Investigation of protein intakes of Māori in advanced age

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Abstract

Aim: Current knowledge of protein intakes of Māori in advanced age is extremely limited.

Methods: Dietary intakes of 216 Māori men and women aged 80-90 years were assessed using two 24 hour multiple pass recall dietary recalls. Energy, protein and nutrient intakes were analysed using FOODfiles 2010. Animal vs. plant protein intake, protein intake distribution and protein intake from Kai Māori and contemporary Māori foods protein intakes were examined.

Results: Protein intake and percentage of energy as protein consumed met the nutrient reference values for both genders. The intake of animal protein (men = 52.7g, women = 36.6g) was higher than for plant protein (men = 19.8g, women = 18.5g), and the animal: plant ratios for men and women were 2.63 and 1.94, respectively (p=0.009). Poultry, fish and seafood were the highest contributors of protein intake and percentage energy of protein in men and women. Protein intake at breakfast (men = 11.7g, women = 9.7g) and lunch (men = 16.8g, women = 14.8g) were inadequate (<30g protein per meal) and similar between the genders (p>0.05). Men consumed a larger median amount of protein at dinner than women (34.4g versus 23.3g, p<0.001). For men and women respectively there was a low contribution of protein from Kai Māori (median 1.31g and 1.08g) and contemporary Māori foods (median 3.28g and 2.65).

Conclusion: Advanced age Māori met the total and percentage of energy protein requirements but protein distribution was inadequate in light of recent evidence. They had a higher intake of animal compared to plant protein foods. Traditional Māori foods contributed only a small proportion of protein to the diets of these advanced age Māori.

Key words: protein intake, Māori, nutrition, animal protein, plant protein, protein distribution, traditional food, kai, advanced age, older adults

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Abbreviations

FAO	Food and Agricultural Organization of the United States
g	Grams
EAR	Estimated Average Requirements
MOH	Ministry of Health
NHANES III	National Health and Nutrition Examination Survey
NNS08/09	New Zealand National Nutrition Survey 2008/09
NRV	Nutrient Reference Values
NZ	New Zealand
UL	Upper Limit
WHO	World Health Organization

1.0 Introduction

Māori are the indigenous peoples of New Zealand (NZ). Māori ancestors journeyed to NZ more than ten centuries ago in waka (canoes) (Whiu, McKerchar, & Maxted, 2008). NZ was colonised by European settlers in the 1700's. In 1840 the Treaty of Waitangi was signed (Whiu et al., 2008). The Treaty of Waitangi is an agreement between the British Crown and Māori chiefs (NZ History Online, 2013). The aim of the Treaty was to agree to safety and equality between the Māori and the British (Whiu et al., 2008).

The Māori population today is young but ageing (Statistics New Zealand, 2012a). Māori are living longer, with a life expectancy at birth for Māori men and women of 72.8 years and 76.5 years respectively in 2012 (Statistics New Zealand, 2013c). Disparities in health status are prevalent in Māori, such as higher prevalence of chronic diseases (Ministry of Health, 2013a) and increased socioeconomic deprivation (University of Otago, 2007), which has resulted in a 7 year gap in life expectancy between Māori and non-Māori (Statistics New Zealand, 2013c).

Knowledge about food and nutrition intake in older Māori is currently very limited, particularly in those who have lived to advanced age (80-90 years). The National Nutrition Survey 2008/09 of NZ (NNS08/09) has investigated the nutritional intake of adult Māori; however data have been aggregated for Māori 51+ years and for Māori and non-Māori aged 71+ years due to low numbers (University of Otago & Ministry of Health, 2011). This is problematic as often nutrient recommendations, including protein intake, differ for adults aged 50 to 70 years and for those 71+ years (NHMRC & MoH, 2005).

The dietary protein status of older people is influenced by their higher protein requirements (NHMRC & MoH, 2005), adequacy of energy intakes, the quality of the protein source (animal versus plant proteins) (Y. Lin et al., 2011), and protein distribution throughout the day (Symons, Sheffield-Moore, Wolfe, & Paddon-Jones, 2009a).

Adequate energy and protein intake in older adults is very important to preserve muscle mass, strength and function (Breen & Phillips, 2011). The NNS08/09 reported that greater than 13% of 71+ year old New Zealanders have an inadequate protein intake (University of Otago & Ministry of Health, 2011). Nutritional status is often compromised in older age due to inadequate food intake (Hickson, 2006) which suggests inadequate protein intake may be prevalent in advanced age adults; however there is currently no research to support this.

Animal proteins have a higher biological value when compared with plant proteins, which are often missing one or more essential amino acids (Young & Pellett, 1994).

High animal protein intakes have been associated with approximately 40% greater total and appendicular lean muscle mass in older people which are beneficial for preserving muscle strength and function (Houston et al., 2008). Total amounts of animal and plant protein intakes in NZ adults have not been determined; however the NNS08/09 investigated the food group sources of protein in 71+ year old New Zealanders (University of Otago & Ministry of Health, 2011). Bread, a plant protein, was the largest contributor of protein to the diets of NZ older adults followed by animal protein sources; milk, beef and veal, and fish and seafood (University of Otago & Ministry of Health, 2011). However, it is unknown if these food group protein sources contribute the same amount of protein to the diets of Māori in advanced age (80-90 years).

Recent research indicates that consuming 30g of high biological value protein in one sitting increases the rate of muscle synthesis in older adults to a similar muscle synthesis rate seen in younger adults (Symons et al., 2009a). Consumption of a higher amount of high biological value protein (90g) in one sitting did not further increase the rate of muscle synthesis above that of 30g protein (Symons et al., 2009a). These findings have resulted in recommendations of consuming 30g of high-quality protein foods at every meal (Paddon-Jones & Rasmussen, 2009). This ensures protein intake is distributed throughout the day to maximally stimulate muscle protein synthesis (Paddon-Jones & Rasmussen, 2009). Daily protein intake distribution has not been investigated in older New Zealanders.

Prior to colonisation, the traditional Māori diet included forest birds, sea birds, dogs, fish and seafood as animal foods, and many plant foods such as puha (sow thistle), kumara (sweet potato) and fern root (Buck, 1950). These traditional Māori foods (kai) have special culture significance for Māori. Traditional Māori kai is considered to be conducive to good health and often high in protein (Cambie & Ferguson, 2003; Rush, Hsi, Ferguson, Williams, & Simmons, 2010). Energy was expended in hunting and gathering traditional foods, and processing of these foods was minimal (Rush et al., 2010). After colonisation some foods and cooking processes that were introduced to Māori by the explorers may be considered by some people to be traditional, such as boil ups (meat and/or bones boiled with wild green leafy vegetables and/or kumara), pork and Māori bread (Rush et al., 2010). The knowledge of traditional Māori food consumption in present day advanced age Māori is unknown, and protein intake from traditional Māori foods has not been explored.

This research aims to provide insight into the protein intake of Māori in advanced age (80-90 years). The amount of protein, type of protein sources (animal versus plant protein), food group protein intake, distribution of protein intake throughout the day, and the contribution of traditional Māori food to protein intake will be explored.

Investigating protein intakes in advanced age Māori is crucial to determine the risk of protein deficiency in this population. Protein deficiency has been associated with loss of muscle mass, strength and function, and therefore quality of life. The new knowledge this research provides is advantageous to identify whether older Māori in NZ require dietary interventions, and if so, which types of foods should be promoted and/or if the spread of protein intake should be improved. The results of this investigation will also be useful to guide iwi (Māori tribes), hapū (Māori subtribes) and whānau (Māori families) in ensuring their older members consume adequate amounts of protein, appropriate protein sources and ensure daily protein distribution meets evidence based recommendations.

2.0 Literature Review

This chapter first reviews the literature on health and nutritional status of older Māori, followed by the relationship between protein and health outcomes of older adults. Sources of animal and plant protein and protein food groups are then discussed, followed by research findings describing protein intake distribution throughout the day. Finally, aspects of traditional Māori food will be explored.

2.1 Older Māori in NZ

The population aged 80+ years is the most rapidly increasing age group in the developed world (WHO, 2013). In NZ the advanced age population has increased by 29% from 2006 to 2013, bringing the current 80+ year old population to over 73,000 people (Statistics New Zealand, 2013a). In the future this age group is expected to increase to between 180,000 to 210,000 people by 2036, and to a further 290,000 to 430,000 people by 2061, depending on migration and fertility rates (Statistics New Zealand, 2012c).

In the 2013 Census, almost 15% of the NZ population identified themselves as Māori (Statistics New Zealand, 2013a). While the Māori population is considered youthful, with a median age of 23.9 years (Statistics New Zealand, 2013a), there are currently over 5,400 Māori people aged 80+ years living in NZ (Statistics New Zealand, 2013b). However, both the Māori and total NZ populations are ageing (Statistics New Zealand, 2012b). It is predicted that the number and proportion of older Māori will continue to increase over the next 40 years (Waldon, 2004).

Statistics New Zealand (2012c) reports that the ageing of the Māori and NZ populations is not solely attributed to the ageing of the "baby boomers" – the population group born between 1945 and 1959 after the fertility rate increased dramatically secondary to the return of soldiers from the Second World War (Pool & Du Plessis, 2012). It is also influenced by a lower birth rate and an increased life expectancy (Cornwall & Davey, 2004). After the baby boomers have progressed through the age structure, the NZ population is unlikely to automatically revert to a younger population structure (Statistics New Zealand, 2012c).

Māori experience a lower life expectancy compared with the NZ population. In 2006, Māori men aged 50 years were expected to live to 74.6 years while Māori women of the same age were predicted to live to 77.8 years (Ministry of Health, 2011). On the other hand, the life expectancy of non-Māori of the same age in 2006 was at least 6 years more than Māori which demonstrates the large health inequalities between Māori and non-Māori (Ministry of Health, 2011).

Many older Māori are kaumātua – Māori elders highly respected for their knowledge and wisdom who play a vital role in Māori society (Higgins & Meredith, 2013).

Traditionally, kaumātua are the protectors of tribal knowledge, traditions and tikanga Māori (Māori culture) (Higgins & Meredith, 2013). They are the leaders of the tribe and play a crucial role within whānau, hapū and iwi, using their wisdom and knowledge to enhance their community (Ministry of Health, 1997; Higgins & Meredith, 2013). The lower life expectancy of Māori results in the loss of the kaumātua's invaluable knowledge and wisdom and the Māori community loses a great influence and leader (Ministry of Health, 1997). Kaumātua who pass away prematurely are not able to fully enhance Māori society (Ministry of Health, 1997).

2.1.1 Implications of the ageing population in NZ

There are growing concerns regarding the implications of an ageing population, both in NZ and in many other developed countries (Jacobzone, 1999). In NZ the key socio-economic concerns are: increased healthcare costs, as older people have higher co-morbidity risk and more frequently use health services (Parliamentary Library, 2011), and the sustainability of superannuation and other services for older adults such as housing, transport and community support services (Statistics New Zealand, 2000). A change in the ratio of those who work and pay tax to those who receive tax-funded benefits, also known as the dependency ratio, is occurring (Cohen, 2003). The main factor contributing to the growing dependency ratio is that ageing populations have a fast growing 65+ year old population with a slower growing 15-64 year old population (Cohen, 2003). Fertility rates in NZ are declining and the ratio of younger people to older adults is predicted to halve in the next 50 years (Parliamentary Library, 2011).

There are also implications on industry and labour forces. When older adults retire a decrease in skilled workers and a concurrent decreasing trend of young people entering these trades is likely (Ministry of Business, Innovation & Employment, 2013). Agriculture, food and forestry sectors produce 70% of NZ's merchandise export earnings (Ministry for Primary Industries, 2013); however these industries also have a high median age of workers and business owners (Parliamentary Library, 2011). Also, there is a likely increased need for aged care workers, of which most are currently funded by the government (Parliamentary Library, 2011).

Older Māori in the future are likely to be affected by a number of challenges as a result of the ageing population, for example the modification of family structures, changes to healthcare systems, and potential alterations in government services for older adults (Waldon, 2004). It has been widely reported that Māori have poorer health outcomes and higher morbidity rates than non-Māori (Ministry of Health, 2010, 2011). In the near future it is likely that there will be an increase in the demand for healthcare for the older Māori population, therefore preparation to reduce these increased costs through public health interventions and other methods is essential (Ministry of Health, 2011). It is imperative that the NZ government plans to meet the needs of the ageing population.

2.1.2 Health of Older Māori

2.1.2a The Māori perspective of health

The World Health Organization (WHO) defines health as: "Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (World Health Organization, 1948). This definition has not changed since its creation in 1948 (World Health Organization, 1948). However, this definition may not include all of the values different cultures may attribute to good health. The health of a group of people cannot be assumed unless there is an understanding of this group's cultural health beliefs (Durie, 1985).

The 'Te Whare Tapa Whā' Māori model of health is a contemporary way of explaining traditional Māori health concepts using a four-walled structure (Durie, 1985; Kingi, 2005). The four key components of Māori health are explained using the four walls of a wharenui (meeting house) which is a representation of a person's holistic health (Durie, 1994). These four walls symbolise te taha tinana (physical health), te taha hinengaro (mental/emotional health), te taha whānau (family health) and te taha wairua (spiritual health) (Durie, 1985). These components are equal in importance, and all walls need to be strong in order for a person to be healthy. If one aspect is missing or damaged, the wharenui may topple over or be unbalanced, as may a person's health (Durie, 1998).

Another Māori model of health is Te Wheke (The Octopus). Te Wheke is used to illustrate the concepts of family health (Ministry of Health, 2012c). The head, eyes and the eight tentacles of Te Wheke represent the 10 key components of Māori health (Pere, 1995). The head represents te whānau (family) and the eyes represent waiora (total wellbeing for a single person and for the family) (Ministry of Health, 2012c). Each tentacle symbolises a dimension of life that helps give sustenance to a person (Pere, 1995). These dimensions are: wairuatanga (spirituality), hinengaro (the mind), taha tinana (physical health), whanaungatanga (social connections and extended family), mauri (life force in people and objects), mana ake (uniqueness of individuals and family), hā a koro ma, a kui ma (inherited strength), and whatumanawa (expression of emotion) (Ministry of Health, 2012c). The tentacles can become interlaced with each other, representing a possible integration of dimensions (Pere, 1995). The suction cups on each tentacle represent the various factors that exist within each of these dimensions (Pere, 1995).

The foundation of these health models are based on achieving balance and wellbeing through various aspects of life holistically, rather than only physical or emotional health (Ministry of Health, 2012b). While the WHO definition includes physical, mental and social wellbeing, aligning it with the Māori model of health to an extent, a crucial component of Māori health – wairua (spirituality) is not included.

2.1.2b Te taha tinana - chronic disease in Māori

A healthy body mass index (BMI) for adult Māori is between 18.5 and 26 kg/m^2 (Ministry of Health & the University of Auckland, 2003). This BMI reference range may be too restrictive for adults over the age of 65 years and therefore a more appropriate BMI reference range for older adults is 25-27 kg/m^2 (Heiat, Vaccarino, & Krumholz, 2001; Kvamme et al., 2012).

Obesity has been associated with many chronic diseases, such as cancer, diabetes and cardiovascular disease (Ministry of Health, 2013b). In the older Māori population obesity is largely prevalent. The 2006/07 NZ Health Survey found that 92% of Māori men and 80% of Māori women aged 65+ years were overweight or obese (Ministry of Health, 2011). These older Māori were more likely to be overweight or obese than non-Māori of the same age (Ministry of Health, 2011).

Cardiovascular disease is the main cause of mortality in Māori men and women aged over 65+ years. There were 46% and 71% of older Māori men and women respectively who died from ischaemic heart disease in 2010 (Ministry of Health, 2013a). Lung cancer, diabetes, chronic obstructive pulmonary disease, stroke and other forms of heart disease are the other common chronic diseases that cause mortality in older Māori men and women (Ministry of Health, 2013a). Similar chronic diseases are seen in non-Māori, however higher rates of melanoma of the skin are seen in non-Māori (Ministry of Health, 2013a).

2.1.2c Te taha tinana - functional health of Māori

Functional health is very important for good quality of life. Restricted or lost mobility negatively affects older Māori's ability to carry out their cultural duties which can affect their spiritual health, as well as the other negative consequences of poor mobility such as restricted activities of daily living and quality of life (Webber, Porter, & Menec, 2010).

In 2006 approximately 35% of Māori over the age of 50 years had a functional disability (Ministry of Health, 2011). The 2006/07 NZ Health Survey reported that the most common disability types for older Māori (65+ years) were poor mobility (25% of respondents), and an agility disability such as the inability to bend over and pick up an object from the floor (8% of respondents) (Ministry of Health, 2011). Also, a hearing disability was reported in 6% of older Māori (Ministry of Health, 2011). The rates of disability are higher for older Māori than in older non-Māori (Ministry of Health, 2011).

The top three unintentional injuries that caused mortality in Māori men and women aged over 50 years were falls, motor vehicle traffic accidents and drowning (Ministry of Health, 2013a). Unintentional injuries resulting in hospitalisations or mortality in older Māori men and women are higher than in older non-Māori (Ministry of Health, 2011). In fact, Māori men and women aged over 65 years were more than twice as likely to die from an unintentional injury as non-Māori of the same age, respectively (Ministry of Health, 2011).

Māori are three times as likely to develop diabetes compared to non- Māori (Ministry of Health, 2013c). Diabetes has many complications, including limb amputations. Māori women aged 65+ years surveyed in the 2006/07 NZ Health Survey were found to be more than six times more likely to have a lower limb amputation with concurrent diabetes compared to non-Māori women of the same age (Ministry of Health, 2008). Māori men were 3.7 times more likely to have a lower limb amputation with concurrent diabetes compared to non-Māori men of the same age (Ministry of Health, 2008).

Arthritis, spinal disorders and osteoporosis all affect the functional health of older Māori. While there were no statistically significant differences between Māori and non-Māori older adults in the self-reported rates of arthritis and spinal disorders, older Māori men were 4.5 times more likely to report osteoporosis than non-Māori of the same age (Ministry of Health, 2010)

Oral health function is supported by visiting a dentist, however it has been reported that in 2006 a lower percentage of Māori men and women aged over 65 years went to the dentist in the previous 12 months compared with older non-Māori (Ministry of Health, 2011). This may have a detrimental effect on their oral health function, such as loss of teeth for mastication, and consequently may result in a poor nutritional intake and status. Oral health also plays an important role in the immune system and systemic health (Garcia, Henshaw, & Krall, 2001).

2.1.2d Self-perceived health of Māori

Two ways of measuring health status to predict mortality and measure quality of life in adults are self-rated health status and functional health status (Hoeymans, Feskens, Kromhout, & Van den Bos, 1997).Older Māori's perception of their health status was investigated by Waldon (2004). This study involved the recruitment of 429 older (60+ years) Māori men and women. The "Short Form 36" survey, a widely used tool that assesses physical, mental and social health status, was completed by the older Māori participants. The results of this survey found that the older Māori's general health was perceived as excellent, very good or good by 67% of the older Māori subjects, and fair or poor by 33% (Waldon, 2004). There was a decrease in physical function and vitality as age increased, whereas mental and social health scores were not significantly different between those participants younger than 65 years and those older than 65 years. Also, there were increased reports of health being poorer than it had been in the year prior as age increased.

Often, however, older adults subjectively view their health in a positive light despite decreasing functional health status (Ministry of Health, 1997; Waldon, 2004). This suggests that older Māori perceive their health in an optimistic way which may not correlate with actual levels of physical health disability. Furthermore, after an indefinable age, levels of self-rated health often continue at a steady level regardless of declining function (Hoeymans et al., 1997). This may be due to older adults equating good health with feeling good and being able to manage activities of daily living, rather than good physical or mental health (Ministry of Health, 1997). It is possible that the positively self-perceived health finding is related to the Māori model of health, where physical health is just one component of the four aspects of life that contribute to good health.

2.1.2e Te taha hinengaro - mental health status of Māori

Dementia has been linked to a poorer nutritional status in older adults (Holm & Soderhamn, 2003). Dementia appears to be relatively prevalent in Māori, where dementia (including Alzheimer's) mortality was apparent in over half (56%) of Māori men aged over 65 years and three quarters of older Māori women (Ministry of Health, 2011). The 2006/07 NZ Health Survey found that 7% and 8% of Māori men and women aged 65+ years respectively, had a high or very high probability of anxiety or depressive disorder (Ministry of Health, 2008). Older Māori in the 2006/07 NZ Health Survey were more likely to report mental illness indicators than non-Māori of the same age (Ministry of Health, 2008). Another report, "Te Rau Hinengaro: The NZ Mental Health Survey", also found that Māori men and women aged over 65+ years had a high lifetime prevalence of any anxiety disorder or any mood disorder, at 15% and 8%, respectively (Oakley Browne, Wells, & Scott, 2006). Te taha hinengaro (mental health) is one of the walls of the Māori model of health and a good mental health-related quality of life is important for older Māori.

2.1.3 Health disparity in Māori

Socioeconomic status is a social determinant of health that includes interlinked factors such as employment, finances and income, level of education, housing, and social inclusion and exclusion, which all have an association with health status (WHO, 2008). Socioeconomic status correlates with health status, as individuals who have a higher socioeconomic status generally have better health outcomes and a lower mortality rate (Ministry of Health, 1997).

An association between socioeconomic status and ethnicity has been reported (Hallden, le Grand, & Hellgren, 2008), with Māori generally experiencing a lower socioeconomic status (Milne, Byun, & Lee, 2013). This may be due to a lower education level attainment and higher rates of unemployment leading to lower income, which has been apparent among the Māori population for many generations (Ministry of Health, 1997). In 2006, 35% of Māori men aged over 65+ years had achieved a level 2 school certificate or higher education and 24% of older Māori women achieved this qualification (Statistics New Zealand, 2006). Older Māori education rates are over 15% lower than for non-Māori of the same age (Statistics New Zealand, 2006). The unemployment rate is also higher in Māori (11%) than non-Māori (5%) (Ministry of Business, Innovation & Employment, 2009).

The NZDep2006 is a deprivation index that indicates the level of deprivation lived by people in defined geographical areas, but does not portray deprivation experienced by individuals (Ministry of Health, 2011; University of Otago, 2007). The deciles are ranked from decile 1 to decile 10, with decile 10 being the most deprived areas and decile 1 being the least deprived areas (University of Otago, 2007). Ethnic disparity can be seen in the NZDep2006 deprivation index (University of Otago, 2007). There is an increasing trend between the percentage of Māori aged 50+ years and the neighbourhood deprivation decile (Ministry of Health, 2011). In 2006, only 3% of Māori aged over 50+ lived in decile 1 areas of NZ , whereas a quarter of older Māori lived in decile 10 areas and experienced considerable deprivation (Ministry of Health, 2011). A report by the Ministry of Health (1997) confirms these findings, as it was reported that at meetings of older people including Māori, their main wellbeing concerns were appropriate and adequate housing for older people, and sufficient income to be able to pay for home heating and nutritious food.

2.2 Nutritional Health of Older Māori

Current knowledge of food intake in older Māori is limited, especially in those over 80 years old. A cross-sectional study was conducted by McElnay et al. (2012) which investigated the nutritional risk of community-living Māori adults aged 65+ years (n=40). Nutritional risk was measured using the validated Seniors in the Community Risk Evaluation for Eating and Nutrition (SCREEN II) questionnaire and additional questions assessing nutritional knowledge. This study found that almost two thirds of the older Māori surveyed were at high risk of poor nutritional status. Māori were also more than five times more likely to have a poorer nutritional status than non-Māori. The results also found that the living situation of older adults was associated with nutritional risk, where those who lived alone were 3.5 times more likely to be at high risk of poor nutritional status than older adults who lived with others. Further investigations revealed that the most frequent nutritional risk factors for the Māori participants were low fruit and vegetable intake, low milk product intake, low meat and meat alternatives protein intake, skipping meals, and their weight was self-perceived to be more or less than it should be.

2.2.1 Energy intakes

Energy must be consumed for fuel in order for physiological functions to be carried out (NHMRC & MoH, 2005). Energy also allows individuals to complete day-to-day activities, such as their occupation, socialising, physical activity, and cultural activities, as well as the basic activities of daily living such as showering and getting dressed (NHMRC & MoH, 2005). The wide difference in the energy needs of individuals varies due to differences in behaviour, metabolism and physiology, resulting in a range of recommended average energy intakes for humans (NHMRC & MoH, 2005).

An important source of information about the current Māori diet is The National Nutrition Survey. This is a population-based nutrition survey of NZ adults funded by the NZ Government's Ministry of Health. The latest National Nutrition Survey 2008/09 (NNS08/09) surveyed 4271 adult New Zealanders over the age of 15 years, of which 1040 identified themselves as Māori (University of Otago & Ministry of Health, 2011). This survey investigated self-reported food and nutrient intake, eating patterns, food habits, food security and nutrition-related diseases and risk factors for diseases (University of Otago & Ministry of Health, 2011).

The NNS08/09 investigated the energy intakes of Māori aged 51+ years and New Zealand older adults (combined ethnicity aged over 71 years). The 51+ year old Māori men and women had a median daily intake of 8897 kJ and 6483 kJ, respectively (University of Otago & Ministry of Health, 2011). The NNS08/09 also found the median energy intake of older NZ men aged 71+ years was lower at 7926kJ, similar to older NZ women who had a median energy intake of 6014 kJ (University of Otago & Ministry of Health, 2011). A sub-report was created from the NNS08/09 that focused solely on data collected on self-identified Māori aged over 15 years (n=1040) (Ministry of Health, 2012a). The "A Focus on Māori Nutrition: Findings from the 2008/09 NZ Adult Nutrition Survey" report found that the median daily intake of energy was higher in Māori aged 15+ years than those Māori aged 51+ years, at 11,449 kJ for Māori men aged 15+ years and 7632 kJ for Māori women of the same age (Ministry of Health, 2012a).

These results indicate that older adults have lower energy requirements (NHMRC & MoH, 2005). This has been reported in the literature to be a result of decreased fat-free mass, a gain in less metabolically-active adipose tissue, and lower physical activity levels (Manini et al., 2009). It is therefore likely that the median energy intake reported in the NNS08/09 for Māori 51+ years is not representative of Māori in advanced age.

2.2.2 Protein

2.2.2a Protein requirements

The Australia and NZ Nutrient Reference Values (NRVs) provide recommendations for the intake of energy, macronutrients and micronutrients (NHMRC & MoH, 2005). The dietary protein values are based on the evidence collated by the US: Canadian Government Dietary Reference Intake review of protein requirements, with further consideration of key research papers that were not included in the review and the dietary protein intake recommendations by other countries or organisations (NHMRC & MoH, 2005).

The recommended dietary protein requirement is a hotly debated issue within scientific circles. The current data describing protein requirements in advanced age adults (>80 years) is limited. Current estimated average requirements (EAR) for protein are based on short-term nitrogen balance studies in young men and provide the minimum amount of essential amino acids that satisfy body protein building requirements. The factorial method was used to determine the protein requirements for older adults.

A key paper influencing the Australia and NZ NRVs for protein intake in older adults was a meta-analysis by Rand, Pellett, and Young (2003), who found that the median daily protein requirements of older adults was approximately 25% higher than younger adults requirements. However, this difference was not statistically significant and the data analysed was limited.

Research by Campbell, Trappe, Wolfe, and Evans (2001) also provided evidence that indicated further research is needed to develop appropriate older adult protein requirement recommendations. It reported that an intake of 0.8g protein/kg/day (the United States recommended daily allowance for protein and current EAR for NZ adults) in US older adults over a 14 week period resulted in metabolic and physiological adaptation to the dietary intake, which suggests the protein intake was inadequate. There was also a significant decrease in mid-thigh muscle area. It was concluded that recommending 0.8g/kg/day of dietary protein was inadequate to meet the protein needs of older adults. Similar results were found by Morse, Haub, Evans, and Campbell (2001).

Despite the limited data, these studies' results influenced the decision to increase the dietary protein intake recommended to older adults in Australia and NZ to 25% higher than the US protein recommendations (NHMRC & MoH, 2005). Table 1 shows the current recommendations for the daily amount of protein intake recommended for 71+ year old adults:

Table 1. Australia and NZ protein requirements in older adults

Recommendation	Men	Women
Protein EAR (>70 years)	65g/day (0.86g/kg/day)	46g/day (0.75g/kg/day)

The data for an upper limit (UL) for total protein intake is also limited apart from research in young adult men (NHMRC & MoH, 2005). The Food and Agriculture Organization of the United Nations (FAO) recommends a protein intake of less than 2g/kg/day in adults (FAO, WHO, & UNU, 2004). High protein intakes from protein supplements has been associated with negative health effects, however the risk of negative effects from high protein diets consumed from everyday foods is low (NHMRC & MoH, 2005). Therefore no UL for protein has been set, but caution is advised when consuming protein supplements.

The number of investigations into what are appropriate protein recommendations for older adults has increased dramatically since the 2005 NRVs literature review. Volpi et al. (2013) presented an up-to-date review on the requirements of protein for older adults and explored the challenges associated with increasing protein intake in older adults. The review found that many epidemiological and clinical studies reported the current dietary protein recommendations may not encourage adequate intake of protein to prevent muscle mass, strength and function loss or be optimal for good health. However, it was suggested that future research into developing novel methodologies to measure the effects of dietary protein on function and health in older men and women are needed. There is also a need for more longitudinal studies and randomised clinical trials on dietary protein and older adult health. The authors then concluded that there is unlikely to be a consensus on adequate protein recommendations until these types of research have been done.

2.2.2b Protein intake in older Māori

Protein intake was explored in Māori aged 51+ years and New Zealand adults aged 71+ years in the NNS08/09 (University of Otago & Ministry of Health, 2011). This survey found that the median daily intakes of protein in Māori men and women aged 51+ years were 92g and 67g, respectively (University of Otago & Ministry of Health, 2011). Inadequate protein intake prevalence in these older Māori was estimated to be 8% in the men, while the prevalence of inadequate protein intake in the women was less than 1% (University of Otago & Ministry of Health, 2011). This data should be interpreted with caution however, as it combined the protein intakes of middle-aged and older Māori adults due to low numbers of older Māori, and middle-aged and older Māori have different protein requirements (NHMRC & MoH, 2005). Therefore it is likely that these figures underestimate the prevalence of inadequate protein intake in Māori of advanced age.

The NNS08/09 also showed that NZ men aged 71+ years consume a median daily protein intake of 78g of protein while older NZ women consume a median daily intake of 60g of protein per day (University of Otago & Ministry of Health, 2011). Inadequate protein intakes in 71+ year old New Zealanders in the NNS08/09 were estimated to be 13% in older men and 16% in older women (University of Otago & Ministry of Health, 2011). The higher prevalence of inadequate protein intakes may be related to the 25% higher protein requirements in older adults (NHMRC & MoH, 2005; University of Otago & Ministry of Health, 2011).

2.2.2c Macronutrient distribution of protein

The Acceptable Macronutrient Distribution Range (AMDR) are recommended percentages of total energy from macronutrients that appear to be within acceptable intake limits to reduce chronic disease risk (NHMRC & MoH, 2005). These recommendations also include consideration of a macronutrient intake that is able to meet micronutrient recommendations. An intake outside of the AMDR may or may not increase chronic disease risk; however there is not enough data on intakes outside these ranges to conclude either way (NHMRC & MoH, 2005).

The lower limit of the AMDR is usually developed from other intake recommendations set for the nutrient, but may be modified if dietary modelling suggests this may not be nutritionally adequate (NHMRC & MoH, 2005). The US: Canadian Dietary Reference Intake review suggested that the lower limit for protein should be 10-11% of dietary energy from protein (Institute of Medicine of the National Academies, 2002); however dietary modelling showed that this is not a nutritionally adequate level of protein to consume daily. It was indicated through further investigations that the lower limit of dietary energy from protein needed to be at least 15% to provide a nutritionally adequate diet, particularly in individuals who consume less than 15,000 kJ per day (NHMRC & MoH, 2005).

The evidence for the upper limit of the AMDR for protein is conflicting in relation to the association of a high protein intake and the risk of a number of chronic diseases (NHMRC & MoH, 2005). The FAO upper limit for protein intake (2g/kg/day) is approximately equivalent to an intake of 22-25% energy from protein (FAO, WHO, & UNU, 2004). The lower limits of the AMDR's for carbohydrates (45% energy) and fat (25% energy) were used to give a preliminary upper limit of 35% of total energy from protein (NHMRC & MoH, 2005), which is the upper limit of the AMDR for protein in the United States and Canada (Institute of Medicine of the National Academies, 2002). The usual daily intake of protein in the general Australian and NZ populations is less than 25% in those who meet their EARs for micronutrients (NHMRC & MoH, 2005). A cautious upper limit of 25% of energy from protein was therefore set for the general Australian and NZ populations. In summary, the acceptable macronutrient distribution range for protein intake in adults is 15-25% of energy intake (NHMRC & MoH, 2005).

2.2.2d Protein percentage of energy intake in older Māori

The NNS08/09 investigated the protein percentage of energy in the NZ diet. It found the mean daily percentage of energy from protein in NZ men and women aged 71+ years was 16.4% in the men and 17.0% in the women (University of Otago & Ministry of Health, 2011). This suggests the average 71+ year old living in NZ is likely to be consuming an adequate protein percentage of energy intakes. The survey also showed that Māori men and women aged 51+ years consumed a mean percentage of energy from protein within the AMDR for protein, with 17.7% and 17.6%, respectively (University of Otago & Ministry of Health, 2011). This implies the average 51+ year old Māori are also meeting their protein energy requirement needs. It is possible however, that due to lower energy requirements and higher protein requirements an older person's percentage of energy from protein may seem adequate, but the total amount of protein consumed may not meet their requirements.

The NNS08/09 Māori sub-report also explored the percent energy from protein (Ministry of Health, 2012a). This report found that 15+ year old Māori men consumed 16.8% of energy from protein, and 16.3% in 15+ year old Māori women. This suggests an adequate percentage of energy from protein intake for at least half the Māori population, but is unlikely to be representative of older Māori

2.2.3 Protein sources

The NNS08/09 investigated the protein contributions from food groups in NZ men and women aged 71+ years (University of Otago & Ministry of Health, 2011). The six major contributors to protein intake in the older age group were both animal and plant protein sources. The largest protein contributor was bread which contributed 14% of protein to the protein intakes, followed by milk which contributed 11% and 12% to older men and women protein intakes, respectively. The third largest contributor to protein intake was beef and veal, which contributed 10% and 9% of the older men and women's protein intake respectively. Other food groups that contributed large amounts of protein to the intakes of older adults in NZ were fish and seafood (7% and 6% for men and women, respectively), poultry with 5% and 6% for men and women respectively, and vegetables (5% and 6% for men and women, respectively).

Animal protein sources were often consumed by Māori aged 51+ years surveyed in the NNS08/09 (University of Otago & Ministry of Health, 2011). This report found that meat (which included beef, pork, mutton, lamb and goat) was consumed one to four times per week by 66% and 77% of older Māori men and women aged 51+ years, respectively. Chicken was consumed one to four times per week by approximately three quarters of older Māori surveyed, while fresh or frozen seafood was consumed one to two times per week in 46% and 49% of the older Māori men and women, respectively.

Consumption of animal protein sources by 71+ year old NZ adults was also reported in the NNS08/09. Approximately 69% of NZ 71+ year old men and women consumed meat one to four times per week, while 79% and 90% of the older men and women consumed chicken one to four times per week, respectively (University of Otago & Ministry of Health, 2011). Fresh or frozen seafood was consumed one to two times per week by 46% and 60% of the older NZ men and women, respectively.

2.2.4 Food security

Food security in older NZ adults (71+ years) and older Māori (51+ years) was investigated by the NNS08/09 (University of Otago & Ministry of Health, 2011). It was found that 83% and 80% of older men and women were categorised as fully or almost food secure, while only 60% and 46% of older Māori men and women were fully or almost food secure (University of Otago & Ministry of Health, 2011).

Food security in lower and higher deprivation areas were also determined by the NNS08/09 (University of Otago & Ministry of Health, 2011). Forty percent of men and women living in the most deprived quintile of the NZDep2006 deprivation index was categorised as fully or almost food secure, compared with 71% and 67% of men and women living in the least deprived quintile respectively (University of Otago & Ministry of Health, 2011).

2.3 Dietary protein needs

Protein in the body has structural and functional uses, for example roles in muscle, enzymes, coenzymes, antibodies, antigens and hormones (Hansen, Raja, & Allena, 2006). Some of the 20 amino acids used to make proteins are synthesised by the body, however some are required from the diet – these are known as "essential amino acids" (Volpi, Kobayashi, Sheffield-Moore, Mittendorfer, & Wolfe, 2003). Protein turnover occurs constantly in the body as proteins are constantly degraded into amino acids (catabolism) and resynthesised (anabolism) to form new body proteins (Welle & Nair, 1990).

Proteins have varying structures depending on the amino acid composition. This influences the protein's digestibility and biological value, exampled by the differences in quality between proteins found in animal and plant foods (Volpi et al., 2003). Animal proteins have amino acid profiles similar to that required by humans and provide all essential amino acids (Young & Pellett, 1994). Plant proteins however are commonly lacking on one of more essential amino acids – usually lysine, methionine or threonine (Young & Pellett, 1994). Protein synthesis, and therefore physiological function, may be compromised if the amounts of amino acids are not available in the correct quantity (NHMRC & MoH, 2005).

The body has the ability to adapt to a wide protein intake (NHMRC & MoH, 2005). When starvation, fasting or severe disease occurs the body's need for energy takes priority. This results in dietary and body proteins being oxidised for fuel through gluconeogenesis. Consequently, after extended periods of time the functions of the protein that have been oxidised are decreased or lost, which can lead to disabilities and other severe consequences such as the loss of heart muscle (Cederholm, Jagren, & Hellstrom, 1995). It is therefore important that sufficient non-protein energy is consumed as well as sufficient protein to ensure that amino acids are not used as fuel (NHMRC & MoH, 2005).

Protein energy malnutrition occurs when inadequate protein is consumed long term, or there is an imbalance of amino acids being consumed (Cederholm et al., 1995). In NZ protein energy malnutrition is uncommon in the healthy population, however it can be found in the older adult population (NHMRC & MoH, 2005). Protein intake in older adults may be compromised by many factors, including the tendency to consume smaller meals, increased satiation after intake of food, lower energy requirements combined with higher protein requirements, physical dependence on others to acquire and prepare food, anorexia, altered preferences for protein-rich foods with age, food insecurity, and inappropriate distribution of protein intake throughout the day (Hickson, 2006; Symons et al., 2009a; Volpi et al., 2013).

2.3.1 Dietary protein and muscle mass, strength and function

As the process of ageing occurs there is an on-going loss of lean muscle mass and strength with a resulting loss of muscle function (Koopman & van Loon, 2009). It has been reported that the body weight of younger adults is approximately 50% lean muscle mass, however in older adults 75-80 years this proportion decreases to approximately 25% (Sakuma & Yamaguchi, 2012).

There have been many factors researched in determining what influences the loss of lean muscle mass. Inadequate diet, changing concentrations of hormones, altered metabolism, reduced physical activity and long-term disease all play a role in the decrease in muscle mass with ageing (Tanimoto et al., 2012). An important factor is inadequate protein intake to stimulate muscle anabolism. Recent studies have suggested that it is the decreased anabolic response to the intake of protein in older adults that is a major factor influencing the decrease in skeletal muscle mass associated with ageing, as the post-prandial stimulation of muscle synthesis rate is not different between younger and older men (Koopman & van Loon, 2009; Breen & Phillips, 2011). This decreased stimulation of muscle synthesis subsequently results in less muscle protein synthesis and does not balance with protein degradation, resulting in a loss of muscle mass, strength and function. This loss of mass, strength and function can severely impact activities of daily living and health, which in turn affects independency and quality of life (Tanimoto et al., 2012).

The relationship between a range of dietary protein intakes and loss of muscle mass were investigated by the Health ABC study (Houston et al., 2008). The Health ABC study evaluated associations between dietary protein intake and total and appendicular lean mass in 70-79 year old men and women living in the community in the United States (n=2066) (Houston et al., 2008). Dietary intake was measured using a 108-item food-frequency questionnaire and changes in total and appendicular lean mass over three years were assessed using dual-energy X-ray absorptiometry. The results of the Health ABC study found that subjects who had the highest quintile of total protein intake per day (mean protein intake = 91g per day, 1.2g/kg/day protein intake, 18.6% energy from protein) lost approximately 40% less total and appendicular lean mass than participants in the lowest quintile of protein intake (mean protein intake = 57g per day, 0.8g/kg/day, 10.9% energy from protein). The researchers therefore concluded that modifying dietary protein intake could aid in preventing muscle mass, strength and functional loss.

Similar results were found in a recent cross-sectional study by Ruiz Valenzuela et al. (2013) which investigated the amount of dietary protein intake, and related these findings to appendicular skeletal muscle mass in apparently healthy >60 year old adults living in Mexico (n=78). The researchers used three non-consecutive 24 hour dietary recalls to measure dietary intake, and dual-energy X-ray absorptiometry to measure appendicular skeletal mass. The results of found a positive, significant association ($p < 0.05$) between appendicular skeletal muscle mass and protein intake. Inadequate protein intakes were found in 28% of the participants. . The researchers concluded that despite mean intakes of dietary protein greater than current dietary recommendations (men = 0.99g/kg/day, women = 0.88g/kg/day), sarcopenia was not prevented in the older adults (Ruiz Valenzuela et al., 2013).

The intake of protein and amino acids stimulates the rate of skeletal muscle synthesis whilst correspondingly reducing or inhibiting muscle catabolism in both younger and older adults (Volpi, Ferrando, Yeckel, Tipton, & Wolfe, 1998; Volpi, Mittendorfer, Wolf, & Wolfe, 1999; Paddon-Jones et al., 2004; Symons et al., 2007). A study conducted by Paddon-Jones et al. (2004) found that oral intake of 15g of essential amino acids raised the muscle protein synthesis rate in six young and seven older people with no significant differences between the two age groups' rates. Symons et al. (2007) investigated whether the decrease in muscle mass associated with ageing could be attributed to a disruption in the anabolic response to a protein-rich meal. The rate of muscle synthesis after ingestion of 113g of lean beef (approximately 10g of essential amino acids or 30g of high biological value protein) was not significantly different between older adults (70.2 years ± 5.1) and middle-aged adults (41.1 ± 8.0 years). Therefore muscle synthesis stimulation by protein and amino acids is not blunted in older age. However the anabolic response to an intake of protein or amino acids in the older adults may be impaired when carbohydrate is consumed at the same time as the amino acids or protein (Volpi, Mittendorfer, Rasmussen, & Wolfe, 2000)..

A 12 year longitudinal study investigated the changes in skeletal muscle mass, strength and function in a small cohort (n = 12 at baseline, n = 7 at completion) of older men (65 ± 4.2 years at baseline, 77.6 ± 4.0 years at conclusion) (Frontera et al., 2000). The results showed significant skeletal muscle loss around the knee and elbow over the 12 year period, and the mass of all thigh skeletal muscles were decreased. The researchers concluded that the loss in muscle mass is a key factor in the decrease in muscle strength with age. However, this study did not examine the effects of any factors such as protein intake that have been associated with changes in muscle mass. Newman et al. (2003) investigated the muscle strength and quality in older men and women aged 70-79 years (n=2,623). Body composition, and upper and lower extremity muscle strength and quality were measured, and the results found that both the upper and lower limbs' strength and quality was decreased with age. The decrease in strength was mostly explained by a lower muscle mass; therefore preserving muscle mass is likely to be an important factor in maintaining muscle strength and function.

Similar findings were found in the New Mexico Elder Health Survey, which found that 53% and 43% of older non-Hispanic white men and women over the age of 80 years (n=808) had an appendicular skeletal muscle mass of greater than two standard deviations, respectively (Baumgartner et al., 1998). There was also a significant inverse relationship between age and muscle mass, where 14-24% in people under 70 years had low muscle mass whereas over 60% of those over 80 years old had low muscle mass (Baumgartner et al., 1998). These results indicate that there are dramatic differences in body composition as age increases, which may have a profound impact on advanced age adults ability to complete activities of daily living, such as cooking meals, grocery shopping, and financial management which have been associated with loss of muscle mass and strength , independent of age and BMI (Tanimoto et al., 2012). These activities of daily living indicate a person's ability to live independently in their home and community (Lawton, 1970).

2.3.2 Animal versus plant proteins

Animal proteins have a high biological value, where they contain all of the essential amino acids needed to produce and maintain the body's proteins (Young & Pellett, 1994). Plant proteins are often missing or have very low amounts of one or more essential amino acids, resulting in lower quality proteins (Young & Pellett, 1994). However, combining plant protein sources in the diet can provide all essential amino acids for good health (Young & Pellett, 1994).

One of the amino acids plant protein often lacks is leucine, a potent signalling molecule for protein metabolism. A high leucine intake has been linked to increased muscle synthesis rate in older adults (Katsanos, Kobayashi, Sheffield-Moore, Aarsland, & Wolfe, 2006; Casperson, Sheffield-Moore, Hewlings, & Paddon-Jones, 2012). Animal protein sources contain higher amounts of leucine than plant protein sources (USDA, 2011), suggesting that animal protein sources may stimulate skeletal muscle synthesis more than plant protein sources.

The amount of skeletal muscle mass an older adult has may be determined by the amount of animal and plant protein intake, and the animal: plant protein ratio. The Health ABC Study also explored associations between animal and vegetable protein intake with total and appendicular lean mass in community-dwelling older adults aged 70-79 years (n=2066) (Houston et al., 2008). The average intakes of animal and vegetable protein in participants with the top 20% of total protein intake were 60.7g and 30.3g respectively. Those participants with the lowest 20% of protein intake had animal and vegetable protein intakes of 27.0g and 29.9g, respectively. Higher animal protein intake were associated with increases in total and appendicular lean mass after adjusting for many confounders ($p<0.01$). Plant protein intake was not however significantly associated with changes in lean mass or appendicular lean mass in the fully-adjusted model.

The relationship between animal and plant protein intakes with skeletal muscle mass was also investigated by Aubertin-Leheudre and Adlercreutz (2009) in healthy adult women whose regular diet was omnivorous (mean age = 43 years ± 13, n=21) or vegetarian (mean age 48 ± 12, n=19). Dietary intake was evaluated by a five day food diary over four seasons and skeletal muscle mass was measured by urinary creatinine. Animal protein intake was significantly higher in the omnivorous women compared to the vegetarian women, with 44g and 32g of protein respectively. More plant protein contributed to dietary protein intakes in the vegetarian women than the omnivorous women, with 26g versus 21g, respectively. The animal: plant protein intake ratio was 2.09 in the omnivorous women and 1.23 in the vegetarian women ($p=0.001$). The omnivorous women had over five kilograms more skeletal muscle mass than the vegetarian women ($p=0.01$). Higher animal protein intake and animal:

plant ratio was associated with greater muscle mass, while no association with plant protein was found. These findings however cannot be generalised to older adults.

The dietary sources of protein in 60+ year old US adults were described by the Third National Health and Nutrition Examination Survey 1988-1991 (NHANES III) (Smit, Nieto, Crespo, & Mitchell, 1999). Dietary intake was assessed using one 24-hour dietary recall from 7,924 participants. Animal protein contributed 66% of total protein in the older men and 64% in the older women. Grains were the main source of plant protein, contributing 18% and 19% of total protein intake in the older men and women respectively, while vegetables contributed the second highest plant protein intake in the older men and women (8% versus 9%, respectively). Other plant protein food groups contributed less than 3% of protein to total protein intakes. Meat, fish and poultry contributed the most protein to the 60+ year old adult's diets, with 41% and 39% of total protein intake in the older men and women, respectively. Dairy products contributed 19% and 21% of protein to the protein intake in the older men and women, respectively. The ratio of animal: plant protein intake was 2.7:1 in the older men and 2.7:1 in the older women.

The intake of animal and plant protein and their relationship with being overweight or obese was investigated in the Belgian population (Lin et al., 2011). Dietary intake was assessed as a part of the Belgian National Food Consumption Survey and was measured by two non-consecutive 24 hour dietary recalls. More than 3000 participants completed the dietary assessments, of which 704 participants were over the age of 75 years. The animal protein intakes of the older men and women were 49g and 40g, respectively, while plant protein intake amounted to 25g in the older men and 19g in the older women. The animal protein intake as a percentage of energy was 10.3% and 11.2% in the older men and women, respectively, while plant protein intakes contributed 5% of energy in both genders.

The food groups that contributed to animal and plant protein intakes were also investigated in the Belgian National Food Consumption Survey (Lin et al., 2011). Meat and meat products including poultry contributed 27g and 22g of animal protein to the diets of the older Belgian men and women (Lin et al., 2011). Fish and shellfish contributed 5g and 4g of animal protein to the men and women's diets, respectively, and dairy products contributed 10g and 9g, respectively. Cereals and cereal products contributed the most plant protein, at 13g and 9g of protein in the older men and women, respectively, while potatoes and other tubers contributed 4g and 3g of protein to the protein intakes of the older men and women, respectively. Other plant protein food groups contributed less than 3g of protein to the older adults' diets. An association between the source of protein and BMI was also found. Plant protein intake was associated with a lower BMI in both genders ($p<0.05$) while higher intakes of animal protein were associated with an increased BMI in men only.

A 2011 cross-sectional study evaluated the sources of dietary protein intake in community-dwelling older men and women from the Netherlands aged 75-97 years (n=1177) (Tieland, Borgonjen-Van den Berg, Van Loon, & de Groot, 2012). Meat, dairy and bread were the top 3 contributors of dietary protein. Meat contributed to the largest percentage of protein (30%), followed by dairy excluding cheese (19%) and bread (15%). Cheese contributed 8% of protein and fish gave 5% of protein. 'Other' foods that did not fit into the five main defined food groups also contributed large amounts of protein (23%).

2.3.3 Protein intake distribution

Current research suggests that after consumption of a protein-rich meal, the rate of muscle synthesis in older adults is similar to that of younger individuals (Symons et al., 2007; Koopman et al., 2009). However, this post-prandial muscle synthesis rate may be blunted with age if the meal contains carbohydrate (Volpi et al., 2000) or after consuming meals that contain 15g or less of protein per meal (Symons, Sheffield-Moore, Wolfe, & Paddon-Jones, 2009b). Consumption of 30g of high-quality protein by older adults in one sitting was found to stimulate the rate of muscle synthesis to similar rates seen in younger adults (Symons et al., 2009a). Symons et al. (2009a) then investigated the skeletal muscle protein synthesis response to different amounts of protein in older adults. The results showed that the synthetic response to protein was not significantly different when 30g or 90g of high biological value protein was consumed. This led to a recommendation that consumption of multiple servings of medium-sized portion (30g) of high-quality protein food sources over the day may be more beneficial for maximal muscle protein synthesis in older adults, compared with the typical one large-sized high-quality protein meal (Paddon-Jones & Rasmussen, 2009).

This protein intake distribution recommendation has led to novel investigations into the distribution of protein intake throughout the day in older adults. In 2011, a cross-sectional study evaluated the protein intake distribution in community-based, frail and institutionalised older men and women from the Netherlands aged 75-97 years (n=1177) (Tieland et al., 2012). Protein intake at breakfast was 10g in community-living older adults, 8g in frail elderly adults, and 12g in institutionalised men and women. Lunch time protein intakes consumed were 27g in community-dwelling, 18g in frail, and 25g in institutionalised older adults. Dinner protein intakes were approximately 28g in community-living, 30g in frail, and 15g in institutionalised older adults. Recommendations for protein intake distribution (30g per meal) were not met at breakfast and lunch by all groups' mean protein intakes, and not met by community-dwelling and institutionalised older adults' protein intakes at dinner.

A recent cross-sectional study by Ruiz Valenzuela et al. (2013) investigated the relationship between the spread of protein intake and appendicular skeletal muscle mass in healthy 60+ year old adults (n=78). The researchers used three non-consecutive 24 hour dietary recalls to measure dietary intake, and dual-energy X-ray absorptiometry to measure appendicular skeletal mass. The results found the intakes of breakfast protein in the older men and women were 19g and 15g, respectively.

The amount of protein intake at lunch was the largest amount consumed during the day, at 33g for men and 27g for women. Dinner protein intake was 20g in the men and 14g in the women and was significantly different between genders. Both breakfast and dinner protein intakes did not meet the recommended intake of protein at each main meal of (30g per meal). The study also found that older adults who had an intake of less than 25g of protein at all meals, as opposed to those who consumed 25g of protein at one or more meals, had a lower appendicular skeletal muscle mass when adjusted for body weight, sex and height. Although the intake of total protein consumed by the older adults was greater than current dietary recommendations, loss of muscle mass was not prevented if protein distribution and total protein intake are not met.

Bollwein et al. (2013) investigated protein intake distribution in community-dwelling older adults aged 75+ years (n=194). The participants completed a 12 month food frequency questionnaire which included timing questions for 46 foods identified as main food sources of protein. The researchers found that there were no significant differences between the total amount, g/kg body weight amount or percentage of energy from protein intakes between the frail, pre-frail and non-frail participants. There was no association between those who consumed a low or high amount of protein and frailty status. It was reported, however, that there were statistically significant differences between the protein intake distribution between frail, pre-frail and non-frail participants. A lower percentage of total protein intake at breakfast was consumed by frail older adults compared with pre-frail and non-frail older adults (12%, 15% and 17%, respectively. p=0.007). Frail and pre-frail participants ate the largest proportion of their daily protein intakes at lunch compared to non-frail participants, at 61%, 61%%, and 55%, respectively (p=0.024). Dinner protein intakes were not significant different between the non-frail, pre-frail and frail participants, with intakes of 24%, 25% and 24% of daily protein consumed respectively. These findings suggest that a more even distribution of protein intake may be more important for frailty status in older adults than total protein intake. Further research in this area is however needed.

The amount of protein consumed per meal in adults aged over 71 years was investigated using the US Department of Agriculture NHANES III survey data. The protein intakes in this cross-sectional study were assessed by two 24-hour dietary recalls. The results of this analysis found that the older US men consumed 15g, 18g, 34g, and 8g of protein at breakfast, lunch, dinner and snacks, respectively. The older women's protein intakes were at breakfast, lunch, dinner and snacks were 11g, 15g, 27g, and 6g, respectively. Both the older men and women consumed 45% of their daily protein intake at dinner, while the least percentage of total protein was consumed at breakfast (both genders approximately 20%). Both genders did not meet the meal protein recommendations (30g per meal) at breakfast and lunch, similar to the results found by Ruiz Valenzuela et al. (2013)

In New Zealand, daily protein intake distribution has not been assessed in older adults. The NNS08/09 has however assessed frequency of breakfast consumption in Māori men and women aged over 51+ years and older New Zealanders (University of Otago & Ministry of Health, 2011). Over 60% of the older Māori men ate breakfast every day and 16% consumed breakfast zero to two times per week. The NNS08/09 also found that in New Zealanders aged over 71+ years (combined Māori and non-Māori data), breakfast was reported to be consumed every day by 95% of the older adults, and less than 2% ate breakfast zero to two times per week (University of Otago & Ministry of Health, 2011). These findings suggest that there may be significant differences in breakfast consumption between middle-aged and older Māori men and women, and the lower frequency of consumption of breakfast may result in low breakfast protein intake.

2.4 Traditional Māori foods

2.4.1 Pre-colonial Māori food

Prior to the arrival of the first settlers in the 1300's, there were no indigenous land mammals apart from two bat species (Buck, 1950). When the Māori migrated to NZ from Polynesia, they brought many plants and animals with them (Buck, 1950). The species that survived in NZ included the kumara (sweet potato), taewa (Māori potato), taro, kiore (rat), kuri and ruatangi (dog breeds) (Whiu et al., 2008). Māori lived off the land, where local flora and fauna was hunted, harvested and gathered to source food (Whiu et al., 2008).

Forest birds were a large source of protein in the traditional Māori diet (Buck, 1950). These included wood pigeons (e.g. kereru), parrots (e.g. kaka), parson birds (e.g. tui), parakeets (e.g. kakariki), kiwi and other bird types (Buck, 1950). Procurement of these birds involved new hunting and trapping techniques unique to NZ, such as using knowledge of the birds' feeding habits to place snares and traps at ideal catching times. Sea birds such as mutton birds and albatross were caught using methods specific for the bird species. Mutton birds were caught in upright nets on misty nights with fires behind the nets to attract the birds as they migrated, while albatross were caught by a baited hook (Buck, 1950).

Salt water and fresh water fish and shell fish (ika moana and ika wai whenua) were a large contributor of protein to the traditional Māori diet (Buck, 1950). Fish was often hung up and dried (Buck, 1950). Older Māori in the 1950s continued to consume and enjoy dried shark (Buck, 1950). Shellfish and smaller fish such as whitebait were cooked before drying in the sun.

Mammals that were brought over with early Māori included the Polynesian rat (kiore) and Polynesian dog (kuri). The two indigenous bat species were not an important source of food (Buck, 1950). Rats were procured by many different types of traps, such as rat pits and spring traps.

Kumara grew throughout the North Island and the top of the South Island (Buck, 1950). The cultivation of kumara included rituals and chants to ensure the gods promoted an abundant crop (Buck, 1950). These rituals and chants are unique to Māori, as the kumara was not highly regarded in Polynesia therefore no rituals or chants were performed alongside the planting of kumara in Polynesia (Buck, 1950).

Māori had the ability to preserve and store birds, fish, shellfish and other foods to last them until the next season in storehouses (pataka), which was necessary as the abundance of fresh food was limited compared to Polynesia (Buck, 1950).

The change in eating patterns of Māori post colonisation was immense (Whiu et al., 2008). Colonisation brought many varieties of plants and animals to NZ, such as pumpkin, potatoes, pigs, chickens, sheep and cows, and many tools used to process foods for consumption (Petrie, 2012). Intake of dog meat decreased as introduced foods were integrated in to the diet and the dog species became extinct (Buck, 1950). However seafood continued to be a popular food and a high source of protein (Buck, 1950).

The subsequent introduction of foods and tools by the early explorers changed the way Māori in the1800's ate (Buck, 1950). Māori used customary food preservation methods with these new foods and some Māori consider these new foods and food preparation methods as a part of Māori culture (Whyte, Hudson, Hasell, & O'Reilly, 2001). Boil ups for example were able to be prepared and consumed which is often considered to be traditional. Basic boil ups consist of meat and/or bones, wild greens such as puha or watercress, and kumara or potato all boiled together in a pot (Rush et al., 2010).

2.4.2 Māori food beliefs

The environment provides a spiritual significance for Māori, and pollution or dumping of unwanted products into oceans, lakes or other places where foods are collected potentially affects not only affect physical health, but also the spiritual health of Māori (Durie, 1985). This is particularly important for seafood as there is spirituality that comes with consuming seafood (Durie, 1985).

There are traditional rituals associated with food. For example, karakia (prayer) is said throughout collection and prior to consumption of food, and tapu (unsafe), noa (safe) and rahui (restricted) rules regard what foods can be gathered and consumed and at what times (Whiu et al., 2008). Manaakitanga is the practice of sharing and giving food to others and being hospitable (Whiu et al., 2008). Also, cleansing the body and the preparation and consumption of food must not be combined. Keeping within Māori cultural rituals is crucial for good health for Māori (Durie, 1985).

2.4.3 Modern consumption of traditional Māori food

Traditional Māori foods are considered to be healthy among nutrition experts (Rush et al., 2010). These foods are procured by hunting or gathering which consumes energy, and are prepared and cooked in ways which ensures minimal processing of the food (O'Dea et al., 1991).

Rush et al. (2010) explored traditional foods that were reported to be frequently consumed by Māori living in the Waikato and Southern Lakes Districts (n=2669, mean age 48 years ± 13). Participants were surveyed by trained interviewees in the participants' homes. The results of this study found that kaimoana (seafood) (55%), puha (26%), watakerehi (watercress) (24%), hāngi (earthen oven cooking method) (18%), paraoa parai (Māori bread/rewena/fried bread) (18%), and boil ups (16.5%) were the six most frequently consumed traditional Māori foods reported. Other foods frequently consumed included kumara (14%), mutton bird (5%) and many individual species of seafood. No significant difference in traditional food consumption between gender or age.

Hāngi was reported to be consumed approximately three times a year by the participants, with less than 1% of participants consuming hāngi every week, while 23% did not consume hāngi within the last year (Rush et al., 2010). Hāngi is a traditional pre-colonial cooking method used to prepare foods for large gatherings (hui) (Buck, 1950; Rush et al., 2010). The hāngi method is described in more detail in section 2.4.4 Traditional Māori food preparation methods below. Boil ups were reported to be consumed approximately ten times per year, with 12% of participants consuming boil ups at least once a week, and 21% did not consume boil ups (Rush et al., 2010).

Kaimoana was more likely to be considered a traditional food if a participant's marae (meeting house) was located near the sea than inland (60% and 53% respectively). Kaimoana was also more likely to be consumed at a hui (meeting) if the marae was close to the sea than in those marae found inland (35% versus 29% respectively). The locations of their personal dwelling or age however were not associated with a decrease in kaimoana consumption at hui or consumption as a traditional food. Rush et al. (2010) found meals and special occasions in Māori culture are based around protein- rich foods, as evidenced by the high percentage of reporting of consumption of meat and seafood.

Bread was a frequently identified traditional food despite flour being introduced by colonisation. Rush et al. (2010) suggested that this finding shows evolution of culture and traditions as foods, tools and environments change.

Another investigation into traditional food intake in 704 Māori adults was done by the 1997 National Nutrition Survey (University of Otago & Ministry of Health, 1999). Intake was assessed by a food frequency questionnaire and 24-hour dietary recalls. It was found by this survey that traditional Māori foods, such as kaimoana, kumara, puha, watercress and kamokamo, were consumed more often by Māori adults than by non-Māori adults. However, traditional Māori foods were not consumed often with 1-2% of Māori men and less than 1% of Māori women consuming these traditional foods at least once a week. Older Māori adults were more likely to report consumption of traditional foods than younger Māori. However, the general diet in the Māori adults' diet was predominantly Western.

Traditional food consumption in Māori adults (n=30) living in Christchurch was investigated by Whiu et al. (2008). A food frequency questionnaire and survey was completed by a sample of 30 Māori adults in the community in Otautahi (Christchurch). This study investigated what foods were considered traditional, the frequency of consumption of traditional foods, the factors that prevented or permitted Māori from consuming traditional foods, and regularly practiced cultural customs. Many foods were considered traditional, including kaimoana, kunikuni pig, Māori potatoes, kumara, native birds, watercress, puha and cabbage tree, among others. Frequently consumed traditional Māori foods were kaimoana, kumara, watercress, and preparing foods using hāngi and boil up food preparation methods, especially at special occasions. There were many factors that were found to prevent Māori from consuming traditional foods, which included the migration to larger cities from rural communities, the availability of convenience foods, and introduction of metal pots and pans allowing the frying of foods, among others. Cultural practices around traditional Māori food practiced by the participants included tapu (unsafe), noa (safe) and rahui (restricted) food beliefs, practicing karakia (prayer), maanakitanga (sharing, entertaining and hospitality), and whanaungatanga (support of one another).

2.4.4 Traditional Māori food preparation methods

Food processing methods in pre-colonial Māori included hāngi (an earthen oven), drying, steaming, and smoking, among others (Whiu et al., 2008). In further detail, traditional hāngi consisted of hot stones in a deep hole in the ground. The food was wrapped in large leaves or hessian sacks then sprinkled with water. Water was also sprinkled onto the hot stones to give steam. Plaited flax mats were laid down on the hot stones, and then the wrapped food were placed on top of the flax mats. The hole was then filled with soil, and the food was steamed. This method of earthen cooking is similar in many ways to methods used in Polynesia; however the act of steaming is unique to Māori, where dry heat was used by inhabitants of Polynesia (Buck, 1950).

Traditional food preparation methods of four foods considered to be traditional were described by Whyte et al. (2001) after discussions with four Māori elders and groups of Māori food preparation experts. The traditional food preparation methods described were for tiroi (mussels and puha), kina (sea urchin or sea egg), kanga kopiro (fermented corn) and titi (mutton bird or sooty shearwater). These methods included consuming raw, steaming, boiling, preserving in fat, storing in fresh water, fermenting, burying, storing in a cool dark place, and refrigeration. Also, there are some customs surrounding food collection and preparation, for example only collecting kina when the kowhai tree is in bloom.

.After colonisation, there was a large increase in the variety of cooking techniques, particularly due to the introduction of metal pots and pans. Boiling foods became increasingly popular due to rapid cooking and ease of use, especially for daily family cooking (Buck, 1950). Hāngi is still used for large scale cooking, usually for tangi (funerals) or feasts (Buck, 1950; Whiu et al., 2008).

To summarise, this literature review has reported on the older Māori population demographics and its health and nutritional status. Dietary protein intake and its relationship with health in older adults was discussed, including the type of protein, protein food groups and the distribution of protein throughout the day. Lastly, key aspects of traditional Māori food were explored.

3.0 Methods

3.1 Aims and objectives

3.1.1 Aim

To investigate the protein intake and foods in Māori of advanced age

3.1.2 Objectives

- To determine the amount of protein consumed daily in Māori of advanced age
- To explore the types of protein-containing foods consumed by Māori of advanced age
- To investigate the spread of protein intake through the day in Māori of advanced age
- To examine the protein intake from kai Māori and contemporary traditional Māori kai

3.2 Study design: Life and Living in Advanced Age: A Cohort Study in NZ – Te Puāwaitanga o Nga Tapuwae Kia Ora Tonu

The "Life and Living in Advanced Age: A Cohort Study in NZ - Te Puāwaitanga o Nga Tapuwae Kia Ora Tonu" (LiLACS NZ) study is a quantitative total population longitudinal cohort study of advanced ageing. It is currently the only longitudinal study of ageing in the literature that has included a cohort of indigenous people – the NZ Māori men and women elders (Kaumātua). The Māori name for the study, "Te Puāwaitanga o Nga Tapuwae Kia Ora Tonu", translates to "the blossoming of the path to maintain good health" (Dyall, Kerse, Hayman, & Keeling, 2011).

The aim of the LiLACS NZ Study is to establish the predictors and relative contributions of factors that result in successful ageing in Māori and non-Māori, including health, social and culture-related factors. The two equal sized cohorts enrolled in LiLACS NZ in 2010 were Māori aged 80-90 years (n=421), and non-Māori aged 85 years (n=516). The response rates for the Māori and non-Māori cohorts were equal, at 58%. This different age criteria for the two cohorts allowed equal explanatory power for the main analyses, as Māori have a lower life expectancy (Statistics New Zealand, 2010). The participants will be followed up annually on an on-going basis to determine status and function. The first assessment was completed in 2010 (Wave 1). Wave 2 data collection occurred in 2011, and Wave 3 was completed in 2013. Ethical approval was given by the Northern X Regional Ethics Committee of NZ for the LiLACS longitudinal study in December 2009 (approval number NTX/09/09/088).

3.3 Study design: cross-sectional study

The current study was a cross-sectional analysis of the intake of protein by the Māori cohort data that was collected in Wave 2 of the LiLACS NZ study. Eligible subjects were Māori men and women who were born between the 1st of January 1920 and the 31st of December 1930; aged between 80 and 90 years in 2010, lived in the Bay of Plenty and Lakes District Health Boards' catchment areas, and had their dietary intake assessed in Wave 2 of the LiLACS NZ study. Therefore, the sample size of the current study included 216 advanced age Māori men and women.

3.4 Recruitment of participants

Full recruitment protocols of the LiLACS NZ study was published elsewhere (Hayman et al., 2012). Methods relating to the recruitment of participants of the current study are briefly summarised here.

Recruitment of participants was done by subcontractors on behalf of the University of Auckland. Six community organisations were subcontracted to introduce, recruit, enrol and interview the Māori participants in the study. Among these community organisations were four Māori tribal organisations (Rūnanga) and two Primary Health Organisations (health care providers that are funded by the NZ government). A governing group was formed to ensure the principles relating to appropriate conduct for Māori participating in the study were upheld (Te Rōpū Kaitiaki o tikanga Māori). This group involved six Māori leaders from different districts within the Lakes and Bay of Plenty DHB areas.

A variety of methods were utilised to ensure the total population was aware of the participation opportunity in the study. These included research staff attending and speaking at older adult meetings, for example Māori elder (kaumātua) groups, aged care facilities and community service organisations. Printed media was employed by way of newspaper articles in local newspapers and creating posters and pamphlets for placement in community areas such as doctor's clinics, shopping centres and pharmacies. The NZ General and Māori electoral rolls, Primary Health Organisations and General Practices' databases were screened for eligible participants. Further potential participants were identified through social and community networks. Use of Kaupapa Māori methods of recruitment, as described by Smith (1999), were used in combination with scientific recruitment methods, to ensure appropriate methods were used to engage with Māori and allowed the protection, partnership and participation of Māori according to the Treaty of Waitangi. Methods of recruitment were employed prior to and during the collection of data.

Information about the study was given to all eligible older adults by a familiar person, their primary health provider or a representative from their Māori iwi (tribe). Next, the eligible older adults were sent written information about the study, telephoned by a researcher or were paid a visit by Māori study representatives where the entire study was explained to them. Participants gave written informed consent prior to any data collection.

The field staff were Māori and non-Māori nurses and local community members who completed a three day staff training programme held in the Bay of Plenty and Lakes Districts in March 2010. These sessions were run by the University of Auckland and explained the methods of conducting a standardised interview and the protocols of the research. The nurses were each supplied with an equipment set for use in assessments of the participants. All staff were supplied with take home resources such as detailed protocol and procedure manuals and equipment usage guidelines that could be referred to during the data collection process.

3.5 Measures

3.5.1 Demographics

Age, gender, ethnicity, deprivation index, living situation, employment and current marital status were investigated. The questions were adapted from the 2006 NZ

Census questions and those used in the Newcastle 85+ study (Collerton et al., 2007).

3.5.2 Health

The 'Medical Outcomes Study Short Form Health Survey (SF 12)' was used to measure the participants' general health and health-related quality of life status (Brazier & Roberts, 2004). Participants were also asked to self-rate their health in comparison to older adults of the same age. The participants' weight and heights were measured, and body mass index was calculated.

3.5.3 Cultural practices

The Māori cohort consisted of those participants who self-identified as Māori. Their culture and cultural practices were investigated, including identification of their hapū (extended family group), iwi (tribe) and rohe (iwi regional boundary), and fluency in Te Reo Māori me ona tikanga (Māori language). Contact with other Māori and visits to a marae were assessed using questions that were adapted from Te Hoa Nuku Roa (Stevenson, 2004). The importance of hapū and iwi to wellbeing, the understanding of tikanga (cultural practices), and the importance of language and culture to the participants' wellbeing were determined. It was also investigated whether the participants were living in their hapū area.

3.5.4 Nutritional assessment

The 216 Māori men and women participants of this study provided at least one 24-hour dietary recall, where 204 participants completed two recalls. Those participants who completed only one dietary recall included two participants who died before completing the second dietary recall and ten participants refused to do the second recall Data was collected as a part of Wave 2 of the LiLACS NZ longitudinal study from the beginning of January 2011 to the end of the first quarter of 2012. An interview took place in the participants' home or offered at another site depending on what the participant chose, and a structured and standardised questionnaire was used. The questionnaire was available in English or Te Reo Māori.

3.5.4a Data collection protocol

Data was collected as a part of Wave 2 of the LiLACS NZ longitudinal study from the beginning of January 2011 to the end of the first quarter of 2012. An interview took place in the participants' home or offered at another site depending on what the participant chose, and a structured and standardised questionnaire was used. This interview took approximately two to four hours to complete, not including gaining consent. The questionnaire was available in English or Te Reo Māori.

3.5.4b 24 hour multiple pass recall

Assessment of nutritional intake was done via at least one 24-hour dietary recalls, which were completed by the participants on two separate days by trained interviewers using the multiple pass recall (MPR) protocol. The MPR method consists of several "passes" over the food recall by a trained interviewer. The first pass is an uninterrupted quick recall of the participant's food and fluid intake over the last 24 hours. This is followed by the second pass, which consists of probing questions about the person's intake to ensure as much detail is collected about the foods as necessary, for example the time food was eaten, quantities consumed and cooking methods. In the third pass, the interviewer then reviews the recorded intake with the participant, which allows foods forgotten to be recorded and to confirm the participant is confident with the accuracy of the recall. This method was developed by the US Department of Agriculture for their national surveys (Conway, Ingwersen, Vinyard, & Moshfegh, 2003). It has been validated for use in NZ's national surveys (University of Otago & Ministry of Health, 2011), and has been used in the US NHANES national surveys (Moshfegh et al., 2008). The MPR method has also been validated in advanced age adults in the Newcastle 85+ study (Adamson et al., 2009).

The advantages of using 24 hour MPR include a minimal burden on participants, effective use of time and money, the intake can be assessed in person or over the phone, and it does not exclude illiterate participants (Biró, Hulshof, Ovesen, Amorim Crus, & Group, 2002). The disadvantages of this assessment method include the reliance on memory especially in older adults, inaccurate portion size estimation, requires trained interviewers, and development of a coding system (Buzzard et al., 1996).

3.5.4c Quantification of food intake

The quantity of a food and fluid consumed in a 24-hour dietary recall is estimated so that further nutrient analyses can be completed. In order to gain a more accurate estimate of the food consumed recorded in the 24 hour recall, tools for quantifying intakes are used. One tool used to quantify food intake was household measurers, for example a set of measuring cups. Another tool used in this study was an adapted 'Photographic Atlas of Food Portion Sizes', which was developed on behalf of the Nutritional Epidemiological Group UK. This Photographic Atlas contained photographs of different amounts of 644 foods, which helped the participants to visually identify the quantity of a food they consumed the previous day. These household measures were used in conjunction with the Photographic Atlas of Food Portion Sizes. Prior to use, the Photographic Atlas was piloted on some older participants to ensure it was suitable for use in the target population and to ensure it included local food preferences. After its pilot, several foods were added including many types of fruit and vegetables e.g. avocado, rhubarb, and kiwifruit to name a few. Results from the pilot also indicated that cultural foods for Māori should be added e.g. kaimoana and kumara, while other foods such as Yorkshire pudding could be excluded.

Foods in the Photographic Atlas were photographed on a standard size dinner plate or bowl against a white background by a professional photographer. To ensure the perception of size was more accurate, cutlery was used as a standard of reference. All of the photography and presentation of the adapted Photographic Atlas used the guide for users of the UK Photographic Atlas (Nelson, Atkinson, & Meyer, 1997)

3.5.4d Data entry

Once the paper interview forms were collected they were examined for any missing data, missing codes or indistinguishable handwriting. If any concerns were raised after review of the forms, the trained interviewers were contacted to solve any problems. The paper data forms were edited manually as necessary, and then entered electronically into a Microsoft Access database.

After data collection was completed the 24-hour dietary recall data, including recipes, was checked for accuracy and coded by a qualified dietitian as they have an in-depth knowledge of the food composition database, 'FOODfiles'. 'FOODfiles' is the software that uses the nutrient data from the NZ Food Composition Database. The NZ Food Composition Database is a joint venture by the NZ Institute for Plant & Food Research Limited and the NZ Ministry of Health (The NZ Institute of Plant & Food Research Limited, 2013). It is the largest and most detailed catalogue of the nutrient data of commonly consumed foods in NZ. An in-depth knowledge of FOODfiles and the NZ Food Composition Database is important in coding and entering the data from the 24-hour dietary recalls as each food is matched electronically with foods' and beverages' and the associated nutrition data available in FOODfiles.

3.6 Data processing

3.6.1 Animal and plant protein foods

A list of all foods consumed by the participants was compiled into a Microsoft Excel spreadsheet. Each food was then categorised into animal or plant protein as their main contributor to protein. Unprocessed foods consisted of either animal or plant protein sources, such as meat, eggs, and vegetables. The recipes and ingredients lists of foods that contained both animal and plant protein food sources were reviewed and the amount of protein contributed from both protein types was calculated. The main type of protein determined if the food was categorised as animal or plant protein. For example, in a white bread recipe the protein-containing foods are white flour (four cups) and one egg. Four cups of flour have 13g of plant protein while one egg has 6g of animal protein in it, therefore white bread was categorised as a plant protein. Foods that contained no protein were excluded from the list. This resulted in the formation of two data variables – animal protein and plant protein.

3.6.2 Protein food groups

A short literature review was conducted to decide which protein food groups would be used. Five papers investigating animal and plant protein intake were critically reviewed for their relevance to this thesis and how the food groups were organised. Each article's food groups were organised into a table for comparison and discussion at a meeting with two research supervisors. It was decided at this meeting that an adapted organisation of food groups would be used, combining and adapting the protein food groups of the National Nutrition Survey 08/09 (University of Otago & Ministry of Health, 2011), and food groups utilised by Lin et al. (2011) and Lin et al. (2010) as it was a population based study and had succinct food groups. The National Nutrition Survey 08/09 gave NZ-relevant protein food groups and the contribution of each food group to protein intake, which would allow comparisons between this thesis' and the National Nutrition Survey 08/09's results and ensure the highest protein sources of those aged 71+ years were appropriately analysed. Lin et al. (2011) was a population based study of the intake of animal and plant protein and its association with overweight and obesity in the Belgian population as a part of the Belgian National Food Consumption Survey. The Premier Trial (Lin et al. 2010) investigated the source of protein in 810 participants in the United States and. The food groups employed by Lin et al. (2010) were succinct, created for analysis of animal and plant protein intakes, and were relatable to the NNS08/09.

The six animal food groups used for the current investigation were:

- Meat
- Dairy Products
- Eggs and Egg Products
- Fish and Seafood
- Pork
- Poultry

The six plant food groups were:

- Bread and Bread-Based Dishes
- Potatoes and Other Tubers
- Cereals
- Vegetables
- Fruit Including Nuts and Seeds
- Legumes

3.6.3 Distribution of protein intake

Meals were self-defined by the participants as breakfast, lunch, dinner, snacks or supper. The amount of protein throughout the day was calculated by taking the estimated protein per 100g for a given food item and multiplying it by the weight of the food item consumed to calculate the protein consumed. Protein from all the foods consumed at one meal was summed to get the total protein for that meal. This was repeated for the same meal on the second dietary recall, and then the two values were averaged.

3.6.4 Assessment of traditional Māori food intake

The terms "traditional Māori" food and "Kai Māori" have many complexities associated with them, particularly when forming a rigid, scientific definition for each of them. It is a combination of the complexities and cultural barriers to understanding between Māori culture and practices with English language and the understanding of the word "traditional" by non-Māori. After multiple discussions, meetings and emails discussing these complexities, working definitions for the foods culturally special to Māori have been formed. These definitions are only appropriate for the scope of this thesis.

Firstly, a brief literature review of articles published on traditional Māori food and the lists of foods and definitions of traditional Māori food described in these articles was collated. The papers reviewed were from many different tribal regions around NZ which gave a variety of foods local to each different area. There were inconsistencies surrounding the definition of "traditional Māori" food, including the consumption of food introduced by explorers and preparation of foods using tools that were introduced by explorers.

3.6.4a Kai Māori

Discussions with a Māori cultural advisor and research supervisor about the brief literature review findings raised the issues and complexities of defining traditional Māori food. It was decided at this meeting that a conservative definition of "Kai Māori" was to be used. This definition included those foods that were uncultivated wild foods that were hunted or harvested from the tribal rohe, which could be near the sea, the forest or by a lake. These foods would be minimally processed prior to consumption, where pre-colonial methods of preparing food for consumption were used i.e. raw, hāngi (earthen oven), smoked or steamed. No contemporary foods or tools, such as pots or pans used in boil ups, would be used to prepare food classified as Kai Māori. There was also an issue as to the cultural practices around food, such as karakia (prayer) before consuming food; however it was decided this would not be included in the definition for this thesis as it could not be measured and would not affect the nutritional content of the foods consumed.

A base list of foods to be included for the Kai Māori food list was drafted. A survey of wild food consumption by a Bay of Plenty and Lakes Districts iwi, Te Arawa, gave a list of foods that were consumed by Māori living in the Rotorua Lakes area (Tipa, Nelson, Emery, Smith, & Phillips, 2010). An adapted version of this list was used as the list of Kai Māori foods, as seen in Table 1.

Table 1. Kai Māori food list

Butterfish	Kahawai	Mussels (salt and	Scallops
Cockles	Kamokamo	fresh water)	Shark
Cod	Kina	Muttonbird	Snapper
Crayfish (salt and	Kingfish	Oysters	Tarakihi
fresh water)	Kumara	Paua	Toheroa
Eel	Lampreys	Pipi	Trevally
Flounder	Moki	Puha	Trout
Gurnard	Morihana	Pupu	Tuatua
Hapuka	Mullet	Seaweed	Watercress
			Whitebait

Next, the raw 24-hour recall data for each participant was analysed for consumption of foods that fit the Kai Māori criteria. A Māori cultural advisor was consulted with if there were any uncertainties if a food was Kai Māori or not.

It was found during this analysis that the criteria of Kai Māori may not include those contemporary foods consumed by Māori that may be cultural, for example pork hāngi at a tangi (funeral) or boiled kumara or puha which have been consumed by Māori for more than 100 years but are not pre-colonial.

3.6.4b Contemporary traditional Māori food

On the advice of a Māori cultural advisor and research supervisor it was decided that a second, broader definition of "traditional" food would be created. This list of food includes two types of foods – those foods included on the Kai Māori list that have been cooked using contemporary methods, such as kumara that is boiled in a pot or roasted, and foods that are not on the Kai Māori list that were cooked by a pre-colonial Māori method, for example pork cooked in a hāngi. This second list allowed inclusion of many of the foods that appear to be considered contemporary traditional Māori food; however it was limited in that it also allowed the inclusion of foods that were not considered traditional Māori food in any form, such as deep fried battered fish.

The foods identified from the dietary recalls as Kai Māori and Contemporary Māori Foods were then matched to the foods available in the FOODfiles database and entered into a database to provide the nutrient content of each participant's Kai Māori and Contemporary Māori Food intake. Examples of foods categorised as Contemporary Māori Food is found in Table 2.

Table 2. Examples of foods included in the Contemporary Traditional Māori Food list

Cockles, boiled Crayfish, boiled Eel, boiled and fried Fish, boiled, grilled and baked - various species including flounder, hoki, blue cod, gurnard, snapper and others	Kamokamo, boiled and roasted Kina, boiled Kumara, boiled, roasted and baked Mussels, boiled and curried	Toroi (mussels and puha), puha is boiled Mutton bird, boiled Paua, creamed Pipis, boiled and fried Pork, hāngi Puha, boiled Scallops, boiled

3.7 Statistical analyses

Prior to beginning of statistical analyses, the data was cleaned and checked for coding errors. The cohort characteristics were analysed using descriptive statistics: mean ± standard deviation if data was normally distributed or median (interquartile range) if the data was non-normally distributed. Percentages were used in categorical data. Normally distributed scale data was compared using two-tailed independent t-tests, while non-normally distributed scale data was compared using nonparametric tests. A p value of less than 0.05 was considered significant. The statistical software used was IBM SPSS Statistics for Windows, Version 20.0 (released 2011).

4.0 Results

4.1 Demographics

The demographic characteristics of the participants are shown in Table 1. Women were older than the men (median 82.0 vs. 83.2 years, p=0.019). The men weighed more than women (p=0.001), however there was no significant difference between the men and women's body mass index (p=0.449). There were also no significant differences in self-rated health, physical health and mental health T scores between the genders.

Table 1. Age and health characteristics of the participants

Characteristic	Men	Women	Total	p value
Age years*	n=91 82.0 [81.0, 85.0]	n=122 83.5 [81.0, 86.0]	n=213 83.0 [81.0, 85.0]	0.019
Weight kg*	n=75 77.5 [68.4, 86.6]	n=105 66.5 [59.0, 79.9]	n=184 71.8 [63.4, 83.8]	0.001
BMI kg/m^2	n=74 27.9 [25.5, 31.3]	n=106 28.7 [24.0, 31.7]	n=180 28.4 [24.7, 31.6]	0.449
Self-rated health %	n=91	n=122	n=213	0.788
Excellent and very good	23.1%	19.7%	21.1%	
Good	37.4%	37.7%	37.6%	
Fair and poor	39.6%	42.6%	41.3%	
Physical health T-score[1]	n=77 46.8 [33.2, 52.6]	n=105 43.9 ± 10.6	n=182 45.6 [35.6, 52.6]	0.368
Mental health T-score[1]	n=77 54.5 [45.7, 58.8]	n=105 55.3 [47.7, 59.1]	n=182 54.7 [47.1, 59.0]	0.368

Mean ± SD reported if data is normally distributed, median [IQR] reported if data is non-normally distributed. Significant difference found between the genders = *p<0.05, **p<0.001. Values rounded to three significant figures. Percentages may not sum to 100% due to rounding. Chi square statistic determined significance. [1]SF12 questionnaire T-score.

Socio-demographic characteristics of the participants are shown in Table 2. The results showed that there were significant differences in marital status between men and women, where more men were married and more women were widowed. The living situations of the participants were also statistically significant, where 45.5% of men were living with a spouse/partner only, whereas 50.9% of women were living alone (p=0.001). Occupations also significantly differed between the genders (p<0.001), where women were more likely to work in non-professional, non-technical occupations than men. There was an upward trend of more participants living in the higher decile areas; however there was no significant difference between the genders.

Table 2. Socio-demographic characteristics of the participants

Characteristic	Men	Women	Total	p value
Education n(%)	n=91	n=120	n=211	0.213
Primary school/no schooling	34 (37.4)	31 (25.8)	65 (30.8)	
Secondary school, no qualification	33 (36.3)	46 (38.3)	79 (37.4)	
Secondary school, qualification	16 (17.6)	28 (23.3)	44 (20.9)	
Trade, occupational	4 (4.40)	3 (2.50)	7 (3.32)	
Tertiary qualification	4 (4.40)	12 (10.0)	16 (7.58)	
Occupation n(%)**	n=92	n=124	n=216	<0.001
Professionals	27 (29.3)	27 (21.8)	54 (25.0)	
Technicians	16 (17.4)	9 (7.26)	25 (11.6)	
Non-professional, non-technicians	49 (53.3)	88 (71.0)	137 (63.4)	
Marital Status n(%)*	n=91	n=122	n=213	0.002
Never married/partnered	2 (2.20)	2 (1.64)	4 (1.88)	
Married/partnered	43 (47.3)	29 (23.8)	72 (33.8)	
Widow/widower	40 (44.0)	87 (71.3)	127 (59.6)	
Separated	2 (2.20)	1 (0.82)	3 (1.41)	
Divorced	4 (4.40)	3 (2.46)	7 (3.29)	
Living situation n(%)*	n=77	n=106	n=183	0.001
Alone	19 (24.7)	54 (50.9)	73 (40.0)	
With spouse or partner only	35 (45.5)	19 (17.9)	54 (29.5)	
With spouse and child or other relative	8 (10.4)	9 (8.49)	17 (9.29)	
With child and not spouse	8 (10.4)	15 (14.2)	23 (12.6)	
With other(s), not spouse or children	7 (9.09)	9 (8.49)	16 (8.74)	
Deprivation index n(%)	n=92	n=124	n=216	0.310
Decile 1	0 (0)	0 (0)	0%	
Decile 2	1 (1.09)	2 (1.61)	3 (1.39)	
Decile 3	1 (1.09)	9 (7.26)	10 (4.63)	
Decile 4	11 (12.0)	15 (12.1)	26 (12.0)	
Decile 5	4 (4.35)	4 (3.23)	8 (3.70)	
Decile 6	11 (12.0)	12 (9.68)	23 (10.6)	
Decile 7	10 (10.9)	7 (5.65)	17 (7.87)	
Decile 8	14 (15.2)	18 (14.5)	32 (14.8)	
Decile 9	8 (8.70)	20 (16.1)	28 (13.0)	
Decile 10	32 (34.8)	37 (29.8)	69 (31.9)	

Occupation was the main lifetime occupation of the participant or their spouse, whichever was in the highest category. Significant difference found between the men and women = *p<0.05, **p<0.001. Values rounded to three significant figures. Percentages may not sum to 100% due to rounding. Chi square statistic determined significance. Professionals = Legislators, administrators, managers, professionals, agriculture and fishery workers. Technicians = Technicians & associate professionals; trades workers. Non-professional non-technician = Clerks; service and sales workers; plant and machine operators and assemblers; elementary workers (incl. residuals)

4.2 Cultural practices

Table 3 describes the identification and importance of hapū and iwi by the participants. It was found that men were significantly more likely to live in their hapū/with extended family/where they come from than the women (p=0.029). No other significant differences between the genders were found.

Table 3. Hapū and iwi identification and importance by the participants

Variable	Men	Women	Total	P value
Hapū identification n(%)	n=92	n=124	n=216	0.105
No	54 (58.7)	86 (69.4)	140 (64.8)	
Yes	38 (41.3)	38 (30.6)	76 (35.2)	
Iwi identification n(%)	n=92	n=124	n=216	0.964
No	8 (8.70)	11 (8.87)	19 (8.80)	
Yes	84 (91.3)	113 (91.1)	197 (91.2)	
Living in hapū or with extended family or where they come from n(%)*	n=92	n=123	n=215	0.029
No	47 (51.1)	81 (65.9)	128 (59.5)	
Yes	45 (48.9)	42 (34.1)	87 (40.5)	
Importance of hapū for wellbeing n(%)	n=87	n=117	n=204	0.400
Not at all	12 (13.8)	21 (17.9)	33 (16.2)	
A little	13 (14.9)	11 (9.40)	24 (11.8)	
Moderately	13 (14.9)	21 (17.9)	34 (16.7)	
Very	38 (43.7)	42 (35.9)	80 (39.2)	
Extremely	11 (12.6)	22 (18.8)	33 (16.2)	
Importance of iwi for wellbeing n(%)	n=88	n=117	n=205	0.427
Not at all	12 (13.6)	13 (11.1)	25 (12.2)	
A little	10 (11.4)	15 (12.8)	25 (12.2)	
Moderately	12 (13.6)	23 (19.7)	35 (17.1)	
Very	44 (50.0)	46 (39.3)	90 (43.9)	
Extremely	10 (11.4)	20 (17.1)	30 (14.6)	

Significant difference found between the genders = *p<0.05, **p<0.001. Values rounded to three significant figures. Percentages may not sum to 100% due to rounding.

The proportions of the participants who socialise with other Māori are depicted in Table 4. No significant differences between the genders were found for socialising with other Māori.

Table 4. Socialising with other Māori

Variable	Men	Women	Total	P value
Contact with other Māori n(%)	n=68	n=96	n=164	0.069
Mainly Māori	32 (47.1)	35 (36.5)	67 (40.9)	
Some Māori	27 (39.7)	33 (34.4)	60 (36.6)	
Few Māori	7 (10.3)	26 (27.1)	33 (20.1)	
No Māori	2 (2.94)	2 (2.08)	4 (2.44)	
Ever visited a marae n(%)	n=68	n=97	n=165	0.631
No	1 (1.47)	2 (2.06)	3 (1.82)	
Yes	67 (98.5)	95 (97.9)	162 (98.2)	
Marae visits in last 12 months n(%)	n=67	n=93	n=160	0.623
Zero times	9 (13.4)	21 (22.6)	30 (18.8)	
Once	12 (17.9)	14 (15.1)	26 (16.3)	
A few times	11 (16.4)	17 (18.3)	28 (17.5)	
Several times	24 (35.8)	27 (29.0)	51 (31.9)	
More than once a month	11 (16.4)	14 (15.1)	25 (15.6)	

Significant difference found between the genders = *$p<0.05$, **$p<0.001$. Values rounded to three significant figures. Percentages may not sum to 100% due to rounding.

Te Reo Māori (Māori language) and tikanga (Māori culture) characteristics of the participants are described in Table 5. No significant differences between the genders were found.

Table 5. Te Reo Māori and tikanga Māori characteristics of the participants

Variable	Men	Women	Total	P value
Fluent in Te Reo Māori n(%)	n=68	n=97	n=165	0.366
No	33 (48.5)	54 (55.7)	87 (52.7)	
Yes	35 (51.5)	43 (44.3)	78 (47.3)	
Mother tongue language n(%)	n=68	n=97	n=165	0.949
Māori	27 (39.7)	39 (40.2)	66 (40.0)	
English	41 (60.3)	58 (59.8)	99 (60.0)	
Understanding of tikanga n(%)	n=88	n=117	n=205	0.673
Not at all	14 (15.9)	15 (12.8)	29 (14.1)	
A little	10 (11.4)	18 (15.4)	28 (13.7)	
Moderately	20 (22.7)	30 (25.7)	50 (24.4)	
Very	24 (27.3)	35 (29.9)	59 (28.8)	
Extremely	20 (22.7)	19 (16.2)	39 (19.0)	
Importance of language and culture to wellbeing n(%)	n=68	n=96	n=164	0.079
Not at all	5 (7.35)	5 (5.21)	10 (6.10)	
A little	1 (1.47)	7 (7.29)	8 (4.88)	
Moderately	18 (26.5)	13 (13.5)	31 (18.9)	
Very	33 (48.5)	46 (47.9)	79 (48.2)	
Extremely	11 (16.2)	25 (26.0)	36 (22.0)	

Significant difference found between the genders = *p<0.05, **p<0.001. Values rounded to three significant figures. Percentages may not sum to 100% due to rounding.

4.3 Summary of dietary intakes

The median [IQR] total protein intake of the men was 72.9g [53.7, 93.2g], which contributed 16.3% [14.2, 18.6%] to their total energy intake. Based on their average weight, the men consumed 0.941g/kg/day of protein. The women participants consumed 55.2g [46.1, 72.4g] of total protein, contributing 16.3% [13.7, 19.8%] of their total energy intake. The women consumed 0.830g/kg/day of protein, based on their average weight. Both the men and women subjects median protein intakes were in line with the Australian National Health and Medical Research Council (NHMRC) and NZ Ministry of Health's Nutrient Reference Values for adults >70 years of age, as shown in Table 6 (National Health and Medical Research Council & Ministry of Health, 2005).

Inadequate intakes of total protein were more prevalent in the men than the women, with 34.8% of men and 24.2% of women consuming an inadequate amount of protein compared to the EAR for protein. On the other hand, the women had a higher rate of inadequate protein percentage of energy intake, where 32.6% of men and 34.7% of women did not meet the lower limit of the AMDR for protein percentage of energy.

The median intake of fat as a percentage of energy was higher than the upper limit of the acceptable macronutrient distribution range in both genders. Correspondingly, the intake of carbohydrates as a percentage of energy was less than the lower limits of the carbohydrate acceptable macronutrient distribution range.

Table 6. Macronutrient intake and distributions by the participants

Nutrient	Men (n=92)	Nutrient reference value	Women (n=124)	Nutrient Reference Value
Energy (kcal)	1840 ± 612	-	1440 ± 432	-
Total protein (g)	72.9 [53.7, 93.2]	65g/day[a]	55.2 [46.1, 72.4]	46g/day[a]
Inadequate total protein n(%)	32 (34.8)	-	30 (24.2)	-
Protein (%TE)	16.3 [14.2, 18.6]	15-25%[b]	16.3 [13.7,19.8]	15-25%[b]
Inadequate protein %TE n(%)	30 (32.6)	-	43 (34.7)	-
Protein (g/kg/day)	0.941	0.86g/kg/day[a]	0.830	0.75g/kg/day[a]
Fat (g)	76.8 [52.8, 103]	-	59.6 [44.1, 74.4]	-
Fat (%TE)	39.2 ± 9.03	20-35%[b]	38.3 ± 8.04	20-35%[b]
Carbohydrate (g)	194 ± 63.6	-	157 ± 45.1	-
Carbohydrate (%TE)	42.8 ± 8.61	45-65%[b]	44.3 ± 8.72	45-65%[b]

Mean ± SD reported if data is normally distributed, median [IQR] reported if data is non-normally distributed. %TE = percent total energy. Values rounded to 3 significant figures. (-) = no nutrient reference value. [a] = estimated average requirement. [b] =acceptable macronutrient distribution range

Summaries of the participants' vitamin intakes are found in Table 7. The median intakes of dietary folate equivalents, vitamin B6 and vitamin E intake by the men and women did not meet the recommended nutrient reference values.

Table 7. Vitamin intake of the participants

Vitamin	Men (n=92)	Nutrient reference value		Women (n=124)	Nutrient reference value	
Dietary folate equivalents (μg)	279 [201, 383]	320μg/day	↓	264 [185, 395]	320μg/day	↓
Niacin equivalents (mg)	30.9 [23.3, 39.7]	12mg/day	✔	23.2 [17.2, 30.4]	11mg/day	✔
Riboflavin (mg)	1.65 [1.17, 2.23]	1.3mg/day	✔	1.52 ± 0.616	1.1mg/day	✔
Thiamin (mg)	1.36 [0.893, 2.06]	1.0mg/day	✔	1.26 [0.771, 2.01]	0.9mg/day	✔
Vitamin A equivalents (μg)	996 [553, 1380]	625μg/day	✔	794 [520, 1160]	500μg/day	✔
Vitamin B12 (μg)	3.37 [2.47, 5.12]	2.0μg/day	✔	2.72 [1.66, 3.96]	2.0μg/day	✔
Vitamin B6 (mg)	1.30 [0.993, 1.75]	1.4mg/day	↓	1.20 [0.831, 1.72]	1.3mg/day	↓
Vitamin C (mg)	72.9 [40.7, 119]	30mg/day	✔	70.6 [47.0, 127]	30mg/day	✔
Vitamin E alpha-tocopherol equivalents (mg)	7.67 [5.09, 10.6]	10mg/day	↓	6.38 [4.55, 8.89]	7mg/day	↓

Mean ± SD reported if data is normally distributed, median [IQR] reported if data is non-normally distributed. All nutrient reference values based on estimated average requirements (EAR) recommendations for the >70 year old population group by NHMRC and MOH. Values rounded to 3 significant figures.

The intake of minerals and omega-3 fatty acids are found in Table 8. The median intakes of calcium, iodide, potassium, magnesium, selenium, and for the men, zinc, did not meet the nutrient reference values for these minerals.

Table 8. Mineral and omega-3 fatty acid intake of the participants

Micronutrient	Men (n=92)	Nutrient reference value	Women (n=124)	Nutrient reference value
Calcium (mg)	578 [409,864]	1100mg/day ↓	543 [429,746]	1100mg/day ↓
Omega-3 fatty acids (mg)	338 [153, 576]	160mg/day ✔	288 [143, 521]	90mg/day ✔
Iron (mg)**	11.1 [7.62, 14.4]	6mg/day ✔	9.40 ± 3.77	5mg/day ✔
Iodide (µg)	79.3 [39.7, 149]	100µg/day ✔	62.8 [31.6, 108]	100µg/day ✔
Potassium (mg)**	2680 ± 980	3800mg/day ✔	2290 ± 740	2800mg/day ✔
Magnesium (mg)	234 [185, 285]	350mg/day ✔	205 [160,250]	265mg/day ✔
Phosphorous (mg)*	1120 [886, 1400]	580mg/day ↓	950 ± 310	580mg/day ↓
Selenium (µg)	44.2 [31.7, 66.4]	60µg/day ✔	32.4 [22.4, 57.1]	50µg/day ✔
Zinc (mg)*	8.94 [6.80, 12.9]	12mg/day ↓	7.05 [5.29, 9.10]	6.5mg/day ↓

Mean ± SD reported if data is normally distributed, median [IQR] reported if data is non-normally distributed. Significant difference found between the gender's intake and the nutrient reference value = *p<0.05, **p<0.001. Nutrient reference values for calcium, iron, iodine, magnesium, phosphorous, potassium, selenium, and zinc are based on estimated average requirements (EAR) or adequate intake (AI) recommendations for the >70 year old population group by NHMRC and MOH. Omega 3 fatty acid nutrient reference value is based on the AI for total DHA+EPA+DPA long chain n-3 intake for adults >19 years old. Values rounded to 3 significant figures.

4.4 Animal and plant protein intake

Table 9 describes the intake of protein and percent of energy contributed by protein from animal and plant protein sources. The men consumed significantly more animal protein than the women, at 52.7g and 36.6g, respectively (p<0.001). The percentage of the contribution of animal protein to total energy intake, however, was not significantly different between the genders, at 11.4% in the older men and 10.6% in the older women (p=0.216).

The men consumed 19.8g of plant protein, while the women consumed 18.5g, with no significant difference between the genders (p=0.335). A mean intake of 4.69% and 5.12% of total energy from plant protein was consumed by the older men and women, respectively. There were no significant differences in the percent of plant protein contributing to energy intakes between men and women participants (p=0.074).

Animal protein intake contributed to 72.3% of the total protein intake in the men participants. The intake of animal protein in the women participants contributed to 66.3% of the total protein intake. The animal: plant ratio was significantly higher in the older men than in the older women (2.63 versus 1.94, p=0.009).

Table 9. Animal and plant energy, protein and percent contribution to energy from protein intakes of the participants

Protein source	Men (n=92)	Women (n=124)	p value
Animal			
Protein (g)**	52.7 [36.5, 70.5]	36.6 [26.0, 48.2]	<0.001
Protein (%TE)	11.4 [9.03, 14.1]	10.6 [7.86, 13.5]	0.216
Plant			
Protein (g)	19.8 [15.2, 26.8]	18.5 [14.5, 22.4]	0.335
Protein (%TE)	4.69 ± 1.50	5.12 [4.21, 6.35]	0.074
Animal: plant ratio*	2.63:1 [1.65, 4.03]	1.94:1 [1.39, 2.84]	0.009

Mean ± SD reported if data is normally distributed, median [IQR] reported if data is non-normally distributed. Significant difference found between the genders = *p<0.05, **p<0.001. %TE = percent contributed to total energy. Values rounded to 3 significant figures.

4.4.1 Animal Food Groups

The results of the amount of animal protein food groups, percentage of total energy from animal protein food groups, and the contribution of the protein from these food groups to the total protein intake are shown in Table 10. The food group that contributed the most animal protein to the total amount of protein in the male participants was poultry, with 17.3g [6.44, 24.3g] of protein which represents 22.9% [14.3, 35.7] of total protein, and the largest percentage of total energy to protein (3.72% [1.72, 6.79]). Eggs and egg products contributed the least amount of animal protein to the participants' total protein intake with 5.58g [0.415, 8.17g] of protein, 6.77% [0.62, 12.1] of total protein, and was the food group that contributed the lowest percentage of animal protein to total energy, with 0.959% [0.161, 1.64].

For the women participants, fish and seafood contributed the largest amount of animal protein to their diet with 11.3g [4.67, 17.7g], however meat contributed the highest percentage of total protein at 22.9% [14.3, 35.7], and the largest percentage of protein contributing to total energy at 3.09% [1.90, 5.83]. Similar to the male participants, eggs and egg products contributed the least amount of total protein, the smallest percentage of total protein intake and percentage contributing to total energy by animal protein food groups, at 3.39g [0.618, 6.71], 5.87% [1.08, 10.1] of total protein, and 0.959% [0.161, 1.64] of energy from protein.

The amount of protein from meat and poultry was significantly higher in men than in women (p<0.05), however the percentages of protein contributing to total protein intake and energy intake were not significantly different between men and women for these two food groups (p>0.05). Women consumed a significantly higher proportion of energy from protein in dairy products than men (2.51% versus 1.88%, p=0.019), and the contribution of dairy protein to total protein intake was also higher in the women than in the men (16.5% versus 12.1%, p=0.013).

Table 10. Total protein and protein percentage of energy from animal food groups

Food group	Men	Women	p value
Dairy products	n=92	n=122	
Protein (g)	8.56 [5.46, 14.9]	8.31 [5.57, 13.2]	0.890
Protein (%TE)*	1.88 [1.35, 3.96]	2.51 [1.71, 3.96]	0.019
Protein (%TP)*	12.1 [6.91, 21.9]	16.5 [10.0, 25.2]	0.013
Eggs and egg products	n=50	n=73	
Protein (g)	5.58 [0.415, 8.17]	3.39 [0.618, 6.71]	0.084
Protein (%TE)	1.09 [0.087, 1.71]	0.959 [0.161, 1.64]	0.532
Protein (%TP)	6.77 [0.62, 12.1]	5.87 [1.08, 10.1]	0.659
Fish and seafood	n=39	n=56	
Protein (g)	12.4 [3.35, 29.3]	11.3 [4.67, 17.7]	0.615
Protein (%TE)	3.57 [2.05, 5.38]	2.62 [1.17, 4.82]	0.358
Protein (%TP)	22.5 [9.93, 34.1]	15.1 [7.83, 25.6]	0.122
Meat	n=71	n=87	
Protein (g)*	16.4 [9.96, 24.9]	11.1 [6.90, 18.9]	0.010
Protein (%TE)	3.61 [2.18, 5.64]	3.09 [1.90, 5.83]	0.201
Protein (%TP)	22.9 [14.3, 35.7]	19.2 [11.5, 35.0]	0.424
Pork	n=53	n=71	
Protein (g)	7.20 [3.94, 15.4]	5.40 [2.60, 13.2]	0.146
Protein (%TE)	1.78 [0.836, 4.32]	1.47 [0.719, 3.24]	1.00
Protein (%TP)	11.8 [4.20, 23.5]	12.3 [4.10, 20.2]	0.856
Poultry	n=35	n=49	
Protein (g)*	17.3 [6.44, 24.3]	10.9 [5.60, 16.4]	0.008
Protein (%TE)	3.72 [1.72, 6.79]	3.03 [2.07, 4.70]	0.376
Protein (%TP)	24.1 [10.5, 32.8]	18.8 [11.4, 25.8]	0.121

Mean ± SD reported if data is normally distributed, median [IQR] reported if data is non-normally distributed. Significant difference found between the genders = *p<0.05, **p<0.001. %TE = percent contributed to total energy. %TP = percent contributed to total protein. Values rounded to 3 significant figures.

4.4.2 Plant Food Groups

The results of the amount of plant protein, percentage of total protein from plant protein food groups and percentage of total energy from plant protein food groups is shown in Table 11.

The food group that contributed the most protein to the total amount of protein in the men participants was bread and bread-based dishes, with 6.76g [4.46, 10.8g] of protein and 8.82% [5.46, 14.7] of total protein, however it was the cereals food group that contributed the largest percentage of plant protein to energy (1.55% [0.939, 2.17]). Fruit including nuts and seeds contributed the least amount of plant protein to the participants total protein intake with 1.20g [0.407, 2.40g] of protein, 1.88% [0.47, 3.14] of total protein and contributed the lowest percentage of plant protein to total energy (3.38% [2.02, 5.11%]).

Bread and bread-based dishes contributed the largest amount of plant protein to the women's diet with 3.38g [2.02, 5.11g], 12.5% [9.00, 18.0] of total protein and contributed the largest percentage of plant protein to total energy at 1.94% [1.48, 2.77]. The least amount of plant protein contributing to total protein intake was the legumes food group with 1.17g [0.229, 1.87] of protein, 1.56% [0.41, 5.63] of total protein, and also contributed the lowest percentage of plant protein to total energy with 0.304% [0.095, 0.536].

There were significant differences between the intake of protein from legumes between the men and women participants, where men had a larger protein intake than women ($p=0.47$). This did not result in significant differences between the genders for energy and legume protein percentage of energy ($p>0.05$).However, there were low numbers of participants who consumed legumes which may impact on these results.

The amount of protein from potatoes and other tubers was significantly higher in men than in women ($p<0.05$), however the percentage of protein contributing to energy intake was not significantly different between men and women.

The percentage of total protein contributed by bread and bread-based dishes was significantly higher in the women than the men (12.5% vs. 8.82%, $p<0.001$). Higher proportions of total protein in the women compared to the men was found in both fruit including nuts and seeds (2.75% vs. 1.88%, $p=0.033$) and vegetable (3.97 vs. 2.86, $p=0.041$) food groups.

Table 11. Total protein, and protein percentage of energy from plant food groups

Food group	Men	Women	p value
Bread and bread-based dishes	n=89	n=117	
Protein (g)	6.76 [4.46, 10.8]	6.78 [5.15, 9.84]	1.00
Protein (%TE)	1.48 [0.929, 2.28]	1.94 [1.48, 2.77]	0.160
Protein (%TP)**	8.82 [5.46, 14.7]	12.5 [9.00, 18.0]	<0.001
Cereals	n=89	n=120	
Protein (g)	5.79 [3.78, 10.6]	5.04 [3.04, 7.35]	0.146
Protein (%TE)	1.55 [0.939, 2.17]	1.47 [0.862, 2.17]	0.953
Protein (%TP)	8.28 [5.40, 14.3]	8.75 [5.23, 13.9]	0.633
Fruit including nuts and seeds	n=83	n=121	
Protein (g)	1.20 [0.407, 2.40]	1.50 [0.687, 3.11]	0.392
Protein (%TE)*	0.304 [0.095, 0.536]	0.482 [0.226, 0.800]	0.004
Protein (%TP)*	1.88 [0.47, 3.14]	2.75 [1.27, 5.31]	0.033
Legumes	n=12	n=19	
Protein (g)*	2.29 [0.771, 7.86]	1.17 [0.229, 1.87]	0.047
Protein (%TE)	0.594 [0.211, 1.07]	0.271 [0.056, 1.16]	0.609
Protein (%TP)	3.33 [1.25, 7.03]	1.56 [0.41, 5.63]	0.106
Potatoes and other tubers	n=80	n=107	
Protein (g)*	2.73 [1.26, 3.69]	1.73 [1.05, 2.50]	0.023
Protein (%TE)	0.468 [0.286, 0.909]	0.458 [0.273, 0.716]	0.933
Protein (%TP)	2.79 [1.66, 4.59]	3.00 [1.86, 3.94]	0.598
Vegetables	n=89	n=120	
Protein (g)	2.19 [1.06, 3.45]	2.27 [1.40, 3.63]	0.617
Protein (%TE)*	0.493 [0.219, 0.882]	0.678 [0.401, 0.973]	0.029
Protein (%TP)*	2.86 [1.52, 5.07]	3.97 [2.49, 6.43]	0.041

Mean ± SD reported if data is normally distributed, median [IQR] reported if data is non-normally distributed. Significant difference found between the genders = *p<0.05, **p<0.001. %TE = percent contributed to total energy. %TP = percent contributed to total protein. Values rounded to 3 significant figures.

4.5 Daily spread of protein intake

The spread of protein intake over the day, percentage of total protein at meals and protein percent of total energy at meals are shown below in Table 12. Only one participant skipped breakfast, nine did not consume lunch and three participants missed dinner.

The men and women's intake of protein at breakfast was 11.7g [8.66, 17.6g] and 9.74g [7.21, 14.4g], respectively. These intakes equate to 15.7% [10.9, 26.0] and

16.8% [13.2, 24.0] of total protein intake in the men and women, respectively. There was no significant difference between the intakes of protein between men and women participants at breakfast (p>0.05). The protein intakes contributed to 2.62% [1.93, 4.00] and 2.87% [1.96, 4.07] in the older men and women, with no significant difference between genders (p=0.5290).

At lunch, protein consumption in the older men was 16.8g [10.5, 24.2g], while the older women consumed 14.8g [9.26, 23.4g]. There was no significant difference between the intakes of protein between men and women participants at lunch (p>0.05). However, the proportion of total protein consumed at lunch was statistically different between the genders, with men consuming a lower proportion (21.4%) compared to the women (29.1%) (p<0.001). Protein as a percentage of energy consumed by the men and women at lunch contributed 3.56% [2.59, 5.36] and 4.28% [3.11, 6.48], respectively, with no statistical significance (p=0.102)

Dinner was the largest source of protein in both the men and women participants, at 37.4g [19.8, 54.5g] and 23.3g [13.7, 30.4g], respectively. The difference in intake of protein at dinner by the men and women participants was statistically significant (p<0.001), as was the proportion of total protein consumed at dinner time (48.7% vs. 38.9%, respectively, p=0.007). The percentage of total energy from protein consumed at dinner in the men and women was 7.68% [5.07, 11.0] and 6.04% [4.26, 8.86], with a statically significant difference between the men and women (p=0.023).

Snacks also contributed only a small amount of protein (men = 4.91g [1.94, 9.81g] and women = 4.16g [1.97, 8.26g], with no significant difference between the genders (p=0.737). Many participants did not consume supper (n=193), and supper contributed the least amount of protein (men = 2.80g [0.799, 5.06g], women = 2.37g [0.961, 6.44g]). Snacks and supper contributed less than 1% of energy from protein and there was no significant difference between men and women (p >0.05).

Table 12. Daily spread of protein intake throughout the day

Meal	Men	Women	p value
Breakfast	n=92	n=123	
Protein (g)	11.7 [8.66, 17.6]	9.74 [7.21, 14.4]	0.194
Protein (%TE)	2.62 [1.93, 4.00]	2.87 [1.96, 4.07]	0.529
Protein (%TP)	15.7 [10.9, 26.0]	16.8 [13.2, 24.0]	0.297
Lunch	n=85	n=122	
Protein (g)	16.8 [10.5, 24.2]	14.8 [9.26, 23.4]	0.235
Protein (%TE)	3.56 [2.59, 5.36]	4.28 [3.11, 6.48]	0.102
Protein (%TP)**	21.4 [15.8, 31.9]	29.1 [19.0, 37.6]	<0.001
Dinner	n=91	n=124	
Protein (g)**	37.4 [19.8, 54.5]	23.3 [13.7, 30.4]	<0.001
Protein (%TE)*	7.68 [5.07, 11.0]	6.04 [4.26, 8.86]	0.023
Protein (%TP)*	48.7 [32.4, 59.8]	38.9 [29.6, 54.3]	0.007
Snacks	n=91	n=122	
Protein (g)	4.91 [1.94, 9.81]	4.16 [1.97, 8.26]	0.737
Protein (%TE)	0.992 [0.500, 1.95]	1.20 [0.657, 2.30]	0.828
Protein (%TP)	7.07 [3.23, 13.5]	7.28 [3.85, 14.8]	0.722
Supper	n=13	n=10	
Protein (g)	2.80 [0.799, 5.06]	2.37 [0.961, 6.44]	1.00
Protein (%TE)	0.535 [0.184, 0.921]	0.681 [0.258, 1.66]	1.00
Protein (%TP)	3.43 [1.05, 4.62]	5.94 [1.54, 9.04]	0.414[a]

Mean ± SD reported if data is normally distributed, median [IQR] reported if data is non-normally distributed. Significant difference found between the genders = *p<0.05, **p<0.001. %TE = percent contributed to total energy. %TP = percent contributed to total protein. Values rounded to 3 significant figures. [a] = Fishers Exact test

4.6 Kai Māori and contemporary traditional Māori food

4.6.1 Kai Māori

Kai Māori was defined as foods that were uncultivated wild foods that were foods consumed prior to colonisation and were prepared for consumption using pre-colonial methods i.e. raw, hāngi (earthen oven), smoked or steamed. No contemporary foods or tools, such as pots or pans used in boil ups, would be used to prepare food classified as Kai Māori.

Contemporary Māori food was defined as those foods included on the Kai Māori list that have been cooked using contemporary methods, such as kumara that is boiled in a pot or roasted, and foods that are not on the Kai Māori list that were cooked by a pre-colonial Māori method, for example pork cooked in a hāngi.

The amount of protein and protein percent of total energy consumed from Kai Māori is shown in Table 13. The amount of protein consumed from Kai Māori by the men participants was 1.31g [0.683, 2.66g], and 1.08g [0.462, 2.77g] by the women participants, with no significant difference in protein from Kai Māori between the genders. The protein percentage of total energy of Kai Māori was not statistically significant between men and women, with contributions of 0.288% [0.171, 0.562] and 0.308% [0.161, 0.546] in men and women, respectively (p=0.888).

Table 13. Protein intake and protein percent of total energy from Kai Māori

Nutrient	Men (n=32)	Women (n=55)	p value
Protein (g)	1.31 [0.683, 2.66]	1.08 [0.462, 2.77]	0.454
Protein (%TE)	0.288 [0.171, 0.562]	0.308 [0.161, 0.546]	0.888

Mean ± SD reported if data is normally distributed, median [IQR] reported if data is non-normally distributed. Significant difference found between the genders = *p<0.05, **p<0.001. %TE = percent contributed to total energy. Values rounded to 3 significant figures.

4.6.2 Contemporary traditional Māori food

The amount of protein and protein percent of total energy consumed from contemporary Māori foods is shown in Table 14. These foods contributed 3.28g [1.25, 13.8g] of protein to the total protein intake of the men participants, and 2.65g [1.02, 11.7g] to the total protein intake of the women participants, with no significant difference between the genders (p=0.568). The difference in protein percentage of total energy from contemporary Māori foods between men and women was also not statistically significant (p=0.923). There were more participants who consumed the contemporary Māori foods (n=157) than Kai Māori foods (n=87).

Table 14. Protein intake and protein percent of total energy from contemporary traditional Māori foods

Nutrient	Men (n=62)	Women (n=95)	p value
Protein (g)	3.28 [1.25, 13.8]	2.65 [1.02, 11.7]	0.568
Protein (%TE)	0.699 [0.247, 3.35]	0.716 [0.287, 2.91]	0.923

Mean ± SD reported if data is normally distributed, median [IQR] reported if data is non-normally distributed. Significant difference found between the genders = *p<0.05, **p<0.001. %TE = percent contributed to total energy. Values rounded to 3 significant figures.

5.0 Discussion

The aim of this study was to investigate protein in the diet of Māori in advanced age (80 to 90 years). This is a new area of investigation as very little information about the dietary intake of older Māori is known. In the most recent NNS08/09, data were aggregated for Māori over 51 years (University of Otago & Ministry of Health, 2011) and other surveys sample numbers are generally too small.

The findings from this study indicate that although the median intake of protein in this age group of Māori is low compared to similar age groups of older adults in national and international studies, the median protein intake met the EAR for older adults (71 years and over) (NHMRC & MoH, 2005).

Protein intakes were adequate in two thirds of the men (65%) and three quarters (76%) of the women (median intake for men 73g and 0.94g/kg, and for women 55g and 0.83g/kg) versus the EAR for protein intake for those 71+ years (65g/day and 0.86g/kg/day for men and 46g/day and 0.75g/kg/day for women) (NHMRC & MoH, 2005). The EAR reflects the minimum amount of protein and amino acids to satisfy requirements and is estimated from protein balance studies in younger adults (National Health and Medical Research Council & Ministry of Health, 2005). The participants' protein intakes were, however, lower than for Māori men and women aged 51+ years (95g and 68g, respectively) and for 71+ year old men and women (79g and 62g, respectively) in the NNS08/09 (University of Otago & Ministry of Health, 2011).

One third (35%) of the Māori men and a quarter (24%) of the Māori women did not meet the EAR for protein intake. This level of inadequacy is considerably higher than both the inadequate protein intakes recorded in the NNS08/09 for Māori 51+ years (8% for men and less than 1% for women) and for all NZ adults over 71+ years (13% and 16% respectively for men and women) (University of Otago & Ministry of Health, 2011). This anomaly warrants further investigation.

Over half (57%) of the participants were women. As expected the intake of protein in the women was lower than for the men. Māori women have a higher life expectancy than Māori men (Statistics New Zealand, 2012a). The women were more likely to be widowed and live alone than the men. It has previously been established that those who live alone or are widowed are at a higher risk of malnutrition (Wham, Teh, Robinson, & Kerse, 2011). There are also Māori cultural factors that may have an important role to play (Wham, Maxted, Dyall, Teh, & Kerse, 2012). These factors need further exploration in respect to malnutrition risk.

Nearly two thirds (59%) of the Māori participants rated their health positively, similar to findings in a younger 60+ year old group of Māori (Waldon, 2004). This indicates a positive outlook towards health by the participants despite the fact that advanced age adults are more likely to have co-morbidities. The participants also had high mental and physical health-related quality of life which supports this. However the SF-12 questionnaire scores should be interpreted with caution as they may not be appropriate for older Māori or fit with the Māori model of health (Scott, Sarfati, Tobias, & Haslett, 2000; Frieling, Davis, & Chiang, 2013).

A further factor arising from the low protein intake from food may be food security. A higher deprivation index is associated with an increased risk of food insecurity (University of Otago & Ministry of Health, 2011). A third (32%) of our participants lived in higher deprivation decile 10 areas. None of the participants lived in low deprivation decile one areas. A higher proportion of Māori overall live in higher decile areas compared to non-Māori (Ministry of Health, 2011) and experience socio-economic disparities. Those who live in higher decile areas have approximately twice as many avoidable and unavoidable deaths than lower decile areas (Tobias & Jackson, 2007). The cost of food may be a barrier for the purchase of protein rich foods.

Younger Māori have a higher proportion of lean mass (Taylor et al., 2010) compared to non-Māori and this may persist into old age. In this study, the BMI of the Māori men (27.9kg/m^2) and women (28.7kg/m^2) was slightly greater than the recommended range for older adults (25-27kg/m^2) (Kvamme et al., 2012). A higher BMI may be protective to support successful ageing as increased weight is associated with better health outcomes for older people (Kvamme et al., 2012). Among 5,000 older people (65+ years) in Canada, BMI was inversely associated with mortality (Janssen, Katzmarzyk, & Ross, 2005). In Australia, mortality risk for adults aged 70-75 years was lower in those who were overweight (BMI = 25-29.9kg/m^2) (Flicker et al., 2010). In Japanese adults aged 65 to 79 years, an overweight BMI was also associated with a decreased risk of mortality (Tamakoshi et al., 2010). In a meta-analysis of 26 studies investigating the impact of higher BMI on mortality risk in older adults, no association was found between having an overweight BMI and an increased risk of all-cause mortality (Janssen & Mark, 2007). This suggests that universal BMI cut-off points may not be appropriate for Māori people (Taylor et al., 2010).Also, an overweight BMI may be protective in older age (Janssen & Mark, 2007) and may contribute to the successful ageing of our Māori participants.

Findings from the current study showed older Māori protein intakes were lower than protein intakes recorded in advanced aged adults overseas. In 85+ year olds in Newcastle, UK, protein intakes were higher than our participants (80g and 60g versus 73g and 55g of protein for men and women, respectively) (Adamson et al., 2009). Similarly in the US NHANES III study, men and women over 60 years consumed 79g and 60g, respectively (Smit, Nieto, Crespo, & Mitchell, 1999). Older Belgian men and women (75+ years) also had higher intakes of protein (74g and 59g, respectively) (Lin et al., 2011), as did men and women aged 75 and older living in the Netherlands (82g and 72g, respectively) (Tieland, Borgonjen-Van den Berg, Van Loon, & de Groot, 2012).

A higher intake of protein in older adults has been shown to have positive effects on muscle mass and strength (Houston et al., 2008; Newman et al., 2003) and functional ability (Tanimoto et al., 2012). In the Health ABC study, adults (mean age 75 years) who consumed the highest quintile of dietary protein (91g) lost approximately 40% less total lean mass and appendicular lean mass over three years than those in the lowest quintile of protein intake (57g) (Houston et al., 2008). Based on this data, our Māori participants may not be consuming sufficient protein to prevent future muscle mass loss to maintain muscle strength and function.

The percentage of energy intake from protein was adequate in 67% of Māori men and 65% of Māori women participants. The participants consumed a median 16% of energy from protein, lower than the percentage of energy from protein intakes in 51+ year old Māori men and women (18% for both genders) and in men and women aged 71+ years (16% and 17%, respectively) as reported in the NNS08/09 (University of Otago & Ministry of Health, 2011).

The energy intake in our participants was1840kcal in the Māori men and 1440kcal in the Māori women, lower than energy intakes in 51+ year old Māori men (2142kcal) and women (1577kcal) but similar to of men and women aged 71+ years (1896kcal and 1439kcal, respectively) (University of Otago & Ministry of Health, 2011).

The percentage of energy from fat tended to be high in the Māori participants (39% and 38% in men and women respectively versus 20-35% for the AMDR) (NHMRC & MoH, 2005). The intakes of the Māori men and women participants were greater than the fat AMDR, at 39% and 38% respectively. Fat intakes were similar to those in 51+ year old Māori men and women (38% and 37%, respectively) but were higher when compared to fat intakes in adults 71+ years (32% for both genders) (University of Otago & Ministry of Health, 2011). Our participants however had a considerably higher percentage of energy from fat (University of Otago & Ministry of Health, 2011). Maori tend to consume high fat foods more frequently than non-Māori, especially foods such as battered or fried fish and processed meat (University of Otago & Ministry of Health, 2011) which may explain the participants' higher fat percentage of energy intake.

Conversely, the Māori participants were inclined to consume a lower percentage of energy from carbohydrate (43% and 44%, men and women respectively), similar to Māori aged 51+ years (43% and 44% for men and women respectively) but less than older NZ adults (71+ years) at 48% and 49%, respectively (University of Otago & Ministry of Health, 2011). This may reflect the different food selection habits of Māori, and may be related to lower food security (University of Otago & Ministry of Health, 2011). A lower intake of carbohydrate may reduce the limiting effect of carbohydrate on muscle synthesis rate (Volpi, Mittendorfer, Rasmussen, & Wolfe, 2000) which suggests that the participants' lower carbohydrate intake may have a beneficial effect on muscle synthesis independent of protein intake.

Our Māori participants consumed higher amounts of animal protein (53g and 37g) than plant protein (20g and 19g) for men and women respectively. The animal: plant ratio was higher in the men than the women (2.66 vs. 1.98, p=0.009) suggesting the men consume more protein foods of animal origin.

For men, the five main food sources of protein were poultry, meat, fish and seafood, dairy products and pork and for the women were fish and seafood, meat, poultry, dairy and bread. This gender difference in intake of protein food sources may be socially and culturally related (Wham et al., 2012; Wham et al., 2011), where women may defer their food choices to the preferences of others (Kremmer et al., 2002). However many of the participants lived alone; therefore selection of protein foods may not have been influenced by a partner or other household members.

Bread was the main source of protein reported for men and women aged 71+ years in the NNS08/09, followed by milk, beef and veal, fish and seafood (University of Otago & Ministry of Health, 2011). However, bread was the sixth largest source of protein in the men and fifth largest source in the women participants. This suggests that older Māori tend to consume relatively less bread than older New Zealanders and that nutritional data from the NNS08/09 may not be representative of dietary intake in advanced age Māori.

The participants consumed a higher amount of animal protein than 75+ year old men and women living in Belgium (49g and 40g, respectively) (Lin et al., 2011), similar amounts to 60+ year old men and women living in the US (52g and 39g, respectively) (Smit et al., 1999), and less than 65+ year old Catalonian men (54g) and women (48g) (Serra-Majem et al., 2007).

The NHANES III showed the main protein foods consumed in US men and women 60+ years were dairy, grains, beef, poultry and vegetables (Smit et al., 1999). In Belgian adults (75+ years) the main sources were fresh meat (beef, veal, pork and lamb), cereals and cereal products, dairy, processed meat, and poultry (Lin et al., 2011). In older Dutch adults, key protein sources were meat, dairy, bread, cheese and fish (Tieland et al., 2012). These studies indicate that plant-based protein sources feature more in the diets of older adults, in contrast to our Māori participants.

High intake of fish and seafood in older Māori could be linked to the importance of these foods to practice Māori culture (Durie, 1985). NZ is surrounded by ocean, whereas many other countries' borders are mostly landlocked. The current study was undertaken in regions close to the ocean or fresh water lakes where fish and seafood is more accessible to whānau. Fish and seafood are relatively expensive sources of protein if bought from the shops (Statistics New Zealand, 2012b), however fishing and gathering seafood eases these costs and increases accessibility to these important foods.

Animal protein sources contributed the most protein to the older Māori men and women's protein intakes. These findings may relate to the meat-eating and dairy culture in NZ. Poultry, pork, bread and meat were introduced to NZ by the early explorers. Māori appear to consume a more Western-type diet, which aligns with results from the 1997 National Nutrition Survey in NZ (University of Otago & Ministry of Health, 1999). Older adults who consume a higher amount of animal protein have been found to have a higher lean mass (Houston et al., 2008; Aubertin-Leheudre & Adlercreutz, 2009). Higher plant protein intakes may be associated with a lower BMI (Lin et al., 2011). Our participants had both a lower plant protein intake and a higher BMI, which suggests that their higher BMI may be a result of higher lean muscle mass. However, further research into this is warranted.

Participants' protein intakes at breakfast were 12g and 10g, lunch were 17g and 15g, and dinner were 37g and 23g of protein for men and women, respectively. Protein intake at each meal may be crucial for maximising skeletal muscle synthesis (Paddon-Jones & Rasmussen, 2009). A study by Symons, Sheffield-Moore, Wolfe, and Paddon-Jones (2009) found that consuming 30g of high biological value protein stimulated muscle synthesis in older people. Greater amounts of high biological value protein (90g) did not further increase muscle synthesis. Findings lead to the recommendation that 30g of high biological protein should be consumed at each meal to maximally stimulate muscle protein synthesis.

Our advanced age Māori men and women did not consume the recommended amount of protein at breakfast and lunch, and men consumed adequate protein at dinner however the women did not. Participants may be at a greater risk of a lower muscle mass as there may be reduced opportunity for maximal muscle synthesis.

Older (75+ years) Dutch adults also consume low amounts of protein at breakfast (10g), but higher amounts at lunch (28g) and dinner (28g) (Tieland et al., 2012). Older Mexican men and women (mean age 68 years) had protein intakes of 19g and 15g at breakfast, 33g and 27g at lunch, and 20g and 14g at dinner, respectively (Ruiz Valenzuela et al., 2013). Uneven protein distribution throughout the day and may lead to a decrease in appendicular skeletal muscle mass (Ruiz Valenzuela et al., 2013).

In the current study, one participant skipped breakfast, nine did not consume lunch and three participants missed dinner. Over two thirds of 65+ year old Māori reported skipping at least one meal (McElnay et al., 2012). The NNS08/09 found that the percentage of Māori men and women aged over 51 years who consumed breakfast everyday was 61% and 69%, respectively (University of Otago & Ministry of Health, 2011). On the other hand, over 95% of older NZ men and women (71+ years) consumed breakfast everyday (University of Otago & Ministry of Health, 2011). Skipping meals decreases the opportunity for stimulating muscle synthesis and may increase the rate of muscle breakdown (Symons et al., 2009).

The majority of participants (89%) rated Māori culture and language as very important, and 72% rated their understanding of tikanga as moderate or better. Food plays an important role in Māori culture. Traditional foods such as fish and seafood may lead to a higher animal protein intake.

Iwi and hapū are central to Māori culture. Nine out of ten participants were able to identify their iwi, 35% identified their hapū, and half of the men (49%) and a third (34%) of the women lived in their hapū or near their extended family. Iwi and hapū are linked to important cultural food practices, such as hunting and collecting food as a family. Maanakitanga (the sharing of food with others and being hospitable) is an important Māori value and may be associated with a better protein intake in older Māori. Approximately half of the participants reported that their social interactions were mostly with other Māori. The hapū and iwi is also an important component of te taha whānau (social health) (Durie, 1998).

Protein contribution from traditional Māori kai to the diets of older Māori has not yet been quantified. There were many complexities in defining traditional Māori food and two definitions apply. These are kai Māori (foods consumed prior to colonisation using traditional methods of preparation) and contemporary traditional Māori food (pre-colonial foods prepared with introduced tools or cooking methods, and introduced foods cooked in pre-colonial methods).

Kai Māori and contemporary traditional Māori foods did not contribute large amounts of protein to the intakes of the Māori participants (1g and 3g, respectively). Forest birds and many other pre-colonial sources of protein were not consumed by any of the participants. Fish and shellfish, kumara, puha, other pre-colonial Māori foods were consumed by the participants. These findings may be a result of the older age of the participants, who may not be able to source these foods. Also, the intake measured by the 24 hour dietary recall may not have been representative of usual intake. These results cannot be extrapolated to imply kai Māori and contemporary traditional Māori foods have a low frequency of consumption. Future research into the frequency of kai Māori and contemporary traditional Māori foods consumption by Māori is needed.

Limitations

A limitation of this study includes the use of the 24 hour multiple pass recall. This dietary assessment method gives a brief snapshot the participant's usual intake. Where possible consumed foods were matched to the foods in the food database, however sometimes these foods were not identical and the closest match was chosen. Also, during the animal and plant protein foods categorisation there were some foods that had both animal and plant protein food sources, such as baked goods. Another limitation is the kai Māori data did not have a high frequency of consumption

6.0 Conclusion

This study has been the first to investigate the protein intake in Māori of advanced age. The findings showed that the intake of protein in this population group was low compared to older adults in national and international studies. Approximately one third of older Māori have inadequate total protein intake and protein percentage of energy. Dietary interventions may be appropriate to reduce protein deficiency risks in older Māori.

The participants had high intakes of protein from animal sources. Animal protein sources have been linked to greater total and appendicular lean mass. Any dietary protein interventions should consider which foods are being used to promote higher protein intakes to older Māori.

This study also found that the distribution of protein intake throughout the day did not meet current protein distribution recommendations, particularly low breakfast and lunch protein intakes (Symons, Sheffield-Moore, Wolfe, & Paddon-Jones, 2009). These findings could be used to guide public health initiatives of promoting the consumption of high quality protein sources at all meals.

Kai Māori and contemporary Māori food did not contribute large quantities of protein to the participants' diets. These foods should be encouraged when promoting healthy eating to Māori as consumption of traditional foods may enhance both physical and spiritual health.

This study adds to the body of knowledge about protein intakes of Māori in advanced age. Future studies are needed to investigate the association of the intakes of protein with physical function and quality of life in older Maori. Development of animal and plant protein intake recommendations may be valuable, particularly for older adults. Evaluation of protein intakes in advanced age Māori from other areas of NZ may also be helpful to determine the contribution of traditional Māori foods.

Older Māori are taonga (treasures); they are the protectors of Māori knowledge, traditions and tikanga Māori, and are the leaders of their whānau. Successful ageing of older Māori ensures that their invaluable knowledge and wisdom amassed over their lifetime is used to benefit and enhance their whānau, community and greater Māori society for many generations. Therefore all efforts should be made to ensure these treasures are protected.

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Appendix 1 Participant information sheet

Wave II of Life and Living to Advanced Age:

A Cohort Study in New Zealand *Te Puāwaitanga O Ngā Tapuwae Kia Ora Tonu*

Participant Information Sheet, for participants, their Whan au , Relatives and Friends

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An invitation

Nga mihinui ki nga Whanau mo te whakaetanga ki uru mai ki te Rangahau o te Puawaitanga on Nga Tapuwae Kia Ora Tonu. Ko tenei Rangahau mo nga tangata kua eke ki nga Taumata e Kotahi Tau tenei Rangahau e whakamahia ana engari kua timata te Wahanga Tuarua. A tenei taima ka tono atu ano matou kia uru mai ano kia mohio tonu tatou pehea ana to Hauora. Ko nga hiahia e rite tonu mo te hauora, tinana, kia kaha tonu te tinana, kei te haere ki nga a rohe noho, pehea hoki nga putea. Ka mahi tonu me enei tangata ia tau, ia tau hoki. Ka kitea hoki aha nga mea pai, kite o ratou hoa, nga mahi a iwi, nga mahi pa ano ki nga putea. Ma te huruhuru ka rere te mau. Te Tari o Ora Tari o Te Hauora i te Whare Wananga o Tamaki Makaurau ka mahi tahi me Te Kupenga Hauroa Māori. / **Thank you for taking part in the LILACS NZ study about health for people reaching advanced age. The study has been going for a year and we would like to invite you to be part of Wave 2, meaning it is the second time we will be in contact with you. The aims are the same in that we would like to know more about relative importance of health, frailty, social, community and economic factors? Working with the same group of people over a number of years is planned to see how life unfolds and what sustains people. The Department of General Practice and Primary Health Care at the School of Population Health at the University of Auckland will be coordinating this study with Te Kupenga Hauora Māori, the Department of Māori Health.**

Mena kahore koe e pirangi ki tenei Rangahau e pai ki a koe ano te mutunga kahore mou mena kore ko e whakaae kahore e raruraru. Mena e whakaae ana koe, ka watea koe ki te puta ki waiho kahore koe patapataitia. Kahore koe e taka ki te raruraru mo to oranga a mua. Ata whakarotia nga ahuatanga ahakoa pehea te roa pena hiahia ana koe whakawhitiwhiti korero me to Whanau, nga hoa, to Takuta ranei. / **You do not have to take part in this study. It is your choice. If you choose not to take part, any**

care or treatment that you receive will not be affected. If you do agree to take part, you are free to withdraw from the study at any time, without having to give a reason. Withdrawing will in no way affect your future health care. Please take time to consider the information here. You may take as much time as you like and please feel free to discuss taking part with family, whanau, friends or your general practitioner.

He Aha Nga Whainga Mo Tenei Rangahau/**What are the aims of this study?**

Ko te hiahia o tenei Rangahau kia whakautu nga patai./ **This study hopes to answer the following questions:**

- He aha nga mea nui mo Te Puawaitanga o Nga Tapuwae Kia Ora Tonu? Ko nga mea katoa, te hitoria o te Hauora, pehea to wahi noho pehea to koteretere, pehea hoki to kori Tinana. / **What factors are important for successful advanced ageing? For example your family/whanau, medical history or health services, where and how you live, your blood pressure or physical ability.**
- Mena kahore enei mea i te tika ka uaua to ao? / **How do these factors affect how life goes for you?**
- Kai nga kai mama kaua e kai nga kai taumaha penei i te miti, hei hei, me mahi hupa, hua whenua, huarakau? / **What do people of advanced age eat?**

Ko ta matou hiahia kia whakawatia nga tangata i whakawatia i tera tau, a kawhakawatia ia tau mo tekau tau kia hipa mai. / **We aim to interview the same people as last year and visit again every year for 14 years.**

Pehea te ahua o nga tangata ka uru mo tenei Rangahau? / **What types of people can be in the study?**

Mo tenei wahanga nga mea katoa i uru atu ki te LiLACS NZ i tera tau. / **For this part of the study all those involved in LILACS last year are invited.**

E hia nga tangata mo tenei Rangahau? / **How many people will be in the study?**

Ko ta matou hiahia kia kohi atu i te kotahi mano./ **We estimate that about 1000 older people will be involved in this study.**

Pehea mena ka hiahia aha ki te uru atu mo tenei Rangahau? /**What happens if I do decide to take part?**

Mena whakaae koe ka whakawatia koe e toru taima, a ka ka whakamatau Toto. Kahore e utu engari, ko te wa o to taima. He kai whakawae tohutohu ana mo tenei mahi, ko ia te mea e korero whakamarama ki a koe mo nga mea katoa mo to hauora, pehea to ahua whakapono, oranga tinana, me te maumaharatanga hoki, e poto noa iho te wa i tera tau, he kotahi haora ano i roto tenei me hikoi iti. Ko te Nehi Rangahau ka mahi i nga Whakamatau Toto, mo te Manawa hoki, pehea hoki te Taumaha me te Teitei hoki. Ko tenei tau ka hiahia ki te patai he aha nga kai i kainga i nga haora rua tekau ma wha ki muri. Ma te Nehi Rangahau enei mahi katoa. Kaua e whakama e pai ana ki to korero ki a ia, ahakoa he aha te mate. Ka haere mai ia ki to Whare. Ka hiahiatia te Nehi Rangahau ki te whakamatautau i te Wheua Kiato, ka korerorero hoki ratou ki a koe. Ko te haora kotahi me te hawhe te roanga o enei mahi he pai katoa hoki. Na te mea a tatou kai e tini ana ia wiki, ka hiahia te Nehi Rangahau ki te korerorero ano ki a koe i te tahi atu ra. Kotahi whaka wa mo te hauora me rua nga toro atu a te Nehi Rangahau, kotahi mo nga Kai, kotahi mo Whakamatau Toto. Kotahi mo nga Kai anake. Ka mahia enei i to Whare, e wahi pai ana ki to Whanau hoki. E pai ana ka kore koe korero mo nga mea katoa ka hiahia koe ki te mutu e pai ana ka mutu koe. Ko ta matou hiahia ki te whainga i murima ia tau mo te iwa tau. Ko ta matou hiahia mena ka tukunga atu nga hotuku mo nga whakamatau Toto ki to Takuta.

If you decide on participation there will be three interviews plus a blood test. Taking part in the study will not cost you anything but will require a certain amount of your time. An interviewer, specially trained for this project, will talk with you about your health and well-being, such as mood, physical function and simple memory questions. This will take much shorter that last year, about an hour in total and include being timed during a short walk. A study nurse would then like to undertake some physical tests, such as blood pressure, heart tracing, being weighed and measured. This

year we would like to ask what you have eaten over the last 24 hours. The nurse will do this in some detail. Please don't feel shy, it is fine to talk about what ever you have had and the more detail about that the better. This can be done in your own home. A bone density test may also be offered, this is optional and we would like to talk to you at a different time about that. The nurse interview will take about 1 1/2 hours or so. Because what we eat changes over the week the nurse would like to talk with you again on a different day. so that's one interview about health and two nurse visits, one about food and blood pressure, and the second just about food. The interview(s) will take place in your own home or a place and time convenient to you and your family/whanau. You do not have to discuss all the issues and you may stop the interview at any time. We would like to follow up with you to see how things are going every year for another 14 years. We would like to send relevant health data, such as abnormal blood test results to your GP.

Ka patai ano matou mo tetahi atu Whakamatau Toto mo nga Inflammation, me te Ngako Toto, me te mea tuturu mo nga Wai Ira mo te Manawa, nga Kai hoki taea i te ata tatou mai i nga Whakamatau Toto. Ma te tatari i te Toto ka kitea pehea te whakamahi a te Tinana i nga Porautini me nga Wai Ira. Ko nga Whakamatau Toto mai i tera tau ka kitea matou te hauora mo nga Wheua hoki, te kaha o nga Wheua me nga Taiaki Huka (insulin) me nga Ngako Toto ka tataritia ano. Ma enei hoki ka ngoikore i nga takahi i nga tau hipa mai te tatari i te Toto ka kitea pehea ana te ate me nga takahi. Kei te hiahia matou ki te putu i te Whakamatau Toto iti mo te whakamatau tataritanga mo nga tau e tekau ma rima. Mena kaore koe e hiahia ki te hoatu Toto mo te tatari e pai ana kaore raruraru. Mena e hiahia ana koe a whakahokia atu nga Toto kahore i whakamatautia, engari kia mahara kua rereke te ahua o ou Toto a ka taea hoki ki te porowhiu e te taiwhanga putaiao i roto i te u tika.

We ask your permission to take another blood sample to examine the role of inflammation, cholesterol and a special hormone in heart disease; nutrition levels can be estimated from blood tests. Measuring the blood will show how food is used by the body to make protein and hormones. Similar blood tests to last year will look at Vitamin D and how it controls bone strength, and sugar levels (insulin) and cholesterol will be measured again. The kidneys may be weakened over the years; measuring the blood will show the health of your liver and kidneys. If you are not interested in providing blood for these measures then you do not have to. If you wish we will return any unused blood to you (the blood will have already been processed and so may not look exactly like blood) or it will be disposed of by the laboratory in an appropriate way.

Ko nga panuitanga mai i te Uiuinga, Whakamatau Tinana, me te Whakamatau Toto ka whakamahia kia kitea ai te tuhononga o nga mea e kitea ai mo Te Puawaitanga o Nga Tapuwai Kia Ora Tonu. Pehea hoki to noho mai i te timatanga ki te wa mo te Wahanga Tuarua (Wave 2). Kei te hiahia tonu matou ki te whakamahi enei whakaaturanga a i a koe i roto i to pakeketanga.

Information from the interview, physical tests and blood tests, will be used to see what combination of things sheds light on ageing and on how to live well over time. How you have been will be compared between the beginning and Wave II. We would like to continue to use this data as you age.

Kei te hiahia ki te tutaki ano ki a koe i nga marama tekau ma rua mo Te Wahanga Toru (Wave

3). Kei te hiahia ki te korerorero ano ka pataita atu ki te Wahanga Toru (Wave 3).

We would like to follow up this interview in another 12 months (Wave III) to see how you are. We would talk to you again closer to that time with more detail about the Wave III

Pehea te roa mo tenei Rangahau? / **What is the time-span for the study?**

Ka timata a te Maehe rua mano tekau ma tahi (2011) moe te tekau tau (14 years). **/The study is expected to start in March 2011 and will continue possibly for 14 years.**

Ko nga morea me nga painga o te Rangahau/**The risks and benefits of the study**

Ka uru mai ki te Rangahau he nui te wa. Kotahi ano te morea o te Rangahau tena pea ka ngengenia koe i te whakawa tena pehea ka pa pouri koe ki etahi korero e pa ana ki nga pakeke. Mena ka pa mai tenei ahuatanga kia tino marama nga kai whakawa ma ratou koe i whakatau. Kahore he whakapumau i tenei Rangahau ka hari koa matau ko nga painga mo nga iwi katoa. / **Taking part in this study will take some time. The only risk from this study is that you may get tired during the interview, or discussing issues to do with ageing may in some way upset you. If this happens the interviewers are experienced and will reassure you. There is no guarantee that you will benefit directly from being involved in this study, however for most people even just talking with someone about your life and ageing is pleasant. By conducting this study, we hope that it will be of benefit to the wider population.**

Ko nga whakaetanga/**Compensation**

Ko tenei wahanga whakamarama atu e ahei ana ki a whiwhi i te Accident Commission Corporation (ACC) i whara koe i a koe mahi i roto i tenei Rangahau. Ko enei nga mea me whakaatu atu matou ki a koe me te mihi atu hoki mena he raruraru o ki te porearea i a koe. Tena pea ka whara ko i a koe e mahi ana i roto i tenei Rangahau, tena pea kei raro koe te kupenga a te ACC i raro i te aria aitua whara. Ka whakanohonoho me te Kaporeihana Utunga Ture (2001). Pena e patai au mo ACC me korero koe ki te mea e patata mai ana ki a koe.

This paragraph explains that ACC is available to you if some unexpected injury should happen during the study. We are required to put this in this information sheet and apologise if it is confusing. In the unlikely event of a physical injury as a result of your participation in the study, you may be covered by ACC under the Injury Prevention, Rehabilitation and Compensation Act 2001. If you have any questions about ACC, contact your nearest ACC office or the investigator.

Noho Matatapu/
Confidentiality

Ko nga rarangi konae mo nga Rangahau katoa ka noho i roto i te noho matatapu. Kahore tetahi korero mou e puta atu kia mohiotia ai ko koe kei roto i te ropu Rangahau. Mena e whakaae ana koe ka tukua ki to Takuta ki mohio ai ia kei roto koe i tenei Rangahau. Ka mutu tenei Rangahau ko nga rarangi konae ka tiakitia mo te tekau tau i roto i tetahi noho matatapu i Tamaki Makaurau. Nga mea katoa kei runga te rorohiko e kore e taea etahi atu. Me mohi ia ki te kupuwhakawatea. Nga mahi katoa mo enei mohiotanga me ata tiaki i raro i te noho matatapu.

The study files and all other information that you provide will remain strictly confidential. No material that could personally identify you will be used in any reports on this study. If you agree, your GP will be informed of your participation in this study and asked for your medical information where relevant. Upon completion of the study your records will be stored for 14 years in a secure place at the central coordinating centre in Auckland. All computer records will be password protected. All future use of the information collected will be strictly controlled in accordance with the Privacy Act.

Tikanga Tangata/
Your rights

Mena e hiahia ana koe ki te patai a ou awangawanga, me patai ki te Independent Health and Disability Advocate. Ko enei nga waea Kore Waru Kore Kore Kore Rima Rima Rima Kore Rima Kore./ **If you have any queries or concerns regarding your rights as a participant in this study, you may wish to contact an independent health and disability advocate:**

Free phone: 0800 555 050, Free fax: 0800 2 SUPPORT (0800 2787 7678) Email: advocacy@hdc.org.nz'

Take Mana Tangata/**Ethical approval**

Kua whiwhi tenei Rangahau i te Take Mana Tangata mai te Northern x Regional Ethics Take Mana Tangata Komiti. / **This study has received ethical approval from the Northern X Regional Ethics Committee on <date>. Ethics Reference Number: NTX/10/12/127**

Te Hoparatanga mo te Rangahau/**Study Investigators**

Pena hiahia koe ki mohio ano ki etahi atu mea, tono ki a Karen Hayman, tana waea 09 923

6574, Mere Kepa 09 923 6574, Ngaire Kerse, 09 923 4467. / **If you would like some more information about the study please feel free to contact Karen Hayman (ph 09 923 6574) or Mere Kepa (ph 09 923 6574) or Ngaire Kerse (ph 09 923 4467)**

The principal investigators for this study are:

Professor Ngaire Kerse
Department of General Practice & Primary

Health Care

The School of Population Health The University of Auckland Private Bag 92019, Auckland Tel: (09) 373 7599 ext 84467

Dr Lorna Dyall
Te Kupenga Hauora Māori

Faculty of Medical and Health Sciences, The

University of Auckland

Private Bag 92019

Auckland

Tel: (09) 373 7599 ext 84467

THE UNIVERSITY OF AUCKLAND
NEW ZEALAND

Appendix 2 Participant consent form

CONSENT FORM (Wave II)

for Participants in the LILACS NZ study

Project title:

Life and Living in Advanced Age: A Cohort Study

Te Puāwaitanga o Ngā Tapuwae Kia ora Tonu

The LILAC study

Researcher Name:

Professor Ngaire Kerse, Dr Lorna Dyall

School of Population Health Private Bag 92019, Auckland, NZ,

Tamaki Campus, Glen Innes

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	WHAKAWHITI KAI KORERO/		
Turi/**Deaf**	Kai te hiahia mo tetahi Tutohu Reo o Aotearoa, mehemea kai konai tetahi/	Ae/**Yes**	Kao/**No**
	I wish to have a NZ Sign Language		
English	I wish to have an Interpreter.	Yes	No
Māori	E hiahia ana ahau ki tetahi kaiwhakaMāori/kaiwhaka pakeha korero.	Ae	Kao
Samoan	Oute mana'o ia iai se fa'amatala upu.	Ioe	Leai
Tongan	Oku ou fiema'u ha fakatonulea.	Io	Ikai
Cook Island	Ka inangaro au i tetai tangata uri reo.	Ae	Kare
Niuean	Fia manako au ke fakaaoga e taha tagata fakahokohoko kupu.	E	Nakai

Kua riti ahau, a kau te marama nga korero i runga i tenei pepa 19th January 2011 **mo nga Koroheke kua tonu atu kia uru mai ki roto i enei uiuitanga Akoranga mo te noho ki te koroheketanga. /** I have read and I understand the Information Sheet 19th January 2011 for older people invited to participate in the interview study about Living to dvanced age. **I waitea au ki te korerorero mo tenei Akoranga maua me taku Kairangahau. I te whakahoki mai ana ki ahau./** I have had the opportunity to discuss this study with the Researcher. I am satisfied with the answers I have been given.
Kai te marama ki ahau i ahau e uru atu ana ki enei Akoranga naku tena, ana ka watea ahau kit e puta mai i enei Akoranga i te wa e hiahia ana ahua, ano kahore tenei e kati ana te huarahi mo etahi hauora awhina, i ko atu. / I understand that my taking part in this Study is voluntary (my choice) and that I may withdraw from the study at any time and this will in no way affect my continuing or future Health care.
Kai te marama ki ahau mehemea kai te hiahia au ki te kume mai i etahi wahi o aku korero mai i te Akoranga tae ki te wa./ I understand that I may withdraw any part of my information from the study up until (6 months from the interview).

Kai te marama ki ahua ko taku uru atu ki enei Akoranga ka nohotapu, kahore e kore re he aha atu ka mohio ko hau tera ka uru atu ki tahi tuhituhi i roto i tenei mahi Akoranga. / I understand that my participation in this Study is confidential and that no material that could identify me will be used in any reports on this Study. **Kai te marama ki ahau ko te whakawateatanga ki tenei whakataputanga, ka watea mehemea mo taku oranga me etahi atu. /** I am aware that the exception to confidentiality will be if the Interviewer has significant concerns about the safety of myself or others.
Kai te marama ki ahua ko te kai whakapataitai me etahi atu whakatau, ka mutu mehemea ka kitea ka pa mai ki ahua e mea raruraru. / I understand that the Interview or Assessment will be stopped if it should appear harmful to me.
Kai te marama ahau e whakaritenga ano mo enei Akoranga./ I understand the compensation provisions for this Study.
Kua whakaarotia ahau mo te tahi wa, mehemea ka uru atu ahau ki enei mahi./ I have had time to consider whether to take part.
Kai te mohio ahau ko wai taku e tata atu, mehemea e patai aku mo tenei **Akoranga./** I know whom to contact if I have any questions about the Study.

Kai te tohu atu ahau ki taku whakaetanga mo enei e whai ake enei./
I indicate my approval (or otherwise) for the following:

Ki te uru atu ki enei patai whakarite. To participate in the full interview

Ae/**Yes**

Kao/**No**

OR

Kit e uru atu ki enei patai whakarite iti. To participate in a partial interview

Ae/**Yes**

Kao/**No**

Kit e uru atu ki etahi atu e korerotia ana tinana To participate in a physical assessment including talking about food

Ae/**Yes**

Kao/**No**

Ko te Rōpū Rangahau, ka korero atu ki toku Takuta mo etahi atu mate ka kitea./ That the Research Team will inform my GP of any unusual findings

Ae/**Yes**

Kao/**No**

Kai te hiahia ahau kia homai ki ahau era kiteatanga./ I wish to receive a copy of the results.

Ae/**Yes**

Kao/**No**

I understand that there may be a significant delay between data collection and the publication of the study results.

~~Toto me te tataritanga/ **Blood for analyses**~~

Ka whakaeatu au ki te hoata oku Toto me te mahi Tataritanga./ I give permission to take **a** sample of blood and to conduct analyses.

Ae/**Yes**

Kai te marama au akuni pea ka roa te wa, mai i wai tuku Toto ki te wa ka otu na whakatataritanga./ I understand that there may be a delay between the blood being taken and analyses being completed.

Kao/**No**

Ae/**Yes**

Ka te hiahia ahau kia whakahokia mai oku Toto kahore e tataritia./ I

Kao/**No**

wish to receive back any blood not used in analyses.

Ae/**Yes**

Kao/**No**

Kai te marama ahau akuni pea ka rere ke te ahua, i muri o te tataritangatia./ I understand the Blood may look different as it has been processed.

Etahi atu Matauranga/**Further studies**

Ka whakaea ahau mo aku kitenga, ka whakaritea atu ki te Newcastle University Study. Ki te Koroheketanga me etahi atu akoranga kite whakapai atu whakamatautau ka tukua ma te tahi ano tono ki te Rōpū Mahi Whakatikatika ana e kore e ~~taea kite kite ko wai ena, etahi atu mahi akoranga./~~ ~~I give~~ permission for my Results to be combined with the Newcastle Study on ageing and any other studies to improve the health of older people. Further studies would be guided by a separate application to an ethics committee and I would not be able to be identified individually in any further studies

Ae/**Yes**

Kao/**No**

Ko au I konei ka whakae au kia uru atu ki roto I te LILACS Mahi Akoranga Taumatatuarua.

/ I _______________________________________ **hereby consent to participate in**

the LILAC study Wave II.

Tohu/**Signature** .... Tohu o Kai Awhina/

.... **Signature of witness**........................ Te ra/**Date**: .... Ingoa/**Name of witness**.............................

Kai Whakamarama/**Project explained by** .... Tu nga/**Project role** ....

Tohu/**Signature** .... Te ra/**Date** ....

*Tuhinga/**Note**: A copy of the Consent Form is to be retained by the Participant.*

Appendix 3 24 hour dietary recall assessment form

DIETARY ASSESSMENT: 24 HOUR MULTIPLE PASS 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 Not Appl: NA If H: Prompt for recipes	Oven : O Fried : F Grilled : G Boiled: B Steamed: S Not Appl: NA		Preface with W: Weight P: Photo code H: Household	Preface with W: Weight P: Photo code H: Household AA: Ate All	Food code	Weight

Quick List	Time (24 hr)	Description of food or drink (as much detail as possible)	Homemade / retail Homemade: H Retail: R Not Appl: NA If H: Prompt for recipes	Cooking method Oven: O Fried: F Grilled: G Boiled: B Steamed: S Not Appl: NA	Brand	Amount served Preface with W: Weight P: Photo code H: Household	Leftover Preface with W: Weight P: Photo code H: Household AA: Ate All	To be completed by nutritionist	
								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	

RECIPE 3:

Name of home-made dish:______________________________

Ingredients	Amount
Cooking method	

RECIPE 4:

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 ked	0

3. **Did you or the respondent have difficulty with this interview?**

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

FINISH TIME				

Appendix 4 Ethics approval confirmation

Health
and
Disability
Ethics
Committees

pat_chainey@moh.govt.nz

Northern X Regional Ethics Committee
Ministry of Health
3rd Floor, Unisys Building
650 Great South Road, Penrose
Private Bag 92 522
Wellesley Street, Auckland
Phone (09) 580 9105
Fax (09) 580 9001

Please note postal address is : Northern X Regional Ethics Committee, C/o Ministry of Health, PB 92 522 Wellesley St Auckland

17 December 2009

Dr N Kerse
Dept of General Practice
University of Auckland
Private Bag 92019
Auckland 1142

Dear Ngaire

NTX/09/09/088	**Study title: Life and living in advanced age: the cohort study. Te Puawaitanga O Nga Tapuwae kia ora tonu: PIS/Cons V#4, 5/10/09**
Principal Investigator:	Dr Ngaire Kerse
Co-Investigators	Ms Karen Hayman, Dr Mere Kepa, Dr Lorna Dyall, Prof. Martin Connolly, A/Prof Tim Wilkinson, A/Prof Robert Scragg, Dr Carol Wham, Dr Valerie Wright St-Claire, Prof. Peter Davis, Ruth Teh, Dr Santosh Jatrana, Dr Sally Keeling, Dr Kathy Peri, Dr Janine Wiles
Localities:	University of Auckland, Bay of Plenty DHB, Lakes District Health Board

Thank you for your letter and Committee requirements, received 16 December 2009. The above study has been given ethical approval by the **Northern X Regional** Ethics Committee.

Approved Documents

- Participant Information Sheet/Consent Form: V. ISPA V#4 dated 5/10/09
- Participant Information Sheet/Consent Form: V. ISKM V#4 dated 5/10/09
- Participant Information Sheet/Consent Form: V. ISFW V#4 dated 5/10/09
- Participant Information Sheet/Consent Form: V. ISMR V#4 dated 5/10/09
- Questionnaires 4/11/09

Certification
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.

Accreditation
The Committee involved in the approval of this study is accredited by the Health Research Council and is constituted and operates in accordance with the Operational Standard for Ethics Committees, April 2006.

Progress Reports
The study is approved until 31 October 2019 However, the Committee will review the approved application annually and notify the Principal Investigator if it withdraws approval. It is the Principal Investigator's responsibility to forward a progress report covering all sites prior to ethical review of the project on **17 December 2010**. The report form should be forwarded to you but if not received, it is available on http://www.ethicscommittees.health.govt.nz (forms – progress reports). Please note that failure to provide a progress report may result in the withdrawal of ethical approval.

Final Report
A final report is required at the end of the study. The report form is available on http://www.ethicscommittees.health.govt.nz (progress reports) and should be forwarded along with a