PROTEIN INTAKE BY MĀORI OF ADVANCED AGE

*Briar Bennett**

Carol Wham[†]

Ruth Teh[‡]

Simon Moyes[§]

Mere Kepa[‖]

Eruera Maxted[¶]

*Ngaire Kerse***

Abstract

Protein intakes of advanced age Māori participating in Te Puāwaitanga o Ngā Tapuwae Kia Ora Tonu (LiLACS NZ) are presented. Detailed dietary assessments were completed by 216 Māori men and women aged 81–91 years using a repeat 24-hour multiple pass recall. Nutrient intakes were analysed using FOODfiles 2010. Among this cohort of older Māori men and women, the highest contributors of protein intake were fish and seafood, meat and poultry. By contrast, bread, followed by milk, beef and veal were the main protein source in men and women over 70 years

* Te Arawa, Ngāti Tahu. MSc NZ Registered Dietitian, Massey University, College of Health, Auckland, New Zealand.

† Associate Professor, Massey University, College of Health, Auckland, New Zealand. Email: C.A.Wham@massey.ac.nz

‡ Senior Lecturer, University of Auckland, Department of General Practice and Primary Health Care, School of Population Health, Tamaki Campus, Auckland, New Zealand.

§ Biostatistician, University of Auckland, Department of General Practice and Primary Health Care, School of Population Health, Tamaki Campus, Auckland, New Zealand.

‖ Ngāpuhi, Ngāti Whatua, Ngai Tuhoe, Te Whakatohea, Te Whanau a Apanui. Community Scholar, Takahiwai, New Zealand.

¶ Te Arawa, Ngāti Awa, Ngāiterangi, Ngāpuhi. Diabetes Dietician, Lakes District Health Board, Rotorua, New Zealand.

** Professor and Head of School of Population Health, University of Auckland, Department of General Practice and Primary Health Care, School of Population Health, Tamaki Campus, Auckland, New Zealand.

DOI: 10.20507/MAIJournal.2017.6.2.1

in the New Zealand Adult Nutrition Survey 2008/09. Although average protein intakes met the nutrient reference values for both genders, 30% took below the recommended protein intake and the intake was generally low compared with older adults in national and international studies. Improved access to kai Māori may pave the way forward to enhance protein food consumption.

Keywords

aged, dietary assessment, kai Māori, traditional foods, protein

Background

Te Puāwaitanga o Ngā Tapuwae Kia Ora Tonu—Life and living in advanced age: a cohort study in New Zealand (LiLACS NZ) is currently the only longitudinal study of ageing that has included a cohort of Indigenous people. Te RōpūKaitiaki o Ngā Tikanga Māori (the protectors of principles of conduct in Māori research, hereafter referred to as Te RōpūKaitiaki) guided and oversaw the welfare of Māori engaged in this study that began in 2010 (Kēpa et al., 2014). The members of Te RōpūKaitiaki themselves are Māori elders whose vision is for older Māori to age well, to develop and share their knowledge and to contribute to their families, communities and societies.

Māori people are living longer. In 2012 approximately 5000 Māori were aged 80 years or over, considered advanced age, a 50% increase from 2002 (Statistics New Zealand, 2013). Few Māori are represented in statutory surveys, and even fewer older Māori, justifying a study specifically about this age group. Health disparities and a lower life expectancy are prevalent in Māori compared with non-Māori (Ministry of Health, 2013; Statistics New Zealand, 2010) along with increased socioeconomic deprivation (University of Otago, 2007). Despite the continuing processes of colonisation and government policies that have adversely influenced Māori people's health and well-being, those in advanced age have aged successfully and are revered for their experience, knowledge and wisdom.

Good nutrition is important throughout the life course, is often linked to socioeconomic determinants of health and culture and may prevent or delay the onset of chronic health conditions (Bowman, 2007; Correia & Waitzberg, 2003). Our understanding of the nutritional intake of older Māori is very limited, particularly in those who have successfully lived beyond 80 years. Although the New Zealand Adult Nutrition Survey 2008/09 (ANS08/09) investigated nutrient intake by adult Māori, intakes were aggregated for those aged over 50 years (University of Otago & Ministry of Health, 2011). This is problematic as many nutrient recommendations, including protein intake, differ for adults aged over 50 years (National Health and Medical Research Council & Ministry of Health, 2005). Older Māori consume different foods according to their cultural preferences and this may result in different nutrient intakes (Wham, Maxted, Dyall, Teh & Kerse, 2012).

Kai of (traditional) Māori is known to be conducive to good health and relatively high in protein (Cambie & Ferguson, 2003; Rush, Hsi, Ferguson, Williams & Simmons, 2010). Prior to colonisation, kai eaten by Māori included manu, ika, kaimoana and tuna as animal foods and many huawhenua and kai o te ngahere such as kūmara, āruhe, tī kouka, berries and pūhā (Buck, 1950). Energy was expended to hunt, gather or cultivate kai (Rush et al., 2010). During and after colonisation, Māori incorporated into their diet many introduced foods, ingredients and cooking processes from

traders, explorers and settlers. Kai such as boil ups (meat and/or bones boiled with wild green leafy vegetables and/or kūmara), pork, Māori bread and fry bread became part of traditional Māori kai (Rush et al., 2010). Literature on the consumption of traditional Māori food of present-day Māori is scarce, as is analysis and kōrero on protein intake from traditional Māori foods.

Older adults have a higher requirement for protein than younger adults (National Health and Medical Research Council & Ministry of Health, 2005), yet older adults usually eat less, including less protein (Volpi et al., 2013). Sufficient high-quality dietary protein intake is important to preserve muscle mass, strength and function (Breen & Phillips, 2011). Animal protein foods such as fish, meat and eggs have a higher biological value than plant proteins (such as bread) (Young & Pellett, 1994) and have been associated with greater lean muscle mass in older people, which is beneficial for preserving muscle strength and function (Houston et al., 2008). Older adults often consume less animal protein (Gaffney-Stomberg, Insogna, Rodriguez & Kerstetter, 2009) due to factors such as chewing difficulty (Houston et al., 2008), as well as cost and access to such sources. In the ANS08/09, the largest contributor of protein to the diet of New Zealanders aged 70 and over was bread, followed by milk, beef and veal and fish and seafood (University of Otago & Ministry of Health, 2011). However, the protein sources (animal versus plant protein) in the diets of older Māori are unknown.

Evidence suggests that consuming 30 grams of high biological value (animal) protein at one sitting increases the rate of muscle synthesis in older adults by approximately 50% (Symons, Sheffield-Moore, Wolfe & Paddon-Jones, 2009). Consumption of a higher amount of high biological value protein (90 g) does not further increase the rate of muscle synthesis above that of 30 grams of protein. These findings have resulted in recommendations for multiple 30-gram servings of high-quality protein foods distributed throughout the day over the three mealtimes to maximally stimulate muscle protein synthesis. Distribution of protein intake throughout the day has not previously been described.

The aim of this study was to provide insight into the protein intakes in Māori of advanced age, including the amount and type of protein (animal versus plant protein), distribution of protein intake throughout the day and the contribution of traditional Māori food to protein intake. An understanding of protein intake in advanced age Māori is important to redress any shortfall that may be associated with loss of muscle mass, strength and physical function.

Methods

To meet eligibility for the study, the participants' date of birth had to be between 1 January 1920 and 31 December 1930 and their residence within in the geographical boundaries of the Bay of Plenty District Health Board or Lakes District Health Board (excluding the Taupo region). The detail of LiLACS NZ recruitment and assessments has been described elsewhere (Dyall et al., 2013; Hayman et al., 2012). Several sources were used to obtain as complete a sample of eligible older people as possible: the New Zealand General and Māori electoral rolls, primary care databases through primary health organisations and general practice databases. These lists were supplemented through whānau and community networks. Older people were approached and the study introduced by a person known to them where possible. If this was not possible, contact was made by their health provider or Māori iwi representative.

Baseline assessment was undertaken in 2010 to accurately assess the health, social, economic, cultural and physical status of the participants. A detailed dietary assessment occurred at 12 months follow-up in 2011. Four hundred and twenty-one Māori participants were recruited into the study in 2010,

107 dropped out (19 due to poor health, six moved without leaving contact details, 82 did not wish to continue) and 36 died over one year. Of the 278 Māori who were engaged in the 12-month interviews, 216 completed the nutritional assessment and gave consent for medical information regarding hospital admissions to be used. There were 57 participants who did not wish to undertake the nutritional assessment, 17 did not consent for medical information and four declined both. This paper reports on these 216 Māori octogenarians. Ethical approval for this study was given by the Northern X Regional Ethics Committee NXT09/09/88 (Hayman et al., 2012).

Measures

All participants were interviewed by trained interviewers using standardised techniques. Interviewers were fluent users of te reo Māori and knowledgeable in the application of tikanga. Demographic information included gender, marital status, living arrangement, education and main lifetime occupation. Education was based on highest achievement level using an adapted version of 2006 New Zealand Census questions (Statistics New Zealand, 2007). Occupation was the main lifetime occupation of the participant or their spouse, whichever was in the highest category (see below). Occupations were reported based on nine different job classifications assigned to one of three categories:

1. Professionals: Legislators, administrators, managers, professionals, agriculture and fishery workers
2. Technical and trades: Technicians, trade workers and associated professionals
3. Clerks, sales, factory and other: Clerks, service and sales workers, plant and machine operators and assemblers, elementary occupations

Weight and height measurements were completed by trained research nurses using standardised procedures. Weight was ascertained using a Tanita digital measuring scale (BC-541, Tanita Corporation, Japan) and height using a portable stadiometer. Deprivation level (Salmond, Crampton & Sutton, 1998) was ascertained from the address of residence at baseline. Cultural questions developed by Te RōpūKaitaki during the feasibility stage of the project (Dyall, Kerse, Hayman & Keeling, 2011) included hapū and iwi affiliation, and the importance of iwi, hapū and language and culture to well-being.

Detailed dietary assessment occurred at 12 months follow-up (between 2011 and 2012). Assessments were completed by trained interviewers and research nurses using a 24-hour multiple pass recall (24h MPR) protocol on two separate days (usually one week apart), on different days of the week (Adamson et al., 2009).

The 24h MPR was undertaken as follows:

- Pass 1: *Quick list:* The participant was asked to recall what food and drinks they had consumed over the previous 24-hour period from midnight to midnight. An initial prompt was given from the interviewer about snacks, tea, coffee, sweets, soft drinks and alcohol, after which the interviewer recorded all information without interruption. Once completed, additional prompting from the interviewer was provided using standardised prompts. Any additional items were then added to the quick list.
- Pass 2: *Detailed record:* The interviewer then guided the participant through the food items on the quick list and covered each item in more detail, including time eaten, context or occasion of eating, brand, amount/portion of food consumed and cooking method.
- Pass 3: *Review:* The interviewer then reviewed the food and drink recalled with the participant and checked for any missing items. Portion sizes were estimated using a photographic atlas, household measures

and a ruler. The atlas in *A Photographic Atlas of Food Portion Sizes* (Nelson, Atkinson & Meyers, 1997) was adapted to include New Zealand foods.

Following completion of data collection, qualified nutritionists or dietitians experienced in dietary assessment and coding examined all the food recall entries and recorded the estimated weight of the individual foods or food ingredients or photographic food code weight. Recipes were coded for individual foods and ingredients and weights were recorded. Nutrient intakes were calculated by coding all food and drinks recorded by participants using the New Zealand Food Composition Database and FOODfiles (New Zealand Institute for Plant & Food Research Limited, 2011).

Data analysis

The recipes and ingredients lists of foods that contained both animal and plant protein food sources were reviewed, and each food was then categorised into animal or plant protein according to its main type of protein. Protein contributions from both animal and plant protein sources were calculated from recipes and food ingredients that contained both animal and plant protein sources. Six animal food groups were determined: meat, dairy products, eggs and egg products, fish and seafood, pork, and poultry. Six plant food groups were determined: bread and bread-based dishes; potatoes and other tubers; cereals; vegetables; fruit, including nuts and seeds; and legumes. Two definitions were used to define traditional Māori food. Firstly, kai Māori was defined as those foods that were uncultivated wild foods that were hunted or harvested from the tribal rohe, which could be near the sea, a forest or a lake. These foods would be minimally processed prior to consumption, using pre-colonial methods of preparing food for consumption, that is, raw, hāngi, dried, preserved, boiled, 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. 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 (see Table 1).

The second, broader definition of "traditional" food was contemporary traditional Māori food. This list of food includes two types: those foods included on the kai Māori list that have been cooked using contemporary

TABLE 1 Kai Māori list

Butterfish	Kahawai	Mussels (salt and freshwater)	Scallops
Cockles	Kamokamo	Muttonbird	Shark
Cod	Kina	Oysters	Snapper
Crayfish (salt and freshwater)	Kingfish	Pāua	Tarakihi
Eel	Kūmara	Pipi	Toheroa
Flounder	Lampreys	Pūhā	Trevally
Gurnard	Moki	Pūpū	Trout
Hāpuku	Morihana	Seaweed	Tuatua
	Mullet		Watercress
			Whitebait

TABLE 2 Contemporary traditional kai Māori list

Cockles, boiled	Kamokamo, boiled and roasted	Toroi (mussels and pūhā)
Crayfish, boiled	Kina, boiled	Muttonbird, boiled, roasted
Eel, boiled and fried	Kūmara, boiled, roasted and baked	Pāua, creamed
Fish, boiled, grilled, fried and baked—various species including flounder, hoki, blue cod, gurnard, snapper and others	Mussels, boiled and curried, fired	Pipis, boiled and fried
		Pork, hāngi
		Pūhā, boiled
		Scallops, boiled and fried

methods, such as kūmara 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 (see Table 2).

Spread of protein throughout the day was calculated by taking the estimated protein per 100 grams 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. Meals were self-defined by the participants as breakfast, lunch, dinner, snacks or supper.

Descriptive statistics (mean ± standard deviation if data was normally distributed or median [interquartile range] if the data was non-normally distributed) are presented. Percentages were used for categorical data. Normally distributed scale data were compared between groups 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.

Results

Of the 421 Māori enrolled at baseline, 216 contributed food records at 12 months follow-up: 91 men and 122 women. Table 3 shows demographic and anthropometric characteristics of the participants. More men than women were married, and more women than men lived alone. Although men were heavier than women, body mass index (BMI) was similar between the genders.

The tikanga Māori characteristics are shown in Table 4. Nearly half (47%) of the participants were fluent in te reo Māori and for 60% it was their mother tongue. Many (72%) rated their understanding of tikanga as moderate or better, and 89% felt language and culture were moderately, very or extremely important to well-being.

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. Men were more likely to live in their hapū or with extended family or where they come from than women ($p = 0.029$). Most (84%) participants felt that iwi and hapū were important to well-being. Nearly all the participants had contact with other Māori and had visited a marae, most (81%) at least once or more in the last month.

TABLE 3 Participant characteristics

	Men	Women	Total	*p* value
Age	n=91	n=122	n=213	0.019
	82.0	83.5	83.0	
	[81.0, 85.0]	[81.0, 86.0]	[81.0, 85.0]	
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)	
Socioeconomic deprivation n(%) NZ Dep Score	n=92	n=124	n=216	0.310
1–4 least	12 (13)	25 (20)	37 (17)	
5–7	26 (28)	23 (19)	49 (23)	
8–10 most	54 (59)	76 (61)	130 (60)	
Weight (kg) Median [IQR]	n=75	n=105	n=184	0.001
	77.5	66.5	71.8	
	[68.4, 86.6]	[59.0, 79.9]	[63.4, 83.8]	
BMI (kg/m^2) Median [IQR]	n=74	n=1065	n=1804	0.449
	27.9	28.7	28.4	
	[25.5, 31.3]	[24.0, 31.7]	[24.7, 31.6]	

Note: 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.

TABLE 4 Te reo Māori and tikanga Māori characteristics, hapū and iwi identification and importance

	Men	Women	Total	*p* value
Fluent in Te reo Māori n(%)	n=68	n=97	n=165	0.366
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)	
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)	

	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)	

Note: 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.

Table 5 shows that a third (34.8%) of men and a quarter (24.2%) of women had less than recommended intakes of total protein according to the estimated average requirement (EAR) for adults over 70 years of age. Both men and women consumed considerably more animal than plant protein. Adjusted for energy intake, there was no difference in contribution of animal and plant protein between the genders. Examining the distribution of protein intake at meals showed that the median breakfast and lunch protein intakes of men and women were less than 30 grams and most protein eaten was at the evening meal. Kai Māori and contemporary traditional Māori foods contributed a small amount of the total protein consumed.

Table 6 shows the contribution of food groups to protein intake. The largest contributor of animal protein for men was poultry and for women fish and seafood, and eggs and egg products were the lowest contributors for both men and women. Men consumed more animal protein from meat and poultry than women ($p<0.05$).

Bread and bread-based dishes contributed the largest amount of plant protein for men and women. Fruit, including nuts and seeds, contributed the least plant protein for men and legumes were the lowest contributor for women. While men had a higher intake of protein from legumes, potatoes and other tubers than women, women had higher protein intakes of fruit, including nuts and seeds, and vegetables than men ($p<0.05$).

Discussion

This study demonstrates that the median protein intake for men (72.9 g) and women (55.2 g) was lower than previously reported for men (78 g) and women (60 g) aged 71 or older of all ethnicities and Māori aged 51 or older (men 92 g; women 67 g) in ANS08/09 (University of Otago & Ministry of Health, 2011). Lower protein intake observed with advancing years may be a result of the amount of food ingested. Advanced age adults are vulnerable to eating

TABLE 5 Energy, protein intake, type, distribution at meals and contribution from Kai Māori and contemporary traditional Māori food

	Men (n=92)	**Women (n=124)**	***p* value**
Energy (kcal)	1840 ± 612	1440 ± 432	
Total protein (g)	72.9 [53.7, 93.2]	55.2 [46.1, 72.4]	
Less than recommended total protein n (%)	32 (34.8)	30 (24.2)	
[b]Protein (%TE)	16.3 [14.2, 18.6]	16.3 [13.7,19.8]	
Protein (g/kg/day)	0.941	0.830	
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 [1.65, 4.03]	1.94 [1.39, 2.84]	0.009
Distribution at meals			
Breakfast	n=92	n=123	
Protein (g)	11.7 [8.66, 17.6]	9.74 [7.21, 14.4]	0.194
% total protein intake	16%	18%	
Lunch	n=85	n=122	
Protein (g)	16.8 [10.5, 24.2]	14.8 [9.26, 23.4]	0.235
% total protein intake	23%	27%	
Dinner	n=91	n=124	
Protein (g)**	37.4 [19.8, 54.5]	23.3 [13.7, 30.4]	<0.001
% total protein intake	51%	42%	
	(n=32)	**(n=55)**	
Kai Māori Protein (g)	1.31 [0.683, 2.66]	1.08 [0.462, 2.77]	0.454
	(n=62)	**(n=95)**	
Contemporary traditional Māori food Protein (g)	3.28 [1.25, 13.8]	2.65 [1.02, 11.7]	0.568

Note: Mean ± SD reported if data is normally distributed, median [IQR] reported if data is non-normally distributed.

[a] = estimated average requirement for men 65g/day, women 46g/day. %TE = percent total energy.

[b] = acceptable macronutrient distribution range.

TABLE 6 Total protein intake from animal and plant food groups

Median [IQR]	Men	Women	*p* value
Animal food groups			
Dairy products	n=92	n=122	
Protein (g)	8.56 [5.46, 14.9]	8.31 [5.57, 13.2]	0.890
Eggs and egg products	n=50	n=73	
Protein (g)	5.58 [0.415, 8.17]	3.39 [0.618, 6.71]	0.084
Fish and seafood	n=39	n=56	
Protein (g)	12.4 [3.35, 29.3]	11.3 [4.67, 17.7]	0.615
Meat	n=71	n=87	
Protein (g)*	16.4 [9.96, 24.9]	11.1 [6.90, 18.9]	0.010
Pork	n=53	n=71	
Protein (g)	7.20 [3.94, 15.4]	5.40 [2.60, 13.2]	0.146
Poultry	n=35	n=49	
Protein (g)*	17.3 [6.44, 24.3]	10.9 [5.60, 16.4]	0.008
Plant food groups			
Bread/bread-based dishes	n=89	n=117	
Protein (g)	6.76 [4.46, 10.8]	6.78 [5.15, 9.84]	1.00
Cereals	n=89	n=120	
Protein (g)	5.79 [3.78, 10.6]	5.04 [3.04, 7.35]	0.146
Fruit incl. nuts and seeds	n=83	n=121	
Protein (g)	1.20 [0.407, 2.40]	1.50 [0.687, 3.11]	0.392
Legumes	n=12	n=19	
Protein (g)*	2.29 [0.771, 7.86]	1.17 [0.229, 1.87]	0.047
Potatoes and other tubers	n=80	n=107	
Protein (g)*	2.73 [1.26, 3.69]	1.73 [1.05, 2.50]	0.023
Vegetables	n=89	n=120	
Protein (g)	2.19 [1.06, 3.45]	2.27 [1.40, 3.63]	0.617

insufficient food (Donini, Savina, Rosano & Cannella, 2007), and maintaining an adequate energy intake can be a challenge. The total energy intake of Māori participants (1840 kcal for men; 1440 kcal for women) was lower than the national average for Māori men (2142 kcal) and women (1577 kcal) aged 51 or older, but similar to the national average for all men and women aged 71 or over (1896 kcal and 1439 kcal, respectively) recorded in ANS08/09 (University of Otago & Ministry of Health, 2011). As protein needs are a function of lean tissue mass, protein intake needs to increase as a percentage of low energy diets (Layman, 2009).

Daily protein was distributed over breakfast (16%, 18%), lunch (23%, 27%) and dinner (51%, 42%) for men and women respectively. This skewed protein intake pattern is similar to dietary protein distribution in Dutch elderly people over breakfast (15%–21%), lunch (26%–32%) and dinner (38%–44%) (Tieland, Borgonjen-Van den Berg, Van Loon & de Groot, 2015), as well as in the United States (Paddon-Jones & Rasmussen, 2009; Paddon-Jones et al., 2015). Evidence suggests that the consumption of a small amount of animal protein (30g) at each of the three main meals helps to maximise skeletal muscle synthesis (Paddon-Jones &

Rasmussen, 2009). Our findings suggest that the participants' protein intakes fell short at breakfast and lunch meals, and for Māori women at dinner (breakfast 12 g, 10 g; lunch 17 g, 15 g; and dinner 37 g, 23 g for Māori men and women respectively). Similar shortfalls were found in Dutch people 75 years and over, with protein intake distribution at breakfast (10 g), lunch (28 g) and dinner (28 g) (Tieland, Borgonjen-Van den Berg, van Loon, & de Groot, 2012), and among older Mexicans mean age 68 years, with protein intakes at breakfast (19 g, 5 g), lunch (33 g, 27 g) and dinner (20 g,14 g) for men and women respectively (Valenzuela et al., 2013). Potentially uneven protein distribution throughout the day may lead to a decrease in appendicular skeletal muscle mass (Valenzuela et al., 2013). Meeting a protein threshold (30 g/meal) may represent a promising dietary strategy to help maintain muscle mass and function in older adults. Studies that have examined the eating patterns of older adults suggest that daily protein consumption should focus on individual meals or specific eating opportunities, and breakfast provides the greatest opportunity to more evenly distribute the protein available that day (Mamerow et al., 2014). Protein at breakfast is important because the body is in a catabolic state after an overnight fast and protein can help regulate appetite and daily food intake (Layman, 2009).

The majority of protein consumed by Māori participants originated from high-quality animal sources (≥66%) known to be important to stimulate muscle protein synthesis and muscle mass gain (Paddon-Jones et al., 2015). The ratio of animal to plant protein sources was higher for men than for women (2.63 v. 1.94, p=0.009), indicating that men consumed more protein foods of animal origin than women. Poultry, meat and fish and seafood were dominant sources for both Māori men and women. By contrast, bread was the main source of protein for both men and women aged 71 or over in ANS08/09, followed by milk, beef and veal, fish and seafood (University of Otago & Ministry of Health, 2011). Māori participants also consumed a higher amount of animal protein than those aged 75 or over in Belgium (Lin et al., 2011), those over 60 years in the United States (Smit, Nieto, Crespo & Mitchell, 1999) and older Dutch adults (Tieland et al., 2012). Hence, animal-based protein sources feature more in the diets of older Māori participants. This is a positive finding as older adults who consume a higher amount of animal protein tend to have a higher muscle mass (Houston et al., 2008). This may relate to the high BMI of the Māori participants and warrants further investigation.

Overall, kai Māori and contemporary traditional Māori foods were consumed by 87 (40%) and 157 (73%) of Māori participants respectively. Fish and shellfish, kūmara and pūhā made modest contributions. Protein intake from kai Māori (>1 g) and contemporary traditional Māori food (>3 g) was minimal. However, although fish and shellfish are important precolonial Māori foods, they were consumed by less than half of the participants and made a relatively small contribution to overall animal protein intake. Protein intake from kai Māori and contemporary traditional Māori food was averaged for all of the participants so may misrepresent the participants who did consume these important foods. However, as the current study was undertaken in regions close to the ocean or freshwater lakes, the relatively low protein contribution from fish and seafood is a concern. The depletion of fish and seafood due to pollution in the waters and quotas on kaimoana may create a barrier to access to these foods (Moeke-Pickering, Heitia, Heitia, Karapu & Cote-Peek, 2015) and retail costs may be prohibitive. Among 2669 Māori living in the Waikato and Southern Lakes districts (mean age 48 ± 13 years), kaimoana was reported as a frequently consumed food by 55% of the participants (Rush et al., 2010). Kaimoana was more likely to be consumed at a hui if the marae was close to the sea than in those marae found inland (35% v. 29% respectively).

The investigation found that meals and special occasions in Māori culture were based around protein-rich foods and age was not associated with a decrease in kaimoana consumption at hui or consumption as a traditional food. In the current study, only 15% of the participants visited the marae more than once a month. More frequent contact with whānau, marae and other Māori settings may be important to facilitate good protein food intake. Evidence suggests that every opportunity needs to be taken to encourage older people to eat meals with others. Eating is socially facilitated and older people tend to eat less without a companion to share meals (Locher et al., 2008). A quarter of Māori men and half of Māori women lived alone. This gender difference is not unexpected as Māori women have a higher life expectancy than Māori men (Statistics New Zealand, 2013) and are more likely to be widowed and live alone than men. Older people who live alone may be at a higher risk of becoming malnourished (Burge & Gazibarich, 1999; Keller, Roy & Kane, 2005; Visvanathan et al., 2003). Indeed, living alone was an independent risk factor for Māori participants at high nutrition risk in the baseline assessment of LiLACS NZ (Wham et al., 2015). The whanaungatanga an older Māori person receives may be critical to increase food intake and mealtime enjoyment.

Access to affordable and nutritious food is also known to be a key issue for food security of Māori (McKerchar, Bowers, Heta, Signal & Matoe, 2014) and may be a further factor related to the low food protein intakes observed here. A third (32%) of Māori elders lived in higher deprivation areas associated with an increased risk of food insecurity (University of Otago & Ministry of Health, 2011). In an endeavour to develop a food security plan for descendants of Ngāti Awa, a pilot study identified poverty, impacts of colonisation, fast foods, dependency on supermarkets, processed food and lack of educational programmes about nutrition and health as perceived barriers (Moeke-Pickering et al., 2015). By contrast, perceived strengths of food security were access to food gardens, fish and seafood, and food from the bush (Moeke-Pickering et al., 2015). Pilot study participants drew upon intergenerational knowledge of traditional kai. They stressed the importance of inspiring whānau to grow kai at their homes, on their whenua and at the marae, and to grow kai for their mokopuna and kaumātua. The sharing of healthy kai strategies such as tikanga and karakia was perceived as a way to prevent further loss of traditional knowledge. Food security is especially important for advanced aged Māori, who are revered for their wisdom and knowledge, and can help to revive knowledge of the value of traditional Māori kai.

Older Māori who are able to access important traditional foods on a regular basis have a better nutritional status than those without access (Wham et al., 2012). Similarly, the nutritional quality of food intake has been shown to be improved on days when traditional foods are consumed among the Indigenous peoples in Canada (Chan et al., 2012).

While the optimal levels of macronutrients (carbohydrate, protein and fat) remain to be determined for adults in advanced age, maintaining access to desired traditional foods may benefit nutrition-related health outcomes for older Māori.

There are several limitations of this study. Protein intakes were measured by the two 24-hour dietary recalls and may not represent habitual food intake. Future research is recommended to investigate the important role of food in Māori culture and to assess the frequency of consumption of kai Māori and contemporary traditional Māori foods. Traditional foods such as fish and seafood may lead to a higher animal protein intake and these foods should be encouraged when promoting healthy eating to older Māori. Consumption of traditional foods may enhance both physical and spiritual health.

This study has been the first to investigate the types and distribution of protein intake by Māori of advanced age. 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 New Zealand may also be helpful to determine the contribution of traditional Māori foods. There is opportunity to promote the consumption of traditional high-protein foods three times a day rather than to retain the current practice of skewing protein intake towards the dinner meal.

Older Māori are taonga; they are the protectors of Māori knowledge, traditions and tikanga Māori, and are the leaders of their whānau. Successful ageing of older Māori will ensure that the knowledge and wisdom they have 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.

Glossary

āruhe	fern-root
hāngi	earthen oven
hapū	sub-tribe
hāpuku	groper
huawhenua	vegetables
hui	meeting
ika	fish
iwi	tribal group
kai	food
kaimoana	shellfish
kai o te ngahere	plant and forest foods
kamokamo	type of squash or gourd
karakia	prayers, ritual chants
kaumātua	elders
kina	sea egg
kōrero	discussion
kūmara	sweet potato
manu	birds
marae	tribal meeting grounds
moki	blue moki
mokopuna	grandchildren
Morihana	carp
pāua	abalone
pipi	cockle
pūhā	sow-thistle
pūpū	winkle
rohe	area, region
taonga	treasures
te reo Māori	the Māori language
tikanga	customs and practices
tī kouka	cabbage tree
toroi	fermented food
tuna	eels
whānau	family
whanaungatanga	relationships, kinship, sense of family connection
whenua	land

References

Adamson, A., Collerton, J., Davies, K., Foster, E., Jagger, C., Stamp, E., . . . Kirkwood, T. (2009). Nutrition in advanced age: Dietary assessment in the Newcastle 85+ study. *European Journal of Clinical Nutrition*, *63*(Supp. 1), S6–S18. http://doi.org/b6d3g3

Bowman, S. (2007). Low economic status is associated with suboptimal intakes of nutritious foods by adults in the National Health and Nutrition Examination Survey 1999–2002. *Nutrition Research*, *27*, 515–523. http://doi.org/b7bh23

Breen, L., & Phillips, S. M. (2011). Skeletal muscle protein metabolism in the elderly: Interventions to counteract the "anabolic resistance" of ageing. *Nutrition & Metabolism*, *8*(68), 1–11. http://doi.org/dmnc6k

Buck, P. (1950). *The Coming of the Maori*. Wellington, New Zealand: Whitcombe and Tombs.

Burge, K., & Gazibarich, B. (1999). Nutritional risk among a sample of community-living elderly attending senior citizens' centres. *Australian Journal of Nutrition and Dietetics*, *56*(3), 137–143.

Cambie, R. C., & Ferguson, L. R. (2003). Potential functional foods in the traditional Maori diet. *Mutation Research/Fundamental and Molecular Mechanisms of Mutagenesis*, *523–524*, 109–117. http://doi.org/bsbd5s

Chan, L., Receveur, O., Sharp, D., Ing, A., Fediuk, K., Black, A., & Tikhonov, C. (2012). *First Nations Food, Nutrition and Environment Study (FNFNES): Results from Manitoba 2010*. Prince George, Canada: University of Northern British Columbia.

Correia, M. I., & Waitzberg, D. L. (2003). The impact of malnutrition on morbidity, mortality, length of hospital stay and costs evaluated through a multivariate model analysis. *Clinical Nutrition*, *22*(3), 235–239. http://doi.org/bfrrqd

Donini, L., Savina, C., Rosano, A., & Cannella, C. (2007). Systematic review of nutritional status evaluation and screening tools in the elderly. *Journal of Nutrition Health and Aging*, *11*(5), 421–432.

Dyall, L., Kepa, M., Hayman, K., Teh, R., Moyes, S., Broad, J. B., & Kerse, N. (2013). Engagement and recruitment of Māori and non-Māori people of advanced age to LiLACS NZ. *Australian & New Zealand Journal of Public Health*, *37*(2), 124–131. http://doi.org/f4s92b

Dyall, L., Kerse, N., Hayman, K., & Keeling, S. (2011). Pinnacle of life: Māori living to advanced age. *New Zealand Medical Journal*, *124*(1331), 75–86.

Gaffney-Stomberg, E., Insogna, K. L., Rodriguez, N. R., & Kerstetter, J. E. (2009). Increasing dietary protein requirements in elderly people for optimal muscle and bone health. *Journal of the American Geriatrics Society*, *57*(6), 1073–1079. http://doi.org/cc3vxz

Hayman, K., Kerse, N., Dyall, L., Kepa, M., Teh, R., Wham, C., . . . Jatrana, S. (2012). Life and living in advanced age: A cohort study in New Zealand—Te Puāwaitanga o Nga Tapuwae Kia Ora Tonu, LiLACS NZ: Study protocol. *BMC Geriatrics*, *12*(1), 33. http://doi.org/gbcfbq

Houston, D. K., Nicklas, B., Ding, J., Harris, T. B., Tylavsky, F. A., Newman, A. B., . . . Kritchevsky, S. B. (2008). Dietary protein intake is associated with lean mass change in older, community-dwelling adults: The Health, Aging, and Body Composition (Health ABC) Study. *American Journal of Clinical Nutrition*, *87*, 150–155.

Keller, H. H., Roy, G., & Kane, S.-L. (2005). Validity and reliability of SCREEN II (Seniors in the Community: Risk Evaluation for Eating and Nutrition, Version II). *European Journal of Clinical Nutrition*, *59*, 1149–1157. http://doi.org/bh65h9

Kēpa, M., Kēpa, C., McPherson, B., Kameta, H., Kameta, K., Port, W., . . . Reynolds, L. (2014). E kore e ngāro ngā kākano i ruia mai i Rangiātea: The language and culture from Rangiātea will never be lost in health and ageing research. *AlterNative*, *10*(3), 266–287. http://doi.org/cbxc

Layman, D. K. (2009). *Dietary Guidelines* should reflect new understandings about adult protein needs. *Nutrition & Metabolism*, *6*(12), 1–6. http://doi.org/fcpj6b

Lin, Y., Bolca, S., Vandevijvere, S., De Vriese, S., Mouratidou, T., De Neve, M., . . . Huybrechts, I. (2011). Plant and animal protein intake and its association with overweight and obesity among the Belgian population. *British Journal of Nutrition*, *105*(7), 1106–1116. http://doi.org/bx8b8s

Locher, J. L., Ritchie, C. S., Robinson, C. O., Roth, D. L., Smith West, D., & Burgio, K. L. (2008). A multidimensional approach to understanding under-eating in homebound older adults: The importance of social factors. *Gerontologist*, *48*(2), 223–234. http://doi.org/cnpswj

Mamerow, M. M., Mettler, J. A., English, K. L., Casperson, S. L., Arentson-Lantz, E., Sheffield-Moore, M., . . . Paddon-Jones, D. (2014). Dietary protein distribution positively influences 24-h muscle protein synthesis in healthy adults. *Journal of Nutrition*, *144*(6), 876–880. http://doi.org/f542xk

McKerchar, C., Bowers, S., Heta, C., Signal, L., & Matoe, L. (2014). Enhancing Māori food security using traditional kai. *Global Health Promotion*, *22*(3), 15–24. http://doi.org/f7q7rz

Ministry of Health. (2013). *Mortality and demographic data 2010*. Wellington, New Zealand: Author.

Moeke-Pickering, T., Heitia, M., Heitia, S., Karapu, R., & Cote-Meek, S. (2015). Understanding Māori food security and food sovereignty issues in Whakatāne. *MAI Journal*, *4*(1), 29–42.

National Health and Medical Research Council & Ministry of Health. (2005). *Nutrient Reference Values for Australia and New Zealand*. Retrieved from http://www.nrv.gov.au/nutrients/index.htm

Nelson, M., Atkinson, M., & Meyers, J. (1997). *A photographic atlas of food portion sizes*. London, England: Ministry of Fisheries and Food.

New Zealand Institute for Plant & Food Research Limited (2011). *New Zealand FOODfiles 2010 Version 01*. Palmerston North, New Zealand: New Zealand Institute for Plant & Food Research Limited and Ministry of Health.

Paddon-Jones, D., Campbell, W. W., Jacques, P. F., Kritchevsky, S. B., Moore, L. L., Rodriguez, N. R., & van Loon, L. J. (2015). Protein and healthy aging. *American Journal of Clinical Nutrition*, *101*(6), 1339S–1345S. http://doi.org/f7d5hv

Paddon-Jones, D., & Rasmussen, B. (2009). Dietary protein recommendations and the prevention of sarcopenia. *Current Opinion in Clinical Nutrition and Metabolic Care*, *12*(1), 86–90. http://doi.org/d6zjw3

Rush, E. C., Hsi, E., Ferguson, L. R., Williams, M. H., & Simmons, D. (2010). Traditional foods reported by a Māori community in 2004. *MAI Review*, *2*, 1–10.

Salmond, C., Crampton, P., & Sutton, F. (1998). NZDep91: A New Zealand index of deprivation. *Australian New Zealand Journal of Public Health*, *22*, 835–837. http://doi.org/frwnnd

Smit, E., Nieto, F. J., Crespo, C. J., & Mitchell, P. (1999). Estimates of animal and plant protein Intake in US adults: Results from the Third National Health and Nutrition Examination Survey, 1988–1991. *Journal of the American Dietetic Association*, *99*(7), 813–820. http://doi.org/c37gfj

Statistics New Zealand. (2007). *New Zealand's 65+ population: A statistical volume*. Wellington, New Zealand: Author.

Statistics New Zealand. (2010). *National ethnic population projections: 2006(base)–2026 update*. Wellington, New Zealand: Author.

Statistics New Zealand. (2013). *Māori population estimates: At 30 June 1991–2012*. Retrieved from http://www.stats.govt.nz/browse_for_stats/population/estimates_and_projections/maori-population-estimates.aspx

Symons, B., Sheffield-Moore, M., Wolfe, R. R., & Paddon-Jones, D. (2009). A moderate serving of high-quality protein maximally stimulates skeletal muscle protein synthesis in young and elderly subjects. *Journal of the American Dietetic Association*, *109*(9), 1582–1586. http://doi.org/ccxb4g

Tieland, M., Borgonjen-Van den Berg, K. J., van Loon, L. J. C., & de Groot, L. C. P. G. M. (2012). Dietary protein intake in community-dwelling, frail, and institutionalized elderly people: Scope for improvement. *European Journal of Nutrition*, *51*(2), 173–179. http://doi.org/fv734q

Tieland, M., Borgonjen-Van den Berg, K. J., Van Loon, L. J. C., & de Groot, L. C. P. G. M. (2015). Dietary protein intake in Dutch elderly people: A focus on protein sources. *Nutrients*, *7*(12), 9697–9706. http://doi.org/cbxd

Tipa, G., Nelson, K., Emery, W., Smith, H., & Phillips, N. (2010). *A survey of wild kai consumption in the Te Arawa rohe* (Client Report No. HAM2010-096). Hamilton, New Zealand: National Institute of Water & Atmospheric Research.

University of Otago. (2007). *NZDep2006 Index of Deprivation*. Retrieved from http://www.health.govt.nz/publication/nzdep2006-index-deprivation

University of Otago, & Ministry of Health. (2011). *A focus on nutrition: Key findings of the 2008/09 New Zealand Adult Nutrition Survey*. Wellington, New Zealand: Ministry of Health.

Valenzuela, R. E., Ponce, J. A., Morales-Figueroa, G. G., Muro, K. A., Carreon, V.R., & Aleman-Mateo, H. (2013). Insufficient amounts and inadequate distribution of dietary protein intake in apparently healthy older adults in a developing country: Implications for dietary strategies to prevent sarcopenia. *Clinical Interventions in Aging*, *8*, 1143–1148.

Visvanathan, R., Macintosh, C., Callary, M., Penhall, R., Horowitz, M., & Chapman, I. (2003). The nutritional status of 250 older Australian recipients of domiciliary care services and its association with outcomes at 12 months. *Journal of the American Geriatrics Society*, *51*(7), 1007–1011. http://doi.org/b97xfm

Volpi, E., Campbell, W. W., Dwyer, J. T., Johnson, M. A., Jensen, G. L., Morley, J. E., & Wolfe, R. R. (2013). Is the optimal level of protein intake for older adults greater than the recommended dietary allowance? *Journals of Gerontology: Series A: Biological Sciences and Medical Sciences*, *68*(6), 677–681. http://doi.org/f4zp9c

Wham, C., Maxted, E., Dyall, L., Teh, R., & Kerse, N. (2012). *Korero te kai o te Rangatira*: Nutritional wellbeing of Māori at the pinnacle of life. *Nutrition & Dietetics*, *69*(3), 213–216. http://doi.org/cbxf

Wham, C., Teh, R., Moyes, S., Dyall, L., Kepa, M., Hayman, K., & Kerse, N. (2015). Health and social factors associated with nutrition risk: Results from life and living in advanced age: A cohort study in New Zealand (LILACS NZ). *Journal of Nutrition Health and Aging*, *19*(6), 637–645. http://doi.org/cbxg

Young, V. R., & Pellett, P. L. (1994). Plant proteins in relation to human protein and amino acid nutrition. *American Journal of Clinical Nutrition*, *59*(5), 1203S–1212S.