weight loss or malnutrition should be screened for potential depressive symptoms.

Cognitive disorders

 Aging is associated with a decrease in memory. A memory disability (a long lasting condition that causes ongoing difficulty remembering things) affects 25.6% of Maori over 65 years and 13.6% of non–Maori. In both ethnicities memory disability was higher in males (Wang 2007). Cognitive deterioration or memory disability affects day to day functional ability and is associated with disability and dependence (Claggett 1989). Dementia is a significant memory impairment that interferes with many aspects of daily life (Alzheimers New Zealand 2010; Ministry of Health 2010). Approximately one percent of New Zealanders

60 – 64 years have dementia with the prevalence increasing to 30% of those over 85 years. Alzheimer's disease is the main cause of dementia in New Zealand (Alzheimers New Zealand 2010).

Dementia directly impacts the nutrition status of a person due to the following reasons: depression at diagnosis, indifference to foods, memory loss of how to prepare meals and when to eat, resistance to assisted feeding, impaired judgement, delusional behaviour (believing food has been contaminated) and dysphagia (Claggett 1989; Morley and Morley 1995). Additionally, people often have an higher energy expenditure than input due to persistent wandering, restlessness and eating extremes (Claggett 1989; Morley and Morley 1995). Nutritional intervention and therapy in older people with dementia can be challenging and depending on the severity of the disease, often does not improve outcomes (Young, Greenwood et al. 2004).

2.2.4   Perceived state of health

Self-perceived health is a subjective measure that has been repeatedly linked to morbidity, mortality (Idler and Benyamini 1997; Cesari, Onder et al. 2008) and nutrition status (Payette, Gray-Donald et al. 1995; Margetts, Thompson et al. 2003; de Groot, Verheijden et al. 2004). An older person's perception of their health not only takes into account medical diagnoses, but may only factor in financial position, quality of life, and spirituality (Idler and Benyamini 1997). A review of self-perceived health and its relationship to morbidity or mortality found that in 85% of reviewed studies, self-perceived health was a very reliable predictor of mortality, even when other health risks were controlled for. In some circumstances, self-reported health was a better predictor than medical records or medical conditions (Idler and Benyamini 1997).

Studies have reported an improvement in self-perceived heath status with age. A possible explanation is that older people often rate their health in comparison to their peers, or to a time earlier in their life when they may have been unwell (Idler and Benyamini 1997). At a 10 year follow-up of the SENECA study, the number of older men (80-85 years at follow-up) who reported their health as poor decreased from 2.9% to 0% and for women it dropped from 15.9% to 0%. There was also a significant increase in women who reported their health to be good or very good (Toffanello, Inelmen et al. 2010). This trend was not found in older New Zealanders, but adults in advanced age were not separated out in the analysis. Older New Zealanders (≥75 years) were the least positive about their health compared with younger age groups. Older married people were more likely to report a better state of health compared with their single peers (Statistics New Zealand 2004).

Poor self-reported health is related to an increase in nutrition risk. A small New Zealand study found self–reported health was a predictor of nutrition risk among independent community living older people (mean age 82.7 years) (Wham, Carr et al. 2011). A Canadian study found nutrition risk to be higher in older adults

(>55years) with low levels of reported health (Keller, Goy et al. 2005). Payette et al. found older people with a poorer perceived health status had lower protein intakes. Seventy five percent of women with nutrition risk had low self-reported health in comparison to 44% of women not at nutrition risk. For men, 63% with nutrition risk reported poor health compared to 38% of men with no nutrition risk (Payette 2005). According to the literature it would seem prudent to ask about self–reported health during a nutritional assessment.

In summary, the wider determinants of health such as chronic disease, impaired mobility and disability, depression and dementia are common in older adults and have widespread negative impacts of all aspects of life for older people. Illness and disability adversely affect nutritional health, however the relationship is bidirectional as poor nutritional health can lead to or exacerbate disease and disability (Mowé, Bøhmer et al. 1994; Morley and Pulisetty 2007).

2.3   Nutritional Health of Older people

Food and water and nutritional wellbeing are key to health, self-sufficiency, and quality of life in older people (American Dietetic Association 2005). Unfortunately, nutrition risk and malnutrition in older people is widely reported and yet still under diagnosed (Phillips, Foley et al. 2010). Older people, especially those in the highest age bracket (85 years-plus) or those living in institutions, are at greatest risk of impaired nutrition status (Keller and Hedley 2002; Sharkey 2002; Visvanathan, Macintosh et al. 2003; Kaiser, Bauer et al. 2010). A study that looked at the rates of malnutrition and nutrition risk (assessed by the Mini Nutritional Assessment) of 6000 older adults (mean age 82.3 ± 7.5 years) in a variety of different settings, found 43% of participants to be at risk of malnutrition and 23% of participants were overtly malnourished (Kaiser, Bauer et al. 2010). Rates of nutrition risk in community living older people were lower at 32%, six percent were considered malnourished (Kaiser, Bauer et al. 2010). New Zealand research in community dwelling older people is limited, but a similar prevalence of nutrition risk is found. A South Island study looking at the risk of malnutrition in community dwelling older people (n=152) (SCREEN II) found 31% of participants to be at high nutrition risk (Watson, Zhang et al. 2010). The feasibility study for LiLACS NZ (n=108 75 - 85 years) found 52% of participants (Maori and non-Maori) to be at high nutrition risk (SCREEN II) (Wham, Teh et al. 2011). A smaller Auckland study found high nutrition risk in 31% of non-Maori community living older people (n=51, >65 years) (SCREEN II) (Wham, Carr et al. 2011).

2.3.1   Factors that affect the nutrition status of older people

Nutritional health in older people is complex and involves many influences from past and current conditions (Morley 2007). Physiological, cognitive, social and lifestyle changes occur as people age, all of which have an impact on a person's nutrition status (Morley and Pulisetty 2007). Understanding the nutrition related factors depicted in Figure 2.2, will assist in the development of effective prevention and treatment

strategies that ease the burden of malnutrition, disease and disability, and improve the quality of life for older people (Ministry of Health 2010). The following section reviews the individual and lifestyle factors which contribute to the nutritional health of older people.
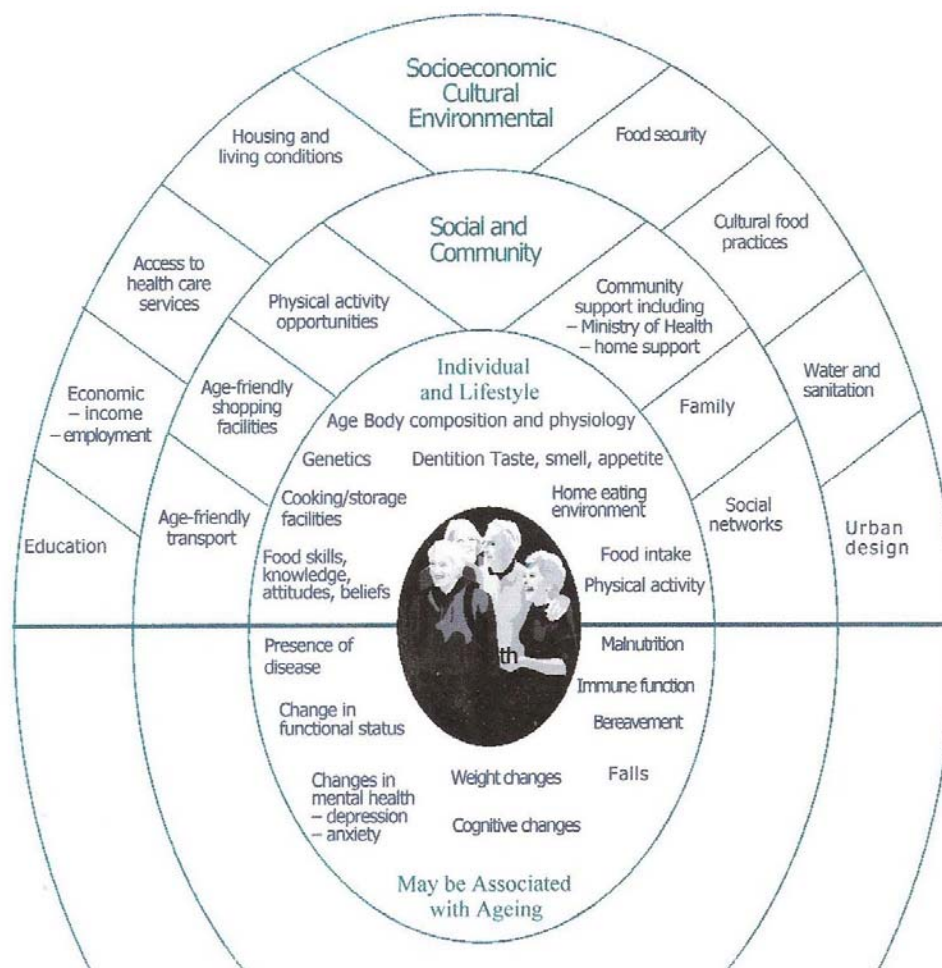
Figure 2.2: Factors contributing to nutrition related health.
Sourced from: Food and Nutrition Guidelines for Healthy Older Adults (Ministry of Health 2010).

Marital status and living situation

Older people who live with a spouse, companion or other family members have a significantly better nutritional status (Schafer, Schafer et al. 1999; Visvanathan, Macintosh et al. 2003; Locher, Ritchie et al. 2005) and lower mortality rates (Statistics New Zealand 2004) than those living alone. Eating is a social activity; older adults who eat with others have larger meals, wider dietary variety and consume more calories (Payette, Gray-Donald et al. 1995; de Castro 1997; Martin, Kayser-Jones et al. 2005). A small study in

older adults receiving home services (n=50) demonstrated an additional 114kcal per meal was consumed when there was social interaction at meal times (Locher, Robinson et al. 2005). This illustrates that eating is socially facilitated (de Castro 1997; de Castro 2002).

When a spouse requires rest home placement or passes away it can cause a major upheaval. Completing daily tasks such as shopping, cooking and cleaning that were usually shared can become difficult. Bereavement is associated with depression and loneliness (Locher, Ritchie et al. 2005), and impaired health and nutrition status (Morley and Morley 1995). Older men often fare worse after losing a spouse as they do not have the skills required to shop and prepare balanced meals (Schafer, Schafer et al. 1999). Women, who are faced with cooking for one, often find cooking a chore (Schafer, Schafer et al. 1999; Martin, Kayser-Jones et al. 2005). Even with frequent visits from friends and family, loneliness is reported in over half of older adults and is associated with a poorer nutrition status (Payette, Gray-Donald et al. 1995). The SOLINUT study examined the relationship between loneliness and nutrition in older people (> 70years) (Ferry, Sidobre et al. 2005). More than a quarter of participants living alone had significant unintentional weight loss and 30% reported a lack of appetite over the previous three months. Forty three percent of the participants were consuming less than 25kcal/kg/day (Ferry, Sidobre et al. 2005). Dietary analyses of older people living alone show higher intakes of fat and sugar (Ferry, Sidobre et al. 2005), decreased energy intakes (Rosenbloom and Whittington 1993; Feart, Jutand et al. 2007) and limited dietary variety (Dean, Raats et al. 2009). The New Zealand's Food and Nutrition Guidelines for Older People includes 'take opportunities to eat with others' as one of the nine guidelines for healthy older people (Ministry of Health 2010).

Ethnicity

Maori in New Zealand have significantly poorer health outcomes at all educational, occupational and income levels than non-Maori (Ministry of Health 2010). Maori have a shorter life expectancy (eight years less than non- Maori) and higher rates of chronic disease (Ministry of Health 2010). The New Zealand Heath Survey (2006/07) reported higher rates of diabetes, cardiovascular disease, cancer and obesity in Maori than the rest of the population (Ministry of Health 2008). Very few Maori over 50 years were under weight, however 63% of men and 51% of women were obese compared to 35% of non-Maori men and 35% of non-Maori women (University of Otago and Ministry of Health 2011). The feasibility study for LiLACS NZ showed Maori participants were at higher risk of malnutrition compared to non-Maori. Nutrition screening in the feasibility study found Maori were more likely to skip meals, have a poorer fruit and vegetable intake and use meal replacements than non-Maori (Wham, Dyall et al. 2011).

Social demographic factors

Education and income are both factors associated with nutritional risk (Webb, Schofield et al. 1999; Locher, Ritchie et al. 2005). It has been suggested that educated older people are better informed about healthy nutritional and lifestyle practices and may find it easier to access available resources in the community

(Locher, Ritchie et al. 2005). An Australian study that looked at the socio-demographic predictors of meeting dietary recommendations found that educated men and women were significantly more likely to meet dietary recommendations and less likely to drink alcohol (Webb, Schofield et al. 1999).

Low socio-economic status (SES) is associated with a poorer health and nutrition status (Ministry of Health 2010). In New Zealand income is the most modifiable determinant of health (National Health Committee 1998). Many older people have limited cash flow which can result in a delay in seeking medical attention, living in poor conditions (Ministry of Health 2010) and food insecurity (Lee and Frongillo Jr. 2001). Food insecurity can be defined as "limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire acceptable foods in socially acceptable ways" (Anderson 1990). Food insecurity typically has a financial connotation, however the assessment of food insecurity in older populations need to address the limited ability or inability to gain access to, prepare or consume food that is within the house, as well as the limited ability or finances to purchase foods (Roe 1990; Lee and Frongillo Jr 2001; Wolfe, Frongillo et al. 2003). Food insecurity results in restricted food choices and inadequate nutritional intake (Morley and Morley 1995; Ministry of Health 2010). Older adults in New Zealand had the lowest reported rates of food insecurity compared to other age groups; however questions had a financial connotation and were likely not specific to older people, therefore the prevalence may have been underestimated (Parnell, Reid et al. 2001).

Polypharmacy and supplement use

The use of more than five medications at one time or inappropriate medication use is defined as polypharmacy, and the use of more than ten medications concurrently is considered excessive polypharmacy (Jyrkkä, Enlund et al. 2011). Polypharmacy is common in older people as they are the highest users of health services and often visit multiple clinicians for a variety of health impairments (Salvà and Pera 2001; Jyrkkä, Enlund et al. 2011). The physiological changes that occur with aging lead to increased medication related side effects (Gammack 2007), drug- nutrient interactions and nutrient deficiencies (Morley 2007). Nutritional related side effects include: increased or delayed absorption of medications and/or impaired absorption of dietary nutrients, development of anorexia, decreased taste and smell acuity (Carr-Lopez and Phillips 1996), or decreased swallowing capacity (Pickering 2004). Table 2.1 lists the side effects of common medications used by older people.

A longitudinal Finish study in 300 elderly (> 75 years) found that over three years the prevalence of excessive polypharmacy increased from 18 to 26% and the risk of malnutrition increased from 31% to 50% (MNA). In addition, there was an approximate 30% increase in those who had difficulties with ADLS and a 20% increase in impaired cognition (Jyrkkä, Enlund et al. 2011).

Table 2-1: Possible side effects of common medications used in older people

Possible side effect	Medication
Nausea and vomiting	Digoxine, reserpine, aldomet, amitryptiline
Loss of ionic nutrients (Ca, K, Zn, Mg)	Prednisone or diuretics
Loss of vitamins A, D , K	Laxatives
Reduces folic acid concentration	Triamterene and barbiturates, treatments for epilepsy
Reduces vitamin D and calcium concentration	Barbiturates
Reduces B12 absorption	KCl
Osteomalacia	Antacid abuse, laxatives,
Fe deficiency	Aspirin
Constipation	Analgesics, antacids, antidepressants, anti-hypertension drugs
Hyponatremia , Hypokalemia	Laxatives, diuretics
Anorexia	Digoxin, NSAIDs, anticonvulsants, benzodiazepines, proton pump inhibitors.
Swallowing difficulties	Methotrexate

Table developed from (Pickering 2004).

The use of nutritional supplements is increasing in older people. In the United States use of supplements in those over 65 years increased from 13.2 to 19.5% between 2002 and 2007 (Chung-Hsuen, Chi-Chuan et al. 2011). The New Zealand 2008/2009 National Nutrition Survey (NNS09) reported regular supplement use (weekly or more) in 38% of older men and 49% of older women (>70 years). The most commonly used supplements by older New Zealanders were oils (19% men, 25% women), glucosamine and chondroitin (13% men and 15% women) and multivitamin and mineral preparations (10% men and 12% women) (University of Otago and Ministry of Health 2011). Adverse effects from drug-supplement interactions are also common (Wold, Lopez et al. 2005); the growing popularity of vitamin and mineral preparations and the prevalence of polypharmacy among older people increases the risk of drug-nutrient interactions. These adverse interactions are usually preventable, regular medication and supplement reviews by the primary physician and pharmacist are recommended.

Oral health

Impaired oral health such as mouth pain, chewing or swallowing difficulties, poor dental status, tooth loss (less than 4 pairs of occluding teeth) (Slade, Spencer et al. 1996; Smith and Parnell 2008), dry mouth, and other causes of troublesome eating can lead to a suboptimal nutritional status and weight loss (Saunders, Stattmiller et al. 2007). A study that looked at the oral health of 563 community living older adults (>70 years) found after a year, one third of people lost more than four percent of their body weight with six percent of men and eleven percent of women losing more than nine percent of their body weight. Predictors of weight loss were being edentulous and use of full dentures (Ritchie, Joshipura et al. 2000). Weyant et al. found a dose response relationship between the extent of periodontal disease and significant (>5%) weight loss in 13% of older adults (n= 1,053) (Weyant, Newman et al. 2004). Other studies have not

found an association between poor oral health and weight loss, however reduced intakes of micronutrients including vitamin A, folate, thiamine, vitamin B_6 and vitamin C, zinc and calcium were documented (Appollonio, Carabellese et al. 1997; Shinkai, Hatch et al. 2001; Bailey, Ledikwe et al. 2004; de Andrade, de França Caldas Jr et al. 2009; de Andrade, Caldas Jr et al. 2011). Intervention studies that improved denture quality or fit found no significant improvements in nutrient intakes or dietary quality (Moynihan, Butler et al. 2000; Quandt, Chen et al. 2010). The relationship between dietary quality, energy intake, weight and oral health is not consistent. Research suggests that older people with poor dentition status, can up to a certain point, adequately compensate for their reduced oral function (Shinkai, Hatch et al. 2001; Smith and Parnell 2008). Regardless it is still considered good practice to question older adults with suspected poor nutrition status about their oral health and chewing ability; nutrition interventions (texture changes) should be tailored accordingly.

Appetite

Appetite decreases with age (Morley 1997). The non-physiological factors related to a decreased appetite have been discussed throughout this review (social, psychological, and medical), however the decline in energy intake can also be attributed to physiological changes related to aging, also termed the 'anorexia of aging' (MacIntosh, Morley et al. 2000). Listed below are the biological mechanisms that control energy intake and are altered with aging:

- A change in neurotransmitters that stimulate or decrease appetite
- Chemosensory changes, change in taste and smell (discussed below)
- Delayed gastric emptying, leading to early satiety
- An increase in gastrointestinal hormones (cholecystokinin (CCK)) which suppresses food intake
- An increase in cytokines (product of inflammation processes) which decreases appetite and increases metabolic rate

(Morley 1997; MacIntosh, Morley et al. 2000)

Small studies in older individuals (64 –78 years) have found that after six months of underfeeding, there is an inability to gain weight and an inability to lose weight after a period of overfeeding, in comparison to younger adults. The authors concluded that older adults have a reduction in perceived hunger before meals and increased satiety post meals (Moriguti, Das et al. 2000). However, a recent study of 17 older adults (64-85 years) investigated energy compensation after three weeks of restricted energy intake (Winkels, Jolink-Stoppelenburg et al. 2011). No changes were found between older and younger men in body weight or composition, resting energy expenditure, gastric emptying rate, or appetite (Winkels, Jolink-Stoppelenburg et al. 2011). Changes in biological mechanisms, in combination with environmental and social factors, attribute to the increased risk of malnutrition found in older age (Roberts, Fuss et al. 1994; Morley 1997; Moriguti, Das et al. 2000).

Chemosensory changes

Taste and smell are important senses for the intake, enjoyment and desire for food (MacIntosh, Morley et al. 2000). Chemosensory disruptions during aging can result in altered food preferences, decreased intake and often weight loss (Schiffman and Warwick 1993; Duffy, Backstrand et al. 1995; Schiffman 1997; Rolls 1999).

A review by Schiffman suggests that the loss of smell is even more pronounced than the loss of taste (Schiffman 1997). Declining olfactory function (smell) impairs flavour perception. Doty et al. investigated smell identification ability in 1955 people ranging in age from 5 – 99 years. Major olfactory deficits were found in 75% of participants over 80 years of age. Women had better olfactory ability than men at all ages (Doty, Shaman et al. 1984). A study that examined olfactory perception in 80 free living older women (65-93 years of age) found that 50% of participants were affected by olfactory changes which were related to decreased interest in cooking, reduced dietary variety and a higher intake of sweets and fats and lower intakes of nutritious foods; no change in overall body weight was found (Duffy, Backstrand et al. 1995).

The loss or distortion of taste during aging is exacerbated by disease states (e.g. Alzheimer's), medications, surgery or nutritional status (e.g. zinc deficiency) (Schiffman 1997). It is speculated that a decrease in taste acuity leads to a decrease in energy intake, however this is not supported by consistent evidence (MacIntosh, Morley et al. 2000). A review by Rolls did not find a clear relationship between a decline in taste sensitivity and food preference or intake and it was concluded that other factors such as health beliefs, social environment and habitual intake were more influential (Rolls 1999; Lambert, Potter et al. 2010).

Flavour and or odour enhancers have been used to increase the dietary intake in older persons. The results of a odour enhancing study in the very old (n=39, mean age 84.6 years) found participants increased their intake in 20 of the 30 enhanced foods, however intake of other foods simultaneously decreased and the daily nutrient intake profile did not change. Other significant positive changes were noted in bilateral grip strength and immune function (Schiffman and Warwick 1993). A sixteen week flavour enhancing trial which sprinkled one gram of flavour enhancer over older participants' meals had three findings: increased intake of flavour enhanced foods resulting in increased daily energy intake; increase in body weight; and increased self-reported feelings of hunger (Mathey, Siebelink et al. 2001). These findings were not supported by a later study of the same duration, using monosodium glutamate, which found no increase in energy intakes, but there was a preference for the enhanced foods (Essed, van Staveren et al. 2007). Adding flavour enhancers to cooked meals is a simple method that may increase oral intake and body weight in older people; however this benefit was only found in small populations of healthy nursing home residents and may not be applicable to community living older people.

Smoking

Smoking is considered as an aging accelerator due to the production of free-radicals and is a leading cause of increased mortality through the development of cancers and vascular and pulmonary diseases (Nicita-Mauro 1990; Nicita-Mauro, Balbo et al. 2008). At 70 years of age those who do not smoke have a 41% probability that they will reach 85 years, those who smoke have a 21% probability (Doll, Peto et al. 2004). Other negative health and nutritional effects of smoking include decreased bone density due to impaired vitamin D and calcium metabolism, and increased risk of under nutrition due to poor oral health (Ministry of Health 2010). Smokers have significantly lower intakes of folate and vitamin C (Dallongeville, Marécaux et al. 1998; Gariballa and Forster 2009), polyunsaturated fat, vitamin E and β-carotene than non-smokers (Dallongeville, Marécaux et al. 1998). Even if smoking cessation occurs after the age of 65 years the mortality risk is decreased and quality of life increased (Sunyer, Lamarca et al. 1998; Doll, Peto et al. 2004). Reduction in the smoking rates of New Zealanders is listed as the top objective for the 'Priority Population Health Objectives' in the *New Zealand Health Strategy* (Ministry of Health 2010).

Alcohol

Alcohol consumption and the associated risks appear to be 'U' shaped with abstinence and heavy intakes carrying the highest health risk (Ministry of Health 2010). In observational studies health risks appear to be lower in light to moderate drinkers (1- 2 standard drinks/day) compared to non-drinkers (Lang, Guralnik et al. 2007). In older populations moderate alcohol use has been associated with a reduction in cognitive impairment, cardiovascular disease, bone mineral loss and disability (Lang, Guralnik et al. 2007; Peters, Peters et al. 2008; Virta, Järvenpää et al. 2010; Yin, Winzenberg et al. 2011).

 Those in advanced age are more prone to the adverse effects of alcohol as liver metabolism is impaired and older people have a decreased body water content and reduced lean body mass (Lang, Guralnik et al. 2007; Peters, Peters et al. 2008; Ministry of Health 2010). Alcohol affects judgement and balance which can lead to increased falls and injuries. Additionally older people on multiple medications are at high risk of alcohol-drug reactions (Ministry of Health 2010). Because of the high risk of adverse effects of alcohol in older people, the US guideline for alcohol consumption is half of what it is for younger adults. New Zealand and the United Kingdom recommendations remain the same for older and younger adults (Lang, Guralnik et al. 2007). A systematic review of two large cohort studies (n=13,333) found no increased risk for older adults (≥65 years) when alcohol was consumed within the United Kingdom's national guidelines for younger adults (Lang, Guralnik et al. 2007).   In New Zealand, alcohol is the most commonly consumed drug with 84% of the population consuming alcohol in the previous 12 months (2008). Men and women over 71 years consumed less alcohol on a regular basis (13.4 and 6.0% respectively) than the population's mean (18% and 10% respectively) (University of Otago and Ministry of Health 2011).

In summary, many individual and lifestyle factors affect the nutritional health of older people. Social and demographic factors such as living alone, bereavement, food insecurity and low educational levels are all factors that contribute to nutrition risk (Ministry of Health 2010). Intakes of multiple medications (polypharmacy), supplements, smoking and alcohol can lead to nutrient interactions which may alter nutrient metabolism and cause anorexia, bowel changes, and dry mouth (Pickering 2004). The age associated physiological changes to the gastrointestinal tract, chemosensory system and hormones (Rolls 1999) have noteworthy impacts on appetite by decreasing the desire and ability to eat (Ritchie, Joshipura et al. 2000). These risk factors are the reason why older people, especially those in advanced age, are prone to nutrition risk and malnutrition. The next section will cover unintentional weight change and changes in body composition as well as the consequences this has on nutrition and health status.

2.3.2 Body weight and composition

Unintentional weight loss

Anthropometrical studies in older adults show body weight increases until approximately 60 years of age (Seidell and Visscher 2000) and significant weight loss is usually identified after 75 years (Perissinotto, Pisent et al. 2002). Weight loss in older people, unlike younger people, is typically associated with a decrease in total body water, bone mass, and a disproportionately higher loss of fat-free mass (Seidell and Visscher 2000). Longitudinal studies in older people report significant weight loss (>5% in the previous one to six months) in approximately 15-25% of the study populations (Wallace, Schwartz et al. 1995; Newman, Yanez et al. 2001; de Groot, Enzi et al. 2002; Alibhai, Greenwood et al. 2005). Higher levels of weight loss are seen in frail community living and institutionalised populations (Alibhai, Greenwood et al. 2005). Research demonstrates that even though some weight loss is expected due to changes in body composition, significant unintentional weight loss is not considered to be part of the aging process, but rather due to the effects of disease (Fernyhough, Horwath et al. 1999; Bales and Ritchie 2002; Huffman 2002).

Evaluating significant changes in body weight is important in older populations and is almost always used for the detection of nutrition risk and malnutrition (Chen, Schilling et al. 2001; Keller, Goy et al. 2005; Kaiser, Bauer et al. 2010). There is much evidence to show weight loss in older people, even a modest amount, increases the risk of disability (Sharkey 2002), frailty (Bales and Ritchie 2002), malnutrition (Mowé, Bøhmer et al. 1994) and mortality (Keller and Østbye 2005; Bamia, Halkjær et al. 2010), even after the exclusion of disease (Newman, Yanez et al. 2001). A 15 year cohort of 2,040 seventy year olds found that a weight loss >10% between the ages of 70 - 75 years significantly increased the risk of five year and ten year mortality in both genders, irrelevant of smoking habits (Dey, Rothenberg et al. 2001). A recent large (n=6,654) case control study found a one kilogram weight loss per year significantly increased mortality risk (OR = 1.65; 95% CI: 1.41-1.92) in older people (>67 years) especially if participants were normal or underweight at baseline (Bamia, Halkjær et al. 2010). These findings were supported by Keller et al., who found a five to seven

kilogram weight change over a five year period significantly predicted mortality in community dwelling seniors (Keller and Østbye 2005).

Change in body weight loss is a more sensitive measure of nutritional risk than body mass index (BMI) in older people as both height and weight decrease with age which reduces the predictive effect of BMI (Dey, Rothenberg et al. 1999; Perissinotto, Pisent et al. 2002). However measuring weight change is limited because it does not provide any information on what component of body composition is affected (muscle, fat, water or bone) (Gibson 2005).

Body composition

Body composition changes as people age (Hughes, Roubenoff et al. 2004). Lean mass decreases and is associated with a simultaneous increase in body-fat mass (Hughes, Frontera et al. 2002). The distribution of fat mass also changes with a decrease in subcutaneous fat and an increase in visceral fat (de Groot, Enzi et al. 2002; Hughes, Roubenoff et al. 2004; Hubbard, Lang et al. 2010). Older people generally have higher waist circumferences, higher waist-to-hip and waist-to-thigh ratios, and lower limb circumferences than younger adults (Hughes, Roubenoff et al. 2004). The assessment of body composition in older people can be difficult due to changes in height, limited mobility, unreliability of skin fold measures and the lack of reference values (Hughes, Roubenoff et al. 2004).

Current methods of assessment vary widely from the precise dual-energy x-ray absorptiometry (DEXA) scan to simple body mass index calculations (BMI). A DEXA scan primarily measures bone mineral density, but it can also accurately measure fat free and fat mass in older people (validated against hydrostatic weighing). Although accurate, a DEXA scan is time consuming and expensive (Svendsen, Haarbo et al. 1991). Bioelectrical impedance analysis (BIA) is a simple, quick, inexpensive and non invasive technique to measure body composition. This method has been validated in younger populations, however reference values are yet to be developed for those over 80 years (Roubenoff, Baumgartner et al. 1997). BIA can have large margins of error in certain conditions such as dehydration, changes in skin temperature and moisture levels (Malafarina, Úriz-Otano et al. 2012). Additionally, co-morbidities that commonly affect older people (renal, cardiovascular and liver disease) are associated with fluid shifts that will decrease the reliability of BIA (Bauer and Vokert 2007). Waist circumference is the preferred measure to estimate visceral fat as it is quick, easy, validated and more accurate than BMI in any age group (Seidell and Visscher 2000). However the most common measure used to assess body composition is BMI as it is non-invasive and quick (Cook, Kirk et al. 2005). Most body composition measurement reference data, with the exception of the DEXA scan, is based on younger populations and therefore may not be applicable or validated to use on adults in advanced age.

Body Mass Index (BMI)

Body composition, weight change and nutritional risk are often measured in longitudinal studies via changes in BMI (Stevens 1998; Dey, Rothenberg et al. 2001; Keller and Østbye 2005; Sánchez-García, García-Peñ et al.

2007; Hubbard, Lang et al. 2010). The WHO defines a BMI of under 18.5 kg/m^2 to be underweight, over 25kg/m^2 is overweight and above 30kg/m^2 is obese (World Health Organization 2004). BMI was developed using younger people for the purpose of determining body composition in population studies. However, BMI is now commonly used for individual diagnosis in all adult age groups, despite its unsuitability and impracticability (Roubenoff, Dallal et al. 1995; Hurley, Bartlett et al. 1997; Dey, Rothenberg et al. 2001). Interpreting body composition with BMI is difficult in older populations due to the age related changes in muscle and fat mass and lack of reliable reference values (Perissinotto, Pisent et al. 2002; Cook, Kirk et al. 2005).

A higher BMI appears to have a protective role in older people. A 'normal' or 'healthy' BMI in older age is associated with an increase in mortality risk (Cook, Kirk et al. 2005; Sánchez-García, García-Peñ et al. 2007). A meta-analysis of 32 papers (participants ≥65 years) found that being overweight (25- 30 kg/m^2) was not associated with an increase in mortality, and being moderately obese (30 – 35kg/m^2) was only associated with a small increase in mortality risk (Janssen and Mark 2007). Corrada et al. found obesity was not associated with increased morality in participants older than 75 years (Corrada, Kawas et al. 2006). A study in nonagerians found men with a 'healthy' BMI and waist circumference had up to a threefold increase in mortality ([HR] 3.09, 95% CI 1.35–7.06) compared to overweight men. The same applied to women but to a lesser degree (Lisko, Tiainen et al. 2011). Two possible explanations for the 'obesity paradox' in older age are: obese older adults have higher survival rates after wasting illnesses; or overweight or obese people who reach advanced age may have protective traits against the adverse metabolic effects of adiposity (Oreopoulos, Kalantar-Zadeh et al. 2009). Having a higher BMI in older age poses less of a risk than being underweight (Heitmann, Erikson et al. 2000; Seidell and Visscher 2000; Dey, Rothenberg et al. 2001), therefore BMI cut-offs likely require revaluation for use in this age group.

Overweight and obesity

This review focuses more on nutrition risk associated weight loss, but any unintentional change in weight can increase nutrition risk (Keller, Goy et al. 2005) . Over-nutrition which may present as being overweight or obese is associated with poor health outcomes (Bannerman, Miller et al. 2002). The most recent national nutrition survey reported approximately 40% of women and 52% of men over 70 years were classified as overweight which is the highest of any age bracket, although rates of obesity (24.4%) were lower in this age group than in younger adults 31 - 70 years (32.5%) (University of Otago and Ministry of Health 2011). Obesity in older people has been associated with decreased quality of life (Yan, Daviglus et al. 2004), increased rates of dependence and disability and obesity related diseases (Launer, Harris et al. 1994; Bannerman, Miller et al. 2002; Yan, Daviglus et al. 2004), however risk of mortality associated with obesity is lower than younger adults (Dey, Rothenberg et al. 2001). A study based in Chicago of 7080 older adults (mean age 74.3 ± 6 years) found poorer quality of life and physical functioning among overweight women (BMI 25- 29), however this effect was not found in men. Additionally, obese participants of advanced age

who lost weight, doubled their risk of disability (Yan, Daviglus et al. 2004). Other studies report even minor weight fluctuations (as little as one kg) or modest weight gains in overweight and obese older people are associated with an increase in mortality risk (Somes, Kritchevsky et al. 2002; Bamia, Halkjær et al. 2010). Higher levels of fat and lower levels of muscle than healthy peers at any BMI can indicate sarcopenic obesity; those with sarcopenic obesity suffer the greatest obesity related risks (Baumgartner, Koehler et al. 1998; Malafarina, Úriz-Otano et al. 2012). At this stage it may be detrimental to suggest obese older adults intentionally lose weight for the management of co-morbidities, as is recommended for younger adults.

Muscle strength (grip strength)

Grip strength is a simple, non invasive marker of muscle strength or muscle function. Grip strength has been inversely associated with post-operative complications, increased length of stay, increased chance of rehospitalisation, decreased physical function and increased mortality (Norman, Stobäus et al. 2010). Grip strength is thought of as a useful tool to monitor changes in nutritional status as muscle function reacts quicker to poor nutrition than muscle mass (Norman, Stobäus et al. 2010). Numerous studies show an association between nutritional supplementation and increased grip strength in hospitalised adults, however evidence was not as strong in older adults (Norman, Stobäus et al. 2010). A randomised control trial in older adults (n=100, mean age 76.8 ±5.3 years) found that after eight weeks of nutrition supplementation grip strength increased, although six months later, grip strength was similar to controls (Edington, Barnes et al. 2004). Another study in rest home residents of the same intervention period found increases in BMI and Mini Nutritional Assessment (MNA) scores, however no significant differences were found in grip strength (Smoliner, Norman et al. 2008). The feasibility study for LiLACS NZ found no significant differences in grip strength between the 'at risk' and 'not at risk' participants (Wham, Teh et al. 2011). A recent review on grip strength in relation to nutritional status concluded that poor grip strength is a marker of general frailty in older age rather than being indicative of nutritional risk (Norman, Stobäus et al. 2010).

In summary, even moderate unintentional weight loss is associated with poor health outcomes and nutrition risk (Bamia, Halkjær et al. 2010). Body composition changes considerably during aging with an increase in visceral and overall fat mass, and a decrease in overall lean body mass (Hughes, Roubenoff et al. 2004). Although BMI is a quick and non-evasive measure of body composition, the current BMI cut-offs are likely too low for use in older people (Dey, Rothenberg et al. 2001) and should be used with caution. Obesity, although associated with lower mortality, is associated with poorer quality of life and functional impairments (Yan, Daviglus et al. 2004). Weight maintenance is more important for overall health in older adults and is associated with better nutritional status and health outcomes.

2.4 Dietary Recommendations and Intakes of Older People

Nutrition requirements in older people are the same if not higher than younger adult populations, with the exception of energy, for which requirements are reduced (NHMRC 2006a). A decreased appetite and reduced energy requirements make it difficult for older people to meet increased nutrient requirements, leaving older people at increased nutrition risk (Ministry of Health 2010). The current *Food and Nutrition Guidelines for Healthy Older People* include nine statements or recommendations, summarised below. The guidelines are based on the food and nutrition guidelines for younger adults with the exception of 'take opportunities to eat with other people' and 'eat three meals every day'.

1. Maintain a healthy body weight
2. Include a variety of nutritious foods from each of the major four food groups
3. Drink plenty of liquids
4. Prepare foods with minimal added fat, low in salt and limited sugar
5. Take opportunities to eat with other people
6. Eat three meals every day
7. Purchase, prepare, cook and store food to ensure food safety
8. Limit intake of alcohol
9. Include 30 minutes of moderate intensity physical activity most days
   (Ministry of Health 2010)

2.4.1 Food groups and dietary patterns

Food group recommendations for older people are essentially the same as younger adults, however the servings of milk products are increased from two to three per day to account for the age associated increase in calcium requirements (1000mg increased to 1300mg). The following are the current recommendations:

- Vegetables and fruit : at least five servings a day , with at least three vegetables and two fruit
- Breads and cereals: at least six servings per day, choose wholegrain breads and cereals
- Milk and milk products: at least three servings per day
- Lean meat, poultry, seafood, eggs, nuts and seed, and legumes: at least one serve per day

The results from the NNS09 reported the intakes of food groups and individual nutrients from older people over 70 years, these results are summarised below (University of Otago and Ministry of Health 2011).

Fruits and vegetables

Older adults, especially women over 70 years, are more likely than the rest of the population to meet the recommended intakes of fruits and vegetables.   Almost 60% of women and 47% of men met both the daily fruit and vegetable intake recommendations. Seventy seven percent of women and 71% of men ate more than three serves of vegetables per day. Although, only 53% of men met the recommended two or more fruit serves a day compared with 71% of women (University of Otago and Ministry of Health 2011).

Breads and cereals

The NNS09 reported bread was the largest source of energy across all age groups (mean 11%). Both men and women over 70 years consumed approximately 14% of energy from bread. This age group was most likely to consume light or heavy grain bread products and the least likely to eat other grains and pastas (5% compared to 7% for total population) (University of Otago and Ministry of Health 2011).

Milk and milk products

Milk and milk products are the most bio-available sources of calcium, however the NNS09 (University of Otago and Ministry of Health 2011) and international studies report older people frequently do not meet calcium recommendations from diet alone (Payette and Gray-Donald 1991; Anderson and Sjöberg 2001). Soft, energy-dense foods such as ice-cream, cream, sour cream, custard, dairy food, and milk puddings were more frequently consumed by those aged 75 years compared to younger age groups (Ministry of Health 2010).

Meat and meat products

 Older people (>70 years) were the highest consumer of red meat. Red meat (beef or veal) was most commonly consumed three to four times per week (44% men and 42% women). Older people were most likely to eat chicken one to two times per week (59% of men and 61% of women). Forty-nine percent of men and 55% of women were likely to have fish at least once per week; this is approximately 10% higher than the population mean. Processed meat was most commonly consumed one to two times per week in 48% of men and 43% of women, this was less than younger age groups (University of Otago and Ministry of Health 2011).

Other foods

People over 70 years were the least likely to consume: takeaways, hot chips, fruit juice, or soft drinks. For all of the above areas older men consumed more than older women with the exception of fruit juice (University of Otago and Ministry of Health 2011).

Fluid

Those over 70 years were the highest consumers of tea and coffee. Spirits/ liqueurs were the alcoholic drink of choice in this age group. Mean daily alcohol intakes (drinkers only) were 13g for men and 6g for women;

this was lower than the population daily mean alcohol intakes of 18g for men and 10g for women (University of Otago and Ministry of Health 2011).

In summary, nutrition recommendations for older adults are similar to younger adults with the exception of an increase in milk products. Older people were more likely than younger adults to:

- Eat the recommended number of servings of vegetables and fruit
- Consume red meat or fish
- Consume more bread (as a percentage of total energy intake), however they were the least likely to consume other carbohydrate sources such as grains and pasta
- Consume soft, energy dense, dairy based food and desserts
- Older people were less likely to consume processed foods, takeaways, and sweetened drinks

2.4.2 Nutrient recommendations and intakes

In order to maintain body systems, nutrient requirements remain constant or increase (protein, vitamin D and calcium) (Ministry of Health 2010), but there is a concurrent decrease in energy requirements (Morley and Pulisetty 2007). Aging is associated with a reduced ability to absorb particular nutrients such as iron, calcium, vitamins B_6, B_{12}, D, E and folate (Morley and Pulisetty 2007). In advanced age it becomes vital that older people eat a wide variety of nutritionally dense foods in order to meet nutrient recommendations within energy requirements (Ministry of Health 2010). Refer to Appendix 12 for the 'Australian and New Zealand Nutrient Reference Values for Older People'.

Energy

Energy requirements in the heterogeneous older population vary considerably depending on age, gender, body size and activity levels (Ministry of Health 2010). Additionally, conditions such as chronic disease and disability can increase or decrease energy requirements (Thomas 2007). In well older people, energy requirements typically decrease with age as a result of reduced physical activity and the loss of muscle mass (de Groot, Van Den Broek et al. 1999; Roberts and Rosenberg 2006; Ministry of Health 2010).

Most national and international longitudinal studies in community living older people show a decrease in energy intakes at follow-up (Moreiras, Van Staveren et al. 1996; Vellas, Hunt et al. 1997; Ministry of Health 2010; Zhu, Devine et al. 2010), but not all (Fernyhough, Horwath et al. 1999; Toffanello, Inelmen et al. 2010). The NNS09 found that between the age brackets of 19 – 30 years and 71 years-plus, energy intake decreased 821kcal/day in men and 531kcal/day in women (cross-sectional) (University of Otago and Ministry of Health 2011). The American National Health and Nutrition Examination Survey III (NHANES) study demonstrated that between the ages of 20 and 80 years, energy intake decreased 1321kcal/day in men and 629kcal/day in women (cross-sectional) (MacIntosh, Morley et al. 2000). A ten year longitudinal study of

older Americans (n= 304, mean age 82 years at follow up) found energy intakes significantly decreased in men and women over the study period, especially in those who dropped out due to illness (Vellas, Hunt et al. 1997). Other studies have found energy intakes remain stable at follow-up in well community living older adults. A longitudinal study in Italians (n= 191, 70-75 years at baseline) found that over ten years dietary habits changed (increase in sweet foods and decrease in non-alcoholic beverages), but energy intake did not (Toffanello, Inelmen et al. 2010). Fernyhough et al. found that over six years energy intake declined in older men only (70 years at baseline), no change in energy intake was observed longitudinally in women (Fernyhough, Horwath et al. 1999). Energy intake appears to decrease with age, however some of the observed decrease in energy intake may be associated with poor health in older age rather than an effect of aging itself (Vellas, Hunt et al. 1997).

Macronutrients: Protein, fat and carbohydrate

Protein

Protein requirements in advanced age increase as a result of age related physiological changes which include a decrease in lean mass, organ tissue, blood components and immune proteins (Chernoff 2004; Ministry of Health 2010). Older adults have less circulating amino acids available for muscle protein synthesis (Katsanos, Kobayashi et al. 2006; Breen and Phillips 2011). This is caused by an age associated two fold increase in the extraction of amino acids by the splanchnic area (gastric, small intestinal, colonic, pancreatic, hepatic, and splenic organs). However once the splanchnic area becomes saturated with an increase in dietary protein intake, positive nitrogen balance can be achieved (Volpi, Mittendorfer et al. 1999). Inadequate protein intake is common in old age as people face the following barriers: cost of animal proteins, perceived intolerance (e.g. lactose), difficulty chewing, fear of consuming too much fat or cholesterol and decreased functional ability to prepare foods (Payette, Gray-Donald et al. 1995; Chernoff 2004). Effects of a low dietary intake of protein include accelerated lean body mass loss (sarcopenia), decrease in immune function, poor wound healing, longer recovery times and increased skin fragility (Chernoff 2004).

Older adults require higher amounts of dietary protein to stimulate muscle synthesis (Dorrens and Rennie 2003; De Souza Genaro and Martini 2010; Jordan, Melanson et al. 2010; Breen and Phillips 2011). The adult protein recommendations of 0.8g/kg of body weight is likely not sufficient to support protein metabolism in older adults and intakes of at least 1.0g/kg are required (Chernoff 2004). The protein recommendation for older New Zealanders is between 15% and 25% of total energy intake or 81g/day (1.07g/kg) for men and 57g/day (0.94g/kg) for women (NHMRC 2006a). Dietary protein of high biological value optimises nitrogen balance and promotes anabolism (Paddon-Jones and Rasmussen 2009; Breen and Phillips 2011); proteins of poor biological value can hinder protein synthesis (Chernoff 2004). Animal proteins are considered to be of high biological value as they contain all of the essential amino acids in the appropriate ratios and are rich sources of iron, vitamin $B_{12,}$ folic acid and biotin. Vegetable protein, with the exception of soy, are not

complete proteins and often require multiple sources of protein to provide a full amino acid profile (Chernoff 2004).

Older New Zealand men and women (>70 years) consume 16% (78g/day) and 17% (60g/day) of their total energy intake from protein respectively (University of Otago and Ministry of Health 2011). The NNS09 reported that 13% percent of men and 16% of women were not meeting protein recommendations, compared to two percent for the rest of the population (University of Otago and Ministry of Health 2011). Bread, milk and beef were the highest contributors to protein intake in those over 70 years (University of Otago and Ministry of Health 2011).

Various studies have aimed to determine the amount and timing of dietary protein needed to optimise nitrogen balance in older people. The spread of protein intake throughout the day can have significant effects on nitrogen balance in older populations (Chernoff 2004; Jordan, Melanson et al. 2010; Breen and Phillips 2011). Jordan et al. demonstrated that if a protein drink (chocolate milk) was consumed by older adults after easy to moderate exercise (i.e. walking), nitrogen balance was more positive compared to consuming the drink earlier in the day. Mean total protein intake in this study was 202g, much more than 1.0g/kg/day (Jordan, Melanson et al. 2010). Protein pulse feeding, or consuming 80% of dietary protein at lunch time is another method that has demonstrated positive results in older people (Bouillanne, Curis et al. 2012). In both the inpatient (Bouillanne, Curis et al. 2012) and outpatient (Arnal, Mosoni et al. 1999) settings pulse feeding was associated with a positive nitrogen balance compared to spread diets (protein spread over the day). In both these studies 35kcal/kg and 1.7g/kg of protein was consumed. An earlier review looking at protein recommendations for the prevention of sarcopenia concluded that 20g – 30g of high biological value protein per meal is required to stimulate protein synthesis in older adults (Breen and Phillips 2011). Amounts less than 20g of dietary protein per meal attenuated skeletal muscle synthesis (Paddon-Jones and Rasmussen 2009). Consuming this much protein may not be feasible for older adults, especially the frail, malnourished and very old (Jordan, Melanson et al. 2010). Nutritional assessment and intervention should place a focus on adequate protein consumption and timing, taking into account active times of the day. Nutritional supplements which include protein may be needed.

Fats

Dietary fat is the most important modifiable determinant of blood cholesterol concentrations (Ministry of Health and University of Auckland 2003). A replacement of dietary trans and saturated fatty acids with mono or polyunsaturated fats can result in a decrease in blood cholesterol and consequently a lower risk of cardiovascular disease (WHO and FAO 2003) which is a leading cause of mortality in advanced age (Wang 2007). The acceptable macronutrient distribution range (AMDR) for fat in all adults is 25 – 30 % of total energy intake (NHMRC 2006a). However older people at nutrition risk may benefit from a higher fat intake as it is energy dense, palatable and encourages intake which can help to stabilize weight (Nieuwenhuizen,

Weenen et al. 2010). The NNS09 found those over 70 years have the lowest total fat intake of the population. Median daily intake was 67g for men and 51g for women, this represents 34% of total energy intake and exceeds the AMDR of 30% (NHMRC 2006a). Mean saturated fat intakes were 12% for both men and women (University of Otago and Ministry of Health 2011), again exceeding the recommended intake of 10% (NHMRC 2006a). Monounsaturated fat intakes (11%) were lower and polyunsaturated intakes (5%) were similar to the population mean. The main sources of fat in those over 70 years are butter and margarine, beef and veal, bread and milk (University of Otago and Ministry of Health 2011).

Carbohydrate

Carbohydrates regulate blood glucose levels, are involved in gastrointestinal health and are the largest and most readily available source of energy (Ministry of Health 2010). There is no RDI for carbohydrate, however the AMDR is 45 - 65% of total energy intake, with a recommendation to consume mostly complex sources (NHMRC 2006a). Older New Zealanders consume approximately half of their total energy intake from carbohydrates (University of Otago and Ministry of Health 2011). Of the total population, adults older than 70 years had the lowest sugar intake. Compared with younger age groups, older adults consumed more bread and fruit and less grains and pastas than younger age groups (Ministry of Health 1999).

Dietary fibre

Adequate dietary fibre is essential for proper functioning of the gut and is indicated in the prevention of constipation and diverticulitis (Russell, Rasmussen et al. 1999; Ministry of Health 2010). Fibre has also been associated with reduced inflammation (University of Otago and Ministry of Health 2011) and risk reduction of a number of chronic diseases, including heart disease, certain cancers and type 2 diabetes (Morley 2007; Ministry of Health 2010). Conversely, a diet too high in fibre can induce early satiety (Nieuwenhuizen, Weenen et al. 2010) and is a concern for older adults at nutrition risk.   The NNS09 found dietary fibre intakes to be 22g for men and 17g for women which is lower than the recommended 25 - 30g per day (NHMRC 2006a; University of Otago and Ministry of Health 2011).

Micronutrients and minerals

Energy requirements decrease with age however the requirements of some vitamins and minerals such as vitamins D, B_6, B_{12} and calcium are required in larger quantities due to the physiologic changes in the liver, kidney (vitamin D and calcium) and stomach (B vitamins) (Hajjar and Nahhas 2008).

Iron

Iron requirements remain constant through adulthood in men (8mg per day) and decrease in women from 18mg to 8mg after menopause (NHMRC 2006a). Older New Zealanders are meeting the RDI, however, the majority of dietary iron is consumed from poorly absorbed non-haem sources like bread and fortified breakfast cereals (University of Otago and Ministry of Health 2011). The prevalence of anaemia is over 20%

in people over 85 years, this usually caused by anaemia of chronic disease or losses through the gastrointestinal tract as dietary iron deficiency is rare in older populations (Thomas 2007).

Zinc

Zinc deficiency can lead to a poor immune response, decrease in taste acuity, diarrhoea, anorexia, poor wound healing and hair loss (Morley 2007). Zinc absorption appears to be similar in older adults as it is in younger adults, however, older adults frequently take diuretics, laxatives , antacids, iron and calcium supplements which decrease zinc absorption. Diabetes, liver cirrhosis and lung cancer are common causes of zinc deficiency that affect older people (Morley 2007). Zinc intakes were lowest in older people (over 70 years) with a mean intake of 9.7mg/day for men and 7.6mg/day for women (population mean 12.9mg/day for men, 9.0mg/day for women). Men fell short of the RDI by approximately 5mg/day. Beef and veal, bread, grains and pasta were the largest contributors of zinc to the diet (University of Otago and Ministry of Health 2011).

Vitamin B_{12}

Vitamin B_{12} is required for haemoglobin (Andres, Loukili et al. 2004), myelin, DNA and fatty acid synthesis (Thomas 2007). The active form vitamin B_{12}, is found in animal products such as, meat, milk products, eggs and seafood (University of Otago and Ministry of Health 2011). Vitamin B_{12} can only be absorbed by the body once bound to intrinsic factor in the stomach. A main causative factor of reduced vitamin B_{12} absorption in older people is gastric atrophy which leads to a decrease in intrinsic factor (Hajjar and Nahhas 2008). Additionally antacids, gastrointestinal surgery, and bacterial overgrowth (secondary to antibiotic use) can all lead to vitamin B_{12} malabsorption in older people. Consequences of vitamin B_{12} deficiency include pernicious anaemia , neurological complications and cognitive impairment (Thomas 2008). The recommendations for vitamin B_{12} are the same for all adults at 2.4mg/day (NHMRC 2006a). Men over 70 years had the highest vitamin B_{12} intakes (5.3mg/day) of the population and women over 70 years the lowest (3.2mg/day) (University of Otago and Ministry of Health 2011). A Christchurch study found that 7.3% of community living older people had low blood vitamin B_{12} levels (Hanger et al 1991). International studies report up to 20% of older people in the community and 40% in institutions are deficient in vitamin B_{12} (Andres, Loukili et al. 2004).

Folate (B_9)

Folate deficiency, although not common in older New Zealanders (Fernyhough, Horwath et al. 1999), produces similar symptoms to vitamin B_{12} deficiency, thus it is important to distinguish the difference between deficiencies (Andres, Loukili et al. 2004). The NNS09 found older adults had the highest levels of red cell folate compared with the rest of the population (University of Otago and Ministry of Health 2011). Folate is present in many natural foods; however it is easily destroyed by cooking. Particularly rich sources include leafy vegetables, legumes, eggs and fortified foods (University of Otago and Ministry of Health 2011).

Calcium

Calcium plays many roles in the body including muscle contraction, nerve function, blood clotting, blood pressure regulation and maintenance of bone mineral density (Goulding 1998). Calcium absorption is reduced in older people over 70 years due to the decline in calcitriol (active vitamin D) production by the kidney and decreased intestinal absorption. The calcium RDI for older people is 1300mg/day, this is higher than the RDI for younger adults (800mg/day) to account for increased requirements. Many older people have suboptimal intake of calcium, the most recent nutrition survey reported daily intakes of 743mg/day for men and 676mg/day women. Calcium balance is also affected by other nutrients; high sodium, protein and caffeine intakes increase urinary calcium loss (Goulding 1998; Ministry of Health 2010). Lack of dietary calcium intake in combination with the age associated reduction in absorption can accelerate the rate of bone loss and elevate the risk of osteoporosis (Ministry of Health 2010). Milk was the largest dietary contributor of calcium in older adults (33%) followed by bread (12%) (University of Otago and Ministry of Health 2011).

 Calcium supplementation (>1200mg) along with vitamin D in adults over 65 has been shown to reduce the rate of bone loss and reduce fall risk (Dawson-Hughes, Harris et al. 1997). However findings are not consistent, as other randomised control trials have shown increases in bone mineral density, but no decreases fracture risk (Grant, Anderson et al. 2005; Reid, Mason et al. 2006). New research has made clinicians hesitant in prescribing calcium supplements due to the moderate increased risk of myocardial infarction and other cardiovascular events (Bolland, Grey et al. 2011).

Vitamin D

Vitamin D levels fall with age regardless of health status and time in the sun (Perry, Horowitz et al. 1999). Up to 25% of community dwelling older people have a vitamin D deficiency (Hajjar and Nahhas 2008). Main sources of Vitamin D are sun exposure and dietary intake from foods such as fortified milk, egg yolks, fish and fish liver oil, although food only contributes a small amount to overall status (Ministry of Health 2010). Deficiency is attributed to decreased sun exposure, increased use of sunscreen, decreased oral intake, decreased 7-dehydrocholesterol skin levels and decreased ability of the kidney to convert 25(OH)D to its active form of 1,25(OH)2D (Morley 2007). Low vitamin D levels have been associated with increased disability, decreased muscle strength (Houston, Tooze et al. 2011), sarcopenia (Visser, Deeg et al. 2003) and increased incidence of falls and hip fractures (Bischoff-Ferrari, Dawson-Hughes et al. 2004). As Vitamin D is involved with the mineralisation and demineralisation of bone, deficiency also increases the risk of ostetomalacia and osteoporosis (Ministry of Health 2010).

Evidence shows that calcium absorption and other health related measures are optimal when serum vitamin D (25OHD) levels are above 80mmol/L (Scragg and Bartley 2007). Older New Zealanders' levels are much lower (approximately 50nmol/L) than US populations (70nmol/L) of similar latitude. Even lower serum levels

were found in Maori and Pacific Island populations (Scragg, Holdaway et al. 1995). Supplementation of vitamin D is recommended in older people with low levels of 25(OH)D (below 50nmol/L) (Scragg and Bartley 2007).

Current recommendations for vitamin D supplementation in older adults is 600 - 800IU-plus per day, however recent research suggests at least 1450 IU/day is required to maintain serum 25(OH)D levels at 75nmol/L (Scragg and Bartley 2007). ACC has published guidelines which suggest a loading dose of 2 x 50,000IU of vitamin D3 in the first month with a maintenance dose of 50,000IU vitamin D3 monthly, thereafter, for life (ACC 2008). Vitamin D supplementation may improve physical performance (Visser, Deeg et al. 2003), reduce the incidence of falls and fractures (Murad, Elamin et al. 2011) and improve glucose tolerance (Scragg, Holdaway et al. 1995). Supplementation is associated with a risk of hypercalcaemia and serum calcium levels should be monitored closely (Zhang 2007).

Selenium

Selenium makes up the body's selenoproteins which are involved in antioxidant defence, thyroid metabolism and immune function (Mann and Truswell 2007). Cases of selenium deficiency manifest as severe gastrointestinal issues, including Chrohn's disease and thyroid problems (Thomas 2007). New Zealand produced plant foods (fruit, vegetables and grains) tend to have lower selenium levels due to low soil concentrations (University of Otago and Ministry of Health 2011). The lowest intakes of selenium were found in older men and women (>70 years). Sixty-four percent of men and 79% of women over 70 years had inadequate intakes of selenium (University of Otago and Ministry of Health 2011). Bread was the largest provider of selenium to the diet of older people (20%), followed by fish and seafood (12%) and eggs and egg dishes (7%) (University of Otago and Ministry of Health 2011).

Sodium

Sodium is an essential nutrient and is important for fluid balance and molecule transport across membranes (University of Otago and Ministry of Health 2011). The relationship between a high sodium diet and cardiovascular risk factors is well established (Ministry of Health 2010). Hypertension is very common in older people and the NHANES II reported up to two thirds of older Americans were taking anti-hypertensive medications (Appel, Espeland et al. 2001). Due to the reduction in renal function and reduced urine sodium excretion older adults are much more sensitive to the effects of dietary sodium and are likely to reap the benefits of a low sodium diet (Morley 2007). The TONE study found that 23% of older people (60 – 80 years) no longer needed their hypertensive medications after following a low sodium diet (27 month follow up) (Appel, Espeland et al. 1995). However, lack of sodium in the diet can make food unpalatable and may increase nutrition risk in a group that already experiences a chemosensory decline and elevated risks of malnutrition (Essed, van Staveren et al. 2007; Hajjar 2008).

Like all ages, sodium is consumed in excess by older people (University of Otago and Ministry of Health 2011). Bread is the greatest source of sodium accounting for a fourth of all dietary sodium (Ministry of Health and University of Auckland 2003). Other foods that contribute to the sodium intakes of New Zealanders include processed meats (10%), sauces (7%), breakfast cereals (6%) and cakes, muffins, biscuits and crackers (5%) (Ministry of Health and University of Auckland 2003).

In summary, energy requirements decrease in older age, however protein requirements increase to at least 1.0g/kg (Ministry of Health 2010). Education in older adults should place emphasis on the consumption of high biological protein sources (Chernoff 2004) spaced evenly over the day (Breen and Phillips 2011) or potentially pulse feeding (80% of protein at lunch time) (Bouillanne, Curis et al. 2012). The NNS09 demonstrated that dietary recommendations for protein and total carbohydrates were met, but total fat and saturated fat intakes exceeded the AMDR. Fibre intakes fell short of the RDI. Micronutrient requirements for calcium and vitamin D, and B_{12} increase with age, however older people are not meeting the increased requirements (Ministry of Health 2010). Inadequate intakes of selenium (low soil levels) and zinc and high intakes of sodium were also reported.

It is common for older people to not meet the RDI for one or more nutrients and this consequently increases the risk of poor nutrition status (Keller, McKenzie et al. 2001). A broad definition of malnutrition is

> 'a pathological state resulting from a relative or absolute deficiency or excess of one or more essential nutrients, this state being clinically manifested or detected only by biochemical, anthropometric or physiological tests' (Jelliffe 1966).

The following section describes the methods of assessing dietary intake and nutrition status in older people.

2.5   Nutritional Assessment of Older People

Generally the nutrition status of older people living at home is better than those living in institutions (Elia, Zellipour et al. 2005; Kaiser, Bauer et al. 2010). Nevertheless, as mentioned previously, high rates of nutrition risk are commonly found in community dwelling older people (Watson, Zhang et al. 2010; Wham, Teh et al. 2011). Nutritional health can be evaluated in various ways from an in-depth nutritional assessment by expert clinicians to simple and quick screening tools which highlight people who are at risk of malnutrition and in need of further investigation or intervention (Keller, Goy et al. 2005). The assessment of malnutrition is complex and requires a thorough evaluation of medical, dietary and medication histories; a physical examination including anthropometric measures; social situation; functional and occupational health; and where able, evaluation of biochemical indices (Posthauer, Dorse et al. 1994; Kondrup, Allison et al. 2003; Gibson 2005). Due to the subjectivity of detecting nutrition risk and malnutrition, no objective

measure or gold standard exists (Keller, Goy et al. 2005). A clinical nutritional assessment should only be performed by trained health professionals (registered dietitians or nutritionists) and should result in a fitting care pathway (Kondrup, Allison et al. 2003). The detection of nutrition risk by a registered clinical dietitian has been considered the gold standard in various studies (Campbell and Kelsey 1994; Keller, McKenzie et al. 2001; Keller, Goy et al. 2005).   Typically, non-dietetic community clinicians have difficulty identifying nutrition risk and as a consequence community living older people are left under diagnosed and under treated (Keller, McKenzie et al. 2001; Elia, Zellipour et al. 2005; Phillips, Foley et al. 2010). This demonstrates the need for a quick, acceptable, easy and reliable method of identifying nutrition risk.

2.5.1   Dietary assessment

The assessment of dietary intake can be achieved in a variety of ways, but the method of choice must be standardised and pre-tested (Gibson 2005).   An accurate dietary assessment is a challenging prospect and this is especially true for older people. Many factors threaten accuracy in this age group including: poor cognitive function and inability to remember foods; dependence on others for food acquirement and preparation; physical impairment that inhibits the ability to record food intake; and sensory impairment that may hinder communication (Adamson, Collerton et al. 2009). The most common and validated methods are estimated or weighed food records, multiple pass twenty four hour recalls (MPR), food frequency questionnaires (FFQ), or dietary histories (Gibson 2005). One of the biggest sources of error in dietary assessment is the estimation of portion sizes. Various visual tools are used to increase the accuracy of portion size estimation such as household measures, food models, and food photographs (Gibson 2005).

Food photographs have proven to be an effective portion size estimation tool in free living subjects.   A study that asked participants to recall portion sizes using food photographs 24 hours after eating prepared meals, found an error of ± 10% for nutrient intakes, with the exception of thiamin and vitamin E. No bias was found in regards to age and gender (Robson and Livingstone 2000). Another study which validated food photographs found that age (>65 years) overestimated energy and fat, and that women, or those with a low BMI, overestimated energy intake (Nelson, Atkinson et al. 1996). A later study by the same author found that estimation errors could be reduced with the presentation of eight portion size photographs of a single food versus one photograph (Nelson and Haraldsdóttir 1998). A limitation of this study was participants were asked to estimate portion sizes only five minutes after eating a meal.

The methodology of creating food photographs must be considered. Photographs taken in different lighting or different angles can appear smaller or larger which affects the accuracy of estimation. Additionally the type of food photographed can have an effect. Studies found that muesli, cheese and butter were frequently poorly estimated (Nelson, Atkinson et al. 1994; Nelson, Atkinson et al. 1996; Robson and Livingstone 2000). Other methods of food estimation such as household measures may also be used.

Food records

A weighed food record is the most precise method of dietary assessment and is considered the gold standard (Gibson 2005). This method requires the individual to weigh and record all food and beverages over a designated time period, including both week and weekend days. Although very accurate food records are time consuming, and can be a burden, especially for older people. An estimated food record is similar to the weighed record, but the portion sizes are estimated using household measures, rulers, food models or photographs. Although estimated food records are less of a burden, they are more inaccurate (Gibson 2005). Food records do not rely on memory, therefore few foods are omitted. Disadvantages include: the participant must be motivated, numerate and literate; training is required to complete the record properly; respondent burden and fatigue over time reduces reliability (Gibson 2005). Finally, studies have shown that respondents will change their eating habits to make the measurement and recording process easier or to impress the researcher (social desirability bias) (Biró, Hulshof et al. 2002).

Twenty four hour multiple pass recall

The twenty four hour Multiple Pass Recall (MPR) is a method of dietary data collection developed by the US Department of Agriculture and has previously been validated and used for national surveys in New Zealand (University of Otago and Ministry of Health 2011), United States (Centers for Disease Control and Prevention 2010) and the United Kingdom (Hughes, Smithers et al. 1995). This method has also been used in participants of advanced age in the UK (Adamson, Collerton et al. 2009). The twenty four hour recall requires a trained interviewer to use multiple prompts and passes through the previous days' intake; portion size estimation tools are used to increase accuracy (Gibson 2005; Adamson, Collerton et al. 2009). To describe an individual's habitual intake, multiple 24 hour recalls on non-consecutive days of the week are required (Gibson 2005), however, if evaluating a population a single recall may be suitable (Biró, Hulshof et al. 2002). A minimum of three days is sufficient to describe usual intakes of energy, protein and most nutrients for older adults (Payette and Gray-Donald 1991).

Advantages of a 24 hour MPR include: minimal respondent burden, time efficiency, no changes in dietary intake, the record can be completed in person or over the phone and illiterate subjects can be interviewed (Biró, Hulshof et al. 2002). Disadvantages include: memory reliance, portion size estimation, and trained interviewers as well as a coding system are required (Gibson 2005). A recent study reported the proportion of older adults who were classified as accurate reporters ranged from 40-63% for men and 60-63% for women (Tooze, Vitolins et al. 2007). A further study of almost 400 older people found that those using more than four medications or high levels of physical activity were significantly more likely to underreport , however no difference in gender or level of education was found (Shahar, Shai et al. 2005).

Food frequency questionnaire

Food frequency questionnaires (FFQ) calculate the frequency that foods or food groups are consumed over an extended period of time (months to a year). The FFQ contains a list of foods from which the participant identifies the frequency (predefined) that the food is consumed (on paper or computerised). The list of foods can be quite defined or be very comprehensive and have the ability to determine dietary diversity and energy consumption (Gibson 2005). The questionnaire can be self-completed or administered by an interviewer (Gibson 2005).

The advantages of the FFQ method include low respondent burden (dependent on the number of foods assessed), literacy is not required (interviewer administered), it is not as costly to analyse as other methods and typically there is good cooperation from participants (Adamson, Collerton et al. 2009). Disadvantages of the FFQ are similar to other retrospective methods of dietary assessment and include memory reliance, observer bias if administered by an interviewer and social desirability bias (Biró, Hulshof et al. 2002; Gibson 2005). Adamson et al. compared a comprehensive FFQ and 24 hour MPRs with a 7-day weighted food record in a population of older adults (85 + years). The FFQ estimated energy intakes 42% and 53% higher for men and women respectively than the MPRs on the same participants. Both methods estimated intake higher than weighed 7-day records from in the UK National Diet and Nutrition Survey (NDNS) (n=459, 85 years). Participants found difficulties in recalling 'usual' intake over the previous 12 months and both participants and interviewers found it hard to maintain interest in the lengthy, comprehensive FFQ. Both interviewers and participants stated the MPRs were more enjoyable and interactive, however this method required significantly more training in comparison to the FFQ (Adamson, Collerton et al. 2009).

Dietary history

The dietary history method was first recorded by Burke (1947). Originally a dietary history included an interview about typical eating habits (types, portions and timing of food), followed by a FFQ or MPR, then a three day estimated record. The dietary history method required trained interviewers, was very time consuming (up to 2 hours) and had a high respondent burden (Gibson 2005). Dietary histories have evolved to take into account typical food intake over weeks or months and is usually completed using a computerized system (Biró, Hulshof et al. 2002). This method is good to identify meal patterns however is less accurate is assessing nutrient intakes (Gibson 2005).

In summary, dietary assessment in combination with anthropometric measures and questions on social and physiological factors make a full nutritional assessment time consuming. Nutrition screening tools are a way to rapidly identify those at nutrition risk who can then be prioritised for further assessment.

2.5.2 Nutrition screening

The purpose of nutritional screening is to identify potential under nutrition, or to determine if a person's current nutrition status is likely to worsen under the conditions (nutrition risk)(Keller, Brockest et al. 2006). A screening tool should not be used to diagnose clinical malnutrition, but to quickly and cost effectively identify those in need of further nutritional assessment (Posthauer, Dorse et al. 1994; Elia, Zellipour et al. 2005).

A successful screening tool:

- Can be completed by a wide number of health professionals with minimal bias (Posthauer, Dorse et al. 1994; Thomas 2008)
- Have a reliable scale with clear cut–offs (Elia, Zellipour et al. 2005)
- Compare well with a qualified assessor (Keller, Goy et al. 2005; Thomas 2008)
- Be practical, and time and energy efficient (Kondrup, Allison et al. 2003)
- Have content validity (include all the relevant components) (Jones 2004; Elia, Zellipour et al. 2005)
- Have construct validity (measure what the tool is supposed to measure) (Jones 2004; Elia, Zellipour et al. 2005)
- Be valid in regards to environment or setting, age, gender and ethnicity (Kondrup, Allison et al. 2003; Phillips, Foley et al. 2010)

A recent systematic review on screening tools for use in older community dwelling people found ten screening tools that had previously undergone validity and reliability testing. Of the ten tools the MNA Short Form, the MUST and SCREEN II were found to be most appropriate for use in the older community dwelling people (Phillips, Foley et al. 2010). The validity and use of these tools are discussed below.

2.5.3 Validation of screening tools

For a screening tool to be effective, ethical and provide accurate feedback the tool must be valid and reliable (setting and population) and be backed by evidence based practice (Keller, Goy et al. 2005; Skates and Anthony 2009). If a screening tool does not meet these requirements there is an increased risk of misclassification of individuals leading to delayed or no treatment, or wasting heath care resources on those who do not need it (Skates and Anthony 2009).

The purpose of validation is to assess if the tool actually measures what it is supposed to measure and this can be defined by sensitivity and specificity (0-100%). Sensitivity is the ability of a tool to detect a condition in individuals who actually have the condition. The higher the sensitivity the more people will be correctly identified as being at nutrition risk. Specificity is the ability of the tool to classify a person as not having the condition, who indeed, does not have the condition. When specificity is low there will be more false positives. A good screening tool will have high specificity and high sensitivity (Keller, Goy et al. 2005; Phillips,

Foley et al. 2010). Difficulty arises when assessing the validity of screening tools as the specificities, sensitivities and positive predictive values can be up to interpretation. This is because there is a lack of a gold standard to detect malnutrition (Elia, Zellipour et al. 2005).

Mini Nutritional Assessment (MNA)

MNA is the most widely used tool to assess nutritional risk in community dwelling older people (and other populations). The tool was designed for use in: frail elderly, people with functional impairments, people living alone or in nursing homes, or older adults over the age of 85 years (Bauer, Kaiser et al. 2008).

The MNA takes approximately 10 – 15 minutes to complete and consists of two parts. The MNA – Short Form which identifies the individual at possible nutrition risk and prompts the interviewer to continue to the full assessment form. The full tool includes: anthropometric measures, six global assessment questions (lifestyle, medication, and mobility), eight nutrition related questions and two questions regarding perceived health status. The MNA has a total score of 30 points and classifies an individual as having adequate nutrition status, at risk of malnutrition, or protein-energy malnutrition (Bauer, Kaiser et al. 2008).

The tool was validated over three different studies and included more than 600 older people. The original validation study compared the tool against two clinical experts who diagnosed the nutrition status of 125 hospitalised older people using the following criterion: macronutrient intake; serum transferrin, albumin, alpha 1 acid glycoprotein, transtheyretin, ceruloplasmin, retinol binding protein, C- reactive protein, gamma – glutamyl transferase, total protein, cholesterol, triglycerides, vitamins B_{12}, B_9, A, and E; zinc, copper, weight, BMI, skin folds, calf and mid arm circumference. The MNA misclassified the nutrition status in three the 125 participants. In subsequent validation studies, 78% and 72% of participants were correctly classified. The sensitivity of the MNA is 96%, specificity is 98% and positive predicative value is 97% (Bauer, Kaiser et al. 2008). Although the MNA had a high sensitivity and specificity in detecting malnutrition, no relationship was found between the MNA score and changes in biochemistry (de Groot, Beck et al. 1998). Completion rate for the MNA can be poor and criticisms include the time needed to complete the tool, requirement of calculations and the need for physical measurements (mid-arm and calf circumference, height and weight) (Thomas 2008). Additionally, the MNA does not include social indicators of nutrition risk such as eating alone and food security, these risk factors would need to be assessed separately.

Malnutrition Universal Screening Tool (MUST)

The MUST was developed with the aim to detect protein – energy malnutrition across all patient groups and settings by the British Association for Parental and Enteral Nutrition (BAPEN). The MUST tool includes three parameters: BMI, weight loss, and acute disease effect. Overall risk is classified by the following: 0=low risk, 1 = medium risk , 2= high risk , each score is associated with a treatment care plan (Stratton, Hackston et al. 2004). The reliability of MUST was established by assessing the agreement of participants malnutrition risk status as obtained independently by healthcare workers and the MUST tool (inter-rater agreement).

Inter-rater reliability is reported to be high at 0.80 – 1.00. A recent study in 300 surgical patients has reported the sensitivity and specificity of MUST to be at 0.89 and 0.93 (using the Subjective Global Assessment as the standard) (Almeida, Correia et al. 2012). The tool is deemed very easy to use (Phillips, Foley et al. 2010) and administration takes approximately 3- 5 minutes. However low completion rates are reported due to the difficulty gaining height and weight measures in hospitals (Neelemaat, Meijers et al. 2011).

Seniors in the Community: Risk Evaluation for Eating and Nutrition (SCREEN)

Seniors in the Community: Risk Evaluation for Eating and Nutrition was a simple tool which aimed to identify the prevalence of nutrition risk in cognitively intact community living older people as well as individual nutrition risk factors that, if not managed, could result in overt malnutrition (Keller, Goy et al. 2005). SCREEN was initially developed to assess the prevalence of nutrition risk for a prospective cohort study (Keller, McKenzie et al. 2001). Since then a newer, refined version of SCREEN that has a higher sensitivity and specificity than the original has been validated (SCREEN II). SCREEN II is now widely used across Canada in a variety of different settings (Keller, Goy et al. 2005), including as a free internet based 'e-tool' (Dietitans of Canada 2012). SCREEN II is used for the purposes of education, research, targeted interventions and screening for community programs (Keller, Hedley et al. 2000). The tool consists of 14 items, which cover food intake and physiological, adaptive, and functional nutrition factors. Each item on SCREEN II is associated with a score of 0-4, when summed, scores equate to a total score between 0 (high risk) to 64 (low risk). Any individual item that is scored less than two is considered to be an area of nutrition risk. SCREEN II has three points of difference over other screening tools:

- SCREEN II can be self–administered or interviewer administered, in person or over the phone
- No anthropometric measures or biochemical measures are required
- Nutrition risk factors specific to the interviewee can be identified (Keller, Goy et al. 2005).

SCREEN II was validated against the criterion of a dietitian's clinical judgement of nutrition risk in 193 adults, 55 – 99 years (94% under 85 years), from a variety of different community settings (Keller, McKenzie et al. 2001; Keller, Goy et al. 2005). Dietitians undertook a standardised nutrition risk assessment which evaluated medical history, weight history, anthropometric measures and a dietary assessment (three 24 hour MPRs)(Keller, Goy et al. 2005). Receiver operating characteristic (ROC) curves were derived to establish appropriate SCREEN II cut–offs for medium and high nutrition risk. A SCREEN II cut-off of below 54 identified nutrition risk and required follow up and re-screening, this had a sensitivity of 84% and specificity of 62%. A cut-off of below 50 identified high nutrition risk and required intervention, this was associated with a slightly higher sensitivity of 86% and specificity of 66% (Keller, Goy et al. 2005). SCREEN II also demonstrated inter-rater (for interviewer administered), test-retest (for self-administered) and inter-modal (interviewer as compared to self-administered) reliability (Keller, Goy et al. 2005). An earlier study using SCREEN found that

the tool can also predict quality of life and mortality (Keller, Østbye et al. 2004). A recent study undertook confirmatory factor analysis which demonstrated that the variables included in SCREEN II measured the concept of nutrition risk (Reimer, Keller et al. 2010).

The Canadian validation study found 67% of participants to be at medium risk, and 19% at high risk (Keller, Goy et al. 2005). Two New Zealand based studies in community dwelling older people have been completed using SCREEN II. The first, a study by Watson et al., looked at the prevalence of malnutrition in older community based adults and found 54% of participants were at some nutrition risk with 27% at high nutrition risk (Watson, Zhang et al. 2010). In the feasibility study for LiLACS NZ high nutrition risk was found in 52% (Wham, Dyall et al. 2011) of community dwelling people in advanced age. An Auckland study found nutrition risk in 31% of older adults (mean age 82.4 years) (Wham, Carr et al. 2011) .

2.6   Summary

Older people are the fastest growing segment of the population and are the largest users of health expenditure (Wang 2007). Life expectancies are increasing however 'health expectancies' (years of full health) are increasing at a slower rate (Wang 2007). This results in more years of poor health and an even greater strain on healthcare resources in the future. Nutrition is a major determinant of health and quality of life in older people. Nutrition risk and malnutrition in this age group is of great concern due to the associated poor functional, physical, mental and social health outcomes.

 The nutrition risk of community living New Zealanders in advanced age is reported to be at least 31% (Watson, Zhang et al. 2010; Wham, Teh et al. 2011; Wham, Dyall et al. 2011). New Zealand research shows that older people have suboptimal intakes of protein, calcium and vitamin D, zinc and selenium (University of Otago and Ministry of Health 2011). Suboptimal intakes of protein can lead to accelerated lean muscle loss (sarcopenia) and increased risk of infections and poor wound healing (Chernoff 2004). Low intakes of calcium and vitamin D have been associated with a low bone mineral density and an increased risk of falls and fractures (Zhang 2007). Zinc deficiency is caused by drug-nutrient interactions and is associated with poor wound healing, decreased taste acuity and anorexia (Morley 2007). Due to low levels of selenium in the soil all New Zealanders are prone to poor selenium intakes which affects thyroid metabolism and immune function.

In many cases nutrition risk can be managed and treated, however nutrition risk and malnutrition of older people is currently under diagnosed and therefore under treated (Phillips, Foley et al. 2010). Registered dietitians have the expertise to identify nutrition risk and diagnose malnutrition, however this is very time and resource consuming. A nutrition screening tool is an easy, acceptable and reliable method to detect nutrition risk in community living older people and to date many screening tools have been developed, although few have undergone validity testing (Elia, Zellipour et al. 2005; Phillips, Foley et al. 2010). Of over 20 tools, SCREEN II was the only validated tool that did not use biochemical measures, had the ability to

detect specific nutrition risk factors, could be self-administered and was specifically developed for use in community dwelling seniors (Keller, Goy et al. 2005). SCREEN II is currently in use to detect nutrition risk in older Canadians and New Zealanders and has been used to detect nutrition risk in various studies (Keller, Goy et al. 2005; Watson, Zhang et al. 2010; Wham, Teh et al. 2011; Wham, Carr et al. 2011; Wham, Dyall et al. 2011). The tool has yet to be validated in a New Zealand setting or in people of advanced age (85 years-plus).

3.0 Methods

3.1   Aims and Objectives

Aim

The aim of this study was to validate the nutrition screening tool, "Seniors in the Community Risk Evaluation for Eating and Nutrition, version II" (SCREEN II) among a subset of participants enrolled in the longitudinal study of ageing 'Life and Living in Advanced Age: A cohort study' in New Zealand (LiLACS NZ).

Objectives

1. To determine the nutrition risk status, as well as the change in nutrition risk status over a 12 month period (between baseline and the 12 month follow-up), among participants of advanced age using SCREEN II.

2. To establish the dietary intake of participants in advanced age by administering and analysing three 24 hour multiple pass recalls.

3. To undertake a comprehensive nutrition risk assessment and assign a Dietitian's Nutrition Risk Rating (DNRR) score for each participant at the 12 month follow-up. The DNRR score will be used as the criterion for the validation of SCREEN II.

4. To determine if the current SCREEN II cut-off for high nutrition risk (<50) is suitable to use for the detection of nutrition risk in people of advanced age living in New Zealand.

This study was undertaken among a sub-set of participants enrolled in a longitudinal study (LiLACS NZ) which aims to determine what physical, social and health factors predict successful ageing. The nutrition screening tool, SCREEN II was chosen to identify nutrition risk in these participants. SCREEN II was administered during the LiLACS NZ baseline data collection. This screening tool validation sub-study was completed by the research dietitian twelve months after baseline during the LiLACS NZ follow-up. At this time participants were re-screened and a full dietitian's nutritional assessment for each participant was undertaken. The nutrition assessment incorporated a medical history, anthropometric measures, functional measures, and three days of dietary recall. The dietitian evaluated all information and used clinical judgement to assign participants' with a DNRR score. Receiver operating characteristic (ROC) curves were created to compare SCREEN II against the criterion of the DNRR score. The sensitivities and specificities of the different SCREEN II cut-offs for nutritional risk were assessed. This chapter will firstly describe the methods used in LiLACS NZ that were relevant to this study and secondly the methods used to validate SCREEN II against the clinical judgement of the dietitian.

3.2   Study design: Life and Living in Advanced Age: A cohort study in New Zealand (LiLACS NZ)

3.2.1   LiLACS NZ participants and recruitment

LILACS NZ has two cohorts running in parallel, one with Māori participants only, the other enrolling non-Maori participants (all other ethnicities). The aim was to recruit 600 non-Maori and 600 Maori participants. Potential participants lived within the Lakes or Bay of Plenty District Health Board and were born between 1 January and 31 December 1925 (aged 85 in 2010) for non-Māori, and between 1 January 1920 and 31 December 1930 (aged 80 - 90 in 2010) for Māori. Awareness about the study was created through various methods such as speaking on local radio stations, at rest homes and at community meetings of older people such as kaumātua groups and through newspaper articles, posters and pamphlets in doctor's surgeries, pharmacies and shopping malls. The New Zealand General and Māori electoral rolls and primary care databases through PHOs and General Practice (GP) were used to establish as complete sample of older people as possible. Older people were approached by a person known to them (where possible) or contact was made by their health provider or Māori iwi (tribal group) representative (Hayman, Kerse et al. 2012).

3.2.2   LiLACS NZ data collection

Baseline data collection was completed in 2010, and the follow-up data collection was undertaken a year later. On both occasions participants were asked to complete a comprehensive health questionnaire (1.5 hours) and a physical assessment (45 minutes). The follow-up data collection also included two days of dietary recall which was collected over two different days. Visits were undertaken by trained nurses and

interviewers, either in the participants' home or at the Research Centre. The first visit included the questionnaire items summarised below and one 24 hr multiple pass food recall (MPR) (Appendix 2). The second visit was scheduled for the following week on a different weekday and included a 45 minute physical assessment and a further 24 hour MPR.

Questionnaire:

- Demographic information: age, sex, ethnicity, marital status and living situation
- Medical history, including:
    - Respiratory conditions, diabetes, cancer, osteoporosis, vision problems, cardiovascular health and disease, joint replacements and others (from GP records)
    - Disabilities (self-reported)
    - Use of prescribed and over the counter medications including supplements and herbal remedies (self-reported)
- Lifestyle habits including alcohol intake and smoking (self-reported)
- Aspects of oral health including dentition, swallowing and chewing issues (self-reported)
- Perceived health status, identified by the question, "In general, would you say your health is…"

3.2.3   Health measures

The following health measures were included as part of the LiLACS NZ interview at both baseline and 12 month follow up. Cognitive and functional measures were assessed by a trained interviewer and anthropometric measures were assessed by a LiLACS NZ nurse.

Cognitive Health Measures

- The Modified Mini Mental State Exam (MMMSE) (Teng and Chui 1987) was used to assess cognitive ability.
- Geriatric Depression Scale (GDS) **-** Short Form was used to screen for depression. A score > 5 indicated possible depression, >10 indicated clinically important depressive symptoms (Sheikh and Yesavage 1986).

Functional Measures

The Short Physical Performance Battery Test (SPPB) (Guralnik, Simonsick et al. 1994) was used to assess mobility. The SPPB is a series of timed physical tests that evaluate physical functional performance. The tasks tested on the SPPB are important for independence and include balance, gait speed, and getting in and out of a chair (Cesari, Onder et al. 2008). The possible total score ranges from 1 to 12, with 12 being the highest level of physical performance.

ADLs were assessed by the Nottingham Extended Activities of Daily Living Scale (NEADL) (Lincoln and Gladman 1992). The NEADL scale measures independence and physical disability. The scale asks whether the older person can complete particular activities in the four domains of: mobility, in the kitchen, domestic tasks and leisure activities. The scale has a possible high score of 22. The higher the score equates to a higher functional level (Lincoln and Gladman 1992).

Anthropometrical measures

Each anthropometrical measurement was taken twice and if the two measurements differed then a third measurement was taken. The closest two measurements were averaged and used for the data analysis.

- Weight (kg), body fat mass, and muscle mass were measured by the Inner Scan Body Composition Monitor BC- 545 (bio-impedance) (Tanita Corporation, Japan). The participants were lightly dressed with indoor clothes and without shoes.
- Height (cm), measured by a portable stadiometer. Measures were taken to the nearest 0.1cm.
- Quetelet's body mass index (BMI) = weight (kg)/ height (m)^2
- Waist and hip circumference (cm), measured with a non-stretchable tape measure over one layer of light clothing using a metal diameter tape. The waist measurement was taken at the natural narrowing, midway between last rib and the crest of the ileum. Hip measurements were taken at the maximum circumference around the buttock (side view).
- Muscle strength was measured using the Takei Digital Handgrip Dynamometer – Grip D (kg). The average of three grip attempts from the strongest hand was used for analysis.

3.2.4   Nutrition measures

Nutrition risk (SCREEN II)

Nutrition risk was assessed at baseline using SCREEN II which included 14 items to assess weight change, eating habits including chewing and swallowing problems, supplement use and shopping and cooking practices (Table 3.1 and Appendix 1). The LiLACS NZ protocol required the SCREEN II questionnaire to be administered in person the trained interviewer.

Each item of SCREEN II has an option of four responses and each response is associated with a score ranging from 0 to 4. Summed scores equate to a highest possible score of 64, higher scores are associated with lower nutrition risk. A score of two or less on any individual item indicates an area of nutrition risk (Keller, Goy et al. 2005). LiLACS NZ used a score of less than 50 to signify high nutrition risk. A score of 50 – 53 indicates medium nutrition risk and above 53 indicates low risk (Keller, Goy et al. 2005).

1. Weight Change:
   a. Has your weight changed in the past 6 months?
      i. If yes, how much?
   b. Have you been trying to change your weight in the past 6 months?
   c. Do you think that your weight is just right or more or less than it should be?
2. Do you skip meals?
3. Do you limit or avoid certain foods?
4. How would you describe your appetite?
5. How many pieces or servings of fruits and vegetables do you eat in a day?
6. How often do you eat meats, eggs, fish, poultry or meat alternatives?
7. How often do you have milk products?
8. How much fluid do you have in a day?
9. Do you cough, choke or have pain when swallowing foods OR fluids?
10. Is biting or chewing food difficult for you?
11. Do you use commercial meal replacements or supplements?
12. Do you eat one or more meals a day with someone?
13. Meal preparation:
    a. Who usually prepares your meals?
    b. Which statement best describes meal preparation for you?
14. Do you have any problems getting your groceries? (can be due to poor health, disability, limited income, lack of transportation, weather conditions, or finding someone to shop)

3.2.5 Dietary assessment - Multiple Pass 24 Hour Recalls

The 24 hour MPR is a method of dietary data collection developed by the US Department of Agriculture and has previously been validated and used for national surveys in New Zealand (University of Otago and Ministry of Health 2011), North America (Payette, Gray-Donald et al. 1995) and the United Kingdom (Adamson, Collerton et al. 2009). The MPR protocol involves a number of passes through the previous twenty-four hours of dietary intake (Appendix 2). Pass 1: *Quick list* - The participant is asked to recall what food and drinks they have consumed over the previous 24 hour period from midnight to midnight (yesterday). An initial prompt is given from the interviewer about snacks, tea, coffee, sweets, soft drinks and alcohol after which the interviewer records all information without interruption. Once the participant has finished, additional prompting from the interviewer is provided using a prompt card (Appendix 3). Any additional items are then added to the quick list.

Pass 2: *Detailed record* - The interviewer then takes the participant through the food items on the quick list and covers each item in more detail, including time eaten, context or occasion of eating, brand, amount of food consumed and cooking method. Portion sizes for each of the foods are assessed by a description of the amount of the packet consumed, or aided by either the photographic atlas or household measures.

Pass 3: *Review* - The interviewer reviews the food recalled and checks for any missing items.

(Adamson, Collerton et al. 2009)

The capacity of containers (e.g. bowls, glasses and mugs) that were habitually used by the participant were measured and recorded by the dietitian (Payette, Gray-Donald et al. 1995). Household measures (1 litre jugs, standard measuring spoons and cups), a ruler and the photographic atlas (Appendix 4- 6) were used for the estimation of portion sizes. Where possible actual foods were weighed and recorded, for example, homemade cookies or scones.

Training for the Multiple Pass Recall method

All research nurses involved in LiLACS NZ and the dietitian completed two days of MPR training to ensure consistency and accuracy in dietary data collection. Protocols and a training program for the MPR method were provided by an international research dietitian (Professor of Public Health Nutrition, Newcastle University) in conjunction with the LiLACS NZ dietitian investigator (Senior Lecturer, Massey University). Following the training, regular quality checks at the various research centres around the Bay of Plenty were provided on a four to six week basis and where needed, ongoing training was provided.

Portion size assessment – the photographic atlas

The accuracy of portion size estimation for the 24 hour MPR was enhanced by the use of a photographic food atlas, household measures and a ruler. LiLACS NZ used a modified version of the photographic food atlas used in the Newcastle 85+ study (Adamson, Collerton et al. 2009). The *Photographic Atlas of Food Portions Sizes* included foods that were commonly consumed by English older adults (65+ years) as determined by the English National Nutrition Survey (Nelson and Haraldsdóttir 1998). The atlas consists of two sections; the first section contains 76 'single food' pages which shows an individual food in a series of eight increasing portion sizes (Nelson and Haraldsdóttir 1998) (Appendix 4). The second section contains thirteen 'guide' pages, each of which contains a particular food group, for example, a variety of bread slices (Appendix 5). A further seven 'guide' pages include a selection of crockery and cutlery volumes (Appendix 6). Before the atlas could be used in older New Zealanders enrolled in LiLACS NZ it required modification. New photographs were taken of foods commonly eaten by Maori and older New Zealanders (>70 years) as determined by the National Nutrition Survey 1997 (NNS97) (Ministry of Health 1999). Examples of the New Zealand foods that were added include: avocado, beetroot, kumara, pumpkin, stewed rhubarb, mussels and pipis, muffins and scones, tomato sauce and mayonnaise, as well as common fruits which included kiwifruit, pears, grapefruit and grapes. Pages that contained English foods that were not typically consumed by New Zealanders were removed (e.g. Yorkshire pudding and English tinned foods).

The list of 'Equivalent Foods' from the original atlas was modified to capture foods that could not be pictured in the atlas. Equivalent foods were foods that had similar density or size as the photographed foods, for instance, yoghurt is listed as an equivalent food for custard (Appendix 7).

Photography

A professional photographer was used to photograph the New Zealand foods (Geoff Dale, Geoff Dale Photography Ltd.). The photography protocols developed for the creation of the UK atlas were closely followed, as below (Nelson and Haraldsdóttir 1998). New Zealand foods were pre-prepared and portioned onto a 25cm white plate. The plate was placed on a backdrop of white matte cardboard. Cutlery was included in the photograph to provide a standard of reference.

> A large diffused strobe flash provided the lighting, which was 'soft' rather than 'atmospheric' or 'contrasting' in order to maximise the clarity of the food and to avoid the creation of any irrelevant or distracting features in the photograph. A [Canon 7D digital camera with a 16mm to 35 mm f2.8 lens] (Geoff Dale, Personal Communication May 2011) was used to give the same perspective as the human eye. The camera's height of view was designed to mirror that of a person of average height, sitting at a table, looking at a plate of food on the table in front of them. The angle of view was 42° above the horizontal.

Formatting of the New Zealand atlas involved scanning the original pages from the English atlas at 600dpi (PDF format). Scanned pages were cropped into a template, ensuring each of the eight photos maintained their size at 60 mm X 85mm. The New Zealand food photographs were added into the same template. Formatting was completed using the Adobe software, InDesign Creative Suite 5, to preserve the quality and resolution of the scanned pages as the original files for the English atlas were not available.

An individual code was created for each photo to reduce coding time. Each code contained two letters and the weight of the food. For example, the first picture on the rice page was 39g of rice, the corresponding code is RIA39 and the code for the last picture on the rice page (362g) was RIH362. A small pilot study was conducted amongst both New Zealand and English participants to ensure the codes on the photographs had no significance which may bias results. New index and contents pages were developed to incorporate the new coding system and the New Zealand photos.

An A5, life size, poster of a place setting (plate, bowl and side plate) was scanned from the English atlas at 600dpi and included with each new atlas. This provided the participants with perspective when completing the 24 hour MPRs.

3.3   SCREEN II Validation Sub-Study Design

The SCREEN II validation study was completed by the research dietitian. The purpose of the validation sub-study was to validate SCREEN II, against the clinical judgement of a registered dietitian. The sub-study involved an interview which included an in-depth nutrition assessment by the dietitian, a third MPR 24 hour recall (on a weekend), as well as administration of the second SCREEN II (12 months after baseline). The objective of the nutrition assessment was to assign the DNRR score which was used as the criterion to validate SCREEN II.

3.3.1   Ethical approval

Ethical approval for the validation sub-study was granted by the Southern Regional Ethics Committee (Appendix 8). In accordance with the ethical requirements, potential participants were mailed an information sheet (Appendix 9) which detailed the purpose of the study and what would be required, as well as participants' rights, confidentiality statement and the researcher's contact numbers. Participation in this study was entirely voluntary. Participants were given two weeks to consider if they would like to take part and the opportunity to ask any questions. Verbal consent was gained over the phone and a home visit was scheduled. Written consent was gained before the start of the interview (Appendix 10). Signed consent forms and personal information pertaining to this study were kept in a locked drawer and electronic files were password protected.

3.3.2   Participants and recruitment

Recruitment for the validation study was undertaken during the second year of LiLACS NZ. Individuals were asked to participate if they had previously indicated that they would like to take part in future sub-studies of LiLACS NZ.   Participants were eligible for the validation sub-study if they: completed the full LiLACS NZ interview at baseline and 12 months later in the months of May and June; resided in Tauranga, Western Bay of Plenty; lived in the community; were non – Maori; and were cognitively able (MMMSE score 72 or higher). Maori participants were excluded as they were engaged in a separate nutrition sub-study, undertaken by a Maori dietitian researcher. Care was taken to avoid over burdening the participants with engagement in sub-studies.

Participants were screened for eligibility for the validation sub-study using their four digit identifier codes (used for any data handling) to blind the dietitian from pending results. Eighty-four participants (non- Maori, MMMSE >72) completed interviews in May or June 2010 and were categorised into low, medium and high nutrition risk based on their baseline SCREEN II score. A total of 45 participants were recruited (the first consenting 15 participants from each nutrition risk group). The sample size was restricted due to time constraints and to avoid over burdening the participants. The LiLACS NZ Project Co-ordinator contacted the

participants by phone to gain consent and a letter of introduction was sent by mail. The research dietitian contacted the participants by phone call to schedule an interview time in the participants' home.

3.3.3   Data collection

All participant interviews were carried out during a weekend home visit by the dietitian researcher.   The interview followed a semi-structured format. Firstly SCREEN II was administered and this was followed by the third 24 hour MPR. Three days of recorded intake has previously proven sufficient to describe the usual intake of energy, protein, and most nutrients in older people (Payette and Gray-Donald 1991). Following the 24 hour MPR a detailed nutrition risk assessment was then completed by the dietitian researcher using the standardised 'Dietitian's Nutrition Risk Checklist' as a guide, detailed below (Appendix 11).

3.3.4   Nutrition measures

Nutrition risk (SCREEN II)

 SCREEN II was administered prior to the 24 hour dietary recall and the dietitian's nutrition risk assessment to reduce the possibility of social desirability bias (participants responding to the screening tool items in a manner that would be viewed as 'healthy' or favourable by the dietitian). The dietitian researcher did not know the participant's baseline SCREEN II scores to minimise any influence the baseline scores may have had on the dietitian's nutrition risk rating assessment. The participant's total SCREEN II scores were not tabulated until the data analysis stage.

Dietitian's Nutrition Risk Rating

A dietitian's assessment of nutrition risk was the primary method used for construct validation for both SCREEN I and II in Canada (Keller, McKenzie et al. 2001). After a full nutritional assessment (guided by the 'Standardised Nutrition Risk Rating Checklist') the dietitian used clinical judgement to assign each participant with a nutrition risk rating score 1- 4 low nutrition risk, 5-7 medium risk and >7 high risk (Keller, McKenzie et al. 2001).

The 'Dietitian's Standardised Nutrition Risk Rating Checklist' was developed for the Canadian SCREEN validation studies and was used to ensure that the nutrition assessments remained consistent between participants (Keller, Goy et al. 2005). The Checklist lists the nutrition risk factors and divides them into four domains (Keller, McKenzie et al. 2001):

- Body composition and weight change
- Medical history
- Dietary related risk factors
- Functional and social risk factors

The Canadian Checklist was adapted for use in this study. Relevant data collected from the LiLACS NZ questionnaire and the physical assessment were added, i.e. the Nottingham EADL scale score, physical performance test (SPPB) score and food security.   The participants weight was assessed in LiLACS NZ thus the domain 'weight change' on the Checklist was altered from self-reported weight change in the past six months to actual weight change over the 12 month study period. This avoided any inaccuracies that can occur with self-reported weight change (Meng, He et al. 2010; Park, Mitrou et al. 2011).   The domain 'diet' was altered to reflect the New Zealand recommendations for nutrient reference values for people over 70 years (NHMRC 2006a). All factors on the checklist were reviewed to ensure that they were consistent with the recommendations for nutrition assessment from the American Dietetic Association (ADA) (Posthauer, Dorse et al. 1994), the European Society for Clinical Nutrition and Metabolism (ESPEN) (Kondrup, Allison et al. 2003) and the latest version of the New Zealand Dietetic Association's Clinical Handbook (Gillanders 2009).

Nutrition risk factors included on the 'Dietitian's Standardised Nutrition Risk Rating Checklist' were ordered in descending order from those most influential on nutrition risk to the least (Dey, Rothenberg et al. 1999; Chen, Schilling et al. 2001; Callen and Wells 2005) (Table 3.2). The objective measures of body composition, weight change, and macronutrient and food group intakes were heavily weighted. These were the main factors used by the dietitian to classify participants at high, medium or low nutrition risk. Other factors such as medical conditions, functional, and social status were used to judge a participant's risk within the risk categories (Figure 3.1). The final DNRR score was determined from evaluation of all the data collected on the Risk Rating Checklist.

 A ROC curve was developed to determine if the current SCREEN II cut-offs of 53 (medium risk) and 50 (high risk) were appropriate for use in people of advanced age in New Zealand.

Table 3-2: Dietitian's Nutrition Risk Rating Checklist

Domain	Risk Factor/ Question	Low (1- 4)	Med (5 – 7)	High (8 – 10)	Comments
Body composition	Physical Assessment	80 – 110% ideal body weight BMI 23 – 30	70 – 79 % ideal body weight BMI 20 – 22 or BMI > 30	70% ideal body weight BMI < 20	Look for Oedema
	Annual weight change	None Less than 5% gain or loss	> 5% loss with stabilization/ gain >5% weight gain in those overweight <5% loss but likely to continue	>5% loss with ongoing weight loss >5% weight gain in those obese >10% loss annually	
Diet	Nutrient intake	1-2 nutrients <67% RDA	3- 5 nutrients <67% of RDA	>5 nutrients 67% below RDA	
	Calorie intake	Adequate	Less than 25kcal/ kg	Less than 20kcal/kg	
	Food group	Meeting requirements of all food groups	Not meeting requirements in 1- 2 food groups	>2 food groups not meeting req. OR misses 1 group completely	
Medical	GI problems	None or rarely: nausea, vomiting, diarrhoea, abdominal pain or anorexia	Some of: nausea , vomiting, diarrhoea, abdominal pain, or anorexia (> multiple times / mth)	Acute GI distress / malabsorption Diarrhoea, anorexia, nausea, vomiting (Chronically/ daily 2/52) Recent/multiple bowel surgeries	
	Medical conditions	No medical conditions	Multiple chronic medical conditions e.g. CHF, osteoporosis uncontrolled DM, significant arthritis	Multiple conditions that affect oral intake or metabolic rate (Stroke, RF, COPD, liver disease, cancer) Severe arthritis/pain Dementia	
Other	Appetite	Current intake is normal Borderline intake, but increasing	Borderline, but decreasing Inadequate w/ no change Inadequate but increasing	Intake is poor more days than good Inadequate intake and decreasing	
	Depression	Never/ rarely down hearted or Depressed	GDS >5 [1] Recent bereavement / stress	GDS >10 Recent bereavement / stress	

Dependency	EADL >18[2] No change in usual activities	EADL 15- 18 Somewhat dependent on others for cooking and shopping	EADL <15 Dependent on other for cooking and shopping (outside of the home)	
Mobility	SPPB 9 – 12 (stable) [3]	SPPB 7- 8	SPPB 6 or less	
Poly pharmacy	<5 Medications (including OTC)	5- 9medications	>10 medications	
Nutritional Supplements	No sip feeds	Occasional use –no script	On prescription	
Living situation	Rarely or never eats alone Lives with others	Often eats alone Lives alone with support	Always eats alone Lives alone with no support	
Oral health	Most teeth or dentures fit well	Missing rear opposing teeth, ill fitting dentures , chewing issues	Edentulous poorly fitting dentures , mouth pain – affecting intake / texture	
Food Security	No problems buying or accessing food	Sometimes have problems buying and/or accessing food	Often or always have problems buying and/ or accessing food	
Hearing and vision	No problems to moderate w/ vision or hearing	Vision interferes very much Hearing interferes very much to extremely	Vision interferes extremely (blindness)	
Pain	None or mild up to 4	Moderate chronic pain 5- 7	High level , chronic 8 – 10	
Fluid intakes (total water)	≥2.8L day women ≥3.4 L men or 30- 40 mls/kg body weight	<2.8L day women <3.4 L men or <30- 40 mls/kg body weight Fluid restriction	Less than 1L intake (unless on fluid restriction)	
Chemosensory changes	No noticed changes	Moderate changes – affects intake	Lost sense of smell or taste- affecting intake	

	Food patterns/ textures	3 meals day +/- snacks	Frequently misses a meal Excludes foods/ group Change in textures to very soft/moist	Eats one meal per day +/- snacks Excessive food restrictions Eats mostly soft/blended foods	
	Eating pace	No change	Eats a bit more slowly	Eats significantly more slowly – doesn't finish meals	
	Substance abuse	Less than 20g/day with a few alcohol free days	More than 20g/d Smoker	Excessive intake more than 6 drinks on drinking occasions , most days of week Heavy smoker	
	Perceived state of health	Excellent / Very good	Good/ Fair	Poor	

(Also found in Appendix 11)

Example of a participant with high nutrition risk: score of 8 – 10.
- Current BMI of 20
- Weight loss >10% over the year, now starting to gain weight.
- Not meeting six RDIs or any of the food groups with the exception of breads and cereals (according to the three 24 hour MPRs).

Score 8
- Previous bowel obstructions
- Appetite improving
- A few depressive symptoms
- Good mobility
- Mostly independent
- Lives with a spouse
- Remaining factors were low risk

Score 10
- Terminal cancer,
- Ongoing weight loss and anorexia
- Depression
- Chemosensory changes related to treatment,
- Lives alone
- Has home help for cleaning and shopping, cooking himself.

Figure 3.1: Example of a participant with high nutrition risk
Objective measures (left box) determined a participant with high risk. Subjective measures (right boxes) classified a person within that risk group.

3.4 Data and statistical analysis

3.4.1 Data analysis

All three MPRs were checked over by the dietitian researcher for quality and completeness. FoodWorks (Xyris Software 2009), which is based on the New Zealand Food Composition Database called FOODfiles (Plant and Food Research), was used to analyse the recalls for macro and micronutrient intakes.   When the consumed food could not be matched in FoodWorks it was matched to an existing food in the database that had a similar nutrition profile. If this was not possible, a new recipe from basic ingredients was created. When a food or beverage item could not be described accurately by the participant and there were no food labels available to verify size (e.g. a pear) then the 'standard' portion from FoodWorks was used (an average of various varieties). Where possible, participants were asked to recall recipes for mixed dishes and these were entered into FoodWorks. The three-day nutrient average was compared against the "Nutrient Reference Values and Recommended Dietary Intakes for New Zealanders and Australians >70 years" (NHMRC 2006a) (Appendix 12). Inadequate nutritional intake was judged as having more than two nutrients below 67% of the RDI or below the AI (Keller, McKenzie et al. 2001).

Energy intake was compared with standardised equations based on age, sex and body weight (Schofield equation). An activity factor of 1.5 (sedentary) was used to account for the physical activity in this age group (Fuller, Sawyer et al. 1996). Energy intakes were checked for outliers, extreme highs or lows were checked against participants' body weight and weight history and if not realistic the data was excluded. Servings per food group were summed from the food records and compared against the Ministry of Health's 'Food and Nutrition Guidelines for Healthy Older People' (Ministry of Health 2010) (Table 3.3) .

Table 3-3: Food groups - recommended servings for healthy older people (Ministry of Health 2010)

Food Group	Advice	Serving size examples
Vegetables and fruit Fresh, frozen, canned and dried	Eat at least **5 servings** per day. At least 3 servings of vegetable and 2 servings of fruit.	1 med potato or kumara (135g) ½ cup of vegetables or salad (50 – 80g) 1 apple, pear, banana 2 small apricots or plums ½ cup stewed fruit/ fruit salad
Breads and cereals Preferably wholegrain	Eat at least **6 servings** per day	1 bread roll (50g) 1 muffin (80g) 1 medium slice of bread (26g) 1 cup cornflakes ½ cup of muesli ½ cup cooked porridge 1 cup of pasta
Milk and milk products	Eat at least **3 serves** per day (choose low or reduced fat options)	1 glass of milk (250ml) 1 pottle of yoghurt 2 slices of cheese 2 scoops of ice cream
Lean meat, poultry , seafood, eggs, nuts and seeds and legumes	Eat at least **1 serve** per day	2 slices of cooked meat (100g) ¾ cup of mince /casserole (195g) 1 egg 1 medium fish fillet ¾ cup dried beans/ lentils ½ cup nuts and seeds

3.4.2   Statistical analysis

Groups were classified by gender in order to describe the study population group and then by their SCREEN II nutrition risk rating (low, medium, or high risk). Basic descriptive analyses were completed for each nutrition risk group. Comparisons were made for the following:

- Demographics – gender, marital status, living arrangements and education
- Anthropometrics - BMI, waist circumference and weight change
- Self-reported health rating
- Geriatric Depression Scale – short form
- Polypharmacy
- Lifestyle – smoking status and alcohol use
- Functional measures – physical performance (SPPB), activities of daily living (Nottingham EADL) and grip strength.

Descriptive statistics were also completed for each individual item on SCREEN II, dietary measures of total energy intake, macronutrients, and micronutrients.

A two-sided p- value < 0.05 was considered significant. Each study parameter was tested for normality using the Shapiro – Wilk test and homogeneity was tested by the Levene's test. Parametric data is presented as mean ± standard deviation and non-parametric data as median [25th, 75th percentile]. The risk groups were used as the factor and the baseline characteristics were considered independent variables. Data analysis was completed using PASW package (version 18: IBM, New York).

 The sample size for the validation study was calculated based on the standard deviation of the DNNR (1.5 points) derived from the Canadian SCREEN II validation study (Keller, Goy et al. 2005) and a significance level of 0.05 with 80 percent power (Margetts and Nelson 1998). A minimum of nine participants were required in each nutrition risk group to determine significant differences in the DNNR score. For other variables such as the anthropometrical measures; a minimum of 30 participants in each nutrition risk group was required for adequate power. Due to constraints within the study a sample size of 90 participants was not feasible.

Categorical baseline characteristics (gender, marital status, living arrangements, education, smoking, alcohol intake and health rating) were described using frequencies and compared using the Chi- Squared Test. Where the assumption of no expected counts less than five was violated the Fisher's Exact Test was used or groups were combined to meet assumptions. Assumptions of independency were met. SCREEN II responses could not be statistically compared due to the high number of counts less than five, including numerous counts of zero.

Parametric continuous variables (SPPB score, BMI, weight, waist circumference, some nutrients) were compared using the ANOVA test. Non-parametric variables (grip strength, GDS, polypharmacy, EADL and

some nutrients) were compared using the Kruskal-Wallis test. To reduce Type 1 error, differences found between groups were determined using the Bonferroni post-hoc analysis (p <0.016). Gender and energy intake was found to be a confounding variable when analysing the nutrient data hence this was controlled for using the ANCOVA test.

Differences between baseline and the follow-up variables (weight, BMI, and SCREEN II) were assessed using a dependent T- test for parametric data or the Mann Whitney test for non-parametric data. New "change" variables were created to assess the differences between baseline and follow-up of the variables. BMI and weight were normally distributed so the ANOVA test was used to compare mean changes between risk groups respectively. SCREEN II scores were compared between groups using the Kruskal-Wallis test.

The screening tool was validated by comparing the DNRR score against the SCREEN II score. A non-parametric Spearman's correlation was conducted to determine the association between SCREEN II and the DNRR score. A Receiver operating characteristic (ROC) curve was created using the rounded mean of the DNRR score as the cut-point for any nutrition risk, and a dietitian's score of >7 (high risk) was used at the cut-point for high nutrition risk. Participants under the cut-point were considered not at risk and above the cut-point, at risk. The output of 'area under the curve '(AUC) indicates whether the measured variable, SCREEN II, is consistent with scoring of the criterion (Dietitian's Nutrition Risk Rating (risk/no risk)), a higher AUC indicates increased consistency (Streiner and Norman, 1996). New cut-points for SCREEN II were identified by looking at trade-offs for sensitivity and specificity.

4.0 Results

4.1   The participants

Fifty participants 85 - 86 years old were invited to take part in the study. Forty five participants completed all of the following assessments: SCREEN II (baseline and follow-up), the LiLACS questionnaire and health assessment (baseline and follow-up); three 24 hour multiple pass recalls (follow-up only); and the dietitian's nutrition risk rating assessment (follow-up only). A total of 50 participants were contacted, five participants declined the invitation to participate due to poor health (4) or not being available during the data collection phase (1). One male participant was excluded from the dietary assessment as his 24 hour recall was considered to be grossly over reported given his weight status, therefore only 44 participants were included in the 24 MPR analyses.

4.1.1   Demographics of participants by gender

Table 4-1: Socio-demographic characteristics of participants

	Men n (%) 24 (53.3)	Women n (%) 21 (46.7)	Total n (%) 45 (100)
Demographic			
Marital Status			
Married / Partnered	17 (70.8)	5 (23.8)	22 (48.9)
Widowed	7 (29.2)	16 (76.2)	23 (51.1)
Living arrangements			
Lives alone	9 (37.6)	15 (71.4)	24 (53.3)
Lives with spouse /others	15 (62.4)	6 (28.6)	21 (46.7)
Education			
Primary	5 (20.8)	2 (9.5)	7 (15.6)
Secondary	11 (45.8)	11 (52.4)	22 (48.9)
Tertiary	8 (33.3)	8 (38.1)	16 (35.5)

Twenty four men and twenty one women participated in the study. Almost an equal number of participants were married / partnered (48.9%) or widowed (51.1%). More participants lived alone (53.3%) than with others (46.7%). Greater than twice as many women (76.2%) had lost their spouse compared to men (29.2%). Similarly, twice as many women (71.4%) lived alone compared to men (37.6%). Education levels were similar between men and women. Approximately half of participants completed secondary education and just over one-third had completed tertiary study. Primary education was the highest level of education for 20% of men and 10% of women.

4.1.2 Lifestyle characteristics of participants and self-reported health

Table 4-2: Lifestyle factors and self-reported health of the participants

	Men n=24 (%)	Women n=21 (%)	Total n=45 (%)
Smoking			
Current	3 (12.5)	0 (0.0)	3 (6.0)
Former	12 (50.0)	9 (42.9)	21 (46.7)
Never	9 (37.5)	12 (57.1)	21 (46.7)
Alcohol*			
Never	4 (16.7)	5 (23.8)	9 (20.4)
Occasionally (monthly)	2 (8.3)	10 (47.6)	12 (27.2)
≥ 2 times/wk	18 (75.0)	5 (23.8)	23 (52.3)
Self-reported health rating*			
Excellent	2 (8.3)	1 (4.8)	3 (6.8)
Very Good	11 (45.8)	9 (42.9)	20 (45.5)
Good	9 (37.5)	9 (42.9)	18 (41.0)
Fair	2 (8.3)	0 (0.0)	2 (4.5)
Poor	0 (0.0)	1 (4.8)	1 (2.2)

* missing one woman response, total n=44

Few participants (all men) were current smokers (n=3) and more men were past smokers than women. Almost half of participants had never smoked. Alcohol was consumed more than two times per week by about half of the participants. More men (n=18), consumed alcohol on a regular basis where as more women consumed alcohol on an occasional basis (n=10). Similar numbers of men (n=4, 16.7%) and women (n=5, 23.8%) never drank alcohol.

Almost all participants (93.2%) rated their health as at least 'good'. Self-reported health ratings of 'good' and 'very good' were most frequently reported for both men (83.3%) and women (85.8%).

4.1.3   Anthropometric characteristics of participants

Table 4-3: Anthropometric characteristics of participants

Measure	Men n=24	Women n=21	Total n=45	p - value
BMI (kg/m^2)	25.9 ± 3.3 (18.5 – 34.5)	26.5 ± 4.1 (20.3 – 34.9)	26.2 ± 3.8 (18.5 – 34.9)	0.609
BMI change (kg/m^2)	-0.01 ± 1.1 (-1.9 – 2.5)	-0.3 ± 1.4 (-2.7 – 2.0)	-0.1 ± 1.2 (-1.9 - 2.5)	0.973
Weight[1]	76.0 ± 10.1 (57.7 – 97.4)	64.9 ± 8.7 (50.8 – 83.8)	70.5 ± 11.1 (50.8 – 97.4)	0.001
Weight change (%)[2]	-0.50 [-3.0, 2.0] (-7.0 – 9.0)	1.0 [-5.0, 2.5] (-11.0 – 9.0)	-0.0 [-4.0, 2.0] (-11.0 – 9.0)	0.982
Waist Circumference (cm)	100.1 ± 8.7 (82.1 – 122.2)	94.2 ± 8.6 (73.0 – 111.4)	97.5 ± 9.3 (73.0 – 122.1)	0.010
Fat mass (%)	27.2 ± 5.1 (16.5 – 33.7)	38.1 ± 5.2 (27.9 – 48.6)	32.2 ± 7.5 (16.5 – 33.7)	0.001
Muscle mass (%)	52.6 [48.1, 54.9] (43.0 – 64.3)	37.5 [34.9, 40.9] (34.1 – 44.0)	43.5 [37.8, 57.1] (34.1 – 44.0)	0.001

All values mean ± SD (range) for parametric data, median [25th – 75th percentile] (range) for non-parametric data. [1] Documented weight at follow-up. [2] Change in weight: Follow-up – baseline weight. Non-parametric data Mann- Whitney test, parametric data T-test.

The mean BMI for the participants was 26.2 ± 3.8 kg/m^2 and was similar between men and women with little change in BMI from baseline to follow-up. Men were significantly heavier than women (+11.1 kg) (p=0.001) and had a larger waist circumference at 100.1 ± 8.7 cm compared to 94.2 ± 8.6 cm for women (p=0.010). For men the fat mass percentage (27.2 ± 5.1%) was lower than for women (38.1 ± 5.2%) (p=0.001) and the muscle mass percentage (52.6 [48.1, 54.9] %) was higher than for women (37.5 [34.9, 40.9] %) (p=0.001).

4.1.4   Functional status of participants

Table 4-4:   Functional performance measures of participants

Functional Measures	Men n=24	Women n=21	Total n=45	p - value
NEADL	19.0 [16.0, 22.0] (14.0 – 22.0)	18.0 [16.0, 20.0] (9.0 – 20.0)	18.5 [16.3, 20.0] (9.0 – 20.0)	0.488
SPPB	9.0 [8.0, 11.0] (2.0 – 12.0)	8.0 [4.0, 8.5] (2.0 – 12.0)	8.0 [7.0, 10.0] (2.0 – 12.0)	0.010
Grip Strength (kg)	28.5 ± 5.6 (18.0 – 39.4)	17.6 ± 2.9 (12.8 – 22.8)	23.4 ± 7.1 (12.8 – 39.4)	<0.001

All values mean ± SD (range) for parametric data, median [25th – 75th percentile] (range) for non-parametric data. NEADL = Nottingham Extended Activities of Daily Living; SPPB= Short Physical Performance Battery Score. Non-parametric data Mann-Whitney test, parametric data T-test.

The scores for functional performance are provided in Table 4.4. The participants had a median NEADL score of 18.5 out of a total of 22. The lower the score the more dependent a person is in their ADLs. There was no significant difference in NEADL scores between men and women. A higher SPPB score indicates better physical performance. The SPPB score of the men (9.0 [8.0, 11.0]) was significantly

higher than for women (8.0 [4.0, 8.5]) (p = 0.010). Men had a greater grip strength (28.5 ± 5.6kg) compared to the women (17.6 ± 2.9kg) (p = <0.001).

4.1.5   Other participant characteristics: polypharmacy and depression

Table 4-5: Medication use of participants

	Men n=24	Women n=21	Total n=45	p - value
Number of medications (polypharmacy)	5.2 ± 2.8 (0.0 – 9.0)	6.3 ± 3.2 (2.0 – 13.0)	5.7 ± 3.0 (0.0 –13.0)	0.265

All values mean ± SD (range); T-test.

The participants were taking a mean of 5.7 ± 3.0 different medications on a daily basis with a range from zero to thirteen medications. More than five medications per day indicates polyphamacy (Jyrkkä, Enlund et al. 2011).

Table 4-6: Depressive symptoms of participants

	Men n=24	Women n=21	Total n=45	p- value
Geriatric Depression Scale	2.0 [1.0, 3.0] (0.0 – 5.0)	1.0 [1.0, 3.0] (0.0 – 8.0)	2.0 [1.0, 3.0] (0.0 – 8.0)	0.452

Median [25th – 75th percentile] (range) for non-parametric data; Mann Whitney test.

The Geriatric Depression Scale (GDS) ranges from 0 – 15 points. A higher score represents more depressive symptoms, a score greater than five is an indicator for possible depression and greater than ten is probable depression (Sheikh and Yesavage 1986). The median GDS score for all participants was two points.

4.1.6   Nutrition risk of participants as determined by SCREEN II and Dietitian's Risk Rating

Table 4-7: SCREEN II and Dietitian's Risk Rating Scores between baseline and 12 months follow-up

	Men n=24	Women n=21	Total n=45	p – value
Baseline SCREEN II score	52.5 [51.0, 56.3] (36.0 – 59.0)	51.0 [41.5, 53.5] (39.0 – 59.0)	52.0 [43.0, 54.0] (36.0 – 59.0)	0.230
Follow-up SCREEN II score	53.0 [45.5 , 56.0] (36.0 – 60.0)	50.0 [55.0, 53.0] (40.0 – 58.0)	51.0 [45.0, 55.0] (36.0 – 60.0)	0.344
Difference in SCREEN II scores	-1.0 [-3.0, 3.0] (-18.0 – 13.0)	0.0 [-4.5, 4.5] (-12.0 – 11.0)	-1.0 [-4.5, 4.5] (-18.0 – 13.0)	0.681
Dietitian's Nutrition Risk Rating score	5.4 ± 2.4 (2.0 – 10.0)	6.2 ± 1.5 (4.0 – 9.0)	5.8 ± 2.1 (2.0 – 10.0)	0.199

All values mean ± SD (range) for parametric data, median [25th – 75th percentile] (range) for non-parametric data; Difference in SCREEN II scores = 12 month follow up score – baseline; non-parametric data Mann- Whitney test, parametric data T-test.

The lower the SCREEN II score the greater the nutrition risk. A score of <50 indicates high nutrition risk, 50 – 53 medium risk, and a score >53 indicates low risk. No significant difference was found between the median SCREEN II scores at baseline versus follow-up.

The DNNR score ranged from 1 - 10, a higher score equated to increased nutrition risk. A score <5 indicated low risk, 5 – 7 indicated medium risk and >7 indicated high risk. No significant difference was found for the DNRR score between men and women. The 'Dietitian's Standardised Nutrition Risk Rating Checklist' that was used to guide the dietitian's risk rating assessment is shown in Appendix 11.

SCREEN II questionnaire items

Table 4.8 shows the percentage of men and women that responded with an answer ≤ 2 which indicated an area of nutrition risk.

Table 4-8: Proportion of men and women with an 'at risk' response to individual SCREEN II items[1].

Questionnaire items on SCREEN II		Men n (%)	Women n (%)	Total n (%)
1(a)	> 2.5kg weight loss	3 (13)	2 (10)	5 (11)
(b)	>2.5kg weight gain	2 (8)	1 (5)	2 (4)
(c)	Unintentional weight change	5 (21)	6 (29)	11 (24)
(d)	Think excess weight	4 (17)	4 (19)	8 (17)
(e)	Think weight less than it should be	4 (17)	2 (10)	7 (16)
2	Often/always skip meals	1 (4)	0 (0)	1 (2)
3	Limits foods	4 (17)	5 (24)	9 (20)
4	Fair/poor appetite	5 (21)	2 (10)	7 (16)
5	≤3 fruits and vegetables	4 (17)	2 (10)	1 (2)
6	**≤ 1 meat alternative serves**	**12 (50)**	5 (24)	**17 (38)**
7	**≤ 2 milk product serves**	**10 (42)**	**8 (38)**	**18 (40)**
8	≤ 3-4 cup fluid/ day	3 (13)	4 (19)	7 (16)
9	Has swallowing difficulty	2 (8)	2 (9.5)	4 (9)
10	Has chewing difficulty	4 (17)	6 (29)	10 (22)
11	Uses meal replacements	1 (4)	0 (0.0)	1 (2)
12	**Eats alone**	**9 (38)**	**13 (62)**	**22 (49)**
13	**Cooking is a chore**	4 (17)	**8 (38)**	**12 (27)**
14	Often/always difficulty w/groceries	0 (0)	0 (0)	0 (0)

[1]Risk for an individual item on SCREEN II is identified as an item score ≤ 2; Bolded data = leading items of nutrition risk.

Weight and weight change

Weight and weight change were not leading nutrition risk factors for men or women. Eleven percent of participants reported > 2.5 kg weight loss (three men and two women) and 7% of participants reported >2.5kg weight gain (two men and one woman). For all participants weight change was unintentional. An equal number (n=4) of men and women felt that they were overweight. More men felt as though they were under weight (n=4) in comparison to women (n=2).

Dietary habits

Low servings of meat and meat alternatives was only a leading risk factor for men (50%). Low servings of milk and milk products was a leading risk factor for both men (41%) and women (38%). Inadequate fluid and fruit and vegetable intake was a concern in less than 20% of men and women. More women limited certain foods, however, more men reported a poor appetite. Only one participant (male) reported skipping meals.

Risk factors for food intake

Eating alone was a leading risk factor for both men and women, with more women reporting eating alone (62%) than men (38%). Finding cooking a chore was one of the top three risk factors for women only. More participants (22%) reported issues with chewing than swallowing (9%) with little difference between men and women. None of the participants had any difficulties accessing groceries from the store.

To summarise, the top three items of nutrition risk for men were (in descending order): ≤ 1 serve of meat product per day; ≤ 2 serves of milk products per day and eating alone. For women the top three items of nutrition risk were: eating alone, finding cooking a chore and consuming less than 2 serves of milk products per day. The three items of least concern for participants were: using meal replacements, eating less than 2 serves of fruits and vegetables per day and weight gain.

4.1.7 Macronutrient and micronutrient intakes by gender

Table 4-9: Macronutrient intakes from the 24 hour MPRs, by gender

Macronutrients	Men n=23[1]	AMDR	Women n=21	AMDR	Total n=45	p-value[Σ]
Energy (kJ)	8291 ± 1378 (5237 − 10642)	8900[¥]	6784 ± 1037 (5093 − 8653)	7200[¥]	7572 ± 1433 (5093 − 10642)	**<0.001**
Energy (kcal)	1955 ± 325 (1235 − 2510)	2119	1621 ± 245 (1201 − 2041)	1714	1786 ± 338 (1201 − 2510)	
Calories/kg	26.1 ± 4.9 (17.4 − 36.5)		25.7 ±5.7 (17.2 − 36.8)		25.9 ± 5.2 (16.7 − 36.8)	0.817
Protein (g)	84.5 ± 21.2 (53.0 − 141.0)	81	64.5 ± 13.9 (43.0− 101.0)	57	75.0 ± 20.5 (43.0 − 141.0)	**0.001**
% of total E intake	17.5 ± 4.3 (13.0 − 28.0)	15-25	16.4 ± 4.1 (10.0 − 26.0)	15-25	17.0 ± 4.2 (10.0 − 28.0)	0.415
g/ kg*	1.1 ± 0.3 (0.7 − 1.8)	1.07	1.0 ± 0.3 (0.5 − 1.6)	0.94	1.1 ± 0.3 (0.5 − 1.8)	0.294
Carbohydrate (g)	202.7 ± 41.5 (92.0 − 275.0)	n/a	191.3 ± 40.3 (136.0 − 305.0)	n/a	197.0 ± 40.8 (92.0 − 305.0)	0.359
% of total E intake	42.0 ± 6.6 (24.9 − 56.6)	45-65	48.0 ± 6.5 (37.9 − 60.9)	45-65	44.7 ± 7.2 (24.9 − 60.9)	**0.003**
Sugar (g)	96.7 [78.7, 121.1] (29.4 -156.0)	n/a	93.4 [71.5, 121.4] (53.5 − 190.6)	n/a	94.3 [76.9, 119.3] (29.4 − 190.6)	0.664
% of total E intake	20.1 [17.7, 22.5] (8.4 − 29.1)		24.0 [19.1, 30.6] (12.1 − 38.1)		20.6 [18.6, 25.0] (8.4 − 38.1)	**0.042**
Fibre (g)	21.1 ± 5.1 (9.8 − 32.0)	30	19.8 ± 5.5 (7.5 − 33.0)	25	20.5 ± 5.3 (7.5 − 33.0)	0.445
Total Fat (g)	80.0 [64.8, 96.7] (47.0 − 136.4)	n/a	65.0 [46.9, 77.6] (39.6 − 94.1)	n/a	69.0 [56.0, 83.8] (39.6 − 136.4)	**0.011**
% of total E intake	36.7 [29.8, 39.1] (25.9 − 50.7)	20-35	33.1 [28.0, 40.1] (23.8 − 47.3)	20-35	35.4 [29.7, 39.2] (23.8 − 50.7)	0.581
Saturated Fat (g)	31.9 [26.0, 37.4] (16.0− 54.0)		24.0 [18.1, 31.7] (15.3 - 49.2)		28.9 [21.3, 37.0] (15.3 − 54.0)	**0.053**
% of total E intake	14.4 [12.2, 17.3] (0.9 − 21.1)	<10%	13.8 [11.0, 16.7] (8.5 − 23.3)	<10%	14.0 [12.0, 17.0] (8.5 − 23.3)	0.518
Polyunsaturated fat (g)	11.0 [8.4, 14.2] (4.4 − 27.1)	n/a	7.6 [6.0, 12.0] (4.2 - 22.0)	n/a	9.0 [6.9, 13.8] (4.2 − 27.1)	**0.057**
% of total E intake	5.3 [3.9, 6.2] (2.1 − 10.1)		4.2 [3.1, 6.7] (2.6 − 11.6)		4.8 [3.6, 6.4] (2.1 − 11.6)	0.630
Monounsaturated fat (g)	24.2 [21.6, 32.8] (17.0 − 42.3)	n/a	20.5 [15.8, 25.6] (13.2 - 38.6)	n/a	23.0 [18.5, 30.1] (13.2 − 42.3)	**0.008**
% of total E intake	12.0 [10.2. 13.7] (9.2 − 16.7)		11.1 [9.0, 13.7] (8.3 − 19.3)		11.5 [9.7, 13.7] (8.3 − 19.3)	0.307

All values mean ± SD (range) for parametric data, median [25th – 75th percentile] (range) for non-parametric data; E=energy [1] One participant's data was excluded as intake was grossly overestimated; * g/kg is grams per kilograms of body weight, mean body weight for men 76.0 ± 10.1kg, mean body weight for women 64.9 ± 8.7kg. [¥] Energy requirements from AMDR based on physical activity factor of 1.4 (sedentary). Men's based on weight of 79.4 and women's based on weight of 63.6kg. [Σ] p-value is a comparison between men and women; Mann Whitney for non- parametric data and T- test for parametric data.

Energy - The mean energy intake for all participants was 7572 ± 1433 kJ (1786 ± 338 kcal). The mean energy intake for men was approximately 700kJ (165kcal) less than the AMDR for men >70 years (weight of 79.4kg). The mean energy intake for women was about 400kJ (100kcal) less than the AMDR for women >70 years. Men consumed 1500kJ (360kcal) more than women (p<0.001). The intake of kcal/kg was similar for men (26.1 ± 4.9kcal/kg, median body weight 76.0 ± 10.1kg) and women (25.7 ±5.7kcal/kg (median body weight 64.9 ± 8.7kg) (p=0.817).

Protein – Both men and women consumed more than the AMDR for protein (+3.5 g for men, +7.5g for women). Men consumed approximately 25g more protein per day than women (p= 0.001). The g/kg intake between men (1.1g/kg) and women (1.0g/kg) was similar (p=0.294) and met the AMDR. The percent of total energy intake for protein fell within the lower end of the AMDR range of 15- 25% for both men and women.

Carbohydrate - Carbohydrate intake made up approximately 45% of total energy intake. Men had a lower proportion of energy from carbohydrate (42%) than women (48%) (p=0.003). By quantity, men consumed similar amounts of sugar as women (p=0.359); however women consumed more sugar as a percentage of total energy intake (24% women versus 20% men) (p=0.042). Mean intakes of fibre were 9g and 5g below the AMDR for men and women respectively with no significant difference between the genders (p=0.445).

Fat – Men consumed significantly more total fat (+15g, p =0.011), saturated fat (+8g, p = 0.053), polyunsaturated fat (+3.4g, p = 0.053) and monounsaturated fat (+3.7g, p = 0.008) than women. As a percentage of energy intake, men (36.7%) exceeded the AMDR for total fat (20-35%). Both men (14.4%) and women (13.8%) exceeded the AMDR for saturated fat (less than < 10% of total energy intake).

Table 4-10: Micronutrient intakes from the 24hour MPRs by gender

Micronutrients		Men n=23[1]	RDI^ >70 years	Women n=21	RDI^ >70 years	p – value ¥
Vitamins	Unit					
Thiamin	mg	1.4 [1.2, 1.8] (0.8 – 4.4)	1.2	1.1 [1.4, 0.9] (0.6 – 2.7)	1.1	**0.030**
Riboflavin	mg	1.9 [1.5, 2.5] (1.1 – 4.0)	1.6	1.4 [1.2, 1.8] (0.7 – 2.3)	1.3	**0.008**
Niacin (equivalents)	mg	31.5 ± 6.6 (21.4 – 41.4)	16	25.3 ± 6.5 (15.4 – 40.3)	14	**0.011**
Folate (equivalents)	µg	343.0 [267.4, 465.5] (138.3 – 1228.0)	400	305.2 [235.8, 362.7] (116.3 – 614.1)	400	0.162
Vitamin C	mg	91.0 [56.5, 150.3] (38.8 – 196.0)	45	105.4 [68.5, 141.6] (23.5 – 404.5)	45	0.664
Vitamin D*ᵶ	µg	2.3 [1.3, 4.1] (0.01 – 7.3)	15	1.7 [0.9, 3.0] (0.03 – 4.7)	15	0.235
Vitamin E*(α-tocopherol equivalents)	mg	9.7 ± 2.9 (4.9 – 15.7)	10	8.9 ± 3.1 (3.5 – 14.5)	7.0	0.262
Vitamin A (retinol equivalents)	µg	1020.7 [815.0, 1332.9] (434.9 – 2808.4)	900	960.8 [632.2, 1126.0] (341.3 – 2011.8)	700	0.418
Vitamin B$_{12}$	µg	4.0 [2.8, 6.2] (1.6 – 11.7)	2.4	3.1 [2.4, 3.4] (1.1 – 5.8)	2.4	**0.045**

Micronutrients		Men n=23[1]	RDI[^] >70 years	Women n=21	RDI[^] >70 years	p – value[¥]
Minerals	Unit					
Sodium*	mg	2742.8 ± 768.3 (1749.8 – 4917.6)	460-920	2183.9 ± 654.0 (1115.6 – 3392.8)	460 – 920	**0.013**
Potassium*	mg	3331.9 [2864.5, 4069.0] (2113.1 – 6296.0)	3800	2832.7 [2540.7, 3436.4] (1631.6 – 4861.9)	2800	0.130
Magnesium	mg	313.7 ± 82.6 (169.9 – 526.2)	420	266.9 ± 69.0 (144.1 – 450.8)	320	**0.049**
Calcium	mg	850.4 [687.1, 1230.9] (343.6 – 2527.0)	1300	688.6 [547.9, 963.8] (275.8 – 1366.3)	1300	**0.042**
Phosphorus	mg	1399.2 [1178.2, 1718.0] (850.6 – 2743.0)	1000	1130.4 [969.7, 1297.1] (718.7 – 1975.3)	1000	**0.002**
Iron	mg	11.9 [10.6, 13.9] (8.5 – 23.0)	8.0	10.7 [8.8, 11.8] (5.1 – 15.5)	8.0	**0.017**
Zinc	mg	10.8 ± 2.6 (7.0 – 16.0)	14	9.1 ± 2.4 (4.6 – 13.8)	8.0	**0.029**
Selenium	µg	51.0 [26.4, 60.5] (16.9 – 97.9)	70	31.1 [24.8, 41.6] (19.1 – 82.8)	60	0.136
Manganese*	mg	3.9 ± 0.9 (2.5 – 6.9)	5.5	3.5 ± 1.1 (1.9 – 5.9)	5.0	0.276
Copper*	mg	1.4 [1.2, 1.7] (0.8 – 2.7)	1.7	1.2 [1.0, 1.6] (0.6 – 2.1)	1.2	0.107

All non- parametric values stated as median (25th, 75th percentile) and parametric data mean ± SD; [1] One participant's data was excluded as intake was grossly overestimated * Adequate intake (AI). [≠]assumes minimal sun exposure. [^]Recommended daily intakes for men and women over 70 years (NHMRC 2006a). [Σ] p-value is a comparison between men and women; Mann Whitney for non- parametric data and T- test for parametric data.

B vitamins – Mean or median intakes for all B-vitamins met the RDI's with the exception of folate. Men fell short of the folate RDI (400ug) by 57µg and women by 95µg. Men had significantly higher intakes than women for the following B-vitamin intakes: thiamine (p=0.03), riboflavin (p=0.008), niacin (p=0.011) and B_{12} (p=0.045).

Fat soluble vitamins – No significant differences were found for the intake of fat soluble vitamins between men and women. Vitamin A (RE) was the only fat soluble vitamin where both men and women reached the RDI. Men had vitamin E intakes that were 0.34 mg α-TEs short of the adequate intake (AI) and intakes for women exceeded the AI by 0.10 mg α-TE. Oral vitamin D intakes were only 15% and 11% of the AI for men and women, respectively. No information was collected for vitamin K.

Minerals - Participants' intakes (both genders) for phosphorus and iron were adequate. Sodium intakes were more than double the recommendation of 460 – 920 mg per day. Men consumed significantly higher amounts of sodium (2742.8 ± 768.3 mg) than women (2183.9 ± 654 mg) (p=0.013). Even the lowest intakes of sodium were above the AI for men and women.

Median intakes of potassium were approximately 500 mg short of the AI (3500 mg) for men, whereas women met the AI of 2800 mg. This was similar for copper, men had a median intake of 1.4 [1.2, 1.7] mg which did not meet the AI of 1.7 mg, women's copper intake met the AI of 1.2 mg.

Men consumed significantly more calcium than women (p=0.042). Calcium intake was 65% of the RDI for men (850.4 [687.1, 1230.9] mg) and at 54% of the RDI for women (688.6 [547.9, 963.8] mg). Neither men nor women met the RDI for magnesium, selenium or manganese. Although men consumed more magnesium (p=0.049) than women, women's intake was close to the RDI (82%) compared to men (74%). Median selenium intakes for men were 71% of the RDI and median intakes for women were 51% of the RDI. Both men and women were consuming 70% of the manganese AI.

The percentage of participants meeting the RDI for particular vitamins and minerals is depicted in Figure 4.1. As a group, less than half of the participants were meeting the RDI for calcium and selenium. Approximately three quarters of participants met the RDI for magnesium and folate, 84% of participants met the RDI for zinc. Ninety –three percent of participants reached the RDI for thiamine, B_{12}, and vitamin A. Almost all participants met the RDI for riboflavin, vitamin C and iron.
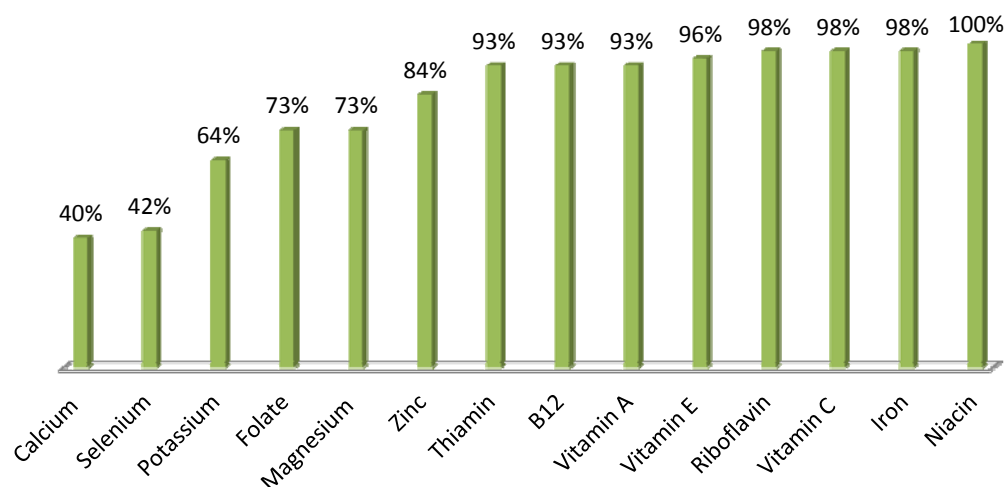
Figure 4.1: The percentage of participants meeting the RDI's for individual nutrients

4.2 Nutrition risk status of the participants

4.2.1 Demographics of participants

Table 4-11: Participants demographics by nutrition risk (SCREEN II follow-up)

Characteristic	Low Risk >53[*] n=16(%)	Medium Risk 50-53[*] n= 12(%)	High Risk <50[*] n= 17(%)	Total n=45(%)	p-value
Gender					**0.032[¥]**
Men	12 (75)	3 (25)[Ω]	9 (53)	24 (53)	
Women	4 (25)	9 (75)	8 (47)	21 (47)	
Marital Status *					**0.006[¥]**
Married Partnered	13 (81)	5 (42)[Ω]	4 (24)[c]	21 (47)	
Widowed	3 (19)	7 (58)[Ω]	13 (77)[c]	23 (51)	
Living arrangements*					**0.017[¥]**
Lives alone	5 (31)	5 (42)	14 (82)[c]	24 (53)	
Lives with others	11 (69)	7 (58)	3 (18)[c]	21 (47)	
Education					0.619
Primary	5 (31)	1 (8)	1 (6)	7 (16)	
Secondary	4 (25)	7 (58)	11(65)	22 (50)	
Tertiary	7(44)	4 (33)	5 (29)	16 (36)	

[¥] P-value derived from Chi- Square test; [c] Significant difference found between low and high risk using bonferroni post-hoc analysis. [Ω] Significant difference found between low risk and medium risk using bonferroni post-hoc analysis; [*] SCREEN II scores.

Sixteen participants were classified with low nutrition risk, 12 with medium nutrition risk and 17 with high nutrition risk. Gender differed across the nutrition risk groups with significantly more men (n=12) and significantly less women (n=4) at low nutrition risk compared with medium nutrition risk (men=3, women =9) (p=0.03). An almost equal number of men (n=9) and women (n=8) had high nutrition risk. Participants classified at high nutrition risk were significantly more likely to be widowed (77%) (p<0.01) and live alone (82%) (p=0.02). Eighty-two percent of participants with low nutrition risk were married

and 69% lived with others. Over half of the participants with medium nutrition risk were widowed, and 42% lived alone. No significant differences were found between level of nutrition risk and education.

4.2.2   Lifestyle factors and self-reported health by SCREEN II risk group

Table 4-12: Lifestyle factors and self-reported heath by nutrition risk (SCREEN II follow-up)

	Low Risk >53 n=16 n (%)	Medium Risk 50-53 n= 12 n (%)	High Risk <50 n= 17 n (%)	Total n=45 n (%)	p- value
Smoking					**0.033**
Current or former	5 (31.3)	6 (50.0)	13 (76.4)^c	24(53.3)	
Never	11 (68.8)	6 (50.0)	4 (23.5)^c	21 (46.7)	
Alcohol$^\wedge$					0.180$^\alpha$
Never	4 (25.0)	3 (25.0)	2 (11.8)	9 (20.0)	
Occasionally (monthly)	3 (18.8)	4 (33.3)	4 (23.5)	11 (24.4)	
≥ 2 times/wk	9 (56.3)	3 (25.0)	11 (65.7)	23 (51.1)	
General health rating*					0.122
Excellent – Very good	11(68.8)	7 (58.3)	11 (64.7)	29 (64.4)	
Good – Poor	5 (31.3)	4 (33.3)	6 (35.3)	15 (33.3)	

*one missing value, medium risk; $^\wedge$ two missing values, medium risk; $^\alpha$Fisher-Freeman-Halton test used for categorical values due to small sample sizes. ^{c} Significant difference found between low and high risk.

There was a significant difference between the SCREEN II nutrition risk groups and smoking status. Those with high nutrition risk were more likely to be current or former smokers (76%) compared to participants with low nutrition risk (31%) (p=0.03). Almost 70% of participants with low nutrition risk had never smoked. No significant difference was found for alcohol intake between the nutrition risk groups; about half of all participants drank two or more times per week.

The majority of participants had an 'excellent' or 'very good' self-reported health rating. Approximately one third of participants from each nutrition risk group reported 'good' to 'poor' general health.   Only three people reported fair or poor health.

4.2.3   Functional status by SCREEN II nutrition risk groups

Table 4-13: Functional performance measures by nutrition risk (SCREEN II follow-up)

	Low Risk >53 n=16	Medium Risk 50-53 n= 12	High Risk <50 n= 17	Total n=45	P value
NEADL[1]	19.0 [16.5, 20.0] (14.0 – 22.0)	19.0 [17.0, 20.0] (15.0 – 22.0)	18.0 [16.0, 19.8] (9.0 – 20.0)	18.0 [16.5, 20.0] (9.0 – 22.0)	0.576
SPPB[2]	8.4 ± 2.7 (2.0 – 12.0)	8.1 ± 3.1 (2.0 – 12.0)	7.3 ± 2.9 (2.00 – 12.00)	7.9 ± 2.9 (2.0 – 12.0)	0.551
Grip Strength (kg)	28.3 [21.0, 33.3] (12.8 – 39.4)	19.3 [16.7, 22.2] (13.8 – 31.7)	21.7 [17.8, 26.9] (14.6 – 38.0)	22.9 [18.8, 30.7] (12.8 – 39.4)	0.069

[1] NEADL= Nottingham extended activities of daily living ; [2] SPPB = Short physical performance battery test; All values mean ± SD (range) for parametric data, median [25th – 75th percentile] (range) for non-parametric data.

There was little difference between risk groups for the NEADL score (median 18.0 [16.5 – 20.0] points) and the SPPB score (mean 7.9 ± 2.9). Median grip strength for participants with low nutrition risk (28.3

[21.0, 33.3]kg) was 9kg higher than in participants with medium nutrition risk and 6.5kg higher than in participants with high risk. Although the difference in scores was non-significant a trend was identified (p = 0.069).

4.2.4 Anthropometric characteristics by SCREEN II nutrition risk groups

Table 4-14: Anthropometric characteristics by nutrition risk (SCREEN II follow-up).

	Low Risk >53 n=16	Medium Risk 50-53 n= 12	High Risk <50 n= 17	Total n=45	p-value
BMI (kg/m^2)	26.4 ± 3.1 (20.3, 32.8)	26.8 ± 3.4 (22.0, 33.0)	25.6 ± 4.6 (18.5, 34.0)	26.2 ± 3.8 (18.5, 34.0)	0.710
BMI change (kg/m^2)*	0.2 ± 1.2 (-2.5, 2.5)	-0.4 ± 1.3 (-2.7, 2.4)	-0.3 ± 1.1 (-2.4, 2.0)	-0.1 ± 1.2 (-2.7, 2.5)	0.391
Weight change (%)*	0.6 ± 4.9 (-11.0, 9.0)	-1.6 ± 4.6 (-9.0, 8.0)	-0.7 ± 4.5 (-7.0, 9.0)	-0.5 ± 4.6 (-11.0, 9.0)	0.450
Waist Circumference (cm)	99.3 ± 6.9 (86.0 – 108.0)	98.1 ± 10.3 (86.0 – 122.0)	95.4 ± 10.6 (73.0 – 115.0)	97.5 ± 9.3 (73.0 – 122.0)	0.478
Muscle mass %	48.8 ± 7.8 (34.1, 61.5)	42.6 ± 8.7 (34.6 – 64.3)	45.3 ±8.8 (34.2 – 61.7)	45.9 ± 8.6 (34.1 – 64.3)	0.179
Fat mass %	30.3 ± 6.4 (17.1 - 40.9)	35.2 ± 5.1 (26.8 - 41.9)	32.0 ± 9.3 (16.5 - 48.6)	32.2 ± 7.5 (16.5 – 48.6)	0.248

All values mean ± SD (range) for parametric data, median [25th – 75th percentile] (range) for non-parametric data. * Change between baseline and follow-up.

There were no statistical differences in any of the anthropometric characteristics between the nutrition risk groups. As expected, weight change (%) and change in BMI followed a similar pattern with the participants at low nutrition risk having a mean positive increase in weight and BMI. Likewise participants at medium and high nutrition risk experienced a mean decrease in weight and BMI. The mean waist circumference for all participants was 97.5 ± 9.3cm. Participants with high nutrition risk had lower mean waist circumference than those with low and medium nutrition risk (non-significant).

Fat mass and muscle mass were inversely related. Participants with low nutrition risk had the highest muscle mass percentage (48.8 ± 7.78 %) and lowest fat mass percentage (30.3 ± 6.36 %).

4.2.5 Other participant characteristics: polypharmacy and depression

Table 4-15: Geriatric Depression Scores by nutrition risk (SCREEN II follow-up)

	Low Risk >53 n=16	Medium Risk 50- 53 n= 12	High Risk <50 n= 17	Total n=45	p- value
Geriatric Depression Scale	1.0 [0.3, 2.0] (0.0 – 5.0)	1.0 [1.0, 3.0] (0.0 – 3.0)	2.5 [1.3, 4.8]^c (1.0 – 8.0)	2.0 [1.0, 3.0] (0.0 – 8.0)	0.016*

*Non-parametric Kruskall-Wallis test with post-hoc bonferroni test; ^{c} Significant difference between low risk and high risk; All values are non-parametric listed as median [25th – 75th percentile](range).

The median GDS score for all nutrition risk groups was below five. Participants with high nutrition risk had a significantly higher GDS score of 2.5 [0.0 – 8.0] and wider range of scores compared to participants with low nutrition risk (p=0.016).

Table 4-16: Medication use by nutrition risk (SCREEN II follow-up)

	Low Risk >53 n=16	Medium Risk 50- 53 n= 12	High Risk <50 n= 17	Total n=45	p- value
Number of Medications (polypharmacy)	4.0 [2.3, 6.8] (0.0 – 9.0)	5.0 [4.0,8.0] (3.0 – 10.0)	8.0 [4.3, 9.0][c] (2.0 – 13.0)	5.0 [3.0, 8.0] (0.0 – 13.0)	**0.032***

*Non-parametric Kruskall- Wallis test with post-hoc bonferroni test; [c] Significant difference between low risk and high risk; All values are non-parametric listed as median [25th – 75th percentile] (range).

Participants with high nutrition risk took significantly more medications (8.0 [4.3, 9.0]) than those with low nutrition risk (4.00 [2.25, 6.75]) (p=0.03).

4.2.6   SCREEN II and Dietitian's Risk Rating Score by nutrition risk.

Table 4-17: Change in SCREEN II scores between baseline and follow-up

	Low Risk >53	Medium Risk 50- 53	High Risk <50	Total	
Baseline	**n = 15 (33%)**	**n = 15 (33%)**	**n = 15 (33%)**	**n=45**	
SCREEN II	58.0. [54.0, 58.0] (54.0 – 59.0)	51.0 [52.0, 52.5] (50.0.0 – 53.0)	39.5 [41.0, 42..0] (36.0 – 49.0)	52.0 [43.0, 54.0] (36.0 – 59.0)	
Follow-up[a]	**n = 16 (36%)**	**n = 12 (27%)**	**n = 17 (38%)**	**n=45**	
SCREEN II	56.0 [55.0, 58.0] (54.0 – 60.0)	51.0 [50.3, 52.0] (50.0 - 53.0)	43.0 [40.0, 47.0] (36.0 – 49.0)	51.0 [45.0, 55.0] (36.0 – 60.0)	
					p- value
Change in score *	1.5 [1.0, 3.0] (-3.0 – 7.0)	0.0 [-1.8, 6.3] (-6.0 – 11.0)	- 4.0 [-7.5, 3.0] (-18.0 – 13.0)	-1.0 [-3.0, 3.0] (- 18.0 – 13.0)	0.099[b]

All values median [25th – 75th percentile] (range) for non-parametric data. *Change in score = follow-up SCREEN II score – baseline SCREEN II score; [b] Kruskall-Wallis non-parametric test.

At the follow-up SCREEN II assessment, 16, 12, and 17 participants were classified with low, medium and high nutrition risk respectively. No significant change in nutrition risk over the year was observed. The median SCREEN II score at follow-up (51.0 [44.5, 55.0] points) was one point lower than the baseline SCREEN II median score (52.0 [42.5, 54.0] points) (non-significant).

SCREEN II questionnaire items by nutrition risk

 Tale 4-18 displays each of the 14 items from the follow-up SCREEN II questionnaire and the frequency at which participants selected an answer that indicated an area of possible nutrition risk (scores ≤2).

Table 4-18: Proportion of participants with 'at risk' response to individual SCREEN II items [1]

Items on SCREEN II	Low >53 n=16 (%)	Medium 50-53 n=12 (%)	High <50 n=17 (%)	Total n=45
> 2.5kg weight loss	0 (0)	0 (0)	5 (29)	5 (11)
>2.5kg weight gain	0 (0)	0 (0)	2 (12)	2 (4)
Unintentional weight change	0 (0)	3 (25)	8 (47)	11 (24)
Think excess weight	0 (0)	3 (25)	5 (29)	8 (17)
Think weight less than should be	1 (6)	0 (0)	7 (41)	7 (16)
Often/always skip meals	0 (0)	0 (0)	1 (6)	1 (2)
Limits foods	1 (6)	2 (17)	6 (35)	9 (20)
Fair/poor appetite	1 (6)	1 (8)	5 (29)	7 (16)
≤3 fruits and vegetables serves	0 (0)	1 (8)	0 (0)	1 (2)
≤ 1 meat alternative serves[^]	**7 (44)**	**5 (42)**	5 (29)	**17 (38)**
≤ 2 milk product serves[^]	**5 (31)**	**4 (33)**	**9 (53)**	**18 (40)**
≤ 3-4 cup fluid/ day	2 (13)	3 (25)	2 (12)	7 (16)
Has swallowing difficulty	0 (0)	1 (8)	3 (18)	4 (9)
Has chewing difficulty	0 (0)	3 (25)	7 (41)	10 (22)
Uses meal replacements	0 (0)	0 (0)	1 (6)	1 (2)
Eats alone[^]	**4 (25)**	**5 (42)**	**13 (76)**	**22 (49)**
Cooking is a chore[^]	1 (6)	1 (8)	**10 (58)**	**12 (27)**
Often/always difficulty w/groceries	0 (0)	0 (0)	0 (0)	0 (0)

[*] Any score ≤2 signifies an area of nutrition risk; [^] Bolded numbers are the top three items of nutrition risk .

Weight and weight change: None of the weight domains were leading risk factors in any of the nutrition risk groups. Almost 50% of participants with high nutrition risk reported unintentional weight change with approximately a third reporting weight loss. Forty percent of participants with high risk reported they were underweight. More participants with high nutrition risk also reported they were overweight compared to other risk groups.

Dietary intake: Low servings of milk and milk products were a leading risk factor across all levels of nutrition risk, especially in participants with high nutrition risk (53%). Low servings of meat and meat alternatives was a leading risk factor only for participants with low and medium nutrition risk. Many more participants with high nutrition risk reported both a poor appetite and limiting foods compared to the other risk groups.

Risk factors for food intake: Eating alone was a primary risk factor for all levels of nutrition risk, especially in high risk participants (75%). Participants with high nutrition risk were the only group to find cooking a chore (58%) compared with only one participant in each of the other risk groups. Chewing difficulties were more common than swallowing difficulties. Participants with high nutrition risk were more than twice as likely to report these risk factors than participants with lower levels of nutrition risk. Food accessibility was not a concern for any of the participants.

The three most prevalent nutrition risk factors for participants with low and medium nutrition risk were low meat and meat alternative intake, low milk product intake and eating alone. For those at high nutrition risk the top three risk factors were eating alone, finding cooking a chore and low milk product intake. The three items of least concern for the study population were difficulty with groceries, the use of meal replacements and fruit and vegetable intake.

Table 4-19 compares the leading SCREEN II nutrition risk factors found in this study with the leading risk factors found in the Canadian SCREEN II validation study (Keller, Goy et al. 2005) and another New Zealand based study in older people in the community (Watson, Zhang et al. 2010). Eating alone and low intakes of milk products were predominant risk factors across all three studies. The risk factors of 'finding cooking a chore' and 'low intake of meat and meat alternatives' were unique to this study.

Table 4-19: Comparison of risk factor items

	SCREEN II Validation (NZ)	SCREEN II Validation study (Canada)[1]	Community living older people (NZ)[2]
1	Eating alone	Perception of being overweight	Unintentional weight change
2	Finding cooking a chore	Low intake of milk products	Eating alone
3	Low intake of meat and meat alternatives	Limits foods	Low intake of milk products
4	Low intake of milk products	Eating alone	Perception of being overweight

[1](Keller, Goy et al. 2005); [2](Watson, Zhang et al. 2010)

4.2.7   Food groups

Consuming less than three serves of dairy products, less than two serves of meat products and less than three serves of fruits and vegetables per day was considered to be an 'at risk' behaviour on SCREEN II. Figure 4.2 shows the proportion of participants who reported consuming less than the recommended food group servings per day compared against their average daily servings from the three MPRs
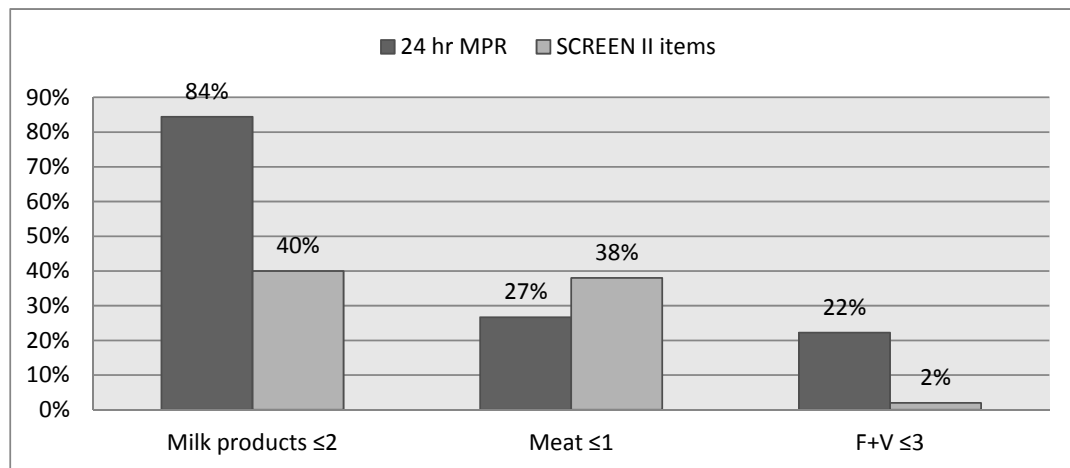
Figure 4.2: The percentage of participants who reported low servings of milk products, meat products or fruits and vegetables on SCREEN II compared with the mean three day intakes from the MPRs.

Forty percent of participants reported consuming less than three serves per day of milk products. However, actual intakes from the MPRs showed that 84% of participants consumed less than three milk products per day, a difference of 44%. On SCREEN II, almost all participants reported that they consumed more than three serves of fruits and vegetables daily. The actual intake based off the MPRs demonstrated that 22% of participants were consuming less than three serves of fruits and vegetables daily. There was a 10% difference between self-reported intake and actual intake for meat products. Almost 40% of participants reported eating less than two serves of meat per day whereas the results from the MPRs showed 27% of participants consumed less than two serves of meat and meat alternatives daily.

4.2.8 Macronutrient intakes by nutrition risk derived from the 24 hour MPRs

Macronutrient and micronutrient intakes were derived from the three 24 hour MPRs. Intakes were analysed according to the dietitian's rating of nutrition risk as nutrient intakes were used as one aspect of the dietitian's risk rating assessment (Table 4-20).

Macronutrient	Low Risk <5 n=14	Medium Risk 5-7 n=21	High Risk >7 n=9[1]	Total n=44	p-value
Energy (kJ)	8098 ±1219 (5985-10004)	7198 ± 1376 (5093- 10642)	7626 ± 1739 (5237 – 10540)	7572 ± 1433 (5093 – 10642)	0.191
Energy (kcal)	1910 ± 288 (1411 – 2359)	1698 ± 325 (1201 – 2510)	1798 ± 410 (1235 – 2486)	1786 ± 338 (1201 – 2510)	0.191
Calories/kg^ (men)	22.6 [23.2, 29.4] (20.0 – 35.3)	24.4 [22.3, 24.7] (20.4 – 25.1)	26.8 [22.9, 29.3] (16.7 – 36.5)	26.0 [22.4, 29.4] (16.7 – 36.5)	0.465
Calories/kg # (women)	25.8 [18.3, 35.8] (18.2 – 36.8)	24.4 [21.0. 29.7] (20.8– 30.5)	27.9 [20.1, 29.6] (17.1 – 33.5)	27.5 [20.7, 30.0] (17.1 – 36.8)	0.995
Protein (g)	86.0 ± 23.7 (54.0 – 141.0)	69.1 ± 19.0* (43.0– 110.0)	71.5 ± 11.5 (50.0 – 87.0)	75.0 ± 20.5 (43.0 – 141.0)	0.169 $^{\alpha}$
% of total intake	18.1 ± 4.4 (13.0 – 28.0)	16.5 ± 4.2 (10.0 – 26.0)	16.6 ± 4.0 (11.0 – 23.0)	17.0 ± 4.2 (10.0 – 28.0)	0.175
g/kg (men)^	1.2 [0.9, 1.4] (0.7 – 1.8)	1.0 [0.9. 1.0] (0.8– 1.0)	1.0 [0.9, 1.2] (0.8 – 1.2)	1.0 [0.9, 1.3] (0.7 – 1.8)	0.234
g/kg (women)#	1.0 [0.8, 1.4] (0.7 – 1.5)	1.1 [0.9, 1.1] (0.8 – 1.6)	0.9 [0.7, 1.3] (0.5 – 1.4)	1.0 [0.8, 1.1] (0.5 – 1.6)	0.837
Carbohydrate (g)	198.0 ± 33.7 (146.0 – 265.0)	191.8 ± 34.3 (136.0 – 275.0)	208.8 ± 62.8 (92.0 – 305.0)	197.0 ± 40.8 (92.0 – 305.0)	0.589
% of total intake	42.0 ± 7.4 (24.9 – 57.0)	46.0 ± 5.8 (37.0 – 57.0)	46.0 ± 9.4 (30.0 – 60.9)	44.7 ± 7.2 (24.9 – 60.9)	0.175
Sugar (g)	95.0 ± 18.5 (62.3 -126.2)	94.4 ± 33.0 (32.9 – 156.0)	106.0 ± 48.9 (29.4 – 190.6)	97.0 ± 32.8 (29.4 – 190.6)	0.661
% of total intake	20.0 ± 4.0 (11.0 – 29.0)	22.0 ± 6.9 (8.0 – 37.1)	23.0 ± 9.2 (10.0 – 38.1)	21.9 ± 6.7 (8.0 – 38.1)	0.175
Fibre (g)	21.5 [16.2, 24.5] (9.83 – 25.4)	19.4 [17.2, 23.4] (7.5 – 26.5)	25.0 [13.9, 29.5] (11.8 – 33.0)	20.7 [17.0, 24.2] (7.5 – 33.0)	0.483
Total Fat (g)	79.3 [66.5, 89.9] (47.0 – 136.4)	65.5 [47.5, 81.6] (39.6 – 112.7)	67.4 [52.9, 86.0] (49.8 – 101.2)	69.0 [56.0, 83.8] (39.6 – 136.4)	0.240
% of total intake	36.2 [31.1, 39.1] (26.0 – 51.0)	34.7 [27.6, 40.0] (25.0 – 47.0)	33.1 [27.8, 40.3] (24.0 – 42.0)	35.4 [29.7, 39.2] (23.8 – 50.7)	0.759
Saturated Fat (g)	34.1 [27.7, 42.7] (17.0– 54.0)	25.1 [19.7, 30.8] (15.3 – 49.2)	29.3 [18.7, 37.1] (16.0 – 41.0)	28.9 [21.3, 37.0] (15.3 – 54.0)	0.060
% of total intake	15.8 [14.0, 17.6] (9.0 – 21.0)	13.2 [11.0, 15.3] (9.0 – 23.0)	13.8 [10.2, 16.1] (8.0 – 23.0)	14.0 [12.0, 17.0] (8.5 – 23.0)	0.097
Polyunsaturated fat (g)	9.5 [6.8, 13.5] (4.4 – 27.1)	8.8 [6.8, 15.0] (4.2 – 22.0)	9.0 [6.4, 13.4] (5.2 – 22.0)	9.0 [6.9, 13.8] (4.2 – 27.1)	0.996
% of total intake	4.8 [3.6, 6.2] (2.0 – 10.0)	4.5 [3.9, 6.4] (3.00 – 12.0)	5.17 [2.0, 7.4] (3.0 – 8.0)	4.8 [3.6, 6.4] (2.1 – 11.6)	0.536
Monounsaturated fat (g)	24.1 [21.9, 31.5] (17.0 – 42.3)	23.6 [15.8, 30.1] (13.2 - 36.1)	19.7 [18.7, 28.8] (16.2 – 35.9)	23.0 [18.5, 30.1] (13.2 – 42.3)	0.351
% of total intake	11.2 [10.0, 13.5] (9.0 – 19.0)	11.5 [9.1, 13.6] (8.0 – 18.0)	12.0 [9.6, 13.9] (9.0 – 14.0)	11.5 [9.7, 13.7] (8.3 – 19.3)	0.984

All values mean ± SD (range) for parametric data, median [25th – 75th percentile] (range) for non-parametric data. Kruskal–Wallis test used for non-parametric data, ANOVA test used for parametric data; [1]One participant was excluded due to unrealistic energy intake. $^{\alpha}$Protein adjusted for energy intake, unadjusted p-value=0.04, significant difference found between low and medium risk. ^ mean body weight for men is 74.0 kg; # mean body weight for women is 69.4 kg.

There was no significant difference in energy intakes between the nutrition risk groups. Participants with low nutrition risk had the highest mean energy intake at 8098 ±1219kJ or 1910 ± 288 kcal. Those with medium nutrition risk had the lowest energy intakes of 7198 ± 1376kJ or 1698 ± 325 kcal. All participants had protein intakes of at least 1.0g per kilogram of body weight with the exception of women at high nutrition risk who had protein intakes of 0.9g/kg, the AMDR for women over 70 years is 0.94g/kg. Participants with low nutrition risk had higher protein intakes (86.0 ± 23.7g) than participants with medium and high nutrition risk, however once controlled for gender, no significant difference was found between risk groups (p=0.30).

No significant difference in carbohydrate intake was found between the nutrition risk groups. Fibre intakes for participants with low and medium nutrition risk were lower than the recommended 25- 30 g/day.

Total fat intakes for all nutrition risk groups were between 33.1 – 36.2% of total daily energy intake with a median of 35.4[29.7, 39.2] %, which is at the upper end of the AMDR of 20 - 35 %. All nutrition risk groups had saturated fat intakes of at least 13% of energy intake, exceeding the AMDR of 10%. .

4.2.9 Micronutrient intakes derived from 24 hour MPRs' by nutrition risk

Table 4-21: Micronutrient intakes derived from the 24 hour MPRs, by Dietitian's Risk Rating

Vitamins	Unit	Low <5 n=14	Medium 5-7 n=21	High Risk >7 n=9[1]	Total	P-value
Thiamin	Mg	1.3 [1.1, 1.5] (0.7 – 2.6)	1.1 [0.9 – 1.5] (0.7 – 2.7)	1.5 [1.0, 2.0] (0.9 – 4.4)	1.3 [1.0, 1.5] (0.7 - 4.4)	0.364
Riboflavin	Mg	1.8 [1.4, 2.6] (1.3 – 4.0)	1.5 [1.2, 2.0] (0.7 – 2.7)	1.6 [1.4, 2.3] (1.3 – 3.8)	1.6 [1.3, 2.1] (0.7 – 4.0)	0.128
Niacin (equivalents)	Mg	30.2 ± 8.3 (21.4 – 40.0)	26.1 ± 7.3 (11.0 – 41.4)	26.8 ± 8.9 (22.9 – 37.7)	28.2 ± 7.5 (11.0 – 41.4)	0.532
Folate (equivalents)	µg	367.8 [260.3, 479.9] (181.9 – 603.1)	305.2 [240.2, 362.8] (116.3 – 508.5)	354.5 [274.5, 503.2] (232.3 – 1228.0)	334.7 [249.7, 402.6] (116.3 –1228.0)	0.270
Vitamin B$_{12}$	µg	4.8 [3.1, 5.8] (1.7 – 8.6)	3.0 [2.2, 3.5] (1.1 – 11.7)	3.0 [2.7, 3.4] (2.4 – 6.2)	3.2 [2.7, 4.8] (1.1 - 11.7)	0.063
Vitamin C	Mg	87.0 [67.6, 131.1] (54.4 – 196.0)	105.4 [59.5, 134.2] (23.5 – 172.7)	91.0 [52.9, 193.3] (35.8 – 405.5)	94.1 [64.9, 147.2] (23.5 – 404.5)	0.926
Vitamin E* (α-tocopherol equivalents)	mg	9.2 ± 2.5 (4.9 – 13.3)	9.1 ± 3.2 (3.5 – 15.7)	9.3 ± 3.3 (5.25 – 15.4)	9.1 ± 3.0 (3.5 – 15.7)	0.993
Vitamin A (retinol equivalents)	µg	1017.6 [895.2, 1277.0] (675.2 – 1756.7)	1000.5 [585.2, 1232.0] (434.9 – 2808.5)	927.8 [544.1, 1320.3] (341.3 – 1700.0)	1007.5 [681.5, 1239.3] (341.3 – 2808.5)	0.502
Vitamin D*≠	µg	2.1 [1.0, 4.7] (0.6 – 7.3)	2.1 [1.0. 3.1] (0.03 - 4.1)	2.00 [1.6, 2.2] (0.01 – 3.1)	2.1 [1.2, 3.2] (0.01 – 7.3)	0.454

Table 4-21 continued

Minerals	Unit	Low <5 n=14	Medium 5-7 n=21	High Risk >7 n=9	Total	P-value
Sodium*	mg	2357.1 [2017.9, 2801.6] (1556.0 – 3354.0)	2270.3 [1807.2, 2983.0] (1155.6 – 4917.6)	2658.7 [1927.6, 3130.3] (167.3 – 3906.0)	2436.4 [1931.2, 3024.0] (1155.6 – 4917.6)	0.692
Potassium*	mg	3549.8 ± 1044.4 (2461.7 – 6296.0)	3102.5 ± 832.0 (1631.6 – 4702.2)	3316.8 ± 920.1 (2185.4 – 4861.9)	3288.7 ± 921.2 (1631.6 – 6296.0)	0.150
Magnesium	mg	279.0 [241.7, 346.3] (225.6 – 395.0)	275.7 [229.5, 355.2] (144.1 – 526.2)	282.8 [204.3, 329.7] (169.8 – 450.8)	278.9 [231.1, 342.5] (144.1 – 526.2)	0.928
Calcium	mg	846.3 [705.5 ,1273.6] (564.3 – 2527.7)	687.1 [580.7, 1084.4] (275.8 – 1440.3)	760.3 [451.0, 981.8] (343.6 –1236.3)	765.1 [595.4, 1007.3] (275.8 – 2527.7)	0.175
Phosphorus	mg	1395.5 [1190.6, 1766.1] (1127.1 – 2743.0)	1134.0 [974.4, 1395.2] (718.6 – 2082.5)	1178.2 [1053.7, 1507.2] (868.5 – 1626.8)	1243.1 [1094.0, 1515.0] (718.6 – 2743.0)	0.194^{α}
Iron	mg	11.4 [10.2, 13.5] 9.4 – 14.5	10.9 [8.9, 12.5] 5.1 – 18.4	11.5 [9.3, 13.7] 8.5 – 23.0	11.2 [9.6, 13.1] 5.1 – 23.0	.621
Zinc	mg	10.8 [8.9, 13.0] 7.8 – 16.0	9.2 [7.2, 11.4] 4.6 – 14.4	9.4 [7.7, 11.7] 7.3 – 13.1	9.7 [7.9, 12.0] 4.5 – 16.0	0.181
Selenium	µg	54.7 [32.9, 76.9] 19.3 – 97.8	31.1 [22.8, 55.6] 16.9 – 82.9	30.7 [27.7, 41.3] 17.4 – 51.0	37.1 [26.0, 57.9] 16.9 – 97.8	0.072
Manganese[*]	mg	3.8 [3.0, 4.2] 2.5 – 5.1	3.7 [2.2, 4.3] 1.9 – 6.7	3.9 [2.8, 4.3] 2.1 – 5.9	3.67 [2.9, 4.1] 1.9 - 5.9	0.929
Copper*	mg	1.4 ± 0.2 1.1 – 1.9	1.4 ± 0.5 0.6 – 2.7	1.2 ± 0.4 0.8 – 2.1	1.4 ± 0.4 0.6 – 2.7	0.695

All values mean ± SD (range) for parametric data, median [25th – 75th percentile] (range) for non-parametric data. * Adequate intake (AI); [≠]assumes minimal sun exposure . [α] Phosphorus adjusted for energy intake, unadjusted p-value = 0.044; [1]One participant was excluded due to unrealistic energy intake

B vitamins – Generally, B vitamin intakes were adequate and similar between risk groups. Folate was the only B vitamin where intakes, for any nutrition risk group, did not meet the RDI of 400µg/day.

Vitamin C – All median intakes of vitamin C exceeded the RDI (45mg).

Fat soluble vitamins -   All nutrition risk groups met the RDI or AI for vitamin E and A, however intakes of vitamin D were less than 15% of recommendations for all nutrition risk groups. Intakes between nutrition risk groups were similar for vitamin Es and D.

Minerals – The mean intakes of calcium, selenium, magnesium or manganese for participants with low, medium or high nutrition risk did not meet the AIs or RDIs. Intakes of magnesium, iron, manganese, and copper were similar between nutrition risk groups. The median calcium intake for all participants was just over half the RDI of 1300mg. All mean intakes of sodium were at least double the RDI of 460 – 920mg.

4.2.10   SCREEN II validation

Table 4-22: Correlation between Dietitian's Nutrition Risk Rating score and SCREEN II score

Dietitian's Risk Rating	Low Risk <5 n=14 (31%)	Medium Risk 5-7 n=21 (47%)	High Risk >7 n=10 (22%)	Total n=45
Median Score	4.0 [3.0, 4.0] (2.0- 4.0)	6.0 [5.0, 7.0] (5.0 – 7.0)	8.0 [8.0, 9.3] (8.0 – 10.0)	6.0 [4.0 ,7.0] (2.0 - 10.0)
SCREEN II score 12 months follow-up	**Low Risk >53 n=16 (36%)**	**Medium Risk 50-53 n=12 (27%)**	**High Risk <50 n=17 (38%)**	**Total n=45**
Median score	56.0 [55.0, 58.0] (54.0 – 60.0)	51.0 [50.3, 52.0] (50.0 - 53.0)	43.0 [40.0, 47.0] (36.0 – 49.0)	51.0 [45.0, 55.0] (36.0 – 60.0)
Correlation between total Dietitian's Risk Rating score and total SCREEN II score r = -0.759 <0.01[Ω]				

[Ω]Spearmean's correlation for non –parametric data. All values mean ± SD (range) for parametric data or median [25th, 75th percentile] (range) for non-parametric data.

The dietitian classified 14 participants with low nutrition risk, 21 with medium risk and 10 with high risk (Table 4-22). There was a strong correlation between the DNRR score and the follow-up SCREEN II score (r= -0.759, p= <0.01). The dietitian rated a total of seven participants at a lower level of nutrition risk than SCREEN II. Ten participants were rated at high nutrition risk by the dietitian, whereas SCREEN II rated 17 participants with high nutrition risk. The dietitian rated 14 participants with low nutrition risk compared to 16 participants at low nutrition risk as per their SCREEN II score.

Cut –point for medium nutrition risk

SCREEN II was validated against the median DNRR score (6.0 on a scale of 1- 10). The receiver operating curve (ROC) and the area under the curve (AUC) were derived to evaluate sensitivities and specificities of potential cut-offs (Table 4.23; Figure 4.3). The SCREEN II score of 53 was considered a good cut-off for nutrition risk with a sensitivity of 88% and specificity of 71%, the AUC was 89%. The AUC in conjunction with a high specificity and sensitivity indicated that SCREEN II was an adequate marker of nutrition risk in comparison to a dietitian's clinical judgment. Therefore, any SCREEN II score of 54 - 64 would be considered 'at low nutrition risk' and a score greater than 53 would be considered at 'medium nutrition risk'. Using the cut-off of >53 the percentage of participants 'at low nutrition risk' for the 12 month follow-up remained at 36%.

Table 4-23: Sensitivity and specificity[*] of SCREEN II (any risk)

Score	Sensitivity	Specificity
36	0%	100%
37	4%	100%
39	8%	100%
40	13%	100%
41	25%	100%
42	29%	100%
43	33%	100%
44	38%	100%
45	46%	100%
47	50%	100%
48	58%	100%
49	63%	100%
50	67%	95%
51	71%	86%
52	83%	81%
53	**88%**	**71%**
54	88%	62%
55	92%	52%
56	96%	43%
57	96%	29%
58	96%	19%
59	100%	10%
60	100%	5%
62	100%	0%

ROC Curve

Figure 4.3: ROC curve for total SCREEN II compared to the dietitian's risk rating (risk >5 on rating 1- 10). AUC=88.9%, p- value >0.001. Cut-off point (x) for any risk at specificity of 1.0 - 0.29 and sensitivity of 0.88.

[*]Sensitivity is the proportion of older people ranked as 'at risk' by SCREEN who were also identified as 'at risk' by the dietitian. Specificity is the proportion of seniors ranked as 'not at risk' by SCREEN who were also identified as 'not at risk' by the dietitian. The cut point has been bolded.

Cut - point for high nutrition risk

The cut-off point for high nutrition risk in SCREEENII was determined using the DNRR score of >7, indicating high risk. A second ROC curve was derived with an AUC of 87% (Figure 4.4). The SCREEN II score of <49 was determined as a good cut-off for high risk as it was at the point where sensitivity and specificity crossed over at their highest points (Table 4-24). Sensitivity was at 90% and specificity was at 86%. Using the new cut-off of <49, participants 'at high nutrition risk' (follow-up SCREEN II scores) dropped from 38% to 33% with a consequent shift in participants with medium nutrition risk from 27% to 31%

Table 4-24: Sensitivity and specificity* of SCREEN II (high risk)

Score	Sensitivity	Specificity
36	0%	100%
37	10%	100%
39	20%	100%
40	30%	100%
41	50%	97%
42	50%	94%
43	60%	94%
44	70%	94%
45	70%	89%
47	70%	86%
48	**90%**	**86%**
49	90%	83%
50	90%	77%
51	90%	69%
52	90%	57%
53	90%	49%
54	90%	43%
55	90%	34%
56	90%	26%
57	90%	17%
58	90%	11%
59	100%	6%
60	100%	3%
62	100%	0%

Figure 4.4: ROC curve for SCREEN II (high risk) compared to dietitian's risk rating (high risk; risk >7 on rating of 1 – 10). AUC=0.866, p- value<0.001. Cut-off point (x) for high risk at specificity of 1.0 - 0.14 and sensitivity of 0.90.

*Sensitivity is the proportion of older people ranked as 'at high risk' by SCREEN who were also identified as 'at high risk' by the dietitian. Specificity is the proportion of seniors ranked as 'not at risk' by SCREEN who were also identified as 'not at risk' by the dietitian. The cut point has been bolded.
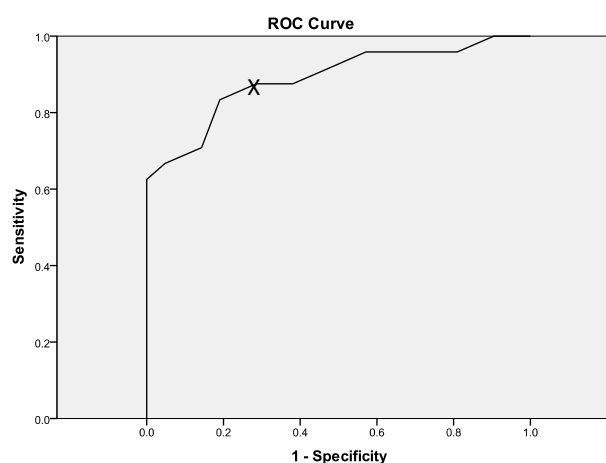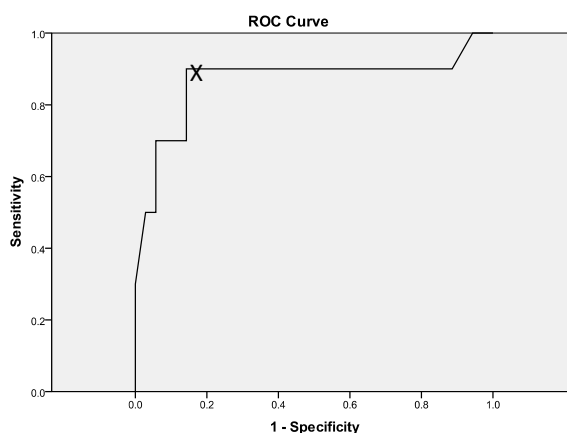
5.0 Discussion

The aim of this study was to validate the nutrition screening tool, SCREEN II, in community dwelling people of advanced age (85 -plus years). SCREEN II was selected as the tool to identify participants at nutrition risk in the LiLACS NZ study as it is easy to use, provides prevalence of nutrition risk as well as nutrition risk factors and was designed for use in community living older people (Keller, Goy et al. 2005). Previous validation of SCREEN II in Canada included a wide range of older participants; half (48%) were 65-74 years, 44% were75-84 years and only 6% were ≥85 years (Keller, Goy et al. 2005). Given there is no gold standard to diagnose malnutrition, SCREEN II was validated against the criterion of a dietitian's clinical judgement of nutrition risk. The tool was shown to correlate well with a dietitian's nutritional assessment and have a high level of sensitivity and specificity in detecting nutrition risk (Keller, Goy et al. 2005). As the validation sample in Canada was considerably younger than participants in LiLACS NZ, evaluation was deemed necessary among participants of advanced age and in the New Zealand setting.

Forty five participants were selected from the baseline cohort of LiLACS NZ according to their SCREEN II score (low, medium and high nutrition risk). Fifteen participants from each risk bracket were enrolled. Twelve months later, all 45 participants were re-screened using SCREEN II. Although there was no significant change in nutrition risk status there was a slight increase in participants found to be at high nutrition risk (SCREEN II scores <50: 38% at follow-up versus 33% at baseline) and a corresponding decrease in participants with medium nutrition risk (SCREEN II scores 50-53: 27% at follow-up versus 33% at baseline). This result was not entirely unexpected as health and consequently nutrition status declines with age (Wang 2007).

Study participants enrolled in this study lived independently in the Tauranga region of the Bay of Plenty. Tauranga is a major retirement centre with a large percentage of over- 65s. Half of the participants were married or partnered; more than the national average of 20% for people over 84 years (Statistics New Zealand 2006). Most of the participants (85%) had completed secondary school so were more highly educated than the national average (33% of adults 85 years and older have below a fifth form education). Nearly all of the participants (92%) rated their health as good to excellent and possible depression was reported in only two subjects. The mean number of medications used by participants was 5.7 ± 3.0 which signalled border line polypharmacy (5-10 polypharmacy, >10 excessive polypharmacy). The participants had a median BMI of 26.2 kg/m^2 which is ideal for this age group (Kvamme, Holmen et al. 2011), however there was a large variation in BMI (range 18.5 – 34.9kg/m^2). The demographic profile of participants indicated that they were a 'well' sample of adults in advanced age.

Nutrition screening in this study identified four nutrition risk factors that potentially increased the nutrition risk of the participants. These were: eating alone, a low milk and milk product intake, a low meat and meat alternative intake and finding cooking 'a chore'.

Eating alone was a risk factor for 62% of women versus 38% of men. This may be a reflection of the documented differences in life expectancies between men and women (Wang 2007) as older women are much more likely to be widowed and live alone than older men (Pinquart and Sörensen 2001). Indeed, 76% of women were widowed compared to 30% of men, and 71% of women lived alone compared to 38% of men. Eating alone adversely impacts nutrition risk (American Dietetic Association 2000; Ferry, Sidobre et al. 2005; Keller 2007; Dean, Raats et al. 2009). Eating is typically a social activity and social interaction at meal times is important for the enjoyment of food. When older people eat with others, especially with friends and family (de Castro 1997), there is an increase in meal size (up to 46%) (de Castro 1997; de Castro 2002), increase in calorie consumption (Ferry, Sidobre et al. 2005) and improved dietary variety (Bernstein, Tucker et al. 2002). Dietary variety in older populations is associated with higher levels of lean body mass, better nutrient and energy intakes and improved health outcomes (Bernstein, Tucker et al. 2002). The New Zealand Ministry of Health's *Food and Nutrition Guidelines for Healthy Older People* recognises eating alone as a leading, modifiable nutrition risk factor unique to this age group. 'Take opportunities to eat with others' is one of the nine 'Food and Nutrition Guideline Statements' (Ministry of Health 2010). Nutrition interventions in this age group therefore need to address the living situation of older people as a potential barrier to healthy eating.

Forty percent of participants in this study reported consuming less than the recommended three servings of milk products per day; this was similar among men and women. The nutrient analysis showed 84% of participants consumed less than three serves of milk products daily. Milk and milk products are one of the most bio-available sources of dietary calcium (Guéguen and Pointillart 2000). Therefore the high prevalence of inadequate milk product intake among older people is a concern and likely means calcium intake is sub-optimal.

Low intakes of meat and meat alternatives (less than three serves a day) was a nutrition risk factor for 40% of the participants and this was more evident in men compared to women. An earlier study offers a possible explanation; wives contribute more to husbands' dietary quality than the reverse (Schafer, Schafer et al. 1999). When men lose their spouse they may not have the skills or knowledge required in meal preparation to meet their nutritional requirements which can result in a poorer dietary quality and variety (Schafer, Schafer et al. 1999). The nutrient analysis showed over a quarter (27%) of participants consumed less than two servings of this food group (poultry, fish, eggs, nuts or tofu) per day. Protein requirements increase with aging; although participants of this study were meeting their protein requirements, it is not known whether high biological sources of protein such as meat, poultry, fish and eggs (which optimise protein synthesis) (Chernoff 2004) were included. The NNS09 reported that bread and milk were the largest sources of protein for men and women over 71 years (University of Otago and Ministry of Health 2011) and this may have been the same in the current study.

Finding cooking 'a chore' was a risk factor especially among women (women 38%, men 17%). Qualitative research has shown that women, especially those widowed and/or living alone, are more likely to find

cooking as a chore compared to men (Martin, Kayser-Jones et al. 2005) and are less inclined to cook for themselves (Locher, Ritchie et al. 2005; Martin, Kayser-Jones et al. 2005). Additionally, simple food procurement and preparation tasks such as shopping and carrying bags, may become more problematic for women without the assistance of a spouse (Ferry, Sidobre et al. 2005). Women in advanced age have a poorer functional status and more chronic diseases than men of the same age and younger women (Castel, Shahar et al. 2006). This can make standing during meal preparation and cooking more difficult (Keller 2007). Interventions such as Meals on Wheels, cooking classes and access to easy-to-prepare foods may help those who find these tasks challenging. In Canterbury programmes such as Senior Chef teaches older adults how to prepare and cook food for those identified to be at nutrition risk. Additionally Nutri E- SCREEN, a free web based service provided by the Canadian Dietitian's Association provides an opportunity for older adults to self-administer SCREEN II and gain instant individualised feedback. This type of tool can be limiting for some people in advanced age who may need assistance or resources to use an internet-based tool.

In this study it was identified that participants at nutrition risk were significantly more likely to be women, widowed, live alone, to be a current or former smoker, have some depressive symptoms, and take multiple medications (polypharmacy).

Overall, women were significantly more likely to be at nutrition risk (medium) compared to men (p=0.032). This has been reported in other studies (Quandt and Chao 2000; Castel, Shahar et al. 2006; Chen, Bai et al. 2007). In this study more women lived alone and were widowed compared to men, both of which are known nutrition risk factors (American Dietetic Association 2005). Gender differences in nutrition risk among older people appear multifaceted and can include differences in food preference, food security, health and functional status. It has been reported that older women have a preference for foods higher in fat and sugar (Toffanello, Inelmen et al. 2010) and consume less protein than their male peers (Bates, Prentice et al. 1999). The nutrient analysis from this study showed that women consumed proportionally more sugar and total carbohydrate and proportionally less protein than men (as a percentages of total energy intake). Typically women who lose their spouse report higher levels of food insecurity or difficulty with access to food due to transport difficulties (driving or taking public transport) and less money available to purchase foods (Locher, Ritchie et al. 2005). Older women are also more likely than men to report poorer health and have multiple chronic diseases (Castel, Shahar et al. 2006). Chronic disease can increase muscle catabolism which can escalate age related muscle loss (sarcopenia) and result in poor functional status (Payette, Hanusaik et al. 1998) and high levels of dependency (Payette, Gray-Donald et al. 1995).

Participants who were married were significantly more likely to be at low nutrition risk than widowed participants (p=0.006). Conversely those living alone were significantly more likely to have high nutrition risk (p=0.017). Being married has benefits for older people's nutrition status, health and mortality risk (de Castro 1997; Schafer, Schafer et al. 1999; McDonald, Quandt et al. 2000; Visvanathan, Macintosh et

al. 2003; Locher, Ritchie et al. 2005). Widowers and people living alone have higher levels of weight loss (Shahar, Fraser et al. 2003), decreased energy intakes (McDonald, Quandt et al. 2000; de Castro 2002) and poorer dietary variety (Rosenbloom and Whittington 1993; Shahar, Shai et al. 2005). These differences can be attributed to decreased interaction at meal times (Rosenbloom and Whittington 1993; de Castro 2002), food insecurity (accesses to food and financial limitations) (Shahar, Shai et al. 2005) as well as knowledge gaps in meal preparation (McDonald, Quandt et al. 2000). In addition loneliness and depression are common after bereavement and can lead to weight loss and nutrition risk (Morley and Morley 1995; Ferry, Sidobre et al. 2005).

It was not surprising to find that participants who were current or former smokers were significantly more likely to be at high nutrition risk (p=0.033). A study of 434 older people also found smokers at higher nutrition risk (based on BMI, skin folds, albumin and serum nutrient levels) and had poorer outcomes than non smokers (Gariballa and Forster 2009). The effect of smoking on nutrition status is multifactorial. Dietary data from the NHANES III found smokers have lower dietary intakes of vitamin C, folate, fibre, and vitamin B_{12} than non-smokers (Gariballa and Forster 2009). Other studies report older smokers have higher levels of weight loss and lower BMIs than non-smokers (Alibhai, Greenwood et al. 2005). Smoking accelerates aging and greatly increases the risk of multiple chronic diseases such as cancers, lung and cardiovascular diseases (Nicita-Mauro, Balbo et al. 2008). Smoking also has a negative impact on oral health (Ministry of Health 2010) which is associated with poorer nutrient intake, food avoidance and increased nutrition risk (Quandt, Chen et al. 2010). In addition, smoking alters calcium and vitamin D metabolism and reduces bone mineral density (Ministry of Health 2010) leading to an increase in hip fracture risk (Law and Hackshaw 1997). Nutrition intervention in older people who smoke has a limited effect (Morley 2007) however, people should be encouraged to stop smoking because cessation, even in old age, correlates with improved health outcomes (Doll, Peto et al. 2004).

Levels of depression in this study were low, with a median GDS score of two for all participants. Where scores greater than five indicate possible depression and scores greater than ten indicate probable depression (Sheikh and Yesavage 1986), only two participants scored greater than five and the highest reported score was eight. Nevertheless the study showed depressive symptoms were associated with high nutrition risk (median score 2.5) (p=0.016). Depressive symptoms and depression are frequently associated with increased risk of poor nutrition (Thompson and Morris 1991; Cabrera, Mesas et al. 2007; Saka, Kaya et al. 2010; Ülger, Halil et al. 2010) and a poor perceived health status (Roberts, Kaplan et al. 1997), even after controlling for age, gender, ethnicity, co-morbidities, social support and medications (Chen, Chang et al. 2005). A review by Morley and Morley stated that depression is the leading cause of weight loss in older people after 'unknown causes' (Morley and Morley 1995). This study shows that even having a few depressive symptoms may increase nutrition risk. Therefore it is arguable that adults in advanced age who are showing signs of increased nutrition risk (e.g. unexplained decrease in appetite or weight loss) should be screened for depressive symptoms.

Participants with high nutrition risk were significantly more likely to consume more medications (8.0 [4.3, 9.0]) compared to participants with low nutrition risk (4.0 [2.3, 6.8]) (p=0.03). Polypharmacy, or consuming more than five medications concurrently, was found in almost half of the participants with 11% of participants taking more than ten medications daily. The Canadian validation study of SCREEN also reported a significant association between the number of medications and SCREEN score (mean 4.2 medications per day) however this may not be comparable to the current study because participants were younger (>55years), with a mean age of 74 ± 9.1 years (Keller, McKenzie et al. 2001). Medication use in this study was lower than international reports of adults in advanced age. Jykra et al. found 65% of Finnish octogenarians consumed more than five medications per day, with 26% having more than ten medications per day. Polypharmacy was associated with higher nutrition risk, poorer ADL scores and lower MMMSE scores (Jyrkkä, Enlund et al. 2011). Other studies have found polypharmacy (>5 medications) or excessive polypharmacy (>10 medications) to be associated with nutrient malabsorption, dry mouth, taste changes, nausea and vomiting, and altered bowel habits (Pickering 2004; Jyrkkä, Enlund et al. 2011). Cognition changes, depression, elevated blood glucose levels, osteoporosis and Parkinsonism, are also associated with polypharmacy and have a negative effect on nutrition status (Ministry of Health 2010). This study has demonstrated that even among a relatively healthy sample of people in advanced age, the use of multiple medications is common and is associated with increased nutrition risk. Therefore people in advanced age should be monitored for medication related side effects and drug-nutrient interactions. This may help to avoid a decline in nutrition status.

There was a trend among participants with low nutrition risk to have a stronger grip strength than participants with medium nutrition risk (p=0.069). As grip strength is a measure of muscle function it was expected that participants with stronger grip strength would have a higher muscle mass. Participants at low nutrition risk had the highest grip strength (28.3 [21.0, 33.3]kg) and muscle mass (48.8 ± 7.8%) and participants at medium nutrition risk had the lowest grip strength (19.3 [16.7, 22.2]kg) and muscle mass (42.6 ± 8.7%). Analysis showed that grip strength was 10kg stronger in men compared to women. The median grip strength (23.4 ± 7.09kg) was similar to that found in a Georgian study of octogenarians (21.5 kg) (Cress, Yasuyuki et al. 2010). Grip strength has been shown to be associated with nutritional risk in some studies (Edington, Barnes et al. 2004), but not others (Smoliner, Norman et al. 2008; Wham, Teh et al. 2011). Smoliner et al. argue that grip strength is not a measure of nutritional status in older people because nutritional intervention has not consistently improved grip strength (Smoliner, Norman et al. 2008). Instead, grip strength should be considered a marker of frailty (Smoliner, Norman et al. 2008; Norman, Stobäus et al. 2010). However, someone who is frail is generally malnourished (Fried, Tangen et al. 2001) and is likely to require nutrition support.

A comprehensive dietary assessment from three 24 hour MPRs was used as part of the dietitians risk rating assessment. Clinical judgement was used in assessing nutrition risk. The limitations of retrospective dietary assessment in this age group include underreporting and reliance on memory (Omran and Morley 2000); thus if a participant had reported a poor nutrient intake but all other risk

factors indicated low nutrition risk (anthropometrics, medical history, functional status, and social situation) then the dietitian may not necessarily classify the participant at nutrition risk.

No significant differences were found between levels of nutrition risk and nutrient intakes. However the nutrition risk groups were likely to be too small to detect differences. Participants with low nutrition risk tended to have higher intakes of most nutrients, however once controlled for energy intake and gender, any significant difference disappeared. Macronutrient intakes were adequate for all participants, with the exception of saturated fat being higher than the AMDR and fibre intakes lower than the AMDR (NHMRC 2006a). Macronutrient intakes were similar to the NNS09 results for adults over 70 years; however, intakes of fibre were higher than the national average for older adults (University of Otago and Ministry of Health 2011).

The median intakes of folate and vitamin D among the participants were below recommendations and median sodium intakes exceeded recommendations (NHMRC 2006a). However, current food composition data is considered unreliable for these particular nutrients and serum and/or urine analysis is required for accurate assessment (University of Otago and Ministry of Health 2011). Participants' median calcium intake was low at 765mg/day and 60% of participants were not meeting the calcium RDI (1300mg/day). The results from this study were similar to the average calcium intakes for adults over 70 years from the NNS09 (710mg/day)(University of Otago and Ministry of Health 2011). The NNS09 reported the main sources of calcium for older women were milk, cheese, vegetables, bread, dairy products, and fruit. For men main sources were milk, vegetables, cheese, bread, dairy products and breakfast cereals (University of Otago and Ministry of Health 2011). The combination of low calcium intakes with inadequate serum vitamin D levels (which is common in older New Zealanders (Scragg and Bartley 2007)), may lead to an increased risk of falls, impaired mobility, and osteoporosis, all of which can increase the nutrition and mortality risk in older people (Tang, Eslick et al. 2007; University of Otago and Ministry of Health 2011).

It was identified that sixty per cent of participants had inadequate intakes of selenium. TheNNS09 reports inadequate intakes in 60% of older men and 79% of older women (>70 years). Low selenium dietary intakes are secondary to low levels of selenium found in New Zealand's soil (University of Otago and Ministry of Health 2011). Selenium requirements can be easily reached by consuming two brazil nuts a day, however some older people may find these difficult to eat.

For men, median zinc intakes were suboptimal which was also found in the NNS09 (Ministry of Health 1999; University of Otago and Ministry of Health 2011). The LiLACS feasibility study found participants with high nutrition risk were more likely to have lower serum zinc levels (Wham, Teh et al. 2011). The main dietary sources of zinc for older New Zealanders include beef and veal, milk, bread, poultry and vegetables. Manifestations of a sub-optimal zinc status include a lessened taste acuity (Morley 2007).

Zinc supplementation in deficient older adults can make food more enjoyable and stimulate appetite (Stewart-Knox, Simpson et al. 2008).

Among some of the participants, the evaluation of nutrition risk by SCREEN II (at follow-up) differed to the dietitian's evaluation of nutrition risk. The DNRR score identified fewer participants with high nutrition risk (SCREEN II n=16 vs. Dietitian n=10), more participants with medium nutrition risk (SCREEN II n=12 vs. Dietitian n =21), and similar numbers of participants at low nutrition risk (SCREEN II n=16 vs. Dietitian n = 14). This suggests the current SCREEN II cut-offs may overestimate the proportion of participants at nutrition risk (<50 high risk, 50- 53 medium risk and >53 low risk).

Below describes individual cases from the study where there were differences between the risk classification for SCREEN II and the DNRR:

- Participant A - Low risk by SCREEN II versus high risk by the DNRR due to: nausea and vomiting secondary to chemotherapy, chronic coughing and shortness of breath which equated to an increase in energy expenditure and weight loss (unreported by the participant), as well as recent bereavement.
- Participant B – Low SCREEN II risk versus medium nutrition risk by DNRR due to: cluttered and unkempt living conditions, lived alone but supported by daughter, meat and other foods left in oven over days, many cats on tables and benches (food safety), taking a lot of questionable 'naturopathic' remedies (possible drug-nutrient interactions), adequate calorie intake but very low protein intake (0.7g/kg).
- Participant C – High risk by SCREEN II versus medium nutrition risk by the DNRR due to: participant had reported poor appetite on SCREEN II however calorie intake was over 30kcal/kg, with a stable weight; reported history of skin cancers, but nothing systemic; lived alone, but in a very supportive community with a 'lady friend' a few houses down. Drank up to four glasses of alcohol per day, but this did not appear to replace food as was having three balanced meals +/- snacks. Was still very active and enjoyed international travel.

As demonstrated by these examples, factors contributing to nutrition risk can be complex and stem from various physical, social, psychological as well as dietary causes. These examples support the need to use a combination of subjective and objective measures to determine the DNRR score.

Validation of SCREEN II was achieved by creating an ROC curve which compared participants' SCREEN II scores against their DNRR scores (criterion). The same method was used in the previous SCREEN (I and II) validation studies (Keller, McKenzie et al. 2001; Keller, Goy et al. 2005). The ROC curve outputs demonstrated that the proposed cut-off for high nutrition risk should be decreased from <50 to <49 (sensitivity= 90%, specificity=86%) and the cut-off for medium risk should remain at >53 (sensitivity=88%, specificity=71%). Using these new cut-offs, 36%, 31% and 33% of participants would be at low, medium

and high nutrition risk respectively, compared to the original cut-offs where 36%, 27% and 38% of participants were classified at low, medium and high nutrition risk.

Specificity and sensitivity were higher in this study compared with the original validation study by Keller et al. (sensitivity 88%, specificity 66%). Methodological differences between the SCREEN II administration methods between the studies may account for some of the difference seen in specificity. SCREEN II was self-administered in the Canadian validation studies and interviewer administered in the current study. This was to minimise respondent burden in this older group of respondents. Keller et al. acknowledge that the use of an interviewer administered tool would likely increase the sensitivity and specificity (Keller, Hedley et al. 2000). Additionally, sensitivity and specificity may be higher in this study due to the defined age group of '85 years' compared with Keller's studies who recruited a wide age group of participants 55- 99 years (Keller, McKenzie et al. 2001; Keller, Goy et al. 2005).

Although there were some discrepancies of nutrition risk classification between the DNRR score and SCREEN II, overall there was a significant correlation between SCREEN II and the DNRR score (r_s= -0.76, n-45, p <0.01). This indicates that SCREEN II is, in fact, a valid tool in detecting nutrition risk of people in advanced age.

Limitations

A small sample size and lack of randomisation were two key limitations of this study. According to the sample size calculation (Margetts and Nelson 1998), a minimum of 27 participants were required to detect significant differences in the DNRR score (based on the mean and standard deviation of the Canadian validation study). However this study also looked at a multitude of other variables such as; micronutrient and macronutrient intakes, BMI, body composition, and functional tests which require a much larger sample size to detect significant differences, therefore results must be interpreted with caution. Due to limited time and resources for data collection; a larger sample size was not feasible. Participants were unable to be randomised into the low, medium and high nutrition risk groups as recruitment for this validation study was based on participants' baseline SCREEN II score.

The participants in this study were identified to be a healthier, more independent sample of New Zealanders in advanced age. Four of the five participants that declined the study were in poor health (self-reported). Additionally all participants who participated had a MMMSE score of above 72 indicating no cognitive impairment, it is well known that older people with impaired cognitive function have a poorer nutrition status (Ministry of Health 2010).

Participants were non-Maori and results may not be applicable to older Maori. To be reliable, screening tools must be valid with respect to setting and population (Elia, Zellipour et al. 2005). The LiLACS feasibility study found that Maori were at high risk for malnutrition despite higher BMI and higher levels of activity (Wham, Dyall et al. 2011). The feasibility study also found that several items from SCREEN II were interpreted differently among Maori compared to non-Maori. This may lead to over or under

detection of nutrition risk. For this reason future research is required to validate SCREEN II among Maori.

SCREEN II was validated against a registered dietitian's nutrition risk rating. An issue with the reliability of this method, identified in an earlier study, was that dietitians were not consistent in their subjective rating of nutrition risk, therefore creating a problem for the 'gold standard' (Bryan, Jones et al. 1998). This limitation was, however, minimised in the current study as only one dietitian undertook all of the nutrition assessments. Further, the 'Standardised Dietitian's Nutrition Risk Rating Checklist' was used to maintain consistency between the assessments. Contamination bias has been identified in other screening tool validation studies (de Groot, Beck et al. 1998; Keller, Goy et al. 2005) and was a concern in this study as the dietitian researcher became more familiar with SCREEN II over time. An effort to reduce this bias was made by using four digit identifier codes for identification of the participants so that the dietitian did not associate participants' names with their baseline SCREEN II scores. Additionally the total SCREEN II scores were not tabulated until the data analysis stage.

Body composition was determined using bioelectrical impedance (Tanita Inner Scan Body Composition Monitor BC- 545). It is acknowledged that this is not the most accurate measurement for body composition in this age group as no reference values are available and the accuracy of bioelectrical impedance can be affected by fluid status and skin temperature. However the gold standards of computerised topography or DEXA (Dual-emission X-ray absorptiometry) scan were not feasible in this study.

Determining an individual's habitual dietary intake based on three days of dietary data has limitations, both in this age group and in younger age groups (Gibson 2005; Adamson, Collerton et al. 2009). Given the importance of minimising respondent burden the MPRs were considered the best option for determining nutritional intake. However dietary assessment in advanced age is prone to inaccuracies for the following reasons:

- The participant may have no knowledge of, or involvement in, food acquisition or preparation which limits the ability to accurately name or describe the foods consumed
- Impaired memory may reduce the ability to recall intake resulting in under or over reporting
- A proxy or carer may be reporting on dietary intake, but may not be with the participant at all eating occasions

(Shahar, Shai et al. 2005; Adamson, Collerton et al. 2009)

To maximise accuracy the protocol for the 24 hour MPR recall was followed closely, and tools such as the modified photographic atlas and household measures were used. To increase accuracy of portion size estimations, participants were asked to describe how much of the food they ate by using the food photographic atlas which contained a single food pictured in eight different portions. This method is

more accurate than using a single portion size photograph (Nelson, Atkinson et al. 2002). Some participants in this study had difficulty with using the food photographs if they had trouble with their eyesight or did not prepare their meals. Additionally some of the foods were light in colour on white plates (e.g. porridge and rice) and the contrast was not high enough to determine the correct portion size. In these cases household measures were used.

Nutrient intakes from the 24 hour MPRs were analysed using FoodWorks 2009, however the New Zealand food composition database used in this version of the tool did not contain the most up to date dietary information and may have caused some inaccuracies in the data analysis.

Strengths

This validation study was a sub-study of a large cohort study, LiLACS NZ, which afforded the following strengths:

- A robust methodology which followed the protocols of LiLACS NZ in all aspects of the data collection.
- The support of the LiLACS NZ staff which enabled three different days of dietary data collection using a standardised method.
- The ability to access data which was collected over two time points, 12 months apart; this enabled the inclusion of many variables.

This study has demonstrated that SCREEN II is a valid nutrition screening tool to use among non-Maori people of advanced age. Other community based studies in this age group may use this tool with confidence. Currently malnutrition is poorly detected and undertreated, especially in community dwelling older adults in advanced age. SCREEN II is useful in identifying nutrition risk factors as well as sub-optimal nutrition status. Community based health care services and clinicians may be able to use this tool to develop appropriate interventions to help prevent a decline in health and quality of life associated with poor nutrition status.

6.0 Conclusion

This study has been the first to demonstrate that SCREEN II is a valid tool for the assessment of nutrition risk in community dwelling older people. The findings from this study show a strong correlation between the DNRR and the SCREEN II scores (r_s = -0.76 (p<0.01)) which indicates that SCREEN II is a valid tool for detection of nutrition risk in this older age group. As derived from the ROC curves, a newly defined cut-off of <49 would more accurately assess high nutrition risk (AUC 0.87, p value < 0.01). This cut-off is associated with a high specificity (86%) and sensitivity (90%) and is recommended for future nutrition risk assessment of non - Maori in this age group.

Although the sample size in this study was small, findings do add to the body of evidence that high nutrition risk is evident in a third of community-dwelling older people of advanced age. Living alone, being widowed, smoking, depressive symptoms and polypharmacy were factors associated with being at high risk of malnutrition.

Nutrition risk factor items identified in SCREEN II were eating alone, consuming less than three serves of milk products a day, less than two serves of meat or meat alternatives a day, and women finding cooking 'a chore'. Effective nutrition interventions may need to include appealing food preparation ideas. Senior cooking classes may help to mitigate the low servings of meat.

As evident in the NNS09 for older people over 70 years, this study also found low intakes of calcium, selenium, folate, and zinc. Strategies to address the low intakes are outlined in the Ministry of Health's 'Food and Nutrition Guidelines for Healthy Older Adults'.

 In summary this study has shown that SCREEN II is an easy to use, nutrition screening tool to identify nutrition risk in non- Maori older adults. The identification of a valid cut-off to determine high nutrition risk in advanced age will enhance the reliability of findings which seek to identify the relationship between nutrition risk status and health outcomes.

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Appendices

- Weight change reported in both pounds and kilograms
- LiLACS NZ has copyright license for the use of SCREENII

SCREENII Score

SCREENII- Interviewer

Name: _____ Date: _____

- You will be asking the senior questions about his/her eating habits.
- Emphasize that you are asking about their *typical day*.
- Indicate that there are no right or wrong answers, only answers that best describe their eating habits.
- Read each question slowly and clearly. Repeat questions as needed.
- Use the question as a starting point for discussion. Through conversation you will probably learn which answer describes them best. Check the most appropriate response.
- To help answer some questions, it may be easier to show the senior the options.
- Record any pertinent information in the Notes & Comments column on the right.
- Add up the numbers beside the checked responses and enter the total score in the box.
- Compare score to SCREEN Scoring Guide.

Notes & Comments

1a. Has your weight changed in the past 6 months?

- 4☐ No, my weight stayed within a few pounds.
- 0☐ I don't know how much I weigh or if my weight has changed.

Yes, *I gained ...*
- 0☐ more than 10 pounds
- 1☐ 6 to 10 pounds
- 2☐ about 5 pounds

Yes, *I lost ...*
- 0☐ more than 10 pounds
- 1☐ 6 to 10 pounds
- 2☐ about 5 pounds

1b. Have you been trying to change your weight in the past 6 months?

- 4☐ Yes
- 4☐ No
- 0☐ No, but it changed anyway

1c. Do you think your weight is ...?
- 0☐ more than it should be
- 4☐ just right
- 0☐ less than it should be

2. Do you skip meals?
- 4☐ Never or rarely
- 2☐ Sometimes
- 1☐ Often
- 0☐ Almost every day

3. Do you limit or avoid certain foods?
- 4☐ I eat most foods.
- 2☐ I limit some foods and I am managing fine.
- 0☐ I limit some foods and I am finding it difficult to manage.

4. How would you describe your appetite?
- 4☐ Very good
- 3☐ Good
- 2☐ Fair
- 0☐ Poor

5. How many pieces or servings of fruit and vegetables do you eat in a day?
Fruit and vegetables can be canned, fresh, frozen, or juice.
- 4☐ Five or more
- 3☐ Four
- 2☐ Three
- 1☐ Two
- 0☐ Less than two

6. How often do you eat meat, eggs, fish, poultry, OR meat alternatives?
Meat alternatives are dried peas, beans, lentils, nuts, peanut butter, tofu.
- 4☐ Two or more times a day
- 3☐ One to two times a day
- 1☐ Once a day
- 0☐ Less than once a day

7. How often do you have milk products?
Includes fluid milk, cooking with milk, milk puddings, ice cream, cheese, yogurt, and milk alternatives like fortified soy beverages.

- 4☐ Three or more times a day
- 3☐ Two to three times a day
- 2☐ One to two times a day
- 1☐ Usually once a day
- 0☐ Less than once a day

8. How much fluid do you drink in a day?
Includes: water, tea, coffee, herbal drinks, juice, and soft drinks, but not alcohol.

- 4☐ Eight or more cups
- 3☐ Five to seven cups
- 2☐ Three to four cups
- 1☐ About two cups
- 0☐ Less than two cups

9. Do you cough, choke or have pain when swallowing food OR fluids?

- 4☐ Never
- 3☐ Rarely
- 1☐ Sometimes
- 0☐ Often or always

10. Is biting or chewing food difficult for you?

- 4☐ Never
- 3☐ Rarely
- 2☐ Sometimes
- 0☐ Often or always

11. Do you use commercial meal replacements or supplements?
Shakes, puddings, or energy bars

- 4☐ Never or rarely
- 2☐ Sometimes
- 0☐ Often or always

12. Do you eat one or more meals a day with someone?

- 0☐ Never or rarely
- 2☐ Sometimes
- 3☐ Often
- 4☐ Almost always

13a. Who usually prepares your meals?

- ☐ I do.
- ☐ I share my cooking with someone else.
- ☐ Someone else cooks most of my meals.

13b. Which statement best describes meal preparation for you?

- 4☐ I enjoy cooking most of my meals.
- 2☐ I *sometimes* find cooking a chore.
- 0☐ I *usually* find cooking a chore.
- 4☐ I'm *satisfied* with the quality of food prepared by others.
- 0☐ I'm *not satisfied* with the quality of food prepared by others.

14. Do you have any problems getting your groceries?
Problems can be poor health or disability, limited income, lack of transportation, weather conditions, or finding someone to shop.

- 4☐ Never or rarely
- 2☐ Sometimes
- 1☐ Often
- 0☐ Always

THE LILAC STUDY

DIETARY ASSESSMENT: 24 HOUR RECALL

LILACS NZ

PARTICIPANT'S NAME	

| PARTICIPANT'S ID NUMBER | | | | |

| GENDER | |

| DATE OF BIRTH | | | | | | |

| DAY OF WEEK RECALLED | |

| TODAY'S DATE | | | | | | |

| STUDY NURSE NAME | |

| START TIME | | | | |

Quick List													

Time (24 hr)	Description of food or drink (as much detail as possible)	Homemade / retail	Cooking method	Brand	Amount served	Leftover	To be completed by nutritionist	
		Homemade: H Retail: R Or N/A If H: Prompt for recipes	Oven : O Fried : F Grilled : G Boiled: B Steamed: S Or N/A		Photo code OR Preface with W: Weight H: Household	Photo code OR Preface with W: Weight H: Household AA: Ate All	Food code	Weight

RECIPE 1:
Name of home-made dish: _____

Ingredients	Amount

Cooking method

RECIPE 2:
Name of home-made dish: _____

Ingredients	Amount

Cooking method

1. **Was the amount of food that you had yesterday about what you usually have, less than usual or more than usual?**

   Usual amount.. 1
   Less than usual.. 2
   More than usual... 3
   Don't know.. 7
   Refused to answer... 9
   Not asked.. 0

2. **Was the amount of drink that you had yesterday about what you usually have, less than usual or more than usual?**

   Usual amount.. 1
   Less than usual.. 2
   More than usual... 3
   Don't know.. 7
   Refused to answer... 9
   Not asked.. 0

3. **Did YOU / OR the respondent have difficulty with this interview? (please circle appropriate response)**

   Yes.. 1   (Go to Question 4)
   No.. 2   (Go to Question 5)
   Not asked.. 0

4. **What was the reason for this difficulty?**

   Did not understand the questions................................ 01
   Poor memory of food.. 02
   Did not prepare food... 03
   Sick.. 04
   Visual impairment... 05
   Hearing impairment... 06
   Language barrier.. 07
   Uncooperative/impatient.. 08
   Frequent interruptions... 09
   Other (specify).. 10
   Not applicable... 98
   Recall not completed... 90

5. **Overall, how well do you think the record reflects what the respondent ate and drank over this 24 hour period**

   Good.. 1
   Moderate.. 2
   Poor.. 3
   Recall not completed.. 0

6. **Please add any additional comments in the box below:**

7. **24 HOUR RECALL COMPLETED WITH:**

   PARTICIPANT ALONE.. 1
   PROXY ALONE... 2
   PARTICIPANT AND PROXY.. 3
   RECALL NOT COMPLETED... 0

   IF 3 WAS THIS

   MAINLY PARTICIPANT... 1
   MAINLY PROXY.. 2
   EQUAL CONTRIBUTION.. 3

   NOT APPLICABLE... 8
   RECALL NOT COMPLETED.. 0

PROMPT CARD 1

Coffee, tea, soft drinks or milk

Alcoholic drinks

Biscuits, cakes, sweets, chocolate bars or other confectionery

Crisps, peanuts or other snacks

Sauces, dressings, salt and sugar

Nutritional supplements – such as Fortisip, Ensure, Resource Plus or Complan?

Anything else you have not already told me about?

TEN STEPS

1. TRANSFER ITEM FROM QUICK LIST AND TICK BOX.

2. ASK: 'About what time was that' AND RECORD TIME.

3. ASK FOR DETAILED DESCRIPTION- GET AS MUCH INFORMATION AS POSSIBLE AND RECORD THIS.

4. ASK ABOUT COOKING METHOD (IF APPROPRIATE) AND RECORD THIS

5. ASK FOR BRAND NAME AND RECORD THIS (IF RECALLED AT FIRST REQUEST, OTHERWISE LEAVE UNTIL THE END).

6. ASK FOR AMOUNT (IDENTIFY WHETHER WEIGHT, PHOTO OR HOUSEHOLD MEASURE) AND RECORD THIS. N.B. RECORD THE AMOUNT SERVED NOT THE AMOUNT EATEN.

7. PROMPT FOR RECIPES; RECORD EACH INGREDIENT ON A SEPARATE LINE.

   BEFORE MOVING ONTO THE NEXT ITEM ON THE QUICK LIST:

8. ASK ABOUT LEFTOVERS AND RECORD IN LEFTOVERS COLUMN.

9. ASK ABOUT SECOND HELPINGS AND RECORD ON SEPARATE LINE.

10. CHECK FOR COMMONLY FORGOTTON ITEMS USING PROMPT CARD 1.

   THEN GO TO NEXT ITEM ON LIST

Appendix 4: Photographic atlas page - single food kumara

KMA58

KMB99

KMC140

KMD181

KME221

KMF262

KMG303

KMH344

Appendix 6: Photographic atlas page - guide page crockery
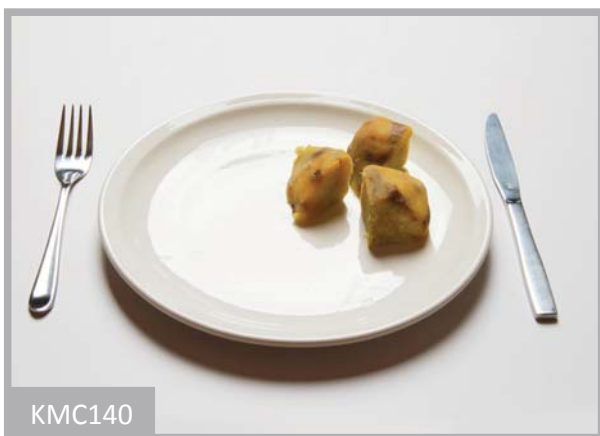
Equivalent Foods

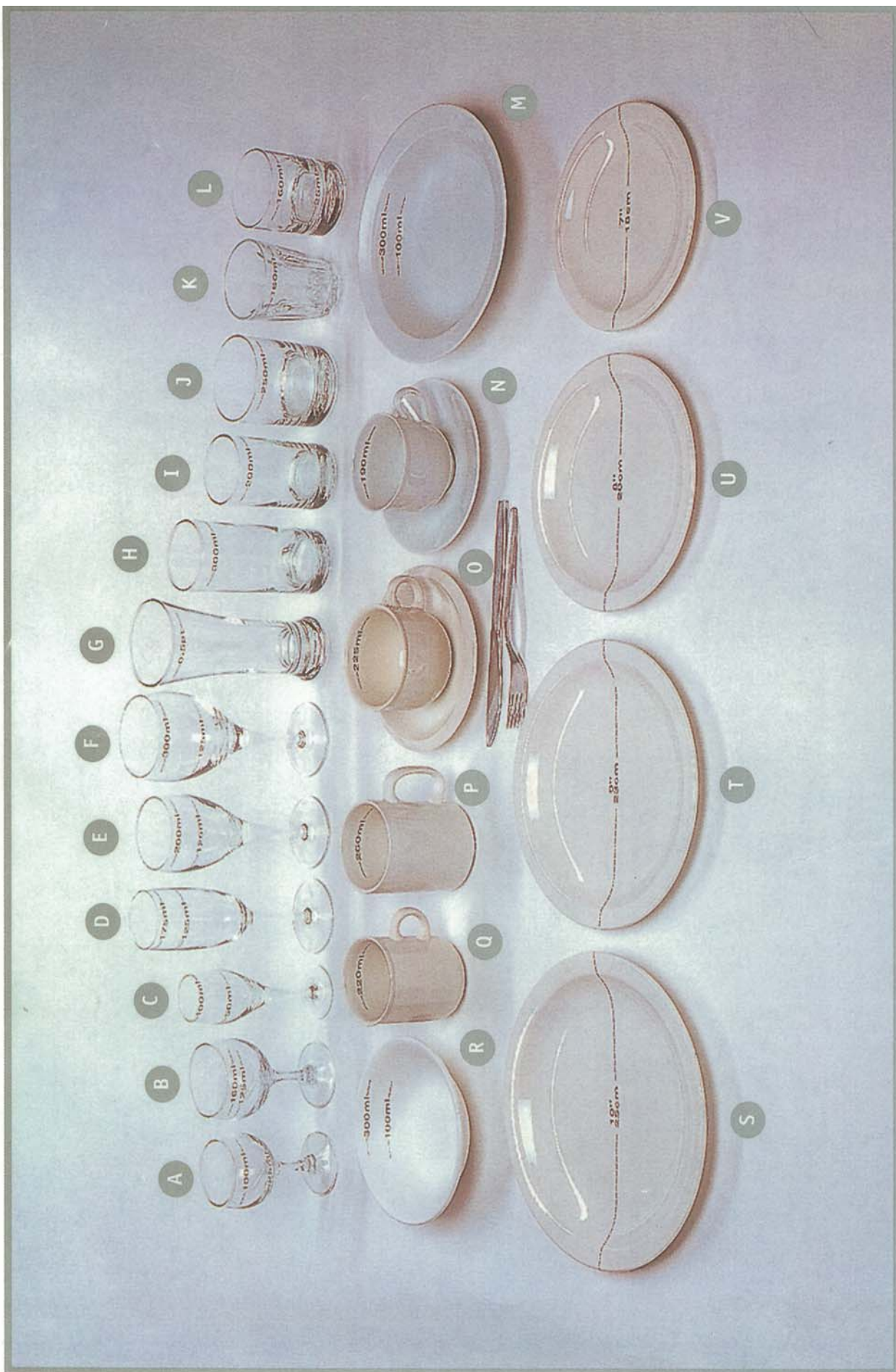There are many foods whose appearance on the plate and/or density are similar to foods which have been selected for the Atlas. It may therefore be possible to use the existing photographs to represent volumes of foods. For example, sweetcorn, although different in colour from mixed vegetables (58) and peas (60), is nonetheless similar in terms of the size of individual items, the way it falls on the plate when served, and density. Thus it may be possible to use the photographs of mixed vegetables or peas to represent the size of a serving of sweetcorn.

The following list of equivalent foods is not meant to be exhaustive. It is intended merely to provide some suggestions. There are no doubt many other equivalent foods which would be appropriate. Items marked with an * may have densities very different from the food photographed, and any estimate of weight based on the photographed food will need to be adjusted accordingly.

Pg No.	Food Photograph	Equivalent foods
1	RI Rice	
2	PS Pasta Shells	Other pasta shapes
3	SG Spaghetti	Noodles
4	AB All Bran	Other bran type cereals
5	CN Cornflakes	Other similar cereals
6	MS Muesli	
7	PG Porridge	Rice porridge
8	FC Fruit cake	All fruit cakes*
9	GT Gateau	Similar cakes with cream
10	LC Loaf cake	Other similar 'loaf cakes' e.g. ginger loaf* , malt loaf*
11	SC Sponge cake	All sponge cakes
12	CE Cheesecake	Other similar desserts, e.g. lemon meringue pie
13	CD Custard sauce – plain	Whipped cream* Other similar desserts, e.g. mousse, yoghurt Blancmange
14	CP Custard sauce (served on standard portion of sponge pudding)	Other similar sauces poured over puddings
15	IC Ice cream	Other frozen puddings e.g. frozen yoghurt, sorbet
16	JL Jelly	Baked custard, Blancmange
17	TF Trifle	Other similar desserts
18	CH Cheddar cheese	Other 'hard' cheeses, e.g. Edam, Tasty
19	BC Brie cheese	Camembert and other soft cheeses with rind
20	CR Cream cheese	Other soft cheeses, e.g. Cheese spread, Quark Other spreads, e.g. peanut butter
21	CC Cauliflower cheese	Other vegetables served in white / cheese sauce
22	MC Macaroni cheese	Other similar pasta dishes
23	QH Quiche	Other sweet/ savoury flans
24	TB Butter- spread on toast	Margarine and other fat spreads
25	CK Butter - spread on crackers	Margarine and other fat spreads
26	RB Roast beef	Slices of other red meats
27	SK Steak	
28	MM Minced meat	Other mince based dishes, e.g. Chilli con carne

Health and Disability Ethics Committees

15 March 2011

Ms Kristy Redwood
Massey University
1158b Morrinsville Rd
RD6
Hamilton

Dear Ms Redwood -

Re: Ethics ref: **LRS/11/02/003**   (please quote in all correspondence)
     Study title: Validation of the nutritional screening tool, "Seniors in the Community
                          Risk Evaluation for Eating and Nutrition version II" (SCREEN II) in New
                          Zealanders of advance age
     Investigators: Ms Kristy Redwood, Dr Carol Wham

This study was given ethical approval by the Lower South Regional Ethics Committee on 15 March 2011. This approval is valid until 30 September 2011, provided that Annual Progress Reports are submitted (see below).

Access to ACC
For the purposes of section 32 of the Accident Compensation Act 2001, the Committee is satisfied that this study is not being conducted principally for the benefit of the manufacturer or distributor of the medicine or item in respect of which the trial is being carried out. Participants injured as a result of treatment received in this trial will therefore be eligible to be considered for compensation in respect of those injuries under the ACC scheme.

Amendments and Protocol Deviations
All significant amendments to this proposal must receive prior approval from the Committee. Significant amendments include (but are not limited to) changes to:
  — the researcher responsible for the conduct of the study at a study site
  — the addition of an extra study site
  — the design or duration of the study
  — the method of recruitment
  — information sheets and informed consent procedures.

Significant deviations from the approved protocol must be reported to the Committee as soon as possible.

Annual Progress Reports and Final Reports
The first Annual Progress Report for this study is due to the Committee by 15 March 2012. The Annual Report Form that should be used is available at www.ethicscommittees.health.govt.nz.

Please note that if you do not provide a progress report by this date, ethical approval may be withdrawn.

A Final Report is also required at the conclusion of the study. The Final Report Form is also available at www.ethicscommittees.health.govt.nz.

We wish you all the best with your study.

Yours sincerely

[e-signed]

Rohan Murphy
Administrator
Lower South Regional Ethics Committee
Email: lowersouth_ethicscommittee@moh.govt.nz

Information Sheet

DETERMINING YOUR FOOD AND NUTRITION INTAKE

Hello I'm Kristy Redwood, a student at Massey University working towards my Masters of Science in Human Nutrition.

I would like to invite you to participate in a nutrition project about older people. Please read this carefully before deciding whether or not to participate. Participation is entirely voluntary.

The aim of this project is to determine if the questionnaire, SCREEN II, is accurate in determining nutrition risk. I have asked you to participate as you are part of the LILACS NZ study.

Should you agree to take part you will be invited to:

- Partake in one additional 24 hour dietary recall. This will be completed by myself (the study dietitian) during a home visit and will take approximately 45 minutes

- Additionally you will be asked to complete a nutrition questionnaire which will take approximately 10 minutes

Thank you for considering this study, I will be in phone contact with you over the next week or so to answer any questions. If you would like to participate, I will make an appointment with you for a home visit, preferably on a Sunday or Monday.

Previous information gathered by the LILACS researchers will also be collated. You may withdraw at any time without any disadvantage to yourself of any kind.

Data will be used only for this and the LILACS study. Your name will not be used. All results will be stored safely and only the study researchers will have access to the results.

Please let me know if you would like to receive a copy of the results.

You will be asked if you want your GP to be informed of your participation in the study.

If you have any questions or concerns about your rights as a participant in the study either now or in the future you may wish to contact a Health and Disability Advocate,   Telephone: 0800 423 638.

This study has been reviewed and approved by the Lower South Regional Ethics Committee.

If you have any questions about the project please feel free to contact either myself or my supervisor.

Thank you,

Kristy Redwood

Investigator
Kristy Redwood NZRD
Masters Student
Ph: 0223658015
Home: 07 856 9900

Supervisor
Dr. Carol Wham
Senior Lecturer
Massey University
Ph: 09 414 0800 ext. 41130

Consent form

DETERMINING YOUR FOOD AND NUTRITION INTAKE

- I have read and I understand the information sheet for volunteers.

- I understand the study is designed to look at the dietary intakes in community living, older adults and to assess nutrition risk.

- I understand that this study requires a home visit of about one hour.

- I have had a chance to talk about the study and ask questions. I am satisfied with the answers I have been given.

- I have had the opportunity to use family / whanau support or a friend to help me ask questions and understand the study.

- I agree to the researcher using my previously gathered study data from LILACS NZ

I understand:

- That taking part in this study is voluntary (my choice)

- I may withdraw from the study at any time and this will in no way affect my future health care.

- I have had this project explained to me by Kristy Redwood, Study Dietitian.

- That my participation in this study is confidential and that no material which could identify me will be used in any reports on this study.
- I have had time to consider whether to take part.
- I know who to contact if I have any questions about the study

If you agree to participate, this consent form will be signed during the interview.

I consent to my GP being informed about my participation in this study.

   YES   /   NO   (please circle response)

I wish to receive a copy of the results at the completion of the project.

   YES   /   NO(please circle response)

I_____ (full name) hereby consent to take

   part in this study.

Date _____Signature_____

Investigator
Kristy Redwood NZRD
Masters Student
Ph: 022 365 8015

Supervisor
Dr. Carol Wham
Senior Lecturer
Massey University
Ph: 09 414 0800 ext. 41130

Appendix 11: Standardised Dietitian's Nutrition Risk Rating Checklist

Domain	Risk Factor/ Question	Low (1-4)	Med (5 – 7)	High (8 – 10)	Comments
Body composition	Physical Assessment	80 – 110% ideal body weight BMI 22 – 30	70 – 79 % ideal body weight BMI 20 – 22 or BMI > 30	70% ideal body weight BMI < 20	Look for Oedema
	Annual weight change	None Less than 5% gain or loss	5% loss –stabilization or gain >5% weight gain in those overweight	>5% loss with ongoing weight loss >5% weight gain in those obese >10% loss annually	
Diet	Nutrient intake	1-2 nutrients <67% RDA	3- 5 nutrients <67% of RDA	>5 nutrients 67% below RDA	
	Calorie intake	Adequate	Less than 25kcal/ kg	Less than 20kcal/kg	
	Food group	Meeting requirement of all food groups	Not meeting requirements in 1- 2 food groups	>2 food groups not meeting req. OR misses 1 group completely	
Medical	GI problems	None or rarely: nausea, vomiting, diarrhoea, abdominal pain or anorexia	Some of: nausea , vomiting, diarrhoea, abdominal pain, or anorexia (multiple times per month – daily)	Acute GI distress / malabsorption Diarrhoea, anorexia, nausea, vomiting (Chronically/ daily 2/52) Recent/multiple bowel surgeries	
	Medical conditions	No medical conditions	Multiple Chronic Medical conditions e.g. CHF, osteoporosis uncontrolled DM, significant arthritis	Multiple conditions that affect oral intake or metabolic rate (Stroke, RF, COPD, liver disease, cancer) Severe arthritis/pain Dementia	
Other	Appetite	Current intake is normal Borderline intake, but increasing	Borderline, but decreasing Inadequate w/ no change Inadequate but increasing	Intake is poor more days than good Inadequate intake and decreasing	
	Depression	Never/ rarely down hearted or depressed	GDS >5 Recent bereavement / stress	GDS >10 Recent bereavement / stress	
	Dependency	EADL >18 No change in usual activities	EADL 15- 18 Somewhat dependent on others for cooking and shopping	EADL <15 Dependent on other for cooking and shopping (outside of the home)	
	Mobility	SPPB 9 – 12 stable / no change	SPPB 7- 8 or higher score but worsening	SPPB 6 or less	
	Poly pharmacy	<5 Medications (including OTC)	5- 9medications	>10 medications	
	Nutritional Supplements	No sip feeds	Occasional use –no script	On prescription	
	Living situation	Rarely or never eats alone Lives with others	Often eats alone Lives alone with support	Always eats alone Lives alone with no support	
	Hearing and vision	No problems to moderate w/ vision or hearing	Vision interferes very much Hearing interferes very much to	Vision interferes extremely (blindness)	

			extremely
Oral health	Most teeth or dentures fit well	Missing rear opposing teeth, ill fitting dentures, chewing issues	Edentulous poorly fitting dentures, mouth pain – affecting intake / texture
Food Security	No problems buying or accessing food	Sometimes have problems buying and/or accessing food	Often or always have problems buying and/ or accessing food
Pain	None or mild up to 4	Moderate chronic pain 5- 7	High level, chronic 8 – 10
Substance abuse	Less than 20g/day with a few alcohol free days	More than 20g/d Smoker	Excessive intake more than 6 drinks on drinking occasions, most days of week Heavy smoker
Chemosensory changes	No noticed changes	Moderate changes – affects intake	Lost sense of smell or taste-affecting intake
Eating pace	No change	Eats a bit more slowly	Eats significantly more slowly – doesn't finish meals
Food patterns/ textures	3 meals day + snacks	Frequently misses a meal Excludes foods/ group Recent change in textures to soft	Eats one meal per day +/- a few snack Excessive food restrictions Eats mostly soft/blended foods
Fluid intakes (total water)	≥2.8L day women ≥3.4 L men or 30-40 mls/kg body weight	<2.8L day women <3.4 L men or <30-40 mls/kg body weight Fluid restriction	Less than 1L intake (unless on fluid restriction)
Perceived state of health	Excellent / Very good	Good/ Fair	Poor

Food groups	Servings	Avg
Fruit and vegetable ½ cup cooked , 1 cup raw, 1 piece of fruit, 25 g dried fruit, glass of juice	5+	
Meat and Non meat 100g meat, 1 egg, 120g steak, fish fillet, 2 drumsticks, 135g beans/lentil	1+	
Dairy products 250mls milk, 150g yogurt, 40g cheese, 150g milk pudding	2+	
Breads and Cereals Bread slice (26g), 1 cup cereal, .5 cup muesli, 1 cup rice, 2 plain biscuit	6+	

Other measures	
W:H ratio	
Waist measure	
Grip strength?	
Total Kj (Schofield (BMR + 1.5 for PAL))	
Kj/kg	
% intake of	
Fat (20 – 35%) / safa%	
Protein (15- 25%)	
Carbohydrates (45-65%)	
Protein intake (g/kg) RDI (1.07/kg)	

Appendix 12: Nutrient Reference Values for Australia and New Zealand Older People (p.142-143, Ministry of Health 2010)

Nutrient	Women aged 51–70 years RDI	Women aged > 70 years RDI	Men aged 51–70 years RDI	Men aged > 70 years RDI
Macronutrients and dietary fibre				
Protein (g)	46	57	64	81
Carbohydrate (g)	–	–	–	–
Dietary fibre (g)	25 (AI)	25 (AI)	30 (AI)	30 (AI)
Total fat (g)	–	–	–	–
Linoleic acid (g)	8 (AI)	8 (AI)	13 (AI)	13 (AI)
A-linolenic acid (g)	0.8 (AI)	0.8 (AI)	1.3 (AI)	1.3 (AI)
LCPUFA n-3 fatty acids (mg) (DHA, EPA, DPA)	90 (AI)	90 (AI)	160 (AI)	160 (AI)
Minerals				
Calcium (mg)	1300	1300	1000	1300
Phosphorous (mg)	1000	1000	1000	1000
Zinc (mg)	8	8	14	14
Iron (mg)	8	8	8	8
Magnesium (mg)	320	320	420	420
Iodine (μg)	150	150	150	150
Selenium (μg)	60	60	70	70
Copper (mg)	1.2 (AI)	1.2 (AI)	1.7 (AI)	1.7 (AI)
Fluoride (mg)	3.0 (AI)	3.0 (AI)	4.0 (AI)	4.0 (AI)
Sodium (mg)	460–920 (AI)	460–920 (AI)	460–920 (AI)	460–920 (AI)
Potassium (mg)	2800 (AI)	2800 (AI)	3800 (AI)	3800 (AI)
Fat soluble vitamins				
Vitamin A (μg RE)	700	700	900	900
Vitamin D (μg)*	10 (AI)	15 (AI)	10 (AI)	15 (AI)
Vitamin E (mg α-TE)	7 (AI)	7 (AI)	10 (AI)	10 (AI)

Nutrient	Women aged 51–70 years RDI	Women aged > 70 years RDI	Men aged 51–70 years RDI	Men aged > 70 years RDI
Water soluble vitamins				
Thiamin (mg)	1.1	1.1	1.2	1.2
Riboflavin (mg)	1.1	1.3	1.3	1.6
Niacin (mg NE)	14	14	16	16
Vitamin B_6 (mg)	1.5	1.5	1.7	1.7
Vitamin B_{12} (μg)	2.4	2.4	2.4	2.4
Folate (μg DFEs)	400	400	400	400
Pantothenic acid (mg)	4.0 (AI)	4.0 (AI)	6.0 (AI)	6.0 (AI)
Biotin (μg)	25 (AI)	25 (AI)	30 (AI)	30 (AI)
Vitamin C (mg)	45	45	45	45
Choline (mg)	425 (AI)	425 (AI)	550 (AI)	550 (AI)
Total water (L) (including food and fluids)	2.8	2.8	3.4	3.4
From fluids only (L)	2.1	2.1	2.6	2.6

Notes:

– = not established; α-TE = alpha-tocopherol equivalents; AI = adequate intake; DHA = docosahexaenoic acid; DFE = dietary folate equivalents; DPA = docosapentaenoic acid; EPA = eicosapentaenoic acid; LCPUFA = long chain polyunsaturated fatty acid; NE = niacin equivalent; NP = not possible to set – there may be insufficient evidence or no clear level for adverse effects; RDI = recommended dietary intake; RE = retinol equivalent.

* Assumes minimal sun exposure.

(NHMRC 2006a; Ministry of Health 2010)

Ministry of Health (2010). Food and Nutrition Guidelines for Healthy Older People: A background paper. Wellington, Ministry of Health
NHMRC (2006a). Nutrient Reference Values for Australia and New Zealand including Recommended Dietary Intakes. Canberra: NHRMC; Wellington: Ministry of Health.

Appendix 13: Abbreviations

ADLs	Activities of daily living
AI	*Adequate Intake (used when an RDI cannot be determined):* The average daily nutrient intake level based on observed or experimentally-determined approximations or estimates of nutrient intake by a group (or groups) of apparently healthy people that are assumed to be adequate.
AMDR	*Acceptable Macronutrient Distribution Range*: The AMDR is an estimate of the range of intake for each macronutrient for individuals (expressed as per cent contribution to energy), which would allow for an adequate intake of all the other nutrients whilst maximising general health outcome
AUC	Area under the receiver operating curve
BIA	Bio-electrical impedance analysis
BMI	Body Mass Index
DEXA	Dual-energy x-ray absorptiometry scan
DNNR	Dietitian's Nutrition Risk Rating
EAR	*Estimated Average Requirement:* A daily nutrient level estimated to meet the requirements of half the healthy individuals in a particular life stage and gender group
GDS	Geriatric Depression Scale
LiLACS NZ	Life and Living in Advanced Age: a cohort study in New Zealand
MMMSE	Modified Mini Mental State Exam
MNA (SF)	Mini Nutritional Assessment (Short Form)
MUST	Malnutrition Universal Screening Tool
NEADL	Nottingham Extended Activities of Daily Living
NHANES	National Health and Nutrition Examination Survey
RDI	*Recommended Dietary Intake:* The average daily dietary intake level that is sufficient to meet the nutrient requirements of nearly all (97–98 per cent) healthy individuals in a particular life stage and gender group
ROC curve	Receiver operating characteristic curve
SCREEN II	Seniors in the Community: Risk Evaluation for Eating and Nutrition version II