Nuts, seeds and heart health

This position statement outlines key findings and recommendations from the Heart Foundation on the relationship between nuts, seeds and heart disease for adults. This position was guided by two research questions and replaces the 'Nuts and heart health' position statement and evidence paper (2012).

Research questions:

1. What is the association between nut intake and cardiovascular disease risk and mortality in adults?
2. What is the association between seed intake and cardiovascular disease risk and mortality in adults?

EXECUTIVE SUMMARY

This position statement builds on the evidence base related to heart health and dietary patterns. There is no single food or nutrient that should be solely promoted to improve heart health. Instead, focusing on the total diet and how foods fit together to form a dietary pattern within an individual's or whānau's lifestyle is likely to result in the greatest heart health benefits.

To inform this position statement, the Heart Foundation assessed the evidence on nut and seed intakes and its association with heart health outcomes up until August 2021. While there was available data on nut intakes, there was limited evidence on seeds and the impact of processing nuts and seeds on heart health outcomes.

The Heart Foundation recommends adults regularly eat nuts and seeds. Risk of heart disease decreases when 3-4 small handfuls of nuts and seeds are eaten each week (which is equivalent to about 15g per day) due to improving blood lipid concentrations. There are likely to be further benefits with higher intakes.

Intakes of nuts and seeds in New Zealand are low, and common barriers include the affordability of nuts, perceived weight gain and dental issues. This can be addressed by encouraging a range of realistic options to suit differing budgets, population groups and eating patterns.

DOI 10.17605/OSF.IO/7QTXJ

KEY OUTCOMES

Eating as little as 3-4 small handfuls of nuts and seeds each week (which is equivalent to about 15g per day) decreases the risk of coronary heart disease by around 20% compared with no or low nut and seed intakes. There are likely to be further benefits with higher intakes. Regular intake of nuts and seeds in these amounts is unlikely to promote weight gain and has a small benefit on lowering total and low-density lipoprotein (LDL) cholesterol levels. There may also be a small benefit to increasing high-density lipoprotein (HDL) cholesterol for those at high risk of cardiovascular disease (CVD).

Eating a variety of nuts and seeds helps with obtaining a wide range of heart-healthy nutrients. To get the greatest health benefits, nuts and seeds should be eaten as close to their natural form as possible, i.e. whole, sliced or ground. Unsalted nuts and seeds without added flavouring or coatings are the best options for heart health. Nut and seed butters (preferably unsalted) that have been minimally processed are also a good option for heart health.

BACKGROUND

The term 'diet' can encompass intakes of certain nutrients or foods, eating occasions or the overall dietary pattern. The Heart Foundation's 2013 evidence paper on dietary patterns identified several ways of eating that reduce the risk of CVD including coronary heart disease and stroke (1). Despite the prevalence of heart disease reducing over time, it is still the leading cause of death in New Zealand and an unhealthy diet is one of the leading risk factors contributing to 'health loss' (2, 3). In 2014, coronary heart disease was the leading cause of premature mortality (25%) which is largely associated with modifiable lifestyle factors, highlighting the importance of prevention and early intervention (3).

Defining nuts and seeds

Tree nuts are botanically defined as dry fruit containing one seed within the ovary wall that becomes hard at maturity (4). For this position statement, the definition of nuts includes tree nuts (almonds, cashews, Brazil nuts, hazelnuts, macadamias, pecans, pine nuts, pistachios and walnuts) and peanuts. Although peanuts are technically a legume they have been included because they have a similar nutritional profile to tree nuts and are consumed in a similar manner (4). Chestnuts have been excluded because when compared to other nuts, they have a higher carbohydrate content (47g per 100g) and similarly, coconuts have been excluded because they have a higher saturated fat content (31g per 100g) and are not consumed in the same manner as other tree nuts (5).

Seeds are defined as the small plant enclosed in a seed coat that works as stored food to nourish the plant as it grows (6). Some seeds need the exterior husk removed before eating while others, such as poppy seeds, do not. For this position statement, the definition of seeds includes sesame seeds, sunflower seeds, flaxseeds/linseeds, pumpkin seeds, chia seeds, hemp seeds and poppy seeds.

This position statement does not focus on nut and seed oils, nut milks and dietary supplements derived from nuts or seeds as these topics were out of scope.

Nutrient content of nuts and seeds

Although individual nuts and seeds contain different types and amounts of nutrients, they are all considered nutritionally dense foods (4, 7).

In general, nuts are a good source of energy, plant protein, unsaturated fatty acids (monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA)) and dietary fibre (8). Seeds have a similar nutrient profile to nuts and tend to be higher in PUFA, protein and dietary fibre (7) (**Appendix 1**). Individual nuts and seeds are rich in a range of essential micronutrients such as magnesium, potassium, copper, zinc, iron, selenium, phosphorus, calcium, folate and vitamin E. Our bodies need very small amounts of these micronutrients to perform vital roles in maintaining good health (5, 7, 9) (**Appendix 2**).

Nuts and seeds are also an important source of phytochemicals such as carotenoids, phytosterols, phenolic acids, polyphenols and tocopherols (7, 8, 10, 11).

Mechanisms for beneficial effects

There are several proposed mechanisms for how nuts may influence CVD risk. There is limited research on seeds, but they are likely to have similar health benefits due to their comparable nutrient content.

High in heart-healthy MUFA and PUFA and low in saturated fat	Substituting dietary saturated fat with MUFA and PUFA is the most effective dietary approach to reducing LDL cholesterol while maintaining or increasing HDL cholesterol (12). Linoleic acid is the predominant omega-6 PUFA which has been shown to be inversely associated with the incidence of CHD and CVD (13, 14). Alpha-linolenic acid (ALA) is a plant-based form of omega-3 PUFA found in walnuts, chia seeds and flaxseeds and has been associated with healthy blood vessel function and lowering cholesterol (15).
Source of plant-based protein	The Heart Foundation's 2020 position statement on red meat and poultry found that replacing at least 1-2 red meat meals per week with plant protein such as legumes, soy or nuts reduced LDL cholesterol by 0.26 mmol/L (16).
Rich in phytochemicals	Protect heart health through antioxidant and anti-inflammatory properties (7, 8, 10, 11).
High in dietary fibre	Fibre is associated with improved heart health outcomes (17). Nuts contain 4–11g/100g of dietary fibre and seeds contain 3–32g/100g of dietary fibre.
Some nuts are high in amino acid L-arginine	Associated with vasodilation and healthy blood vessel flow (11, 18).

Nuts and seed consumption in New Zealand

The New Zealand Ministry of Health's Eating and Activity Guidelines for Adults recommends between 2-4 servings of legumes, nuts, seeds, fish and other seafood, eggs, poultry or red meat per day. The recommended serving size for nuts, seeds and nut/seed butters is 30g which is a small handful of nuts/seeds or 2 tablespoons of nut/seed butter (19).

National nutrition surveys provide the most accurate picture of food consumption and dietary intakes across NZ. The last Adult National Nutrition Survey (2008/2009) determined dietary intakes via 24-hour recall. The mean population intake for nuts and seeds were 4.5g/day. It is important to note that this average includes all people including those who don't consume nuts and seeds. Māori women had the lowest nut and seed intakes (2.5g/day) (20). The most common nuts eaten were almonds, peanuts and mixed nuts. Peanut butter makes a substantial contribution to nut intakes, with adolescents (aged 15-18 years) the highest consumers (21). This data is over a decade old, and the food supply and dietary trends are likely to have changed rapidly in this time with ultra-processed foods now dominating our food supply (22).

A more recent cross-sectional study (2014) surveyed a nationally representative sample of adults via food frequency questionnaire (n=710). Around one third of participants didn't consume nuts or nut butters. Sixteen percent reported eating nuts daily and 7% reported eating nut butters daily (23).

Nuts and seeds are whole foods; however, the majority of foods eaten in countries like NZ are processed or pre-prepared by the food industry (22). International research has reported an increase in the formulation of chia, flaxseed, hemp and pumpkin seeds into food products such as muesli bars, snacks, bakery products, infant food, dairy products, fish and meat products (7). This trend appears to be similar in New Zealand where there has been a noticeable increase in the availability of nuts and seeds in various forms and food products. Examples include a wider range of nut and seed butters, seeds such as hemp seeds and chia seeds and products such as bliss balls, crackers, dips and breakfast cereals.

EVIDENCE FOR NUTS, SEEDS AND HEART HEALTH

In updating the Heart Foundation's position on nuts and seeds, the Heart Foundation's Expert Nutrition Policy (ENP) working group with co-opted expertise followed a rigorous process to consider the available scientific evidence. This process was undertaken by the ENP working group with additional independent systematic review experts, Dr Vanessa Jordan and Emeritus Professor Peter Herbison.

A search was conducted to identify systematic reviews and meta-analyses of trials or prospective observational studies on nut and seed intake and heart health outcomes for the past five years up to August 2021. These were ranked and the most recent publications with relevant health outcomes were assessed using a tool to determine the risk of bias in systematic reviews (ROBIS[1]) to identify reviews with a low risk of bias to inform the evidence base of this position (24). Where it was available, the GRADE (Grading of Recommendations Assessment, Development and Evaluation) framework was used to assess the quality of the evidence available to directly address our stated research questions as high, moderate, low or very low quality (25, 26). A summary of the evidence including GRADE assessments (when they were available) is in **Appendix 3**. Two recently published reviews on nut consumption and heart health were identified but did not inform this position statement due to an unacceptable risk of potential bias (27, 28).

Evidence relating to body weight and nut intake was outside the scope of the review process outlined above, however, we included commentary based on three recent reviews (29-31). Evidence relating to seed intake and heart health outcomes was limited to flaxseed/linseed, sesame and chia seeds, and we included commentary based on five reviews (32-36). Evidence regarding the form and processing of nuts was limited, and we included commentary on three randomised controlled trials (RCTs) (37-39).

Heart disease and nuts

Evidence on heart disease incidence came from a 2016 systematic review and meta-analysis identified as low risk of bias (40). Aune et al. identified 89 eligible publications and from this, 12 cohort studies (11 publications) (n=315,397) reported on nut intake and coronary heart disease risk and 12 cohort studies (11 publications) (n=376,228) reported on nut intake and cardiovascular disease risk. Follow-up of participants ranged from 4.3 to 30 years. This review looked at the relationship between the highest and lowest intakes of nuts, tree nuts and peanuts on coronary heart disease and cardiovascular disease as well as a dose-response of each additional 28g serving of nuts (40).

The highest intakes of nuts showed a 24% reduction in risk of coronary heart disease and 19% reduction in risk of cardiovascular disease compared with the lowest intakes (40). The findings were consistent for tree nut and peanut intakes. A significant non-linear, dose-response showed that eating up to around 15g nuts per day was associated with a ~20% lower risk of coronary heart disease and cardiovascular disease (40). The greatest risk reduction was seen with intakes up to 15g per day with slight reductions above this amount. In the dose-response analysis there was a 29% lower risk of coronary heart disease and 21% lower risk of cardiovascular disease for a one serving per day (28g) increase in nut intake (40).

[1] *ROBIS is a tool designed specifically to assess the risk of bias in systematic reviews.*

A more recent systematic review and meta-analysis reporting on coronary heart disease, heart failure and stroke was identified as low risk of bias (41). Bechthold et al. identified 12 of 261 eligible publications reporting on nut intakes and coronary heart disease, heart failure or stroke (41). A total of 458,157 participants were followed for on average 18 years, with nut intakes ranging from 0-38g/day (41). There was evidence of a non-linear dose-response association and the risk of coronary heart disease decreased by about 21% with intakes of nuts up to ~10-15g/day. No benefit for increasing intake was apparent above this (41).

Blood lipids and nuts

To assess the relationship between nuts and blood lipids, a 2020 network meta-analysis of RCTs by Liu et al. was identified as low risk of bias (42). This review compared the separate effects of diets enriched with walnuts, pistachios, hazelnuts, cashews and almonds on blood lipids when compared to a control diet. Liu et al. considered 117 publications, and from these 34 relevant publications (n=1677) were identified. Trial length ranged from 3-24 weeks and people were either healthy or at high-risk for cardiovascular disease at baseline. The dose of nuts ranged from 15-168g/day. When the data for individual nut types were combined in a random effects meta-analysis, total cholesterol levels were 0.12mmol/L lower and LDL cholesterol levels were 0.09mmol/L lower in those consuming a nut enriched diet (42). The certainty of evidence was assessed as very low to low quality using the GRADE framework.

In addition, a 2020 systematic review and meta-analysis of RCTs by Azad et al. was identified as low risk of bias (43). This review compared the effect of peanut consumption on blood lipids and other CVD risk factors. A total of 13 publications (n=800) were identified. Trials ranged from 4-24 weeks and people were healthy or high-risk for cardiovascular disease at baseline. Within each intervention, the dose of peanuts ranged from 2.6-88g/day (and included peanut sprouts, peanut oil and whole peanuts). When compared with a control diet, HDL cholesterol levels were 0.07mmol/L higher in those randomised to consume peanuts. Sub-group analysis demonstrated this impact was more pronounced in people who were overweight (0.12mmol/L higher HDL cholesterol) or with hypercholesterolemia at baseline and when only peanuts were consumed (0.13mmol/L higher HDL cholesterol) (43). This evidence was assessed as very low quality using the GRADE framework.

Body weight and nuts

A 2021 systematic review and meta-analysis by Nishi et al. of six cohort studies (n=569,910) and 86 RCTs (n=5873) demonstrated no association between nut consumption and weight gain or other adiposity outcomes. In the cohort studies, nut intake (median of 7g/day) was associated with a 7% lower incidence of overweight/obesity. In the trials, nut intake (median of 45.5g/day) had no adverse effect on body weight, body mass index (BMI) or body fat (%) in both healthy and high-risk populations (29). This evidence was assessed as moderate to high quality using the GRADE framework.

A 2021 systematic review and meta-analysis by Guarneiri et al. of 55 RCTs (n=3811) compared the effect of nuts on body weight outcomes with a focus around the way nuts are incorporated into the diet (30). Nut-enriched diets (mean of 48.2g/day) did not result in changes in body weight, BMI or waist circumference in studies either with or without substitution instructions. When nuts

replaced other foods in the diet there was a very small favourable impact on body fat percentage (30).

Similarly, a 2021 network meta-analysis by Fernández-Rodriguez et al. of 105 RCTs (n=6768) compared different nut-enriched diets with control diets and found no association between nut intake and body weight, BMI and body fat (%) across all nut types (31). Subgroup analyses found people with CVD (or at risk) and with overweight or obesity who consumed nuts had a significant reduction in waist circumference when compared to control groups (31). This evidence was assessed as low to very low using the GRADE framework (31).

Forms of nuts

In a randomised crossover design, participants (n=72) consumed 30g/day of either raw or dry roasted, lightly salted (133mg sodium per 100g) hazelnuts for 28 days each (37). Compared with baseline, both forms of hazelnut improved CVD risk factors (HDL cholesterol, apolipoprotein A1 concentrations and blood pressure) without significantly changing body composition (37). Both forms of nut had similar acceptance ratings.

In a randomised trial, participants (n=118) consumed 56g/day of raw unsalted, roasted unsalted, roasted salted, or honey roasted peanuts or peanut butter for 4 weeks (38). Compared with baseline, peanut form and processing did not differentially affect body weight or fasting blood lipids in the total sample (38). Blood pressure was not measured in this study.

In a randomised crossover study, participants (n=48) with mild hypercholesterolemia consumed 30g/day of ground, sliced or whole hazelnuts for 4 weeks (39). Compared with baseline, all forms of hazelnut improved blood lipids (HDL-cholesterol, total cholesterol and LDL-cholesterol) (39).

Blood lipids, blood pressure and seeds

Two recent systematic reviews of trials published in 2021 demonstrated an association between flaxseed/linseed intake and improved blood lipids (32, 33). Masjedi et al. (n=1107) demonstrated reductions in total cholesterol (1.41mmol/L), LDL-cholesterol (0.69mmol/L) and triglycerides (1.47 mmol/L) in dyslipidaemic patients (32). Hadi et al. (n=3772) also demonstrated improvements in blood lipids however authors stated significant between-study heterogeneity (33). A 2016 systematic review by Ursoniu et al. (n=1302) demonstrated an association between flaxseed/linseed intake and reductions in systolic (2.85mmHg) and diastolic (2.39mmHg) blood pressure (34).

A 2018 systematic review by Li Teoh et al. of 14 RCTs (n=526) demonstrated no association between chia seed intake and blood lipids or blood pressure (36). Sub-group analyses demonstrated reductions in HDL cholesterol (0.10mmol/L) and diastolic blood pressure (7.14mmHg) with high dose chia seed intake (36). A 2017 systematic review by Khosravi-Boroujeni et al. of 8 RCT's (n=843) demonstrated an association between sesame seed intake and reduced blood pressure (35). However, given high heterogeneity between studies the findings were limited (35).

Certainty of evidence

The data from observational studies and trials used to inform this position statement were limited and the certainty of evidence is low to very low for most outcomes (**Appendix 3**). One exception is the outcomes related to body weight where there is moderate to high quality evidence available.

Given the popularity, affordability and availability of peanuts and peanut butter in New Zealand, we included a recent systematic review on peanuts and blood lipids by Azad et al. 2020. However, the findings from this review may not be generalisable to all nuts and seeds (43).

Very few systematic reviews are available on seeds, with the majority on flaxseed/linseed. Most trials include seed oil, capsules and supplements which limits the applicability to whole and ground seeds. More research is needed to understand whether there are heart health benefits of consuming commonly consumed whole seeds such as sunflower seeds and pumpkin seeds.

Very few recent trials were found on the form and processing of nuts and there is a lack of systematic reviews and meta-analyses. More research is needed to understand whether the nutritional benefits of nuts and seeds are altered when they are incorporated into food products or processed in any way.

The four systematic reviews and meta-analyses used to inform the position statement (and assessed with ROBIS) did not receive industry funding (40-43). Individual studies within these reviews may have.

DISCUSSION

This position statement provides evidence that increasing population intakes of nuts is beneficial to reduce the risk of coronary heart disease and cardiovascular disease, most likely through a reduction in both total cholesterol and LDL cholesterol levels. There is limited research on seeds, however they have a comparable nutrient profile to nuts and are thought to have similar benefits to heart health. There are benefits to eating 3-4 handfuls of nuts and/or seeds each week (about 15g per day). This advice is broadly consistent with other national and international guidelines where regular intake of nuts and/or seeds 'on most days' is generally recommended (9, 44, 45). The greatest benefit to heart health is achieved from eating up to 15g/day however there are likely to be benefits with greater intakes.

This evidence needs to be interpreted within the context of overall diet because adherence to a heart-healthy dietary pattern is associated with optimal cardiovascular health. Mediterranean, vegetarian and Dietary Approaches to Stop Hypertension (DASH) dietary patterns are all associated with a reduced risk of heart disease. These dietary patterns don't have specific ranges for carbohydrate, protein or fat yet feature plant foods such as vegetables, fruit, whole grains, legumes, nuts and seeds (1, 46, 47).

Nuts and seeds are nutrient dense foods and frequent nut intake has been shown to improve nutrient intakes (MUFA, PUFA and essential micronutrients) and overall diet quality (48, 49). Regular consumption of nuts and seeds within the context of a heart-healthy diet has the potential to support individuals and populations to shift from saturated to unsaturated fat intakes and influence cardiovascular risk (12).

Nuts and seeds should ideally be promoted as a heart-healthy source of fat alongside avocado, olives, oily fish and healthy non-tropical plant oils. The latest international guidelines on cardioprotective diets from the European Society of Cardiology and American Heart Association recommend nuts as a key food within a heart-healthy diet (50, 51). The National Heart Foundation of Australia recommends nuts and seeds as part of a heart-healthy dietary pattern (52).

Nuts and seeds are available in a variety of forms including whole, sliced, ground, as nut butters or incorporated into packaged products (37-39, 53). Whole nuts can be purchased raw or modified by roasting, salting or by adding coatings, flavourings and spices. There is limited evidence of the impact of food processing on nuts and seeds. In two randomised trials there did not appear to be an impact of eating a daily serving of roasted, lightly salted or flavoured nuts on short-term cardiometabolic outcomes (37, 38). However, these trials provide insufficient evidence to draw meaningful conclusions.

A 2020 audit analysed the nutrient composition of 158 nut products in five Australian supermarkets. It found raw and roasted nuts to have similar energy and fat profiles indicating dry-roasting and that oil-roasting did not add additional fat (54, 55). Unsalted nuts were naturally low in sodium (5.3mg/100g) while salted nuts contained an average of 291-343mg sodium per 100g.

Everyone has individual taste and sensory preferences and there are a wide range of nut and seed products available in supermarkets and other food retailers. To reap the nutritional benefits, the best way to consume nuts and seeds is close to how they are found in nature. Raw, unsalted, with skins on (where possible) and with minimal processing (11). When nuts have flavours or salt added this generally increases the sodium/sugar content. However, lightly salted and/or roasted nuts in place of a less healthy snack such as chips or biscuits will provide greater nutritional benefit and if regularly eaten, may displace the intake of other energy dense snacks (49, 56).

While nut and seed intake has been found to be beneficial to heart health, adding them to highly processed foods will not counter the detrimental effects of added sugars, sodium, and saturated fats. Minimally processed products such as nut butters and seeded whole grain breads are likely to be more beneficial to health than highly processed products containing nuts and seeds. Within a food category there may be some products with nuts and seeds incorporated that are a better choice (i.e. a nut-based muesli bar versus a highly refined cereal bar); however, it is important to look at the overall nutrient profile and to obtain nuts and seeds preferably in their whole or minimally processed form.

In New Zealand, intakes of nuts and seeds are low, which is consistent with consumption patterns globally (57). Data from the last Adult Nutrition Survey suggests that average population intakes are around a third of the 15g/day recommendation. Māori females are the lowest consumers of nuts and seeds which presents an opportunity for targeted health messages embedded within te ao Māori. For Pasifika populations, many nuts and seeds are unfamiliar and are not part of traditional diets. Peanuts (within shells) and peanut butter tend to have greater familiarity.

Common barriers to consumption include affordability, dental issues and perception of weight gain (23, 57, 58). Increasing numbers of New Zealand households are finding it harder to afford enough nutritious food for themselves and their families with almost one in five children (19%) living in households with severe-to-moderate food insecurity (59). Peanuts, peanut butter, sunflower seeds, sesame seeds, chia seeds and flax seeds are the cheapest options per 100g when compared to all other nuts and nut butters[2]. Nuts and seeds are generally more cost effective when purchased in greater quantities[1]. An advantage of seeds is that they are more likely to be sold in their natural form, raw and unsalted[3]. These options should be promoted as cheaper yet nutritionally equivalent to encourage nut and seed intakes (60). Peanut butter and nuts that have been sliced or ground should be encouraged for groups where dentition is poor (39, 53).

A further barrier is the perception that nuts may negatively impact on body weight (23, 57). This position statement provides clear evidence that increasing intakes of nuts and seeds does not adversely affect body weight (29-31). This is consistent with New Zealand data from the Adult Nutrition Survey 2008/2009 which demonstrated whole and total nut consumption was associated with a more favourable body composition (body weight, body mass index (BMI), waist circumference and central adiposity) (61).

This may be explained by several proposed mechanisms including the rich protein, fat and dietary fibre content of nuts which may be associated with greater satiety and reduced overall food intake (29, 62). Whole nuts also require considerable effort with chewing which also helps to increase satiety (62). The physical structure of nuts may also result in a lower amount of metabolisable energy from nuts than what is predicted due to incomplete breakdown of cell walls leading to the excretion of undigested nut segments in the faeces (29).

Food allergy to nuts presents a major safety concern regarding nut and seed intakes. In a survey of New Zealanders, 15% of participants reported avoiding nuts due to allergy and a further 8% reported avoiding nuts because they lived with or were in close contact with someone who had a nut allergy (23). People with peanut allergy are at increased risk of having other food allergies although there is little similarity between peanut allergens and other tree nut allergens. Some

[2] Price comparisons for nuts and seeds observed via Countdown Online, November 2021. No flavoured/coated nuts were included in the price comparison. Note there is a range in the type and quality of peanut butter products.

[3] Sodium comparisons for nuts and seeds observed via Countdown Online, November 2021.

people may avoid all nuts to avoid risks (63). Where it is safe to do so and there is no risk of cross-contamination, people with a peanut or tree nut allergy should be encouraged to consume seeds. It is important to check the labels of all foods before purchasing (63).

A further safety concern is the potential for contamination of nuts and seeds. The current import monitoring regime overseen by the Ministry for Primary Industries offers a high level of protection for the importation of aflatoxin-contaminated peanuts and pistachios. Aflatoxin is a family of toxins produced by fungi found on nuts and grains. Long-term exposure is associated with an increased risk in liver cancer (64). Imported spices and nuts (particularly peanuts and peanut butter) are the major sources of aflatoxin exposure in New Zealand (65). The maximum limit for total aflatoxins in tree nuts and peanuts is established at 0.015mg/kg (66). Salmonella contamination also poses a safety risk particularly in tahini and crushed sesame seed products and imported products are tested for Salmonella routinely (66). Internationally, Salmonella has been detected in other nut and seed products, however, the risk is low and therefore Salmonella testing is not a condition of importation (67, 68).

Along with health outcomes, our recommendations must also consider environmental impacts. EAT Lancet recommends a global shift to a dietary pattern which emphasises plant foods including whole grains, fruits, vegetables, nuts and legumes. These foods support a sustainable food system and have less of an environmental impact when compared to animal sourced foods such as red meat and dairy (13, 69). The EAT Lancet reference diet recommends 50g/day of nuts (tree nuts and peanuts) as an alternative to red meat (69).

Nuts, however, require large amounts of water to produce. Globally, seventy-five percent of nuts are produced under water stress in regions including India, China, Pakistan, the Middle East, the Mediterranean and the USA (69, 70). Some types of nuts (e.g. cashews) are more water-intensive than others (e.g. peanuts) (70). To ensure environmental sustainability, global nut production needs to be undertaken in a water-sustainable way. Most nuts in New Zealand are imported, however, a very small proportion are grown in the North and South Islands such as macadamias, walnuts, hazelnuts and almonds.

This review of the evidence has identified notable gaps and areas that would warrant further research. There is a dearth of studies on seeds and their role in health which presents a significant limitation when developing recommendations on nuts and seeds. There is also limited evidence on the impact of processing nuts and seeds on heart health outcomes.

Implications for practise

Eating nuts and seeds within the context of an overall heart-healthy diet is beneficial for all groups in the population including those at high risk of heart disease and people who want to lose weight. A range of meals and snacks across the day can be easily adapted to feature nuts and seeds and boost the nutrient quality and dietary variety.

Ways to support people to eat nuts and seeds:

- Communicate the reduced risk of heart disease by eating 3-4 small handfuls of nuts and/or seeds each week which equates to around 15g per day (or 1 tbsp peanut butter every day).

- Acknowledge the barriers to eating nuts and seeds such as dental issues, allergies, affordability, acceptability and how these may vary between different ages, genders and cultural groups.
- Make people aware that although nuts and seeds are high in fats, eating nuts is not connected with weight gain.
- Recommend people eat a variety of different nuts and seeds to get the greatest health benefits.
- To get the greatest health benefits, nuts and seeds should be eaten as close to their natural form with as little processing as possible. Unsalted nuts and seeds without added flavouring or coatings are the best options for heart health.
- Encourage nut and seed butters like peanut butter as more nutrient-dense options compared to other spreads (i.e. jam or honey).
- When choosing nut and seed butters like peanut butter look for a high proportion of nuts or 'nuts only', unsalted, plain with no added sugar or flavours like syrups or chocolate.
- Encourage nut and seed butters, ground nuts and sliced nuts for people with dental issues.
- Encourage peanuts, peanut butter, sunflower seeds, sesame seeds, chia seeds and flax seeds as cheaper options per 100g when compared with all other nuts, seeds and nut butters.
- Encourage unsalted or lightly salted nuts as a handy and quick snack in place of less healthy snacks such as chips, biscuits, muffins or even processed meats.
- Provide tailored practical ideas for ways to incorporate nuts and seeds into everyday meals and snacks and within baking/cooking.
- Acknowledge nuts and seeds may be an ingredient in many packaged food products such as breads, breakfast cereals, crackers and dips. Encourage people to look for nuts and seeds as a key ingredient in the products they regularly buy. Noting that not all products containing nuts and seeds are heart-healthy and it is important to also look at added saturated fat, sugar and sodium levels and to minimise highly processed foods.

RECOMMENDATIONS

The recommendations around nuts and seeds are to be included within the context of an overall heart-healthy dietary pattern.

The Heart Foundation's dietary pattern for heart health includes (1):

1. eating more vegetables and fruit
2. swapping from refined cereals and grains to whole grains
3. choosing reduced-fat varieties of dairy products
4. eating healthy fats sourced from nuts, seeds, plant oils (other than coconut and palm), avocado, and oily fish in place of animal fats
5. focusing on reducing unprocessed red meat to <350g/week (cooked) spread across 3 meals per week (with an individual portion size of 100g cooked red meat)
6. swapping some red meat meals for plant proteins such as soy, legumes and nuts
7. limiting or avoiding processed red meat
8. reducing highly processed and refined foods such as junk food, takeaways, deep-fried foods, pastries, pies, sweet bakery items, lollies, processed snack foods and sugary drinks.

ACKNOWLEDGEMENTS

The members of the Heart Foundation Expert Nutrition Policy working group; Lily Henderson, National Nutrition Advisor, Heart Foundation; Dave Monro, Chief Advisor Food and Nutrition, Heart Foundation; Dr Andrew Reynolds, University of Otago; Dr Kathryn Bradbury, University of Auckland.

The Heart Foundation would also like to acknowledge the systematic review experts within the Expert Nutrition Policy working group; Dr Vanessa Jordan, University of Auckland and Emeritus Professor Peter Herbison, University of Otago.

The Heart Foundation also acknowledges the following professionals and academics for their peer-review and input into this position statement: Professor Rachel Brown, Otago University; Dr Eithne Cahill, Australian Heart Foundation; Dr Gerry Devlin, Heart Foundation; Alexandria Nicholas, Pacific Heartbeat, Heart Foundation; Kataraina Davis, Heart Foundation.

APPENDIX 1

Macronutrient composition of nuts and seeds (per 100g) (5)

	Energy (kJ)	Protein (g)	Carbohydrate (g)	Total fat (g)	Saturated fat (g)	Monounsaturated fat (g)	Polyunsaturated fat (g)	Fibre (g)
Almonds	2490	20.1	5.7	53	3.76	33.1	15.2	11.6
Brazil nuts	2860	12.0	3.8	68.2	17.4	22.4	25.4	8.0
Cashews	2440	17.0	16.8	49.2	8.37	31.1	7.48	5.9
Hazelnuts	2770	13.5	4.0	64.5	4.84	53.3	5.99	10.4
Macadamias	3040	9.8	4.5	73.7	11.0	58.2	1.27	9.3
Peanuts	2430	24.4	8.0	49.0	9.18	23.4	13.9	8.2
Pecans	2930	7.7	13.8	67.6	5.42	42.2	16.7	7.6
Pine nuts	2540	24.0	12.6	50.7	7.84	19.2	21.5	4.9
Pistachios	2580	20.6	7.7	54.4	6.91	36.8	8.25	10.8
Walnuts	2910	14.5	2.6	68.8	4.90	9.03	50.0	9.0
Chia seeds	1800	19.9	0.2	32.2	3.51	2.24	31.7	32.9
Hemp seeds	2460	29.8	2.5	50.6	4.56	6.22	38.4	4.2
Flaxseeds/Linseeds	1890	18.4	0.7	37.0	3.72	6.60	34.8	24.8
Pumpkin seeds	2380	31.1	1.4	47.5	8.18	16.7	22.6	9.1
Sunflower seeds	2510	20.5	3.6	55.2	5.77	24.1	27.6	7.7
Poppy seeds	2090	20.2	3.2	41.6	3.89	5.03	21.0	19.3
Sesame seeds	2510	26.4	0.8	54.8	7.67	20.7	24.0	3.0

Source: New Zealand Food Composition Database 2019. New Zealand Food Composition Database Online Search. The New Zealand Institute for Plant & Food Research Limited and Ministry of Health. https://www.foodcomposition.co.nz/search

APPENDIX 2

Micronutrient composition of nuts and seeds (per 100g) (5)

	Magnesium (mg)	Manganese (µg)	Selenium (µg)	Copper (mg)	Potassium (mg)	Iron (mg)	Phosphorous (mg)	Zinc (mg)	Calcium (mg)	Vit E (mg)	Folate (µg)
Almonds	300	3600	-	0.81	740	3.8	490	3.00	270	17.3	36
Brazil nuts	410	761	1270	1.10	760	2.80	590	4.20	180	7.18	22
Cashews	250	1510	33.0	1.90	550	5.00	530	5.50	34	0.73	25
Hazelnuts	160	6600	-	1.40	720	3.00	310	2.00	137	15.9	76
Macadamias	116	4130	7.0	0.30	368	2.41	136	1.71	70	0.41	11
Peanuts	180	1840	10.5	0.27	680	2.00	370	2.95	61	10.1	240
Pecans	128	4510	5.3	1.18	392	2.13	291	5.47	36	6.64	22
Pine nuts	218	6550	5.3	1.03	599	9.20	508	4.25	26	13.7	58
Pistachios	129	1200	5.3	1.19	1090	6.8	503	1.35	135	2.70	51
Walnuts	165	3400	-	1.35	470	2.70	380	3.00	78	1.01	86
Chia seeds	390	4500	25.0	1.63	740	7.10	850	5.70	610	0.28	92
Hemp seeds	650	8200	36.0	1.51	1060	12.5	1520	9.40	90	1.30	150
Flaxseeds/Linseeds	330	2300	-	0.62	690	5.90	510	3.40	230	0.16	33
Pumpkin seeds	590	5300	12.0	1.37	770	8.50	1230	7.00	40	0.91	73
Sunflower seeds	400	4000	17.0	2.00	810	4.60	810	6.30	107	16.5	125
Poppy seeds	347	6710	13.5	1.63	719	9.76	870	7.90	1440	5.97	82
Sesame seeds	347	1430	1.7	1.46	407	7.80	776	10.3	131	2.53	97

Source: New Zealand Food Composition Database 2019. New Zealand Food Composition Database Online Search. The New Zealand Institute for Plant & Food Research Limited and Ministry of Health. https://www.foodcomposition.co.nz/search

APPENDIX 3

Question 1: What is the association between nut intake and cardiovascular disease risk and mortality in adults?

Bibliography: Bechthold et al. (2019) and Aune et al. (2016)

Certainty assessment							№ of patients	Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations		Relative (95% CI)	Absolute (95% CI)		
Coronary heart disease occurrence for the highest nut consumers when compared with the lowest nut consumers											
4	Observational studies	N/A	N/A	N/A	N/A	Dose response relationship	5,480 cases from 144,399 participants	RR: 0.80 (0.62 to 1.03)	NR	N/A	CRITICAL
Coronary heart disease occurrence for the highest total nut consumers when compared with the lowest total nut consumers											
11	Observational studies	N/A	N/A	N/A	N/A	Dose response relationship	12,331 cases from 315,397 participants	RR: 0.76 (0.69 to 0.84)	NR	N/A	CRITICAL
Cardiovascular disease occurrence for the highest total nut consumers when compared with the lowest total nut consumers											
11	Observational studies	N/A	N/A	N/A	N/A	Dose response relationship	18,655 cases from 376,228 participants	RR: 0.81 (0.74 to 0.89)	NR	N/A	CRITICAL

Bibliography: Liu et al. (2020)

Certainty assessment when combining nut types[a]							№ of patients	Effect when combining nut types[b]	Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations		Mean difference (95% CI)		
Total cholesterol change due to consuming nuts when compared with consuming no nuts										
NR	Randomised trials	Not serious[c]	Not serious	Not serious	Not serious	Not enough data to assess	Walnut 1279 Pistachio 250 Hazelnut 222 Cashew 207 Almond 582	MD 0.12 mmol/L lower (0.17 lower to 0.08 lower)	⊕⊕ LOW[d]	CRITICAL
LDL cholesterol change due to consuming nuts when compared with consuming no nuts										
NR	Randomised trials	Not serious[c]	Not serious	Not serious	Not serious	Not enough data to assess	Walnut 1279 Pistachio 250 Hazelnut 222 Cashew 207 Almond 552	MD 0.09 mmol/L lower (0.12 lower to 0.07 lower)	⊕⊕ VERY LOW TO LOW[d]	CRITICAL

a This certainty assessment is based on the available information when combining the meta analyses of individual nut types.
b Combined meta for each nut type (does not include any mixed nut interventions).
c Liu et al. removed the studies identified as high risk of bias per pairwise comparison – it did not appreciably change the direction or significance of the results.
d Certainty reported in Liu et al. Network Analysis

Bibliography: Nishi et al. (2021)

Certainty assessment							№ of patients	Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations		Relative (95% CI)	Absolute (95% CI)		
Overweight and obesity incidence											
5	Observational studies	not serious	not serious	not serious	not serious	Dose response relationship	91,256 cases from 520,331 participants	RR: 0.93 (0.88 to 0.98)	NR	⊕⊕⊕⊕ MODERATE	IMPORTANT
Waist circumference incidence											
2	Observational studies	N/A	N/A	N/A	N/A	Dose response relationship	4,290 cases from 9,887 participants	RR: 0.72 (0.65 to 0.80)	NR	⊕⊕⊕⊕ MODERATE	IMPORTANT
Certainty assessment							**№ of patients**	**Effect**		**Certainty**	**Importance**
№ of studies	**Study design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**		**Mean difference (95% CI)**			
Body weight (kg) change from consumption of tree nuts and peanuts											
105	Randomised trials	not serious	Serious inconsistency	not serious	not serious	Dose response relationship	5479 participants	MD: 0.09 kg (0.09 to 0.27)		⊕⊕⊕⊕ HIGH	IMPORTANT
BMI (kg/m^2) change from consumption of tree nuts and peanuts											
90	Randomised trials	not serious	not serious	not serious	not serious	N/A	4783 participants	MD: -0.04 kg/m^2 (-0.12 to -0.05)		⊕⊕⊕⊕ HIGH	IMPORTANT
Body fat (%) change from consumption of tree nuts and peanuts											
43	Randomised trials	not serious	Serious inconsistency	not serious	not serious	Dose response relationship	2345 participants	MD: -0.05 kg (-0.42 to -0.31)		⊕⊕⊕⊕ HIGH	IMPORTANT

REFERENCES

1. National Heart Foundation of New Zealand. Dietary patterns and the heart: Backgound Paper. Auckland; 2013.
2. Ministry of Health. Mortality 2017 data tables. Ministry of Health; 2019.
3. Ministry of Health. Health and Independence Report 2017: The Director-General of Health's Annual Report on the State of Public Health. Wellington2018.
4. Ros E. Health benefits of nut consumption. Nutrients. 2010;2(7):652-82.
5. New Zealand Institute for Plant and Food Research Limited, Ministry of Health. New Zealand Food Composition Database. Auckland, Wellington; 2018.
6. Britannica. Plant anatomy [Available from: https://www.britannica.com/science/testa]
7. Alasalvar C, Chang SK, Bolling B, Oh WY, Shahidi F. Specialty seeds: Nutrients, bioactives, bioavailability, and health benefits: A comprehensive review. Compr Rev Food Sci Food Saf. 2021;20(3):2382-427.
8. Ros E. Nuts and novel biomarkers of cardiovascular disease. Am J Clin Nutr. 2009;89(5):1649S-56S.
9. Ministry of Health. Eating and Activity Guidelines for New Zealand Adults: Updated 2020. Wellington 2020.
10. Bolling BW, McKay DL, Blumberg JB. The phytochemical composition and antioxidant actions of tree nuts. Asia Pac J Clin Nutr. 2010;19(1):117-23.
11. Ros E. Nuts and novel biomarkers of cardiovascular disease. Am J Clin Nutr. 2009;89(5):1649s-56s.
12. Ministry of Health. Cardiovascular Disease Risk Assessment and Management for Primary Care. Wellington: Ministry of Health; 2018.
13. Farvid MS, Ding M, Pan A, Sun Q, Chiuve SE, Steffen LM, et al. Dietary linoleic acid and risk of coronary heart disease: a systematic review and meta-analysis of prospective cohort studies. Circulation. 2014;130(18):1568-78.
14. Riccardi G, Giosuè A, Calabrese I, Vaccaro O. Dietary recommendations for prevention of atherosclerosis. Cardiovasc Res. 2021.
15. Rajaram S. Health benefits of plant-derived α-linolenic acid. Am J Clin Nutr. 2014;100(suppl_1):443S-8S.
16. National Heart Foundation of New Zealand. Red meat, poultry and the heart - Position statement. Auckland; 2020.
17. Reynolds A, Mann J, Cummings J, Winter N, Mete E, Te Morenga L. Carbohydrate quality and human health: a series of systematic reviews and meta-analyses. Lancet. 2019;393(10170):434-45.
18. Huang Y, Zheng S, Wang T, Yang X, Luo Q, Li H. Effect of oral nut supplementation on endothelium-dependent vasodilation - a meta-analysis. Vasa. 2018;47(3):203-7.
19. Brown R, Gray AR, Chua MG, Ware L, Chisholm A, Tey SL. Is a Handful an Effective Way to Guide Nut Recommendations? Int J Environ Res Public Health. 2021;18(15).
20. National Nutrition Survey 08/09 Food File.
21. Brown RC, Tey SL, Gray AR, Chisholm A, Smith C, Fleming E, et al. Patterns and predictors of nut consumption: results from the 2008/09 New Zealand Adult Nutrition Survey. Br J Nutr. 2014;112(12):2028-40.
22. Mackay S NMC, Swinburn B, Eyles H, Young L, Gontijo de Castro T. State of the Food Supply: New Zealand 2019 Auckland: Auckland University; 2019.
23. Yong LC, Gray AR, Chisholm A, Leong SL, Tey SL, Brown RC. Barriers to and facilitators and perceptions of nut consumption among the general population in New Zealand. Public Health Nutr. 2017;20(17):3166-82.
24. Whiting P, Savovic J, Higgins JP, Caldwell DM, Reeves BC, Shea B, et al. ROBIS: A new tool to assess risk of bias in systematic reviews was developed. J Clin Epidemiol. 2016;69:225-34.
25. Alonso-Coello P, Oxman AD, Moberg J, Brignardello-Petersen R, Akl EA, Davoli M, et al. GRADE Evidence to Decision (EtD) frameworks: a systematic and transparent approach to making well informed healthcare choices. 2: Clinical practice guidelines. Gac Sanit. 2018;32(2):167.e1-.e10.
26. Alonso-Coello P, Schünemann HJ, Moberg J, Brignardello-Petersen R, Akl EA, Davoli M, et al. GRADE Evidence to Decision (EtD) frameworks: a systematic and transparent approach to making well informed healthcare choices. 1: Introduction. Gac Sanit. 2018;32(2):166.e1-.e10.
27. Altamimi M, Zidan S, Badrasawi M. Effect of Tree Nuts Consumption on Serum Lipid Profile in Hyperlipidemic Individuals: A Systematic Review. Nutr Metab Insights. 2020;13:1178638820926521.

28. Becerra-Tomás N, Paz-Graniel I, C WCK, Kahleova H, Rahelić D, Sievenpiper JL, et al. Nut consumption and incidence of cardiovascular diseases and cardiovascular disease mortality: a meta-analysis of prospective cohort studies. Nutr Rev. 2019;77(10):691-709.
29. Nishi SK, Viguiliouk E, Blanco Mejia S, Kendall CWC, Bazinet RP, Hanley AJ, et al. Are fatty nuts a weighty concern? A systematic review and meta-analysis and dose-response meta-regression of prospective cohorts and randomized controlled trials. Obes Rev. 2021;22(11):e13330.
30. Guarneiri LL, Cooper JA. Intake of Nuts or Nut Products Does Not Lead to Weight Gain, Independent of Dietary Substitution Instructions: A Systematic Review and Meta-Analysis of Randomized Trials. Adv Nutr. 2021;12(2):384-401.
31. Fernández-Rodríguez R, Mesas AE, Garrido-Miguel M, Martínez-Ortega IA, Jiménez-López E, Martínez-Vizcaíno V. The Relationship of Tree Nuts and Peanuts with Adiposity Parameters: A Systematic Review and Network Meta-Analysis. Nutrients. 2021;13(7).
32. Sadat Masjedi M, Mohammadi Pour P, Shokoohinia Y, Asgary S. Effects of Flaxseed on Blood Lipids in Healthy and Dyslipidemic Subjects: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. Curr Probl Cardiol. 2021:100931.
33. Hadi A, Askarpour M, Salamat S, Ghaedi E, Symonds ME, Miraghajani M. Effect of flaxseed supplementation on lipid profile: An updated systematic review and dose-response meta-analysis of sixty-two randomized controlled trials. Pharmacol Res. 2020;152:104622.
34. Ursoniu S, Sahebkar A, Andrica F, Serban C, Banach M. Effects of flaxseed supplements on blood pressure: A systematic review and meta-analysis of controlled clinical trial. Clin Nutr. 2016;35(3):615-25.
35. Khosravi-Boroujeni H, Nikbakht E, Natanelov E, Khalesi S. Can sesame consumption improve blood pressure? A systematic review and meta-analysis of controlled trials. J Sci Food Agric. 2017;97(10):3087-94.
36. Teoh SL, Lai NM, Vanichkulpitak P, Vuksan V, Ho H, Chaiyakunapruk N. Clinical evidence on dietary supplementation with chia seed (Salvia hispanica L.): a systematic review and meta-analysis. Nutr Rev. 2018;76(4):219-42.
37. Tey SL, Robinson T, Gray AR, Chisholm AW, Brown RC. Do dry roasting, lightly salting nuts affect their cardioprotective properties and acceptability? Eur J Nutr. 2017;56(3):1025-36.
38. McKiernan F, Lokko P, Kuevi A, Sales RL, Costa NM, Bressan J, et al. Effects of peanut processing on body weight and fasting plasma lipids. Br J Nutr. 2010;104(3):418-26.
39. Tey SL, Brown RC, Chisholm AW, Delahunty CM, Gray AR, Williams SM. Effects of different forms of hazelnuts on blood lipids and α-tocopherol concentrations in mildly hypercholesterolemic individuals. Eur J Clin Nutr. 2011;65(1):117-24.
40. Aune D, Keum N, Giovannucci E, Fadnes LT, Boffetta P, Greenwood DC, et al. Nut consumption and risk of cardiovascular disease, total cancer, all-cause and cause-specific mortality: a systematic review and dose-response meta-analysis of prospective studies. BMC Med. 2016;14(1):207.
41. Bechthold A, Boeing H, Schwedhelm C, Hoffmann G, Knüppel S, Iqbal K, et al. Food groups and risk of coronary heart disease, stroke and heart failure: A systematic review and dose-response meta-analysis of prospective studies. Crit Rev Food Sci Nutr. 2019;59(7):1071-90.
42. Liu K, Hui S, Wang B, Kaliannan K, Guo X, Liang L. Comparative effects of different types of tree nut consumption on blood lipids: a network meta-analysis of clinical trials. Am J Clin Nutr. 2020;111(1):219-27.
43. Jafari Azad B, Daneshzad E, Azadbakht L. Peanut and cardiovascular disease risk factors: A systematic review and meta-analysis. Crit Rev Food Sci Nutr. 2020;60(7):1123-40.
44. U.S. Deparment of Agriculture and U.S. Department of Health and Human Services. Dietary Guidelines for Americans, 2020-2025. 9th Edition ed2020.
45. National Health and Medical Rearch Council. Australian Dietary Guidelines Summary Canberra2013.
46. Trichopoulou A, Costacou T, Bamia C, Trichopoulos D. Adherence to a Mediterranean diet and survival in a Greek population. N Engl J Med. 2003;348(26):2599-608.
47. Sofi F, Abbate R, Gensini GF, Casini A. Accruing evidence on benefits of adherence to the Mediterranean diet on health: an updated systematic review and meta-analysis. Am J Clin Nutr. 2010;92(5):1189-96.
48. Brown RC, Tey SL, Gray AR, Chisholm A, Smith C, Fleming E, et al. Nut consumption is associated with better nutrient intakes: results from the 2008/09 New Zealand Adult Nutrition Survey. Br J Nutr. 2016;115(1):105-12.

49. Pearson KR, Tey SL, Gray AR, Chisholm A, Brown RC. Energy compensation and nutrient displacement following regular consumption of hazelnuts and other energy-dense snack foods in non-obese individuals. Eur J Nutr. 2017;56(3):1255-67.
50. Visseren FLJ, Mach F, Smulders YM, Carballo D, Koskinas KC, Bäck M, et al. 2021 ESC Guidelines on cardiovascular disease prevention in clinical practice: Developed by the Task Force for cardiovascular disease prevention in clinical practice with representatives of the European Society of Cardiology and 12 medical societies With the special contribution of the European Association of Preventive Cardiology (EAPC). Eur Heart J. 2021;42(34):3227-337.
51. Lichtenstein AH, Appel LJ, Vadiveloo M, Hu FB, Kris-Etherton PM, Rebholz CM, et al. 2021 Dietary Guidance to Improve Cardiovascular Health: A Scientific Statement From the American Heart Association. Circulation. 2021;144:e472-e487.
52. National Heart Foundation Australia. Dietary position statement: Heart healthy eating patterns. Australia; 2019.
53. Tey SL, Delahunty C, Gray A, Chisholm A, Brown RC. Effects of regular consumption of different forms of almonds and hazelnuts on acceptance and blood lipids. Eur J Nutr. 2015;54(3):483-7.
54. Nuts for Life. The energy, fat and sodium content of nuts: Findings from an audit of nut products from five major retailers. North Sydney, NSW: Nuts for life; 2021.
55. Schlörmann W, Birringer M, Böhm V, Löber K, Jahreis G, Lorkowski S, et al. Influence of roasting conditions on health-related compounds in different nuts. Food Chem. 2015;180:77-85.
56. Rehm CD, Drewnowski A. Replacing American snacks with tree nuts increases consumption of key nutrients among US children and adults: results of an NHANES modeling study. Nutr J. 2017;16(1):17.
57. Neale EP, Tran G, Brown RC. Barriers and Facilitators to Nut Consumption: A Narrative Review. Int J Environ Res Public Health. 2020;17(23).
58. Brown RC, Gray AR, Yong LC, Chisholm A, Leong SL, Tey SL. A comparison of perceptions of nuts between the general public, dietitians, general practitioners, and nurses. PeerJ. 2018;6:e5500.
59. Ministry of Health. Household Food Insecurity Among Children: New Zealand Health Survey. Wellington2019.
60. Ministry of Health. Annual Data Explorer 2019/20: New Zealand Health Survey [Data file]. Wellington2020.
61. Brown RC, Tey SL, Gray AR, Chisholm A, Smith C, Fleming E, et al. Association of Nut Consumption with Cardiometabolic Risk Factors in the 2008/2009 New Zealand Adult Nutrition Survey. Nutrients. 2015;7(9):7523-42.
62. Tan SY, Dhillon J, Mattes RD. A review of the effects of nuts on appetite, food intake, metabolism, and body weight. The Am J Clin Nutr. 2014;100(suppl_1):412S-22S.
63. Australian Society of Clinical Immunology and Allergy. Peanut, Tree Nut and Seed Allergy. Information for patients, consumers and carers 2019.
64. World Health Organisation. Food Safety Digest: Aflatoxins. 2018.
65. Ministry for Primary Industries. The New Zealand Mycotoxin Surveillance Program 06-14 Report Series. Wellington2014.
66. Ministry for Primary Industries. Food Notice: Importing Food. Wellington2020.
67. Zhang G, Hu L, Melka D, Wang H, Laasri A, Brown EW, et al. Prevalence of Salmonella in Cashews, Hazelnuts, Macadamia Nuts, Pecans, Pine Nuts, and Walnuts in the United States. J Food Prot. 2017;80(3):459-66.
68. Zhang G, Hu L, Luo Y, Santillana Farakos SM, Johnson R, Scott VN, et al. Survey of Salmonella in raw tree nuts at retail in the United States. J Food Sci. 2021;86(2):495-504.
69. Willett W, Rockström J, Loken B, Springmann M, Lang T, Vermeulen S, et al. Food in the Anthropocene: the EAT–*Lancet* Commission on healthy diets from sustainable food systems. Lancet. 2019;393(10170):447-92.
70. Vanham D, Mekonnen MM, Hoekstra AY. Treenuts and groundnuts in the EAT-Lancet reference diet: Concerns regarding sustainable water use. Glob Food Sec. 2020;24:100357.