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Barriers to and facilitators and perceptions of nut consumption among the general population in New Zealand

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Abstract

Objective: Despite considerable evidence supporting the health benefits of regular nut consumption, nut intakes remain lower than recommended among many populations. Understanding how the general population perceives nuts could inform strategies to promote regular nut consumption and increase intakes among the general public.

Design: Cross-sectional study. Participants were invited to complete a questionnaire which included information on nut consumption and knowledge and perceptions of nuts.

Setting: The study was set in New Zealand (NZ).

Subjects: Participants (*n* 1600), aged 18 years or over, were randomly selected from the NZ electoral roll.

Results: A total of 710 participants completed the questionnaire (response rate 44 %). More than half of the respondents believed that nuts are healthy, filling, high in protein and high in fat. The most common reason cited by consumers for eating nuts was taste (86 % for nuts, 85 % for nut butters), while dental issues was the most frequent reason for avoidance. About 40 % of respondents were not aware of the effects of nut consumption on lowering blood cholesterol and CVD risk.

Conclusions: Despite overall basic knowledge of the nutritional value of nuts, a substantial proportion of the general population was unaware of the cardioprotective effects of nuts. The present study identified common motivations for eating and avoiding nuts, as well as perceptions of nuts which could affect intake. These should guide the content and direction of public health messages to increase regular nut consumption. The public's knowledge gaps should also be addressed.

Keywords
Nut consumption
Knowledge
Perceptions
Facilitators
Barriers

Nuts are nutrient dense, and are particularly rich sources of *cis*-unsaturated fat, protein, fibre, antioxidants (e.g. Se) and a variety of vitamins (e.g. vitamin E, folate), minerals (e.g. Mg, Ca, K) and phytonutrients[1–3]. The nutrient profiles of nuts, including peanuts, likely contribute to their reported health benefits. The regular consumption of nuts is inversely associated with total mortality[4,5] and in particular with a reduction in the risk of CVD[3,6–8]. This has led to recommendations to consume 30–42 g of nuts daily as part of a cardioprotective diet[9,10].

Despite a wealth of information on the health benefits of regular nut consumption, population intakes of nuts are far lower than recommended[11–14]. For example, the percentage of people who consume whole nuts among populations in New Zealand (NZ), Europe and the USA on a given day is 6–7 %[11–14]. When total nut intake is considered, the percentage of consumers among populations in NZ, Australia, Europe and the USA is 29, 18, 27 and 34 %, respectively[11–15]. In addition, mean population intake of whole nuts in these countries is less than 3·5 g/d, although consumers on the day of the 24 h recall often achieve guidelines around amounts recommended.

Gaining a better understanding of how nuts are perceived in terms of both sensory and health effects, as well as the motivators of and barriers to regular nut consumption, could provide important information for developing public health messages aimed at improving these low levels of nut consumption and raising intakes towards recommended levels, thereby contributing to improving people's health in progressively obesogenic environments. To our knowledge, only two studies have examined knowledge, perceptions, attitudes and

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barriers to nut consumption: one among individuals with low socio-economic status (n 124)[16] and the other among individuals with or at risk of CVD and/or diabetes (n 85)[17].

Among the low socio-economic cohort, Pawlak *et al.* found that only about one-third of participants believed nuts would help lower blood cholesterol levels[16]. In addition, only about one-quarter believed that nuts would lower risk of heart disease. Among those with or at risk of CVD and/or diabetes, approximately 40 % of participants were not aware that nuts could lower the risk of CVD and 33 % were unsure of the impact of nuts on blood cholesterol levels, with an additional 21 % disagreeing that nuts can reduce blood cholesterol concentrations[17]. These perceptions are at odds with data from both epidemiological studies[4,5] and clinical trials[8], which show reductions in CVD risk and lower total and LDL cholesterol concentrations among those regularly consuming nuts.

Although different types of nut differ in their nutrient content, they are all nutrient dense[1–3]. However, data from Pawlak *et al.* indicated that respondents' knowledge of the nutrient content of nuts was poor[16]. Lack of knowledge on the nutrient composition and health effects of nuts could lead to lower intakes of nuts by some individuals.

Interestingly, 37 % of the low socio-economic cohort thought that eating nuts would cause weight gain[16]. However, unlike other energy-dense foods, the regular consumption of nuts has not been associated with weight gain and several epidemiological studies report that nut consumers are leaner than nut non-consumers[18–21]. This is supported by clinical trials, which consistently report either no weight gain or less weight gain than predicted based on energy content alone[22–26]. Explanations for this are the satiating effects of nuts[27,28] and loss of metabolisable energy through increased faecal fat loss when nuts are consumed whole[29–32]. Some of the confusion over nuts and their effects on body weight might stem from earlier dietary recommendations which advised against eating nuts because of their high fat content[33].

Other barriers to nut consumption reported by the low socio-economic cohort included the cost and the high fat content of nuts[16]. However, the overall healthiness of nuts was acknowledged, with strong agreement among participants that they should eat nuts on most days of the week because nuts are healthy. Also, participants reported they would be more likely to eat nuts if their doctor recommended that they do so. Further, among those in the cohort with or at risk of CVD and/or diabetes, 64 % of participants agreed they would consume nuts on most days of the week if their doctor made a recommendation to do so[17]. This suggests that health professionals may have an important role to play in promoting the regular consumption of nuts.

These studies have provided some important insights into factors influencing nut consumption in specific population groups. However, their relatively small sample sizes (both $n \leq 124$) have not allowed precise estimates of effects and, more importantly, their samples were not intended to be representative of the general population, which means that whether their results also hold at this level is currently unknown. To the best of our knowledge, no large studies, using nationally representative samples, have examined the sensory and health perceptions of nuts and the motivators of and barriers to regular nut consumption. Therefore, given the low population intake of nuts and the lack of information on factors which influence nut consumption, the present study aimed to identify current barriers to and facilitators of regular nut consumption as well as perceptions of nuts in a nationally representative sample in NZ.

Methods

Study participants

This was a cross-sectional study using a national sample of NZ adults aged 18 years or over. A total of 1600 participants were randomly selected from the NZ electoral rolls. Oversampling of Māori using the Māori descent flag was used to achieve sufficient numbers for analyses involving this ethnicity. All NZ citizens and permanent residents 18 years or older are required by law to enrol to be registered on the Parliamentary Electoral Roll and the roll is estimated to include 92·6 % of all adults[34]. Recruitment took place from September to October 2014. All respondents were provided with an information sheet outlining the study and provided informed consent by completing the questionnaire. The study was conducted according to the guidelines laid down by the Declaration of Helsinki and all procedures involving human subjects were approved by the University of Otago Ethics Committee (reference number D14/288).

Survey development

Respondents completed either an online or a paper version of the questionnaire, which examined their perceptions of nuts (including nut butters) as well as barriers to and facilitators of nut consumption. The questionnaire content was based on previous work by Pawlak *et al.*[16] and was further developed to include other relevant measures related to nut consumption. The questionnaire was developed by a group of researchers, including a registered dietitian, with expertise in the area of nuts and health, and was pre-tested and modified where appropriate among a group of forty-three members of the general public, establishing both face and content validity. The final version of the questionnaire included questions on nut consumption and intake, facilitators of and barriers to nut consumption, knowledge and perceptions of nuts, as well as participant demographics.

Survey content

Questions on their intake of ten types of nut (almonds, Brazil nuts, cashews, hazelnuts, macadamias, peanuts, pecans, pine nuts, pistachios and walnuts) and five types of nut butter commercially available in NZ (almond butter, cashew butter, hazelnut butter, peanut butter and walnut butter) were included in the questionnaire. For each nut type, respondents were asked about their frequency and usual quantity of consumption. Respondents were asked if they agreed or disagreed with carefully worded statements on perceptions on nuts, including their overall healthiness; energy, macronutrient and micronutrient content; affordability and availability; effects on satiety and weight; and effects on health, both generally and specific disease risks. They indicated answers using 5-point Likert-type items comprising responses of 'strongly agree' = 1, 'agree' = 2, 'neither agree nor disagree' = 3, 'disagree' = 4 and 'strongly disagree' = 5, with an additional option of 'I don't know'. Consumers, of nuts or nut butters, were asked about their reasons for consuming these foods. Correspondingly, nut non-consumers were asked about their reasons for not consuming these foods. A final section on demographics included age, sex, ethnicity (with the option to select multiple ethnicities), weight, height, smoking status, household income, level of education and employment status.

Survey administration

Both online and paper-based questionnaires were developed for the present study. For the online version of the questionnaire, Survey Gizmo© (Widgix Software, LLC, Boulder, CO, USA) was used as the survey tool to gather responses electronically. The paper questionnaire was posted to participants and returned using a reply-paid envelope. This mixed-mode design was aimed at maximising the response rate. Compared with the online questionnaire, the paper version used identical wording in the questions and was designed to be as visually similar as possible.

The study used a modified version of Dillman's Tailored Design Method[35] comprising a total of four mail-outs. The first mail-out to all 1600 participants contained a cover letter and an information sheet regarding the study. The cover letter contained the web address for the online questionnaire. Users were provided with a login code so that each participant could complete the questionnaire only once. As an incentive, participants were informed that if they completed the questionnaire within 2 weeks, they would be eligible to go into a prize draw for one of five grocery vouchers worth $NZ 100 (about $US 72). A second mail-out was carried out 7 d after the first when a thank you and reminder postcard was sent to all 1600 participants. The postcard expressed the researchers' appreciation to those who had completed the questionnaire and encouraged non-respondents to complete the survey. Responses from participants were monitored through the online survey software and those who completed the survey were taken off the mailing list based on their unique study ID numbers. This was done to separate them from the non-respondents who received a further invitation to participate in the study in the third mail-out. This third mail-out was sent 9 d after the second and consisted of a cover letter, a paper version of the questionnaire, a reply-paid envelope and a study-branded pen with the name of the research group on it. Participants were informed that upon their completion and return of the questionnaire within the following 2 weeks, they would be eligible for a prize draw for one of ten grocery vouchers worth $NZ 50 (about $US 36). The final mail-out was sent to all recipients of the third mail-out conducted 12 d later. It comprised a thank you and reminder postcard.

Statistical analysis

To obtain 95 % confidence intervals around proportions with a half-width of 0·05 and assuming a worst-case proportion of 0·5, 404 responses would be required (using asymptotic estimates with continuity correction). Assuming an overall response rate of 50 % and allowing for 2·5 % unusable data for any given question, 829 participants would be required. For subgroups which are a third of the sample, to have confidence interval half-widths of 0·075, 184 usable responses would be required, equivalent to 378 potential respondents in each subgroup. To achieve both goals, 1200 people would need to be selected from the electoral roll. Furthermore, to also provide confidence interval half-widths of 0·075 for estimates specific to Māori respondents overall, an additional sample of 400 from those indicating Māori descent would also need to be drawn from the rolls. Thus, the total number of participants approached was calculated to be 1600.

Survey weights were calculated based on NZ 2013 Census data using prioritised ethnicities (the highest category being Māori, then Asian people, other ethnicities (including Pacific peoples, MELAA (Middle Eastern/Latin American/African) and other ethnic groups) and finally European including NZ European) using Statistics New Zealand's level one ethnicity categories)[36], age groups (under 30 years, between 30 and 64 years, 65 years or over) and sex (male or female), so that respondents were representative of the Census population estimates in terms of combinations of these three demographics. All statistical analyses and percentages incorporate these weights, while numerical counts are based on unweighted data.

Characteristics of respondents are presented as frequencies and percentages for categorical variables and using means and standard deviations for continuous variables. Responders were identified in the original

sample of 1600 and response rates calculated overall and by characteristics in the Electoral Roll (age group, sex (with some ambiguous), Māori descent and NZ Deprivation group). Response rates were compared between levels of these variables using ordinary χ^2 tests. To assess associations between beliefs and perceptions of nuts and intake categories, Kendall's τ_b correlations were calculated for each belief or perception item and each of nut and nut butter intake categories separately (excluding those who answered 'I don't know' to the belief or perception question). To identify associations between reasons for consuming nuts and nut butters and intakes among consumers, Mann–Whitney *U* tests were used to compare nut and nut butter intake categories between those endorsing and those not endorsing each reason. Harrall's *c*-index was used to quantify the strength of these associations. Univariable survey regression (logistic for binary variables and linear for ordinal variables) was used to initially identify associations with predictors comprising: sex (male, female), age (continuous), BMI category (<25·0 kg/m^2, 25·0–29·9 kg/m^2, ≥30·0 kg/m^2), annual household income (≤ $NZ 30 000 (≤ $US 21 600), $NZ 30 001–70 000 ($US 21 600–50 400), ≥ $NZ 70 001 (≥ $US 50 400)), highest level of education (less than high school, completed high school, post-high school non-degree, university degree or above), smoking status (current, not current including former) and prioritised ethnicity (Māori, Asian, Other, European). For age, the addition of a quadratic term was investigated to assess, and where appropriate to model, non-linearities. Where there was evidence of a quadratic association, this is described in notes to the tables which present both linear and quadratic (after centring) effects and identify the minima or maxima as appropriate. For categorical variables, Wald tests were used to identify statistically significant evidence of association and *post hoc* tests were performed only where this initial test was statistically significant, without further adjustment for multiplicity. Those variables with univariable $P<0·25$ were included in the relevant multivariable model. For the logistic regression models which were subject to the guidelines from Peduzzi *et al.*[37] and where not all such variables could be accommodated, they were included in the multivariable model in the order of sex, age, BMI, income, education, smoking and prioritised ethnicity (an order determined based on existing evidence and the potential usefulness of knowing about an association involving each variable). Where there was quasi-complete separation for logistic regression models, collapsing levels of the categorical variable was considered along with removing the problematic variable from the model. For examining differences between nut and nut butter avoiders, the χ^2 test was used when there were no more than 20 % of expected cell frequencies below 5 but there were too few respondents in each category based on Peduzzi *et al.*'s guidelines[37], and Fisher's exact test otherwise. The statistical software package Stata version 14·2 was used for all statistical analyses. All statistical tests were two-sided and $P<0·05$ was considered statistically significant.

Results

Demographics

A response rate of 44·4 % (*n* 710) was achieved. The characteristics of study respondents are shown in Table 1 (numbers of missing responses for each question can be obtained by subtracting responses from 710). The mean age was 52·9 years and 52·7 % were women. A total of 69·4 % of the respondents self-identified as NZ European, 11·3 % as Māori, 2·2 % as Pacific Islanders and 8·5 % as Asian. The mean BMI was 27·4 kg/m^2, with 39·8 % classified as having a

Table 1 Characteristics of the survey participants (*n* 710); a nationally representative sample of adults aged 18 years or over, New Zealand, September–October 2014

	All survey participants	
Characteristic	*n*	Survey-adjusted %
Total population	710	100·0
Gender		
Male	309	47·3
Female	401	52·7
Age (years)		
18–29	170	23·9
30–64	344	48·5
≥65	195	27·5
Ethnicity		
New Zealand European	499	69·4
Māori	88	11·3
Pacific	16	2·2
Asian	44	8·5
MELAA	4	0·5
Other	59	8·1
BMI (kg/m^2)		
<18·5	7	1·1
18·5–24·9	262	39·8
25·0–29·9	243	36·9
≥30·0	147	22·3
Smoking status		
Never smoked	377	58·4
Ex-smoker	244	30·8
Current smoker	70	10·8
Highest education level		
None	7	0·8
Primary	8	0·9
High school	252	36·7
Tertiary non-degree	237	33·0
Tertiary degree	142	22·1
Higher tertiary degree	42	6·6
Employment status		
Not working	74	13·0
Working	437	67·4
Retired	160	16·5
Other	24	3·1
Annual household income ($NZ)		
≤10 000	25	5·9
10 001–30 000	111	16·4
30 001–50 000	99	16·4
50 001–70 000	102	18·8
70 001–100 000	97	17·2
>100 000	132	25·3

MELAA, Middle Eastern/Latin American/African.

normal BMI, 36·9 % as having a BMI of 25·0–29·9 kg/m^2, and 22·3 % as having a BMI of ≥30·0 kg/m^2. Among the respondents, 10·8 % were current smokers. Most participants had a qualification beyond secondary school. Over two-thirds of respondents reported they were currently working and one-quarter reported total annual household income of $NZ 100 000 or greater (although 144 respondents had missing data for this question).

One respondent removed the identification number from his/her survey and we were not able to note him/her as a responder in the original sample of 1600. Excluding this responder, response rates varied by NZ Deprivation group (χ^2 $P<0·001$), with the highest response rate of 53·6 % in the lowest deprivation (highest socio-economic status) group (NZ Dep deciles 1–3), declining to 45·8 % in the middle group (NZ Dep deciles 4–7) and 33·8 % in the most deprived (lowest socio-economic status) group (NZ Dep deciles 8–10). Those indicating Māori descent in the Electoral Roll (*n* 400) were less likely to respond (30·3 %) compared with non-Māori (49·0 %, χ^2 $P<0·001$). Response rates increased with age (χ^2 $P<0·001$), being 26·6 % for 18–29-year-olds, 45·3 % for 30–64-year-olds and 56·8 % for those aged ≥65 years (χ^2 $P<0·001$). Sex was determined from titles used in the Electoral Roll for 1437 (89·8 %) of the sample, with the remainder (*n* 163, 10·2 %) either having gender-neutral titles (e.g. Doctor or Professor) or not providing a title. Those with female titles had higher response rates (46·7 %) than those with male titles (39·3 %), but the highest rate of response was from those not classified as male or female based on their title (54·6 %, χ^2 $P<0·001$).

Intake of nuts and nut butters

About 16 % of respondents reported eating nuts daily, 8 % on most days (approximately five times per week), 20 % on some days (two to four times per week), 13 % once per week, 19 % two to three times per month, and 19 % once per month or less. About 6 % reported that they did not consume nuts. In terms of nut butters, 7 % of respondents reported eating nut butters daily. Approximately 5 % reported eating nut butters on average most days of the week (approximately five times per week), 16 % two to four times per week, 13 % once per week, 12 % two to three times per month, and 17 % monthly or less. Thirty per cent of respondents reported never consuming nut butters.

Perceptions of nuts and nut butters among the general public

Table 2 shows participants' responses on perceptions regarding nuts and nut butters. More than half of all respondents agreed that nuts and nut butters are healthy, high in protein and fat, and are filling. Of the fifteen statements about nuts and nut butters, the statements 'They are healthy' and 'They are high in protein', both strongly

Table 2 Beliefs and perceptions of nuts and nut butters (survey-adjusted percentages and mean scores) among a nationally representative sample of adults aged 18 years or over, New Zealand, September–October 2014

Belief and perceptions	Strongly agree (%)	Agree (%)	Neither agree nor disagree (%)	Disagree (%)	Strongly disagree (%)	Mean score	Do not know (%)	Association with nut consumption*		Association with nut butter consumption*	
								τ_b	*P* value	τ_b	*P* value
They are healthy†	18·5	54·2	15·6	5·1	0·3	2·1	6·4	0·15	**<0·001**	0·01	0·864
They are high in protein†	12·8	55·2	12·1	2·3	0·3	2·1	17·3	0·11	**0·002**	0·08	**0·027**
They are filling†	11·9	55·1	18·2	5·7	0·5	2·2	8·7	0·08	**0·020**	0·05	0·152
They are high in fat†	11·1	40·9	21·0	9·8	0·6	2·4	16·6	0·01	0·836	0·02	0·603
They are low in energy/energy‡	2·3	11·1	18·0	34·1	12·9	3·6	21·7	−0·02	0·573	−0·04	0·240
They are low in vitamins & minerals‡	1·9	8·3	20·5	31·3	9·0	3·5	29·0	−0·14	**<0·001**	−0·02	0·617
Some of them are high in Se†	8·3	28·7	19·1	1·1	0·2	2·2	42·7	0·17	**<0·001**	0·09	**0·046**
They are low in fibre†	2·0	9·1	22·0	29·3	7·4	3·4	30·3	−0·13	**0·001**	−0·06	0·153
Some of them are high in Fe§	4·5	32·1	19·7	2·2	0·3	2·3	41·2	0·10	**0·016**	0·00	0·959
They are high in antioxidants†	4·3	29·1	23·7	4·2	0·9	2·5	37·9	0·11	**0·011**	−0·04	0·329
Eating them can increase people's risk of CVD‡	1·8	8·3	20·9	23·9	6·8	3·4	38·3	−0·11	**0·006**	−0·12	**0·002**
They are naturally high in salt/Na‡	1·8	24·3	19·8	19·4	4·0	3·0	30·7	−0·12	**0·001**	−0·04	0·285
Eating them can increase people's total blood cholesterol‡	1·1	13·2	21·2	17·9	4·8	3·2	41·9	−0·12	**0·004**	−0·09	**0·043**
Eating them will cause people to gain weight‡	2·5	19·4	27·0	26·9	4·2	3·1	20·1	−0·05	0·137	−0·05	0·185
Eating them can help lower people's risk of diabetes‖	3·4	12·5	22·2	8·4	1·2	2·8	52·3	0·07	0·115	−0·07	0·142

Responses scored as 'strongly agree' = 1, 'agree' = 2, 'neither agree nor disagree' = 3, 'disagree' = 4, 'strongly disagree' = 5.
Note that some statements are supported by current evidence and some are worded in contradiction to current evidence.
*Kendall's τ_b correlation with overall frequency of consumption (for those who provided an answer other than 'I don't know'), where positive values indicate higher intakes with greater agreement with the statement. Significant *P* values are indicated in bold font.
†Statements that are supported by current evidence.
‡Statements that are contradicted by current evidence.
§Some nuts such as pistachios, cashews and almonds contain useful (>4 mg non-haem Fe/100 g) amounts of Fe, but bioavailability and significance will rely on other dietary factors.
‖Statements where current evidence is uncertain.

supported by the literature, received the strongest agreement (mean score = 2·1), with 1 indicating 'strongly agree' and 5 indicating 'strongly disagree'. In contrast, the statement 'They are low in energy/calories', strongly contradicted by the literature, received the strongest disagreement (mean score = 3·6). The five statements which received the highest percentages of 'I don't know' responses were 'Eating them can help lower people's risk of diabetes' (52·3 %; current evidence uncertain), 'Some of them are high in selenium' (42·7 %; supported by current evidence), 'Eating them can increase people's total blood cholesterol' (41·9 %; contradicted by current evidence), 'Some of them are high in iron' (41·2 %; true for some nut types) and 'Eating them can increase people's risk of cardiovascular disease' (38·3 %; contradicted by current evidence).

More positive beliefs and perceptions of nuts were associated with higher nut intake frequency categories for eleven of the fifteen items (all $P \leq 0{\cdot}020$), the exceptions being about items about fat, energy, weight gain and diabetes risk. For nut butters, only four of the items were statistically significant, namely protein and Se content and effects on cholesterol and CVD risk (all $P \leq 0{\cdot}046$).

Associations with perceptions of nut consumption

Table 3 shows the adjusted models of perceptions of nuts. Women were more likely than men to perceive nuts as being high in antioxidants ($P = 0{\cdot}014$) and filling ($P = 0{\cdot}002$). Older respondents agreed more that nuts are low in energy or calories ($P = 0{\cdot}020$) and disagreed more that nuts increase total blood cholesterol ($P = 0{\cdot}008$), which is contradicted by the literature. The only association with BMI categories was for salt/sodium content where those with higher BMI were in stronger agreement with the statement that nuts are naturally high in salt ($P = 0{\cdot}001$), which is also contradicted by the literature, although the only pairwise differences were between obese and both normal weight and overweight. The most consistent pattern of associations was with income, where higher income categories were associated with greater disagreement with nuts being low in energy or calories ($P = 0{\cdot}015$), nuts being low in fibre ($P = 0{\cdot}025$), nuts being high in salt ($P = 0{\cdot}015$), nuts cause weight gain ($P = 0{\cdot}048$) and nuts increase total blood cholesterol ($P = 0{\cdot}014$). While there was evidence for an association with the statement nuts are high in fat ($P = 0{\cdot}030$), *post hoc* tests found the only significant difference to be that those on high incomes (≥ $NZ 70 001) were more likely to agree compared with those on moderate incomes, with those on low incomes (≤ $NZ 30 000) falling in the middle. Education displayed an inverse-J association, with those having high school or post-high school non-degree qualifications stating more agreement that nuts are low in energy or calories compared with those with university-level qualifications. Those with post-high school non-degree qualifications also stated more agreement that nuts are high in antioxidants compared with those who completed high school. Current smokers agreed more that nuts are low in energy or calories ($P = 0{\cdot}045$). The only ethnicity-related difference was with the perception that nuts are high in salt/sodium, with Māori expressing more agreement than European or Asian peoples.

Reasons for eating nuts and/or nut butters

Table 4 lists the reasons for eating nuts and/or nut butters among nut consumers in the survey. The top five reasons both nut and nut butter consumers chose to eat nuts were because: they liked the taste of nuts, they believed that nuts are good for health, they thought nuts were a good source of protein or a good source of energy/calories, or because nuts are convenient and portable. For all listed reasons, higher percentages of women selected these as motivation to eat nuts compared with men.

Endorsement of a reason for consuming nuts was associated with higher intakes for fifteen of the seventeen items (all $P \leq 0{\cdot}007$), the exceptions being for taste and convenience. For nut butters, only one statistically significant association was found, namely for promoting satiety ($P = 0{\cdot}021$).

Predictors of the reasons for choosing to consume nuts

The predictors of reasons for nut consumption among nut consumers (n 674) are shown in Table 5. Men had 48 % (95 % CI 0·32, 0·87; $P = 0{\cdot}012$) lower odds of choosing to eat nuts due to nuts being 'a good source of iron' and 55 % (95 % CI 0·28, 0·74; $P = 0{\cdot}002$) lower odds of choosing to eat nuts due to their satiating effects, compared with women. For every 10-year increase in age, there was a 47 % (95 % CI 1·23, 1·76; $P < 0{\cdot}001$) increase in the odds of a consumer eating nuts because it 'can help lower blood cholesterol' and a 41 % (95 % CI 1·23, 1·61; $P < 0{\cdot}001$) increase in the odds of a consumer eating nuts because it 'can help decrease risk of cardiovascular disease'. In addition, as age increased, respondents were more likely to choose to eat nuts because they are a good source of fibre ($P = 0{\cdot}039$), Se ($P = 0{\cdot}036$) and antioxidants ($P = 0{\cdot}002$). Conversely, for every 10-year increase in age, there was a 23 % (95 % CI 0·67, 0·88; $P < 0{\cdot}001$) reduction in the odds of respondents choosing to eat nuts because they are 'convenient and portable'.

Nut consumers who had a BMI of 25·0–29·9 kg/m^2 or ≥30·0 kg/m^2 had 38 % (95 % CI 0·40, 0·97; $P = 0{\cdot}036$) or 56 % (95 % CI 0·26, 0·75; $P = 0{\cdot}002$) lower odds of choosing to eat nuts because nuts are 'a good source of vitamins & minerals', respectively, compared with consumers with a BMI of <25 kg/m^2. Overweight and obese consumers were less likely to eat nuts because they are 'a good source of unsaturated fat' compared with those with a healthy BMI (both pairwise $P \leq 0{\cdot}025$). Obese consumers were significantly less likely than normal-weight respondents to

Table 3 Predictors of perceptions of nuts (*P* value, with the difference and 95 % confidence interval beneath) among a nationally representative sample of adults aged 18 years or over, New Zealand, September–October 2014

	Nuts…							
Predictor	Are healthy*	Are low in energy/ calories†	Are high in protein*	Are low in vitamins & minerals†	Are high in fat*	Are low in fibre†	Are high in antioxidants*	Are naturally high in salt†
Gender					*P* = 0·223	*P* = 0·252	***P* = 0·014**	
Female					0·00	0·00	0·00	
Male					0·11 −0·07, 0·28	0·12 −0·08, 0·32	0·21 0·04, 0·37	
Age	*P* = 0·081	***P* = 0·020**			*P* = 0·182	*P* = 0·386	*P* = 0·069	*P* = 0·329
Per 10 years	−0·04 −0·08, 0·00	−0·08 −0·15, −0·01			0·04 −0·01, 0·09	0·03 −0·03, 0·09	−0·05 −0·10, 0·00	0·03 −0·03, 0·10
BMI (kg/m^2)								***P* = 0·001**
< 25·0								0·00[a]
25·0–29·9								−0·18[a] −0·41, 0·05
≥ 30·0								−0·48[b] −0·75, −0·22
Annual household income ($NZ)	*P* = 0·135	***P* = 0·015**		*P* = 0·294	***P* = 0·030**	***P* = 0·025**		***P* = 0·015**
≤ 30 000	0·00	0·00[a]		0·00	0·00[a,b]	0·00[a]		0·00[a]
30 001–70 000	0·09 −0·12, 0·30	0·14[a] −0·21, 0·49		0·11 −0·27, 0·48	0·09[b] −0·18, 0·35	0·39[b] 0·11, 0·67		0·37[b] 0·12, 0·63
≥ 70 001	0·20 −0·01, 0·42	0·40[b] 0·07, 0·74		0·28 −0·11, 0·68	−0·18[a] −0·42, 0·06	0·31[b] 0·02, 0·61		0·26[b] 0·02, 0·50
Highest level of education		***P* = 0·016**		*P* = 0·081	*P* = 0·440	*P* = 0·205	***P* = 0·039**	*P* = 0·561
Less than high school		0·00[a,b]		0·00	0·00	0·00	0·00[a,b]	0·00
High school		−0·61[a] −1·33, 0·11		−0·27 −1·05, 0·51	−0·46 −1·39, 0·47	−0·39 −0·92, 0·15	−0·52[b] −1·46, 0·43	0·28 −0·81, 1·37
Post-high school (non-degree)		−0·49[a] −1·20, 0·23		−0·11 −0·88, 0·66	−0·40 −1·34, 0·54	−0·28 −0·82, 0·25	−0·75[a] −1·69, 0·19	0·39 −0·70, 1·49
University		−0·21[b] −0·94, 0·52		0·18 −0·63, 0·99	−0·56 −1·50, 0·39	−0·15 −0·72, 0·42	−0·68[a,b] −1·63, 0·27	0·43 −0·67, 1·53
Current smoker	*P* = 0·437	***P* = 0·045**	*P* = 0·106	*P* = 0·746		*P* = 0·378		*P* = 0·444
No	0·00	0·00	0·00	0·00		0·00		0·00
Yes	−0·09 −0·33, 0·14	−0·38 −0·74, −0·01	−0·20 −0·44, 0·04	−0·05 −0·38, 0·28		−0·15 −0·49, 0·19		−0·13 −0·48, 0·21
Ethnicity					*P* = 0·065	*P* = 0·122		***P* = 0·016**
European					0·00	0·00		0·00[a]
Māori					0·16 −0·10, 0·42	−0·01 −0·34, 0·31		−0·40[b] −0·67, −0·14
Asian					−0·11 −0·57, 0·36	−0·29 −0·70, 0·13		0·11[a] −0·29, 0·50
Other/not stated					0·39 0·08, 0·70	−0·45 −0·87, −0·03		−0·09[a,b] −0·42, 0·24

	Nuts…					
Predictor	Are high in Se (some of them)*	Are high in Fe (some of them)‡	Are filling*	Cause weight gain†	Increase total blood cholesterol†	Increase risk of heart disease†	Lower risk of diabetes§
Gender	*P* = 0·161		***P* = 0·002**				
Female	0·00		0·00				
Male	0·12 −0·05, 0·28		0·24 0·09, 0·38				
Age		*P* = 0·953	*P* = 0·176		***P* = 0·008**	*P* = 0·646	
Per 10 years		−0·00 −0·05, 0·05	−0·03 −0·08, 0·01		0·08 0·02, 0·14	0·01 −0·05, 0·07	
BMI (kg/m^2)	*P* = 0·436						
< 25·0	0·00						
25·0–29·9	−0·02 −0·20, 0·16						
≥ 30·0	0·11 −0·10, 0·33						
Annual household income ($NZ)		*P* = 0·140		***P* = 0·048**	***P* = 0·014**	*P* = 0·147	
≤ 30 000		0·00		0·00[a]	0·00[a]	0·00	
30 001–70 000		−0·05 −0·29, 0·20		0·35[b] 0·03, 0·67	0·34[b] 0·07, 0·62	0·21 −0·08, 0·49	
≥ 70 001		0·13 −0·14, 0·39		0·32[b] 0·03, 0·60	0·40[b] 0·12, 0·68	0·29 −0·00, 0·58	
Highest level of education	*P* = 0·063	*P* = 0·179		*P* = 0·267		*P* = 0·236	
Less than high school	0·00	0·00		0·00		0·00	
High school	0·12 −0·30, 0·54	−0·07 −0·81, 0·67		−0·06 −1·05, 0·92		−0·31 −1·12, 0·50	

Table 3 *Continued*

Predictor	Nuts… Are high in Se (some of them)*		Are high in Fe (some of them)‡		Are filling*		Cause weight gain†		Increase total blood cholesterol†		Increase risk of heart disease†		Lower risk of diabetes§	
Post-high school (non-degree)	−0·02	−0·44, 0·39	−0·26	−1·00, 0·47			0·05	−0·93, 1·03			−0·09	−0·89, 0·72		
University	−0·17	−0·59, 0·26	−0·15	−0·90, 0·60			−0·28	−1·29, 0·74			−0·14	−0·98, 0·70		
Current smoker	*P* = 0·443						*P* = 0·997							
No	0·00						0·00							
Yes	0·12	−0·18, 0·41					0·00	−0·28, 0·28						
Ethnicity													*P* = 0·107	
European													0·00	
Māori													0·03	−0·40, 0·46
Asian													−0·30	−0·81, 0·20
Other/not stated													−0·39	−0·73, −0·05

Higher values reflect more disagreement with the statement on a scale from 1 = 'strongly agree' to 5 = 'strongly disagree'. Cells are blank where this variable did not achieve $P < 0·25$ in the univariable model. Significant values are indicated in bold font. Where the overall *P* value is statistically significant, values that share a superscript letter are not statistically different.
Note some statements are supported by evidence and some are worded in contradiction to evidence.
*Statements that are supported by current evidence.
†Statements that are contradicted by current evidence.
‡Some nuts such as pistachios, cashews and almonds contain useful (>4 mg non-haem Fe/100 g) amounts of Fe, but bioavailability and significance will rely on other dietary factors.
§Statements where current evidence is uncertain.

consume nuts because they were 'healthy and nutritious' (pairwise $P = 0·001$).

Current smokers had 56 % (95 % CI 0·20, 0·98: $P = 0·044$) lower odds of choosing to eat nuts because nuts are 'a good source of unsaturated fat', compared with non-smokers. Consumers who earned a total annual household income of ≥ $NZ 70 001 were more likely to choose the convenience and portability of nuts as one of their reasons for choosing to eat nuts, compared with consumers who earned ≤ $NZ 30 000 and those earning N$Z 30 001–70 000 per annum (both pairwise $P \leq 0·035$). Overall, there was a difference by education level in the likelihood of choosing to eat nuts because they are 'a good source of antioxidants' ($P = 0·041$). Pairwise comparisons showed that those with post-secondary and university education were significantly more likely to eat nuts for this reason compared with those with only secondary-level education (both pairwise $P \leq 0·037$). Compared with NZ European and Māori consumers, Asian consumers were significantly less likely to choose to eat nuts because they are 'a good source of selenium' (both pairwise $P \leq 0·003$).

Predictors of the reasons for nut butter consumption

The predictors of reasons for nut butter consumption among nut butter consumers (*n* 503) are shown in Table 6. For every 10-year increase in consumer age, there was a 21 % (95 % CI 1·02, 1·45; $P = 0·030$) increase in the odds of a consumer eating nut butters because they are 'a good source of vitamins & minerals' and a 55 % (95 % CI 1·29, 1·86) increase in the odds because they 'can help decrease risk of cardiovascular disease' ($P < 0·001$).

Nut butter consumers who had a BMI of 25·0–29·9 kg/m^2 or ≥30·0 kg/m^2 had 43 % (95 % CI 0·33, 0·99; $P = 0·047$) or 57 % (95 % CI 0·22, 0·84; $P = 0·014$) lower odds of choosing to eat nut butters because nut butters are 'a good source of protein', respectively, compared with consumers with a BMI of <25·0 kg/m^2. In addition, those in the overweight category had 52 % (95 % CI 0·27; 0·84: $P = 0·011$) and 64 % (95 % CI 0·17, 0·76; $P = 0·007$) lower odds of consuming nuts because they are 'a good source of energy' and 'a good source of vitamins & minerals', respectively, compared with those in the normal-weight category.

Nut butter consumers who earned a total annual household income of ≥ $NZ 70 001 had 3·34 times (95 % CI 1·33, 8·37; $P = 0·010$) the odds of choosing to eat nut butters because they liked the taste, compared with consumers who earned ≤ $NZ 30 000 per annum. Conversely, consumers who earned a total annual household income of $NZ 30 001–70 000 were more likely than consumers who earned an income of ≥ $NZ 70 001 to say they ate nut butters because they were 'a good source of fibre' (OR = 3·58; 95 % CI 1·49, 8·59, $P = 0·004$) or 'a good source of iron' (OR = 4·44; 95 % CI 1·42, 13·92; $P = 0·001$).

Table 4 Reasons for eating nuts and nut butters among nut consumers in the survey (survey-adjusted percentages) of a nationally representative sample of adults aged 18 years or over, New Zealand, September–October 2014

	Nuts					Nut butters				
				Association with consumption*					Association with consumption*	
Reason	Total population (*n* 674) (%)	Males (*n* 288) (%)	Females (*n* 386) (%)	Harrell's *c*-index	*P* value	Total population (*n* 503) (%)	Males (*n* 217) (%)	Females (*n* 286) (%)	Harrell's *c*-index	*P* value
Like the taste of nuts	85·8	88·9	83·1	0·47	0·370	85·3	85·0	85·6	0·55	0·121
Nuts are good for health/nutritious†	67·0	62·3	71·1	0·66	**<0·001**	21·0	20·8	21·2	0·53	0·144
Nuts are a good source of protein†	45·6	44·0	47·1	0·65	**<0·001**	22·9	23·1	22·7	0·54	0·087
Convenience/portability for on-the-go	43·1	39·1	46·6	0·53	0·136	27·2	31·1	23·7	0·50	0·928
Nuts are a good source of energy/calories†	38·9	36·5	41·0	0·62	**<0·001**	19·8	19·7	19·9	0·53	0·154
Nuts are a good source of vitamins and minerals†	30·4	27·9	32·6	0·66	**<0·001**	8·9	8·9	8·9	0·54	0·127
Nuts are a good source of unsaturated fats†	29·8	27·8	31·7	0·69	**<0·001**	10·3	9·1	11·3	0·51	0·703
Nuts are a good source of fibre†	27·5	26·9	27·9	0·63	**<0·001**	7·3	7·0	7·7	0·47	0·206
Some nuts are a good source of Se†	20·4	17·0	23·4	0·66	**<0·001**	5·4	6·0	4·9	0·51	0·741
Eating nuts can help promote satiety†	22·2	15·3	28·3	0·64	**<0·001**	8·0	6·6	9·3	0·56	**0·021**
Nuts are a good source of antioxidants†	18·1	15·8	20·2	0·63	**<0·001**	5·3	5·6	4·9	0·49	0·633
Eating nuts can help lower blood cholesterol†	14·8	15·3	14·1	0·63	**<0·001**	5·8	6·2	5·4	0·50	0·953
Eating nuts can help decrease risk of CVD†	14·5	15·2	13·9	0·65	**<0·001**	4·9	4·8	5·0	0·52	0·417
Some nuts are a good source of Fe‡	13·5	9·6	16·9	0·64	**<0·001**	5·5	5·8	5·2	0·52	0·632
Eating nuts can help with weight management†	14·2	12·2	16·0	0·66	**<0·001**	3·5	4·1	3·0	0·53	0·390
Recommended by doctor	3·3	4·4	2·3	0·71	**0·007**	0·1	0·0	0·3	0·46	0·615
Recommended by dietitian	2·1	1·3	2·8	0·65	**0·011**	0·4	0·5	0·2	0·58	0·190

**P* values from Mann–Whitney *U* tests (significant *P* values indicated in bold font), with positive associations (Harrell's *c*-index >0·5) indicating higher consumption for those endorsing a reason and negative associations (Harrell's *c*-index <0·5) indicating lower consumption for those endorsing a reason.
†Statements that are supported by current evidence.
‡Some nuts such as pistachios, cashews and almonds contain useful (>4 mg non-haem Fe/100 g) amounts of Fe, but bioavailability and significance will rely on other dietary factors.

Table 5 Predictors of reasons for nut consumption among nut consumers (*n* 674; *P* value, with the odds ratio and 95 % confidence interval beneath) in a nationally representative sample of adults aged 18 years or over, New Zealand, September–October 2014

	Nuts…									
Predictor	Taste	Healthy/nutritious	Good source of protein*	Convenience/ portability for on-the-go	Good source of energy/calories*	Good source of vitamins & minerals*	Good source of unsaturated fat*	Good sources of fibre*	Good source of Se (some of them)*
Gender	*P* = 0·344	*P* = 0·055		*P* = 0·213		*P* = 0·461			*P* = 0·176
Female	1·00	1·00		1·00		1·00			1·00
Male	1·30 0·75, 2·26	0·68 0·46, 1·01		0·76 0·50, 1·17		0·86 0·57, 1·29			0·70 0·41, 1·18
Age			*P* = 0·190	***P* < 0·001**	*P* = 0·066			***P* = 0·039**	***P* = 0·036**
Per 10 years			0·92 0·80, 1·04	0·77 0·67, 0·88	0·88 0·77, 1·01			1·14 1·01, 1·29	1·19 1·01, 1·41
BMI (kg/m^2)		***P* = 0·005**	*P* = 0·132	*P* = 0·096	*P* = 0·186	***P* = 0·007**	***P* = 0·003**		*P* = 0·095
< 25		1·00[a]	1·00	1·00	1·00	1·00[a]	1·00[a]		1·00
25·0–29·9		0·65[a,b] 0·41, 1·01	0·65 0·42, 1·00	0·65 0·40, 1·07	0·67 0·43, 1·04	0·62[b] 0·40, 0·97	0·61[b] 0·40, 0·94		0·67 0·38, 1·16
≥ 30·0		0·44[b] 0·26, 0·73	0·72 0·41, 1·25	0·56 0·31, 0·99	0·73 0·42, 1·29	0·44[b] 0·26, 0·75	0·40[b] 0·23, 0·70		0·46 0·23, 0·94
Annual household income (($NZ)	*P* = 0·074		*P* = 0·399	***P* = 0·024**	*P* = 0·576				*P* = 0·223
≤ 30 000	1·00		1·00	1·00[a]	1·00				1·00
30 001–70 000	1·49 0·74, 3·00		0·82 0·46, 1·46	1·32[a] 0·70, 2·49	1·19 0·65, 2·16				0·74 0·36, 1·52
≥ 70 001	2·43 1·13, 5·24		1·13 0·62, 2·06	2·19[b] 1·16, 4·15	1·36 0·75, 2·45				1·15 0·57, 2·34
Highest level of education	*P* = 0·051		*P* = 0·300	*P* = 0·168					
Less than high school	1·00		1·00	1·00					
High school	1·01 0·19, 5·44		4·35 0·51, 37·47	1·40 0·19, 10·27					
Post-high school (non-degree)	2·72 0·48, 15·46		5·82 0·68, 49·92	2·17 0·30, 15·71					
University	1·10 0·19, 6·39		5·25 0·60, 46·10	1·30 0·18, 9·64					
Current smoker				*P* = 0·232		*P* = 0·107	***P* = 0·044**		*P* = 0·072
No				1·00		1·00	1·00		1·00
Yes				0·64 0·30, 1·33		0·52 0·24, 1·15	0·44 0·20, 0·98		0·40 0·15, 1·08
Ethnicity				*P* = 0·251					***P* = 0·002**
European				1·00					1·00[a]
Māori				1·24 0·56, 2·73					1·78[a] 0·76, 4·17
Asian				0·45 0·17, 1·19					0·04[b] 0·01, 0·33
Other/not stated				0·65 0·33, 1·27					0·31[b] 0·11, 0·90

	Nuts…								
Predictor	Promote satiety*	Good sources of antioxidants*	Lower blood cholesterol*	Decrease risk of CVD*	Good source of Fe (some of them)†	Weight management*	Recommended by a doctor	Recommended by a dietitian
Gender	***P* = 0·002**	*P* = 0·210			***P* = 0·012**	*P* = 0·232	*P* = 0·205	*P* = 0·138
Female	1·00	1·00			1·00	1·00	1·00	1·00
Male	0·45 0·28, 0·74	0·76 0·49, 1·17			0·52 0·32, 0·87	0·71 0·41, 1·24	0·45 0·13, 1·56	1·94 0·81, 4·65
Age	*P* = 0·091	***P* = 0·002**	***P* < 0·001**	***P* < 0·001**		*P* = 0·198		
Per 10 years	0·88 0·75, 1·02	1·22 1·07, 1·38	1·47 1·23, 1·76	1·41 1·23, 1·61		0·89 0·74, 1·06		
BMI (kg/m^2)			*P* = 0·390					
< 25			1·00					
25·0–29·9			1·20 0·66, 2·17					
≥ 30·0			1·64 0·81, 3·31					
Annual household income (($NZ)	*P* = 0·189		*P* = 0·363			*P* = 0·117		
≤ 30 000	1·00		1·00			1·00		
30 001–70 000	1·01 0·51, 2·00		0·59 0·27, 1·27			1·15 0·48, 2·80		
≥ 70 001	1·59 0·81, 3·12		0·84 0·40, 1·77			1·97 0·87, 4·47		
Highest level of education		***P* = 0·041**	*P* = 0·312					
Less than high school		1·00[a,b]	1·00					
High school		0·73[a] 0·17, 3·26	1·15 0·15, 8·63					
Post-high school (non-degree)		1·53[b] 0·35, 6·73	1·88 0·25, 14·21					
University		1·32[b] 0·30, 5·85	1·05 0·14, 8·20					

Table 5 *Continued*

	Nuts…															
Predictor	Promote satiety*		Good sources of antioxidants*		Lower blood cholesterol*		Decrease risk of CVD*		Good source of Fe (some of them)†		Weight management*		Recommended by a doctor		Recommended by a dietitian	
Current smoker					$P = 0·625$		$P = 0·286$				$P = 0·065$					
No					1·00		1·00				1·00					
Yes					0·71	0·18, 2·77	0·44	0·10, 1·99			0·22	0·04, 1·10				
Ethnicity	$P = 0·059$										$P = 0·245$					
European	1·00										1·00					
Māori	1·73	0·77, 3·86									1·08	0·43, 2·74				
Asian	0·36	0·13, 1·01									0·42	0·12, 1·44				
Other/not stated	0·54	0·21, 1·40									0·39	0·11, 1·30				

Cells are blank where this variable did not achieve $P < 0·25$ in the univariable model. Significant P values are indicated in bold font. Where the overall P value is statistically significant, values that share a superscript letter are not statistically different.
*Statements that are supported by current evidence.
†Some nuts such as pistachios, cashews and almonds contain useful (>4 mg non-haem Fe/100 g) amounts of Fe, but bioavailability and significance will rely on other dietary factors.

Reasons for not eating nuts and/or nut butters

Table 7 lists the reasons for not eating nuts and/or nut butters among the non-consumers in the survey. There were twenty-three respondents who reported not eating any nuts but did eat nut butters, 194 who reported not eating any nut butters but did eat nuts, and thirteen respondents who reported not eating either nuts or nut butters. Dental issues was the reason most frequently selected by respondents who avoided nuts (43 %) and those who avoided both nuts and nut butters (23 %). The top five reasons selected by respondents who avoided nut butters were because they disliked the taste and/or smell, they disliked the texture, they considered nut butters to be unhealthy, high in fat, and because nut butters were too expensive. Nut butter avoiders were more likely to report they disliked the taste/smell/texture compared with nut avoiders (both $P \leq 0·020$). Conversely, nut avoiders were more likely to avoid eating nuts because of dental issues, compared with nut butter avoiders ($P < 0·001$).

Discussion

To the best of our knowledge, the present study is the first to assess the reasons for consuming or avoiding nuts, as well as perceptions of nuts, in a large nationally representative sample. Approximately 16 and 8 % of our respondents reported eating nuts and nut butters daily, respectively, whereas just under a third reported they did not consume nuts and/or nut butters. Other studies that have used representative samples have employed 24 h recalls to estimate nut consumption, as opposed to the FFQ used in the present study, making direct comparisons problematic. Nevertheless, previous studies have reported that the percentage of respondents consuming whole nuts on the day of the 24 h recall was about 6–7 %[11–14]. The percentage consuming nut butters was higher in NZ and the USA (about 7–8 %)[11,38] compared with Europe (about 1 %)[12].

More than half of our respondents agreed that nuts are healthy, filling, and high in protein and fat. However, there were some important gaps in respondents' knowledge, with about 40 % not aware of the effects of nut consumption on lowering blood cholesterol and the risk of CVD. Liking the taste of nuts was reported as the top reason both nut and nut butter consumers chose to eat nuts, while dental issues was the most frequently selected reason by both nut and nut butter avoiders. Positive beliefs and perceptions of nuts were generally associated with higher intakes, but this finding was much less evident for nut butters. Those endorsing all but two of the positive reasons for eating nuts had higher intakes compared with those not endorsing that particular reason, including recommendations by a doctor or dietitian, again a finding not replicated in nut butters. These findings provide important information to guide and develop public health

Table 6 Predictors of reasons for nut butter consumption among nut butter consumers (*n* 503; *P* value, with the odds ratio and 95 % confidence interval beneath) in a nationally representative sample of adults aged 18 years or over, New Zealand, September–October 2014

	Nut butters…									
Predictor	Taste	Healthy/ nutritious*	Good source of protein*	Convenience	Good source of energy/calories*	Good source of vitamins & minerals*	Good source of unsaturated fat*	Good sources of fibre*	Good source of Se (some of them)*	
Gender				$P = 0{\cdot}170$						
Female				1·00						
Male				1·38 0·87, 2·20						
Age			$P = 0{\cdot}260$		$P = 0{\cdot}229$	$P = \mathbf{0{\cdot}030}$		$P = 0{\cdot}094$	$P = 0{\cdot}204$	
Per 10 years			0·91 0·77, 1·07		0·91 0·77, 1·06	1·21 1·02, 1·45		1·26 0·96, 1·64	1·16 0·92, 1·45	
BMI (kg/m^2)			$P = \mathbf{0{\cdot}028}$		$P = \mathbf{0{\cdot}038}$	$P = \mathbf{0{\cdot}027}$	$P = 0{\cdot}171$			
< 25·0			1·00[a]		1·00[a]	1·00[a]	1·00			
25·0–29·9			0·57[b] 0·33, 0·99		0·48[b] 0·27, 0·84	0·36[b] 0·17, 0·76	0·59 0·29, 1·19			
≥ 30·0			0·43[b] 0·22, 0·84		0·63[a,b] 0·28, 1·39	0·67[a,b] 0·30, 1·48	0·48 0·20, 1·18			
Annual household income ($NZ)	$P = \mathbf{0{\cdot}037}$							$P = \mathbf{0{\cdot}013}$		
≤ 30 000	1·00[a]							1·00[a,b]		
30 001–70 000	1·94[a,b] 0·85, 4·45							2·24[a] 0·68, 7·41		
≥ 70 001	3·34[b] 1·33, 8·37							0·63[b] 0·16, 2·41		
Highest level of education	$P = 0{\cdot}192$						$P = 0{\cdot}067$			
Less than high school	1·00						1·00			
High school	1·35 0·24, 7·58						0·39 0·17, 0·89			
Post-high school (non-degree)	2·68 0·45, 16·11						0·90 0·44, 1·84			
University	2·89 0·48, 17·24						1·00 1·00, 1·00			
Current smoker	$P = 0{\cdot}878$			$P = 0{\cdot}232$		$P = 0{\cdot}143$				
No	1·00			1·00		1·00				
Yes	0·93 0·36, 2·40			1·48 0·78, 2·81		2·06 0·78, 5·41				
Ethnicity		$P = 0{\cdot}243$			$P = 0{\cdot}264$					
European		1·00			1·00					
Māori		1·30 0·65, 2·62			1·38 0·54, 3·56					
Asian		2·68 0·86, 8·41			2·83 0·97, 8·24					
Other/not stated		0·73 0·32, 1·65			1·18 0·51, 2·71					

	Nut butters…							
Predictor	Promote satiety*	Good source of antioxidants*	Lower blood cholesterol*	Decrease risk of CVD*	Good source of Fe (some of them)†	Weight management*	Recommended by a doctor	Recommended by a dietitian
Gender								
Female								
Male								
Age	$P = \mathbf{0{\cdot}003}$‡		$P < \mathbf{0{\cdot}001}$‖	$P < \mathbf{0{\cdot}001}$		$P = 0{\cdot}114$		
Per 10 years	§		§	1·55 1·29, 1·86		1·15 0·97, 1·38		
BMI (kg/m^2)			$P = 0{\cdot}153$					
< 25·0			1·00					
25·0–29·9			1·08 0·42, 2·77					
≥ 30·0			2·31 0·88, 6·03					
Annual household income ($NZ)		$P = 0{\cdot}071$			$P = \mathbf{0{\cdot}035}$			
≤ 30 000		1·00			1·00[a,b]			
30 001–70 000		1·87 0·61, 5·76			1·31[a] 0·46, 3·73			
≥ 70 001		0·61 0·19, 2·02			0·30[b] 0·09, 1·01			
Highest level of education								
Less than high school								
High school								
Post-high school (non-degree)								
University								

Table 6 *Continued*

	Nut butters...							
Predictor	Promote satiety*	Good source of antioxidants*	Lower blood cholesterol*	Decrease risk of CVD*	Good source of Fe (some of them)†	Weight management*	Recommended by a doctor	Recommended by a dietitian
Current smoker								
No								
Yes								
Ethnicity								
European								
Māori								
Asian								
Other/not stated								

Cells are blank where this variable did not achieve $P < 0{\cdot}25$ in the univariable model. Significant P values are indicated in bold font. Where the overall P value is statistically significant, values that share a superscript letter are not statistically different.

*Statements that are supported by current evidence.

†Some nuts such as pistachios, cashews and almonds contain useful (>4 mg non-haem Fe/100 g) amounts of Fe, but bioavailability and significance will rely on other dietary factors.

‡P value is for Wald composite test of both a linear trend (OR = 1·20/10 years; 95 % CI 0·96, 1·49; $P = 0{\cdot}105$) and a quadratic trend after centring (OR = 0·99/10 units; 95 % CI 0·98, 1·00; $P = 0{\cdot}048$), creating an n-shaped association with the highest probability at age 61 years.

§Selected for inclusion in the multivariable model but subsequently excluded due to quasi-complete separation.

‖P value is for Wald composite test of both a linear trend (OR = 1·48/10 years; 95 % CI 1·12, 1·95; $P = 0{\cdot}006$) and a quadratic trend after centring (OR = 0·98/10 units; 95 % CI 0·97, 0·99; $P = 0{\cdot}003$), creating an n-shaped association with the highest probability at age 63 years.

strategies to improve nut consumption among the general population.

The mean scores for the perception questions indicate that respondents generally agreed that nuts are healthy, filling, high in protein, fat, fibre and antioxidants, and some nuts are high in Se. Previous studies examining the perceptions of nuts have used only small, non-representative samples which have included low-income women (*n* 124)[16] or those with or at risk of diabetes and/or CVD (*n* 85)[17]. Despite the differences in study populations, there are important similarities in the pattern of results. For example, in the low-income cohort, Pawlak *et al.* also found that the majority of respondents perceived that nuts were high in energy and fat[16]. They also most strongly agreed with the statement that they should eat nuts on most days of the week because nuts are healthy. In the cohort of those with or at risk of chronic disease, nearly half of respondents agreed with the latter statement[17].

In our study, we specifically asked about Se because NZ soils are low in Se, meaning intake of this nutrient is relatively low[39]. Brazil nuts are a rich, available source of Se[40] and given the added interest in Se in NZ, we were interested to see if this was known by the general public. Nearly 40 % of respondents agreed that some nuts are high in Se. In the two small US cohorts, only about 20 % of participants were able to identify the nut containing the highest Se content[16,17]. This suggests publicity regarding Se in NZ may have improved knowledge in this area.

Two important perceptions of nuts which are at odds with current scientific literature relate to the hypocholesterolaemic effects of nuts and their inverse association with the risk of CVD. Nuts are high in *cis*-unsaturated fatty acids and bioactive constituents, such as plant sterols, which have been shown to favourably affect blood plasma lipids and lipoproteins[8,41,42]. Moreover, there is strong and consistent evidence that there is a negative association between nut consumption and risk of CVD[4,43]. However, these facts were not well known among our sample. Approximately 40 % of respondents did not know about the relationship between nuts and the effects on blood cholesterol and CVD risk. In addition, only 15 % of respondents stated that they ate nuts because they can help lower cholesterol and can decrease the risk of CVD. These are similar to the findings of Pawlak *et al.*, who found among low-income participants that about 60 % did not know that nuts may help reduce cholesterol and lower the risk for a heart attack[16]. In addition, among those at risk of CVD, Pawlak *et al.* found that over 30 % of participants were unaware of the cholesterol-lowering properties of nuts and a further 20 % disagreed that nuts could have this effect[17]. Taken together, these results clearly reflect a disconnect between scientific findings and the perceptions among some members of the general public regarding the health aspects of nuts. Given that CVD remains the leading cause of mortality worldwide[44],

Table 7 Reasons for not eating nuts and/or nut butters, nuts or nut butters (survey-adjusted percentages and unweighted numbers) among a nationally representative sample of adults aged 18 years or over, New Zealand, September–October 2014

	Both nut and nut butter avoiders (*n* 13)		Nut avoiders (but consume nut butters) (*n* 23)		Nut butter avoiders (but consume nuts) (*n* 194)		
Reason	%	*n*	%	*n*	%	*n*	*P* value
Dislike the taste and/or smell	15[a,b]	2	4[a]	1	36[b]	70	0·004‡
Dislike the texture	15[a]	2	0[a]	0	21[b]	41	0·020§
They are high in fat*	0	0	4	1	15	30	0·140§
Dental issues	23[a]	3	43[a]	10	6[b]	11	<0·001§
They are too expensive	8	1	4	1	10	19	0·886§
Unsure how to include them in meals/recipes	8	1	22	5	7	14	0·068§
They are unhealthy†	0	0	0	0	10	19	0·244§
They are naturally high in salt/Na†	0	0	4	1	7	13	1·000§
Eating them can cause weight gain†	0	0	0	0	7	13	0·567§
They are high in energy/calories*	0	0	4	1	5	10	1·000§
Eating them can increase blood cholesterol†	0	0	0	0	5	9	0·767§
Eating them can increase the risk of CVD†	0	0	0	0	3	5	1·000§
Are nut intolerant	0	0	0	0	2	4	1·000§
Are allergic to nuts	15[a]	2	0[a,b]	0	1[b]	1	0·011§
Live with/in close contact with someone who is allergic to nuts	8	1	0	0	1	2	0·186§
There is no supply/they are difficult to purchase	0	0	4	1	1	2	0·401§

Where the overall *P* value is statistically significant, values that share a superscript letter are not statistically different.
*Statements that are supported by current evidence.
†Statements that are contradicted by current evidence.
‡*P* value for difference between avoider groups using χ^2 test.
§*P* value for difference between avoider groups using Fisher's exact test.

the results of our study clearly show there are nutrition education opportunities which could translate into important benefits through the promotion of nuts as part of a cardioprotective diet.

Respondents were even less clear on the effect of nuts on diabetes. More than half of our respondents said that they did not know the effects of nut consumption on risk of diabetes. This is similar to the findings of both studies by Pawlak *et al.*, where 62 % of the low-income cohort[16] and 42 % of those with or at risk of diabetes and CVD[17] were unaware of any beneficial effects of nuts on diabetes. This is not surprising, considering the inconsistency in the research findings on the relationship between the development of type 2 diabetes and nut consumption[45–48]. Continued research in this area is required to clarify this association.

When examining reasons for eating nuts among consumers, our respondents indicated that they did so because they like the taste of nuts, they considered nuts to be healthy/nutritious and good sources of protein and energy, and were convenient and portable. These motivating reasons for eating nuts could be incorporated into public health campaigns to promote nut consumption.

Interestingly, very few (2–3 %) individuals ate nuts on the recommendation of a doctor or dietitian. Pawlak *et al.* reported that about a quarter of their participants agreed that eating nuts was consistent with advice from their doctor[17]. These participants had or were at risk of CVD and diabetes, and may have seen a doctor or dietitian more than the participants in the current study. In the cohort of low-income women studied by Pawlak *et al.*, there was general disagreement that eating nuts daily was consistent with advice from their doctor[16]. Both studies by Pawlak *et al.* indicated strong agreement among participants that they would eat nuts if recommended to do so by their doctor. In the present study, in response to a question about whether they would consume more nuts if asked to by a doctor, 52·9 % indicated they would (10·3 % strongly agreed and 42·6 % agreed), with 10·6 % unsure (data not shown). Therefore, encouraging health professionals to promote nut consumption could be an effective strategy to improve on the current low levels among the general public.

Very few respondents chose to eat nuts to help with weight maintenance. This may stem from the fact that nuts are high in fat and energy, and may be perceived to cause weight gain. The response to the question 'eating nuts will cause weight gain' produced a mixed response, with about a fifth agreeing, a third disagreeing, a third neither agreeing nor disagreeing, and nearly a quarter reporting they did not know. Pawlak *et al.* reported that 87 % of their high-risk cohort agreed that nuts would cause weight gain[17]. There is obviously some confusion regarding this issue. Epidemiological studies suggest nut consumers are leaner than nut non-consumers[18–21], and intervention studies show no or less-than-predicted weight gain when nuts are added to the regular diet[22–26]. Clarifying these facts for the general public may help overcome this potential barrier to regular nut consumption and promote greater nut intakes.

We examined predictors for reasons consumers chose to consume nuts and nut butters. We found that men were far less likely to choose to eat nuts because they are satiating or a good source of Fe, compared with women.

Women also tended to choose to eat nuts because they are healthy and nutritious. This indicates women are perhaps more conscious of their health and food choices, and subsequently more aware of the possible health benefits of nuts. Age was also a predictor for some of the reasons our respondents chose to eat nuts. We found that for every decade increase in age, nut consumers were more likely to eat nuts because they are a good source of fibre, Se and antioxidants, and older nut butter consumers were more likely to eat nut butters because they promote satiety and are a good source of vitamins and minerals. It is also noteworthy that for every decade increase in age, consumers were more likely to eat nuts and nut butters because it can lower blood cholesterol and decrease risk of CVD. It is possible that with increasing age, consumers become more aware of the benefits of nut consumption or this may reflect cohort effects with nuts perceived differently by different generations. Some support for this was found with older respondents being less likely to see nuts as increasing blood cholesterol. It is also possible that increased awareness of the benefits of nut consumption could be due to health issues that increase with age.

We also found that the higher the total annual household income of a nut consumer, the more likely convenience and portability of nuts was selected as a reason nuts were consumed. Additionally, nut butter consumers with higher total annual household income were more likely to choose to eat nut butters because of the taste. This is possibly because these respondents would have more financial ability to choose nut butters of their choice.

Among respondents who chose not to consume nuts and/or nut butters, there were far more nut butter avoiders than nut avoiders. While the dislike of the taste and/or smell was the predominant reason for nut butter avoiders, dental issues was the major concern for nut avoiders. This would presumably be of concern for those with poor dental health and difficulties with mastication. Nuts have been found to be beneficial to the health of older adults[49] and these dentition issues could be preventing the realisation of these benefits for some. Analysis of the comments from nut avoiders (data not shown) indicated concern with health issues such as migraine triggers and skin conditions, or they reported they did not eat nuts because it is not part of their food culture. Some of the comments made by nut butter avoiders indicated that their decisions were based on a preference for unprocessed nuts and the fact they did not like the additives in nut butters such as chocolate, wheat by-products, sugar, salt and oil. It is also noteworthy that 22 % of nut avoiders were unsure of how to incorporate nuts into their meals and recipes. This could easily be addressed by providing consumers with a variety of ideas on how to add nuts to meals/recipes in both public health messages and promotional materials developed by nut growers and councils. The number of respondents citing expense as a reason for not consuming nuts or nut butters was very small and did not appear to vary by income (data not shown).

An important aspect of the current study is that it was the first large cross-sectional study to assess the beliefs, attitudes and perceptions of nut consumption in a national sample of the general population. The resulting representativeness of our sample is a key strength. We employed a vigorous survey method, adapted from Dillman's Tailored Design Method[35] and included incentives to help increase the survey response rate. Additionally, our survey used a mixed-mode design, with both a web and paper mail version of the questionnaire to enhance the response rate[50].

There are also a number of limitations that should be considered when interpreting the present study's results. First, our survey was self-administered and there is the possibility that some respondents did not fully understand all questions. Although the response rate of 44 % was slightly below our expectation of 50 %, this is comparable to other mail surveys conducted across Australasia[51,52]. Lastly, although all attempts were made to ensure our sample was nationally representative (aside from oversampling Māori) and sampling and post-stratification weights were used to make the sample representative in terms of ethnicity as well as age group and sex, those younger, male, more deprived and Māori were less likely to respond to the survey, which may affect how our results are generalisable to the population as a whole. However, while this might have affected estimated means and proportions, there do not appear to be obvious reasons for the associations observed to differ between respondents and non-respondents.

Conclusion

In summary, the present study provides important information to inform future intervention studies and public health initiatives. The majority of respondents understood nuts are healthy and good sources of a variety of nutrients. However, in general this population was largely unaware of the cardioprotective effects of nuts and were confused regarding the effects of nut consumption on body weight. Positive beliefs and perceptions of nuts and endorsing reasons for consuming them were associated with higher intakes, although not for nut butters. Public health practitioners should address these knowledge gaps. They should also use the positive perceptions of nuts and the motivating reasons for consuming nuts that have been identified in the present study to guide content of messages to promote regular nut consumption.

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