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A Systematic Literature Review

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REVIEW

CURRENT DEVELOPMENTS IN NUTRITION

Food and Nutrition of Indigenous Peoples

Traditional Food Energy Intake among Indigenous Populations in Select High-Income Settler-Colonized Countries: A Systematic Literature Review

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ABSTRACT

The traditional diets of Indigenous Peoples globally have undergone a major transition due to settler colonialism. This systematic review aims to provide a perspective of traditional food intake of Indigenous populations in high-income settler-colonized countries. For inclusion, studies reported the primary outcome of interest—traditional food contribution to total energy intake (% of energy)—and occurred in Canada, the United States (including Hawaii and Alaska), New Zealand, Australia, and/or Scandinavian countries. Primary outcome data were reported and organized by date of data collection by country. Forty-nine articles published between 1987 and 2019 were identified. Wide variation in contribution of traditional food to energy was reported. A trend for decreasing traditional food energy intake over time was apparent; however, heterogeneity in study populations and dietary assessment methods limited conclusive evaluation of this. This review may inform cross-sectoral policy to protect the sustainable utilization of traditional food for Indigenous Peoples. *Curr Dev Nutr* 2020;4:nzaa163.

Keywords: Indigenous Peoples, First Peoples, traditional diets, settler colonialism, nutrition transition, dietary intake, nutrition surveys, climate change, food systems

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Supplemental Tables 1 and 2 are available from the "Supplementary data" link in the online posting of the article and from the same link in the online table of contents at https://academic.oup.com/cdn/.

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Introduction

The global population of Indigenous Peoples is ~476 million, living in 90 countries and speaking >4000 distinct languages (1, 2). Indigenous Peoples represent the oldest continuous surviving cultures in the world (3). The biodiverse food systems of Indigenous Peoples have contributed to the health of populations through time (4, 5). Indigenous Peoples' use of traditional food (foods native to the local environment) has aided the transfer of cultural knowledge, the health of the ecosystem and the land and waterways, and health and well-being (6–8).

Settler colonialism has forcibly and continually displaced Indigenous Peoples in many parts of the globe from their lands and People groups and has prohibited or actively discouraged access to traditional food (4, 9–11). Settler colonialism seeks to replace the Indigenous Peoples of a territory with foreign settlers and establish an ongoing system of control and domination that includes exploitation of ancestral lands and resources of Indigenous Peoples (12, 13). Traditional diets undergo rapid and drastic change with settler colonial policies impacting on natural environments and Indigenous Peoples' access to and use of their land and waterways (14), and results in a greater reliance on an introduced food system and, for many, intergenerational loss of skills in the procurement of traditional food (15–17). Current consumption of traditional food is now vastly different for Indigenous Peoples across the globe than prior to settler colonization. This has implications for public health nutrition since traditional foods contain high levels of essential nutrients and contribute importantly to dietary quality and health and well-being (18–21).

There are numerous benefits of traditional food intake that have been identified in the literature. Among Indigenous Peoples in Canada, benefits identified have included more active lifestyles in association with accessing traditional food, cultural continuity, and nutritional and health benefits (21). In Australia, the role of traditional food in

sustaining food security for Indigenous communities has been highlighted (22). Declining intake of traditional foods has been reported among some Indigenous Peoples groups (23, 24) in addition to challenges faced by Indigenous Peoples in accessing traditional food such as the contamination of traditional food sources from mining and military practices (21, 22). A systematic literature review investigated factors influencing dietary behavior among Canadian Inuit Peoples and reported changes in consumption patterns from traditional food sources to store-bought foods in the 2 decades preceding 2014, particularly among younger generations (23). A 2018 scoping review found that traditional foods had become less accessible to Alaskan Native Peoples due to population movement to urban areas (24).

The purpose of this review was to gain a perspective of traditional food intake relative to the whole diet by systematically investigating the contribution of traditional food to dietary energy across Indigenous populations in settler-colonized countries that are categorized as high-income economies by the World Bank, specifically North America (Canada and the United States including Hawaii and Alaska), New Zealand, Australia, and Scandinavian countries (12, 25). The first aim of this study was to determine traditional food intake among Indigenous populations over time from reported studies and assess within-population group differences by age group and gender. The second aim was to assess the quality of evidence obtained through the research and dietary assessment procedures. This review may aid Indigenous and non-Indigenous leaders and policymakers in determining environmental and nutrition cross-sectoral policy to protect and support the sustainable utilization of traditional food for Indigenous Peoples, and help to identify gaps in the literature and strengthen methodology.

Methods

The primary outcome of interest was traditional food contribution to total energy intake [percentage of energy (%E)]. The secondary outcome measures of this research were within-population group differences by age group and gender and the proportion of traditional food items compared with total foods consumed and/or frequency of traditional food intake (times per day, week, month, or year). For this review, foods considered as traditional were interpreted according to how they were categorized and defined in each article. It is acknowledged that traditional foods hold spiritual, cultural, economic, social, physical and mental health, and well-being significance for Indigenous Peoples and, nutritionally, traditional foods provide more than energy (8). For the purpose of providing a first-time partial global perspective on the status of traditional food intake, energy is used as a proxy of dietary significance.

Search strategy

The search strategy for article identification and inclusion was developed in Ovid Medline and adapted for other databases (see **Supplemental Table 1**). Search terms were chosen on the basis of key terms included in articles written by prominent authors in the Indigenous nutrition field (e.g., Harriet Kuhnlein and Sangita Sharma) that were thought to investigate the primary outcome measure. In addition, the population search terms were based on those used in a Cochrane review investigating Indigenous early-childhood well-being (26). Some region-specific terms for traditional foods were included such as "tucker," used in some Australian studies (27, 28).

The search strategy included the following terms—Population: [Aborigin* OR Indigen* OR First Nation* OR Native people* OR First people* OR Torres Strait Islander* OR First Australian* OR Maori* OR Inuit* OR Metis OR Saami* OR Sami* OR Native Hawaiian* OR Alaska* Native* OR Native American OR Native Canadian OR Arctic OR American* adj2 Indian* OR Indians, North American/OR Alaska Natives/OR Inuits/OR Oceanic Ancestry Group/]; Intervention: [(diet* or intake or nutrition) adj2 (assess* or survey* or questionnaire* or transition)] OR Nutrition Surveys/OR [(tradition* or native or cultural or country or local or customary or wild or undomesticated or bush or hunt* or forage*) adj3 (food* or diet* or intake* or edible or tucker)].

The following electronic databases were searched in January 2019 for articles from 1960 to present: Ovid Medline, Embase, Cochrane, CINAHL, Sociological Abstracts, and PsycINFO. No additional filters were applied in order to avoid excluding relevant articles. The first search was conducted on 17 January 2019 (Ovid Medline, including published ahead of print) and the last search on 20 January 2019 (PsycINFO).

Study selection

All articles from the relevant database searches were uploaded into Covidence (Melbourne, Australia); duplicates were removed and articles were screened for inclusion against eligibility criteria (**Table 1**). Inclusion required agreement between 2 authors and conflicts were resolved by the first author (JM). Reference lists of included articles were screened for relevant articles that were not found in the database search.

Data extraction

Data were extracted using a purpose-designed template table to capture the population group (age group, gender, Indigenous population group), setting, data collection period, sample size, definition of traditional food, dietary assessment methods, and the primary and secondary outcome measures. To ensure consistency, data extraction of 2 studies was performed by all authors and discrepancies were discussed and resolved. All authors contributed to data extraction on the remaining articles. All extracted data were then cross-checked for accuracy and consistency by the senior author (JB).

Quality assessment

Quality assessment was performed on all included articles by all authors using criteria adapted from an existing tool developed to appraise research on Aboriginal and Torres Strait Islander Peoples' dietary intakes (29) (**Supplemental Table 2**). Referenced protocols, reports, and/or supplementary material were sourced to assist this assessment. All quality-assessment data were cross-checked and verified by the senior author (JB).

Data synthesis and analysis

Heterogeneity in how data were collected and reported precluded synthesis using meta-analyses. Further, a global indicator of traditional food intake may not be suitable considering the cultural heterogeneity of Indigenous population groups and their unique political, economic, and social contexts. Therefore, data for the primary outcome measure were organized in a chart by date of data collection and by country (in

TABLE 1 Inclusion/exclusion criteria for the selection of studies

Inclusion	Exclusion
Indigenous Peoples in a high-income colonized country—Australia, New Zealand, USA (including Alaska and Hawaii), Canada, Scandinavia (including Greenland)	Populations that are not Indigenous Peoples from high-income colonized countries
Study includes dietary assessment of usual diets	Studies that include a trial or intervention diet
Study results report traditional food intake in the context of the whole diet	Study results focus on individual macro/micronutrients (e.g., vitamin A, vitamin D, iron, selenium, fatty acids) only but do not relate to the whole-diet context
	Studies that have a primary focus on environmental contaminants and do not consider traditional food consumption in the context of whole diets
	Studies that focus on only 1 type or species of traditional food (e.g., fish)
Study reports primary outcome measure—traditional food contribution to total energy intake (% of energy)	Study only reports secondary outcome measures—traditional food contribution to total foods consumed (%) and/or frequency of traditional food intake (times per day, week, month, year) without the primary outcome measure
Study reports primary outcome measure in the Results section	Primary outcome measure not reported in the Results section
Peer-reviewed journal articles	Conference proceedings, abstracts, commentaries, and gray literature such as government reports, websites, and datasets

alphabetical order). For studies that reported the primary outcome measure separately for multiple regions, the primary outcome was calculated as a mean of the values for each region. For studies that reported the primary outcome measure as a range, a median value was taken. Articles that only reported primary outcome data according to participant subgroups (e.g., age or gender) were not included in this chart but were reported descriptively.

Results

Search results

Of the 4229 papers identified during the database searches, 49 studies reporting on 25 unique studies were included (refer to **Figure 1**), including 1 article from reference list screening (30). Included studies described primary outcome data from 4 countries: Canada ($n = 36$), United States ($n = 9$), Greenland ($n = 4$), and Australia ($n = 1$), with 1 study reporting data from both Canada and Greenland (31). No studies for New Zealand or other Scandinavian countries were identified. Studies were published across 4 decades: 1980s ($n = 2$), 1990s ($n = 7$), 2000s ($n = 18$), and >2010 ($n = 22$).

Definition of traditional foods

Included definitions of traditional foods ranged from specific terms such as "bush foods" (18) and "subsistence foods" (30) to lists of specific foods (**Table 2**). Common to most definitions were foods harvested from the local environment through practices such as hunting, fishing, and gathering. Three studies characterized traditional foods by land, sea, and sky (32–34). Two studies included store-bought foods in their definition of traditional food (35, 36), whereas others specified "fish caught in open water" (37) instead of the more ambiguous "fish," which may have included store-bought fish. One study included "minimally processed" in the definition of traditional foods (38), 1 included foods central to the diet prior to the arrival of Europeans (30), and 4 articles mentioned cultural acceptability and practice in their definitions (39–42).

Dietary assessment instruments

The majority of studies used food-frequency questionnaires (FFQs) and/or 24-h recalls to measure dietary intake (**Table 3**). Alternate dietary measures were also administered: weighed food records ($n = 1$), 3-d food records ($n = 1$), and duplicate diet samples ($n = 1$).

Of the 28 studies using FFQs, 16 used FFQs as a stand-alone instrument and assessed intake of traditional and nontraditional foods. The number of traditional food items assessed ranged from 7 to 143 items and 14 studies collected portion size as part of the FFQ. Most studies accounted for animal parts other than flesh that could be consumed—for example, bone marrow, fat, and organs.

Of the 32 studies using 24-h recall, 11 conducted the recall more than once. Studies that used 24-h recall and FFQs all used the 24-h recall data to derive an assessment of traditional food intake to energy intake. Six of the 32 studies using 24-h recall and 2 of the 16 studies that used FFQs alone did not report assessing portion size.

Quality assessment

Figure 2 summarizes the authors' assessment of risk of bias based on information reported in each study, and **Figure 3** summarizes the quality assessment of dietary tools used across the 49 studies included in this review. Thirty-nine studies were rated as low ($n = 16$) or unclear ($n = 23$) risk of bias with regard to Indigenous involvement in the conception and design of studies, conduct or research, and collection and distribution of results. Reporting of this became more prominent in recent years. Studies rated low risk of bias reported on processes that indicated involvement of Indigenous Peoples at the design and conception stage, such as the use of participatory approaches with community representatives (42, 43), working closely with Indigenous organizations, and/or forming partnerships with communities (36). Nearly all studies ($n = 40$) considered the participants' communication needs by use of interpreters or training community members to assist with data collection. The participant recruitment strategy and its appropriateness to the research aims were rated low risk of bias for most articles ($n = 39$). Representativeness of

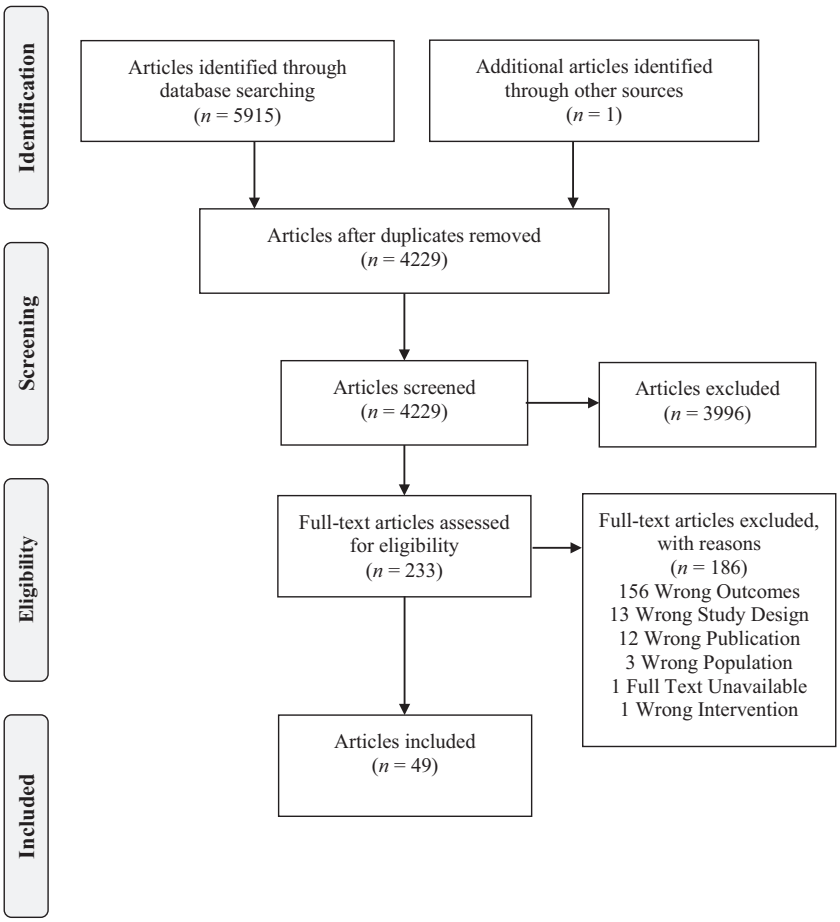

FIGURE 1 PRISMA flowchart of search results and study selection. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

the underlying population was rated as high risk of bias for 13 studies and unclear for 17. Studies that were rated low risk of bias used sampling techniques such as stratified random sampling, invited participation of all households, and/or provided a strong rationale for selection of communities. Participation rate was rated as low risk of bias for 32 studies and unclear or high for 5 studies.

The majority of studies used 24-h dietary recall, assessed as a valid method of population-level dietary assessment, and/or a FFQ pretested for content validity and/or developed with the input of Indigenous Peoples. Of the 16 articles that used an FFQ as a stand-alone instrument, 8 used an FFQ validated against 24-h recall (32, 33, 36, 44, 45, 46–48), 2 were author developed (49, 50), 2 provided no detail on development (31, 37), 1 was said to be developed for the study population with no further detail given (51), and 3 demonstrated input from community representatives and/or Indigenous Peoples with relevant expertise such as Elders (30, 52, 53). One study applied 24-h dietary recall methods but did not provide adequate information on its administration to determine if the method was valid and/or reliable (31). Eight studies did not give a clear description of the dietary assessment method used. Seven of these used a 24-h dietary recall procedure but provided little detail (41, 42, 54–58). The majority of studies used visual aids/prompts to assist with the collection of dietary information ($n = 41$) and included estimates of portion size ($n = 42$). Use of food-composition tables was rated low risk of bias for 42 articles; however, most studies were required to impute substitute nutrient values for specific foods as nutrient composition was not available (e.g., for fermented seal flipper, caribou ribs, racoon, and dried chum salmon). One study, for example, reported 12 of 31 traditional food types that lacked nutrient composition data (53) and another made 157 nutrient-composition substitutions for a total of 283 food items where nutrient data were not available (30).

Data analysis was deemed sufficiently rigorous for 41 of the articles. However, it was unclear for some studies how reported intakes were averaged and/or converted to nutrient intakes. A high proportion of articles did not report taking seasonality into account when performing dietary assessments ($n = 20$; Figure 3). A high proportion of studies, although not all, clearly reported study limitations ($n = 36$).

Contribution of traditional food to dietary intake

Wide variation in contribution of traditional food to energy (megaJoules) was reported across the studies (Table 3), ranging from 1.8% among First Nations Peoples living on reserves in Ontario, Canada, in 2011–2012 (39) to 47% among the Gunwinggu Peoples of Arnhem Land in Northern Territory Australia in 1979/1980 (18) and 68.3% among the Dene First Nations (Dogrib) Peoples in the Northwest Territories of

TABLE 2 Traditional food definitions

Year(s) of data collection	First author, year (reference)	Definition of traditional foods
Australia		
1979–1980	Altman, 1984 (18)	Bush foods[1]
Canada		
1985	Szathmary, 1987 (35)	Tea, sugar, caribou bone marrow, moose, smoked fish, fish, beaver, duck, muskrat, rabbit, soup (dried, homemade, canned, noodles), bannock, blueberries, strawberries, raspberries, broth, lard, flour; all others considered nontraditional[2]
1987–1988	Kuhnlein, 1995 (54)	Locally harvested foods from the natural environment, exclusively wildlife animal and plant species in the Canadian North
1987–1988	Kuhnlein, 1996 (41)	Locally harvested traditional, cultural food
1987–1988	Berti, 1999 (59)	Local animal and plant species
1991	Blanchet, 2000 (52)	Derived from fishing and hunting
1994	Receveur, 1997 (55)	Food, both plant and animal, harvested from the local environment, including berries, birds, fish, and land animals
1994, 1995, 1998–1999	Kuhnlein, 2004 (42)	Animal and plant species culturally identified as food and harvested from the local environment
1994, 1995, 1998–1999	Kuhnlein, 2007 (56)	Sea mammals, land animals, birds, fish/seafood, and plants
Not specified	Wein, 1995 (60)	Wild game meats, fish, berries, and other plants
Not specified	Wein, 1996 (61)	Foods obtained directly from the land or water by hunting, fishing, and gathering
Not specified	Wein, 1998 (62)	Wildlife, fish, and plants obtained directly from the water and land
1998–1999 and 2007–2008	Sheikh, 2011 (63)	Those harvested from the local environment
2000–2001	Nakano, 2005 (57)	Land animals, fish, birds, and berries
2006	Sharma, 2009 (34)	Foods harvested from the local environment; included animals obtained directly from the land, sea, or sky
2006–2010	Gagne, 2012 (64)	Plants and animals harvested from the local environment
2007–2008	Johnson-Down, 2010 (58)	Traditional food items listed included caribou meat, fish, berries, beluga muktuk, narwhal muktuk, and seal meat
2007–2008	Egeland, 2011 (43)	Local nutrient-rich traditional food resources; bannock was excluded based on being introduced by colonists
2007–2008	Jamieson, 2012 (65)	Identified that traditional Inuit foods are largely animal-based
2007–2008	Zienczuk, 2012 (66)	Primarily sea mammals, land mammals, fish, birds, and plants; excluded beverages and bannock
2007–2008	El Hayek Fares, 2018 (67)	General definition of traditional foods not provided; however, traditional Inuit diet identified as being rich in fatty fish and marine mammals
2007–2008	Kenny, 2018 (40)	Foods harvested from the Northern ecosystems, through cultural practice, traditions, and detailed environmental knowledge
2007–2008	Rittmueller, 2012 (33)	Traditional land, sea, and sky foods
2007–2008	Rittmueller, 2012b (32)	Traditional land, sea, and sky foods
2007–2008	Kolahdooz, 2014 (44)	Nutrient-dense traditional foods such as caribou, Arctic char, and musk ox
2007–2008	Sheehy, 2015 (45)	Those harvested from the local environment
2008	Erber, 2010 (68)	Those obtained through subsistence practices such as hunting and fishing
2008	Sharma, 2010 (69)	Those harvested from the local environment
2008	Schaefer, 2011 (46)	A subsistence diet consisting of hunted and gathered food; included sea and land mammals, fish, shellfish, birds, and plants
2008	Sharma, 2013 (47)	Those harvested from the local environment
2008	Sheehy, 2015b (48)	Those harvested from the local environment
2008–2013	Batal, 2018 (38)	Fresh, minimally processed foods obtained from the local environment of First Nations peoples
Not specified	Atikesse, 2010 (70)	Fish, mammals, birds, and berries
2011–2012	Fox, 2015 (53)	Defined as traditional "land" sources vs. commercially available "store bought" foods
2011–2012	Juric, 2018 (39)	Foods obtained from local, natural environment that are culturally acceptable
2014	Calder, 2019 (51)	Locally caught seafood, land mammals, birds, plants, and berries
Canada and Greenland		
2004–2005	Counil, 2008 (31)	Traditional foods defined as country foods (which include marine species) vs. store-bought foods

(*Continued*)

TABLE 2 (*Continued*)

Year(s) of data collection	First author, year (reference)	Definition of traditional foods
Greenland		
1976, 1987, 2006, 2004	Deutch, 2007 (71)	Greenlandic local foods including sea mammals, fish, birds, local plants, and berries
1999–2003	Deutch, 2005 (49)	Local Greenlandic food products, including mainly local fish, mammals, birds, and local berries
2005–2010	Jeppesen, 2014 (37)	Seal, whale, walrus, fish caught in open water, polar bear, musk oxen, reindeer, wild fowl, and berries
United States		
2000–2003	Nobmann, 2005 (36)	Wild fish, meats, fish, sea mammals (and their fats), wild greens, berries, and agutuk[3]
2003–2004	Johnson, 2009 (72)	Foods that were hunted, gathered, or harvested; included fish, land and marine animals, plants, and berries
2003	Bersamin, 2006 (19)	Foods harvested from the local environment; includes berries, marine mammals, fish, game animals, and wild greens
2003–2005	Bersamin, 2007 (73)	Foods harvested from the local environment; includes berries, marine mammals, fish, game animals, and wild greens
2003–2005	Bersamin, 2008 (74)	Foods harvested from the local environment; includes berries, mammal animals, and wild greens
2006	Ballew, 2006 (30)	Fish, shellfish, marine mammals, terrestrial mammals, and plants that made up the Alaska Native diet before the arrival of Europeans
2014–2015	Walch, 2018 (75)	Includes land and marine mammals, fish and other seafood, plants, and berries
Not specified	Giordano, 2015 (50)	Locally harvested foods
Not specified	Sharma, 2015 (76)	Those harvested from the local environment and acquired through subsistence practices

[1] Introduced species (e.g., pig and cattle) were included in this definition.
[2] Definition contains store-bought foods.
[3] Sugar can be added to agutuk in nontraditional recipes.

Canada in 1985 (some store-bought foods were categorized as "traditional" in this study) (35). There was wide variation in the contribution of traditional food to dietary energy intake reported across countries and dates of data collection (**Figure 4**). When comparing earlier studies with more recent studies, there appeared to be a trend for decreasing contribution of traditional food to energy (Figure 4).

Eight of the 49 studies compared the contribution of traditional foods to energy across age groups (Table 3). A general pattern of older generations having higher contributions of traditional foods to dietary energy compared with younger age groups was found. Exceptions to this pattern were a study conducted among children and adolescents that showed an apparent lower intake among older girls (12%; 16–18 y) compared with younger girls (18%; 3–6 y) (59) and another study where there appeared to be no consistent pattern by reported age groups for either gender (36). Variation, however, was not reported for either of these studies to determine if the differences observed were statistically significant (36, 59). Five studies compared traditional food intake between genders and 3 of these also compared traditional food intake by gender across different age brackets. There were no consistent findings to report a difference in traditional food intake between males and females.

Secondary outcome measures were reported in 7 studies and findings also varied widely. There was heterogeneity in the way frequency of traditional food intake was reported—for example, the number of traditional food items consumed per day (61), the number of times traditional foods were consumed per year (70), and the proportion of study participants consuming traditional foods more than once per day (38) or set times per month (58). Three studies reported the proportion of traditional food items compared with total foods consumed; however, reporting of this varied to consider all study participants (57), each study participant separately (50), or according to gender (51). Such heterogeneity in reporting precludes further analysis of the secondary outcome measures.

Discussion

This review aimed to explore the contribution of traditional foods to dietary energy in Indigenous population groups in high-income countries that have experienced settler colonialism in North America (Canada and the United States including Hawaii and Alaska), New Zealand, Australia, and Scandinavian countries. Greater research attention in this field was evident with a progressive increase in the number of studies conducted in each decade from the 1980s (2 articles) to 2010s (22 articles). Among the Indigenous Peoples groups studied and included in this review, traditional foods were reported to contribute importantly to individuals' diets, but the majority of energy intake was provided through store-bought foods. This is consistent with the findings of previous studies that suggest that settler colonialism and lack of sovereignty over traditional lands and natural resources has had a dramatic impact on traditional food intake globally for Indigenous populations (34, 76, 77). The shift from traditional foods, which are nutrient-dense, to diets that contain higher amounts of fat, sugar, and salt and

TABLE 3 Study characteristics and findings[1]

Dates of data collection; first author, year (reference)	Region	Indigenous Peoples[2]	Age groups	Gender	Sample size, *n*	Dietary assessment measure	Primary outcome key findings: %E traditional food; secondary outcome key findings (if stated)	Similar datasets
Australia								
Oct 1979–Nov 1980; Altman, 1984 (18)	Mann-Liverpool Rivers region, north-central Arnhem Land, Northern Territory	Eastern Gunwinggu People	Not specified	Not specified	31 (range 18–44)	Weighed food record	46.2% (SD 9.5%)	—
Canada								
Jun 1985; Szathmary, 1987 (35)	Northwest Territories	Dogrib Indians	<36 to ≥76 y	Males, females	146	24-h recall (conducted once); FFQ (total items: 116, TF items: 18, "usual" winter intake)	24-h recall: Average: 68.3% Rae: 55%, Snare Lake: 66%, Lac La Matre: 76%, Rae Lakes: 76% FFQ: Rae: 66%, Snare Lake: 75%, Lac La Matre: 79%, Rae Lakes 78% <46 y: 54%, 46–65 y: 64%, >65 y: 80%	—
1987–1988; Kuhnlein, 1995 (54)	Baffin, Broughton Island	Baffin Inuit	≥3 y	Males, females	366	FFQ (FFQ items: unclear, TF items: unclear, intake 2 mo prior); 24-h recall (conducted 6 times)	24-h recall (mean ± SD): Seasonal average: Female: 34%, male: 38% 20–40 y: women, 25.2 ± 25.8; men, 30.9 ± 26.3 41–60 y: women, 43.5 ± 24.8; men, 49.2 ± 28.7 >60 y: women, 46.2 ± 29.2; men, 42.6 ± 28.4	Reports on the same sample as (41)
1987–1988; Kuhnlein, 1996 (41)	Baffin Island, Qikiqtarjuaq	Baffin Inuit	≥3 y	Males, females	366	24-h recall (conducted 6 times)	Women, 34%; data not shown for men Children, 15% Teens, 18% 20–40 y: women, 29%; men, 37% 41–60 y: women, 46%; men, 51% >60 y: women, 51%; men, 47%	Reports on the same sample as (54)

(*Continued*)

TABLE 3 (*Continued*)

Dates of data collection; first author, year (reference)	Region	Indigenous Peoples[2]	Age groups	Gender	Sample size, *n*	Dietary assessment measure	Primary outcome key findings: %E traditional food; secondary outcome key findings (if stated)	Similar datasets
Jul 1987–May 1988; Berti, 1999 (59)	Baffin Island, Qikitarjuq	Baffin Inuit	>3 y, <18 y	Males, females	164	24-h recall (conducted 6 times)	3–6 y: girls, 18%; boys, 19% 7–9 y: girls, 19%; boys, 8% 10–15 y: girls, 17%; boys, 13% 16–18 y: girls, 12%; boys, 23%	Reports on a subsample of (54)
1991; Blanchet, 2000 (52)	Quebec, Nunavik, Hudson Bay, Hudson Straight and Ungava Bay	Canadian Inuit	≥18 y	Females	226	FFQ (total items: 65; TF items: 23, intake 1 y prior) (Sante Quebec Inuit Health Survey) (78)	18–39 y: 18%[3] 40+ y: 21%[3]	—
Mar–Apr 1994, Oct-Nov 1994; Receveur, 1997 (55)	Denendeh, Gwich'in, Sahtu, Dehcho, Dogrib, South Slave	Dene/Metis (Denendeh)	≥20 y	Males, females	1012	FFQ (total items: 53; TF items: 53; intake 3 mo prior); 24-h recall (conducted once)	24-h recall Range: 12–33% Median: 20%	Reports on the research program of the Indian and Northern Affairs Canada Northern Contaminants Program—Reports on Dene/Metis sample of (42) and (56)
Sep-Nov, Feb-Apr; 1994 (Denedeh), 1995 (Yukon), 1998–1999 (NWT, Labrador, Nunavut); Kuhnlein, 2004 (42)	Yukon, Northwest Territories, Nunavut, Labrador	Yukon First Nations, Dene/Metis, Inuit (Nunavut and Labrador), Inuvialuit (Northwest Territories)	≥13–20 y	Males, females	3408	FFQ (total items: unclear, TF items: unclear); 24-h recall (conducted once)	24-h recall Range: 10.5–36.0% Median: 23.25% Yukon: 17%; Dene/Metis: 21%; Inuit: 28%	Reports on the research program of the Indian and Northern Affairs Canada Northern Contaminants Program—Adult sample reported in (56)

(*Continued*)

TABLE 3 (*Continued*)

Dates of data collection; first author, year (reference)	Region	Indigenous Peoples[2]	Age groups	Gender	Sample size, *n*	Dietary assessment measure	Primary outcome key findings: %E traditional food; secondary outcome key findings (if stated)	Similar datasets
Sep-Nov, Feb-Apr; 1994 (Denedeh), 1995 (Yukon), 1998–1999 (NWT, Labrador, Nunavut); Kuhnlein, 2007 (56)	Yukon, Northwest Territories, Nunavut, Labrador	Yukon First Nations, Dene/Metis, Canadian Inuit	≥10 y	Males, females	3851	24-h recall (conducted once) + FFQ of TF only	Range: 17–28% Median: 22.5% Yukon: 17% Dene/Metis: Adults: 21% Children 10–12 y: 4.5% Inuit: Adults: 28% Teens 15–19 y: 15%	Reports on the research program of the Indian and Northern Affairs Canada Northern Contaminants Program—Adult sample reported in (42); children's sample reported in (57)
Data collection date not specified; Wein, 1995 (60)	Yukon, Old Crow, Teslin, and Whitehorse	Vuntut Gwich'in people (Old Crow), Champagne-Aishihik First Nations (Haines Junction), Teslin Tlingit First Nations (Teslin), First Nations (Whitehorse)	19–96 y	Males, females	122	24-h recall (conducted 4 times)	Overall 17% Haines Junction: 19%; Old Crow: 19%; Teslin: 18%; Whitehorse: 14%	—
Sep-Nov (data collection year not specified); Wein, 1996 (61)	Yukon, Old Crow, Teslin, and Whitehorse	Vuntut Gwich'in People (Old Crow), Champagne-Aishihik First Nations (Haines Junction), Teslin Tlingit First Nations (Teslin), First Nations (Whitehorse)	≥18 y	Males, females	121	24-h recall (conducted once)	19% Secondary outcome: frequency of TF intake 3.7 times/d	Fall season data only from (60)

(*Continued*)

TABLE 3 (*Continued*)

Dates of data collection; first author, year (reference)	Region	Indigenous Peoples[2]	Age groups	Gender	Sample size, *n*	Dietary assessment measure	Primary outcome key findings: %E traditional food; secondary outcome key findings (if stated)	Similar datasets
Feb-Mar and Oct-Nov (data collection year not specified); Wein, 1998 (62)	Northwest Territories	Canadian Inuit (Sanikiluaq)	>19 y	Males, females	48	24-h recall (conducted 2 times)	47% Older men: 56%; younger men: 33%; older women: 63%; younger women: 25%	—
1998–1999 and 2007–2008; Sheikh, 2011 (63)	Inuvialuit Settlement Region, Nunavut's Kitikmeot, Kivaliq, and Qikiqtaaluk [Baffin] Regions and Labrador (1999); Inuvialuit Settlement Region, Nunavut Territory, and Nunatsiavut Region (N. Labrador) (2008)	Canadian Inuit	≥15 y (1999), ≥18 y (2008)	Males, females	1929; 1476 had 24-h recall data (1999); 2595; 955 had 24-h recall data (2008)	24-h recall (conducted once)	1999: 23.4% 2008: 16.1%	Reports on Canadian IPY Inuit Health Survey 2007–2008 data and the research program of the Indian and Northern Affairs Canada Northern Contaminants Program
Nov-Jan 2000–2001, Aug-Oct 2001; Nakano, 2005 (57)	Yukon, Denendeh, Old Crow, Fort McPherson, Tulita, Carcross, Fort Resolution	Dene/Metis, Yukon First Nations	10–12 y	Males, females	222	24-h recall (conducted 2 times)	4.5% Secondary outcome: 14.6% of total foods consumed were TF	Reports on the research program of the Indian and Northern Affairs Canada Northern Contaminants Program; children's sample reported in (56)

(*Continued*)

TABLE 3 (*Continued*)

Dates of data collection; first author, year (reference)	Region	Indigenous Peoples[2]	Age groups	Gender	Sample size, *n*	Dietary assessment measure	Primary outcome key findings: %E traditional food; secondary outcome key findings (if stated)	Similar datasets
Sep and Dec 2006; Sharma, 2009 (34)	Northwest Territories	Canadian Inuvialuit	≥19 y	Males, females	101	24-h recall (conducted once)	14%	Reports on the Healthy Foods North Program
2006–2010; Gagne, 2012 (64)	The Arctic, Nunavik, Inukjuak, Kuujjuaq, Kangiqsujuaq, Kangiqsualu-jjuaq, Salluit, Kuujjuarapik, Quaqtaq, Umiujaq, Ivujivik, Akulivik	Canadian Inuit	1–4 y	Males, females	217	24-h recall (conducted once)	2.6%[4]	—
Jun-Nov 2007–2008; Johnson-Down, 2010 (58)	Nunavut, Nunatsiavut, Inuvialuit Settlement Region	Canadian Inuit	3–5 y	Males, females	381	FFQ (total items: 46; TF items: 30, intake 1 mo prior); 24-h recall (conducted once, conducted 2 times for 20% of participants)	24-h recall 8.4% ± 13% Secondary outcome: frequency of TF intake: <5 times per month: 13%; >30 times per month: 33%	Reports on Canadian IPY Inuit Health Survey 2007–2008 data
2007–2008; Egeland, 2011 (43)	Nunavut, Nunatsiavut, Inuvialuit Settlement Region	Canadian Inuit	≥18 y	Males, females	2595	24-h recall (conducted once)	29.2%[5]	Reports on Canadian IPY Inuit Health Survey 2007–2008 data; male sample reported in (65)

(*Continued*)

TABLE 3 (*Continued*)

Dates of data collection; first author, year (reference)	Region	Indigenous Peoples[2]	Age groups	Gender	Sample size, *n*	Dietary assessment measure	Primary outcome key findings: %E traditional food; secondary outcome key findings (if stated)	Similar datasets
Jun-Nov 2007–2008; Jamieson, 2012 (65)	Nunavut, Nunatsiavut, Inuvialuit Settlement Region	Canadian Inuit	≥18 y	Men	805	FFQ (total items: unclear; TF items: unclear, intake 1 y prior); 24-h recall (conducted once)	24-h recall[5] 9.8%	Reports on Canadian IPY Inuit Health Survey 2007–2008 data; male sample of (43)
Aug-Nov 2007 and Aug-Nov 2008; Zienczuk, 2012 (66)	Northwest Territories, Nunavut, and Nunatsiavut	Canadian Inuit	≥18 y	Males, females	2097	24-h recall (conducted once)	Sample where 26.0% of total energy intake from CHO: 38.2% (SD 27.4) Sample where 41.5% of total energy intake from CHO: 16.0% (SD 16.9) Sample where 52.5% of total energy intake from CHO: 8.46% (SD 10.9)	Reports on Canadian IPY Inuit Health Survey 2007–2008 data
Aug-Sep 2007, Aug-Oct 2008; El Hayek Fares, 2018 (67)	Nunavut, Northern Labrador, Nunatsiavut, Inuvialuit Settlement Region	Canadian Inuit	>18 y	Females (lactating)	34	FFQ (total items: unclear; TF items: unclear, intake 1 y prior); 24-h recall (conducted once)	24-h recall 11.3%	Reports on Canadian IPY Inuit Health Survey 2007–2008 data
Aug-Nov 2007, 2008; Kenny, 2018 (40)	Inuvialuit Settlement Region, Nunavut Territory (Kitikmeot, Qikiqtaaluk, Kivaliiq), Nunatsiavut, Northern Labrador	Canadian Inuit	≥18 y	Males, females	2095	24-hr recall (conducted once)	Range: 6.4–19.6% Median: 13%	Reports on Canadian IPY Inuit Health Survey 2007–2008 data

(*Continued*)

TABLE 3 (*Continued*)

Dates of data collection; first author, year (reference)	Region	Indigenous Peoples[2]	Age groups	Gender	Sample size, *n*	Dietary assessment measure	Primary outcome key findings: %E traditional food; secondary outcome key findings (if stated)	Similar datasets
Jul 2007, Jul 2008; Rittmueller, 2012 (33)	Northwest Territories: 3 NWT communities	Canadian Inuvialuit	>19 y	Males, females	218	QFFQ (total items: 142; TF items: unclear; intake 30 d prior)	Nonsmokers: Land foods: 9.4% Sea foods: 3.7% Sky foods: 2.3% Smokers: Land foods: 7.8% Sea foods: 3.1% Sky foods: 2.0%	Reports on the Healthy Foods North Program
Jul 2007, Jul 2008; Rittmueller, 2012b (32)	Northwest Territories: 3 NWT communities	Canadian Inuvialuit	>19 y	Males, females	216	QFFQ (total items: 142; TF items: unclear, intake 30 d prior)	Alcohol consumers: Land foods: 7.3% Sea foods: 3.0% Sky foods: 1.9% Non–alcohol consumers: Land foods: 9.4% Sea foods: 3.6% Sky foods: 2.3%	Reports on the Healthy Foods North Program
Date of data collection not specified (Jul 2007-Jul 2008 as per Sharma 2010 study protocol) (79); Kolahdooz, 2014 (44)	Beaufort Delta region, Northwest Territories: 3 NWT communities	Canadian Inuit	≥19 y	Males, females	213	QFFQ (total groups: unclear; TF groups: 3; intake 30 d prior)	11%	Reports on the Healthy Foods North Program
Jul 2007-Jul 2008; Sheehy, 2015 (45)	Northwest Territories: 3 NWT communities	Canadian Inuvialuit	≥19 y	Males, females	218	QFFQ (total items: 142; TF items: 7; intake 30 d prior)	Nontraditional[6]: 3.3% Traditional: 20.7%	Reports on the Healthy Foods North Program

(*Continued*)

TABLE 3 (*Continued*)

Dates of data collection; first author, year (reference)	Region	Indigenous Peoples[2]	Age groups	Gender	Sample size, *n*	Dietary assessment measure	Primary outcome key findings: %E traditional food; secondary outcome key findings (if stated)	Similar datasets
2008; Erber, 2010 (68)	The Arctic Northwest Territories, Beaufort Delta Region (1 community in NWT)	Canadian Inuvialuit	≥19 y	Males, females	64	24-h recall (conducted up to 3 times)	9%	Reports on the Healthy Foods North Program
Date of data collection not specified (Jun-Oct 2008, as per Sharma 2010 protocol) (79); Sharma, 2010 (69)	Nunavut, 2 communities	Canadian Inuit	≥19 y	Males, females	83	24-h recall (conducted once)	14%	Reports on the Healthy Foods North Program
Jun-Oct 2008; Schaefer, 2011 (46)	Nunavut	Canadian Inuit	≥19 y	Females	106	QFFQ (total items: 150; TF items: 39; intake 1 y prior)	21%	Reports on the Healthy Foods North Program
Jul-Oct 2008; Sharma, 2013 (47)	Nunavut, 3 communities	Canadian Inuit	≥19 y	Males, females	208	QFFQ (total items: 150; TF items: unclear; intake 30 d prior)	Overall: 21% Land foods: 11.7% Sea foods: 8.9%	Reports on the Healthy Foods North Program
Jun-Oct 2008; Sheehy, 2015b (48)	Nunavut; Kitikmeot region (3 communities)	Canadian Inuit	≥19 y	Males, females	208	QFFQ (total items: 142; TF items: 7; intake 30 d prior)	Nontraditional[6]: 7.4% Traditional: 27.2%	Reports on the Healthy Foods North Program

(*Continued*)

TABLE 3 (*Continued*)

Dates of data collection; first author, year (reference)	Region	Indigenous Peoples[2]	Age groups	Gender	Sample size, *n*	Dietary assessment measure	Primary outcome key findings: %E traditional food; secondary outcome key findings (if stated)	Similar datasets
2008–2013; Batal, 2018 (38)	British Columbia, Alberta, Manitoba, Ontario	Canadian First Nations living on reserves	≥19 y	Males, females	3700; men = 1379, women = 2321	24-h recall (conducted once)	3.41% Secondary outcome: Frequency of TF intake >1 time/d: 22.7%; females: 21.5%; males: 24.7%	Reports on a subsample of (39)
Date of data collection not specified; Atikesse, 2010 (70)	Newfoundland, Labrador, Sheshatshiu	Canadian Inuit	≥18 y	Males, females	Phase 1: 118; phase 2: 161[7]	FFQ (total items: unclear; TF items: 27; intake 1 y prior); 24-h recall (conducted once)	24-h recall 26% Secondary outcome: frequency of TF intake Women: 54 times per year Men: 64 times per year	—
Nov 2011-Nov 2012; Fox, 2015 (53)	Northern Quebec, Nunavik	Canadian Inuit	All	Males, females	200	FFQ (total items: 108; TF items: 31; intake 1 y prior)	11%	—
Sep-Dec 2011–2012; Juric, 2018 (39)	Ontario	Canadian First Nations living on reserves	≥19 y	Males, females	1429	FFQ (total items: 143; TF items: 143; intake 1 y prior); 24-h recall (conducted once)	24-h recall 1.8%	Reports on a subsample of (38)
Mar-Apr, Jun-Jul, Aug-Sep 2014; Calder, 2019 (51)	Labrador, Lake Melville Region	Labrador Inuit	Not specified	Males, females	1145	FFQ (total items: 88; TF items: 64; intake 3 mo prior)	2%[4] Secondary outcome: Women: 1.4% of total foods consumed were TF Men: 1.9% of total foods consumed were TF	—

(*Continued*)

TABLE 3 (*Continued*)

Dates of data collection; first author, year (reference)	Region	Indigenous Peoples[2]	Age groups	Gender	Sample size, *n*	Dietary assessment measure	Primary outcome key findings: %E traditional food; secondary outcome key findings (if stated)	Similar datasets
Canada and Greenland								
2004–2005; Counil, 2008 (31)	Nunavik/Disko Bay	Canadian Inuit/Greenlandic Inuit	≥18 y	Males, females	640	FFQ (total items: 67; TF items: 23; time period not specified) (used for Greenland sample only); 24-h recall (Nunavik only—conducted once)	Disko Bay: 18–24 y: 10.6% 65+ y: 27.9% Nunavik: Youth: 9.8% 55–64 y: 32.2% 65+ y: 28.2%	—
Greenland								
1976, 1987, 2004, 2006; Deutch, 2007 (71)	Uummannaq, Narsaq	Greenlandic Inuit	Middle-aged (exact age range not specified)	Males, females	32[8]	Duplicate diet	Median: 25% Uummannaq (1976): 41% (range = 11–86%) Qaanaaq (1987): 25%(range = 12–43%) Uummannaq (2004): 13.4% Narsaq (2006): 9.4%	—
1999–2003; Deutch, 2005 (49)	Ittoqqortoormiit, Tasiilaq, Uummannaq, Quaanaaq, Sisimiut	Greenlandic Inuit	18–49 y	Males, females	355	FFQ (total items: 60; TF items: 35; intake 1 y prior); adapted from (80)	21% Women: 22.6% Men: 19.1%	—
2005–2010; Jeppesen, 2014 (37)	Nine towns and 13 villages across Greenland	Greenlandic Inuit	≥18 y	Males, females	2374	FFQ (total items: 68; TF items: 25; TF intake 30 d prior)	Women: 19% Men: 22%	—

(*Continued*)

TABLE 3 (*Continued*)

Dates of data collection; first author, year (reference)	Region	Indigenous Peoples[2]	Age groups	Gender	Sample size, *n*	Dietary assessment measure	Primary outcome key findings: %E traditional food; secondary outcome key findings (if stated)	Similar datasets
United States								
Nov 2000–Sep 2003; Nobmann, 2005 (36)	Norton Sound	Inupiat Eskimo, Siberian Yupik	≥18 y	Males, females	900	FFQ (total items: 97; TF items: unclear; intake 1 y prior); adapted from (81)	Overall: 15% Men: 12.5% (17–39 y); 3.7% (40–60 y); 16% (61–92 y) Women: 10.3% (17–39 y); 15.0% (40–60 y); 13.8% (61–92 y)	—
2003–2004; Johnson, 2009 (72)	Alaska	Alaskan Yup'ik/Cup'ik, Alaska Natives, Inupiat Eskimo	≥13–88 y	Males, females	333	24-h recall (conducted 4 times)	Overall: 21% Yukon Kuskokwim region: 22.8%; Maniilaq region: 19.9%	—
Sep 2003; Bersamin, 2006 (19)	Alaska, Yukon-Kuskokwim Delta	Yup'ik Eskimo	>14 y	Males, females	92	24-h recall (conducted once)	14–19 y: 8.1% 20–39 y: 19.4% 40–81 y: 28.9%	Pilot study for (73)
Dec 2003–Mar 2005; Bersamin, 2007 (73)	Alaska, Yukon-Kuskokwim Delta	Yup'ik Eskimo	>14 y	Males, females	548	24-h recall (conducted once)	22%	
Dec 2003–Mar 2005; Bersamin, 2008 (74)	Alaska, Yukon-Kuskokwim Delta	Yup'ik Eskimo	>14 y	Males, females	312	24-h recall (conducted once); estimated 3-d food record	Median: 19% 24-h recall and weighed food record data combined	Reports on a subsample of (73)
Jun-Aug 2006; Ballew, 2006 (30)	Alaska; 5 tribal health corporations: Norton Sound Health Corporation, Yukon-Kuskokwim	Yup'ik Alaskan Natives	≥13 y	Males, females	655	FFQ (total items: 157; TF items: unclear; intake 1 y prior)	20%	—

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TABLE 3 (*Continued*)

Dates of data collection; first author, year (reference)	Region	Indigenous Peoples[2]	Age groups	Gender	Sample size, *n*	Dietary assessment measure	Primary outcome key findings: %E traditional food; secondary outcome key findings (if stated)	Similar datasets
	Health Corporation, Bristol Bay Area Health Corporation, Tanana Chiefs Conference, Southeast Alaska Regional Health Corporation							
Sep 2014 and Jun 2015; Walch, 2018 (75)	Alaska, Anchorage	Alaskan Natives	>18 y	Females	73	FFQ (total items: unclear; TF items: unclear; intake 1 y prior); 24-h recall (conducted 2 times)	4% (SD + 3%)	—
Date of data collection not specified; Giordano, 2015 (50)	Southwestern Alaska	Yup'ik Peoples	41–80 y	Female	10	FFQ (total groups: 20; TF groups: 10)	31% Secondary outcome: Participant 1, 40–44 y: 15% of total foods consumed were TF; participant 2, 40–44 y: 49%; participant 3, 45–50 y: 50%; participant 4, 45–50 y: 10%; participant 5, 45–50 y: 33%; participant 6, 45–50 y: 8%; participant 7, 55–80 y: 52%; participant 8, 60–65 y: 53%; participant 9, 65–70 y: 65%; participant 10, 75–80 y: 72%	—

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TABLE 3 *(Continued)*

Dates of data collection; first author, year (reference)	Region	Indigenous Peoples[2]	Age groups	Gender	Sample size, *n*	Dietary assessment measure	Primary outcome key findings: %E traditional food; secondary outcome key findings (if stated)	Similar datasets
Date of data collection not specified; Sharma, 2015 (76)	Alaska, Bethel, Wade Hampton	Yup'ik Peoples	≥18 y	Female	82	24-h recall (conducted up to 3 times; 17% completed 3 recalls)	17%	—

[1]CHO, carbohydrate; FFQ, food-frequency questionnaire; IPY, International Polar Year; NWT, Northwest Territories; QFFQ, quantitative food-frequency questionnaire; TF, traditional food; %E, percentage of energy.
[2]Indigenous Peoples are identified by the terms used in the article. Authors acknowledge that terms used to identify Indigenous Peoples change over time.
[3]Energy intake from reported traditional food reported as a percentage of Recommended Nutrient Intakes (RNIs).
[4]Energy intake from traditional food as a percentage of estimated energy expenditure derived from self-reported weight and height data.
[5]Energy intake from traditional food relative to total energy reported for traditional food consumers.
[6]Nontraditional eaters defined as those who consumed <300 g TF daily.
[7]Phase 1 consisted of an FFQ; phase 2 consisted of a 24-h recall.
[8]Thirty-two participants made up of 16 married couples. Also refers to FFQ; however, not clear on how data are used.

low nutrient densities, has negatively impacted the health of Indigenous population groups (77, 82). This has contributed to the current high prevalence of health conditions such as obesity, type 2 diabetes, cardiovascular diseases, chronic kidney diseases, some cancers, and inflammation, which were previously uncommon in Indigenous populations (42, 83–86). Higher reported consumption of traditional food can coincide with a higher-quality diet containing rich sources of key nutrients—for example, PUFAs (75, 87). A higher amount of traditional food intake has also been associated with lower BMI in Indigenous populations (66, 70). Traditional foods are also intrinsically linked to Indigenous Peoples' cultural connectedness and have an important role in maintaining social, emotional, spiritual, and physical health (8, 88). Policy interventions designed by and with Indigenous Peoples to therefore increase access to and connection with traditional foods hold potential to reduce the prevalence of diet-related chronic diseases (77, 89).

There appeared to be a trend of decreasing contribution of traditional food to energy over time; however, this cannot be determined without a longitudinal study design, studies that are representative of whole populations, and standardized dietary assessment methods across studies. A decrease in the contribution of traditional food to energy, from 23.4% to 16.1%, was reported among Canadian First Nations Peoples surveyed in both 1999 and 2008 (63). A pattern of younger generations consuming less traditional foods than older generations was found among studies reporting on this. This generational difference has been attributed to a reduction in the passing of knowledge from one generation to the next (90, 91). Many other factors have been attributed to the decreasing contribution of traditional food to energy experienced with settler colonization. Urbanization of Indigenous Peoples in Canada is reported as coinciding with diminished practice of hunting and harvesting traditions (16, 23, 92). Traditional practices have been inhibited by the irregular migration of animals, with families reporting these practices to no longer be a feasible part of their lifestyle (93, 94). While there is an abundance of knowledge around the benefits of traditional food in Indigenous populations, barriers such as lack of employment income, high license fees to access traditional food, and lack of availability of traditional food have also been reported as reducing the likelihood of regular traditional food consumption (75, 95, 96). Continuity of traditional food practice is important for cultural continuity and for sustaining all populations as vast food biodiversity knowledge rests with Indigenous Peoples, who are estimated to be custodians of 80% of the planet's biodiversity (97, 98).

Based on the criteria of inclusion of articles in this review, Canada has shown the greatest interest in traditional food research since the 1980s and, apparent from this review, has provided funding to the area, in comparison to other countries where funding has been limited (51, 99). Concern about the impact on traditional food sources of environmental contamination and climate change (51, 99) has resulted in funding directed to research on traditional food intake in Canada and the Arctic regions. Fourteen studies in this review were funded due to concern about the effect of environmental contaminants on the traditional food supply. Indigenous Peoples, particularly in the Arctic regions, have been found to be at greater risk of exposure to environmental contaminants such as mercury due to relatively greater consumption of large marine species (51). Guidelines to minimize contaminant exposure while maintaining nutrition sufficiency through consumption of traditional foods are thought to be an important factor in

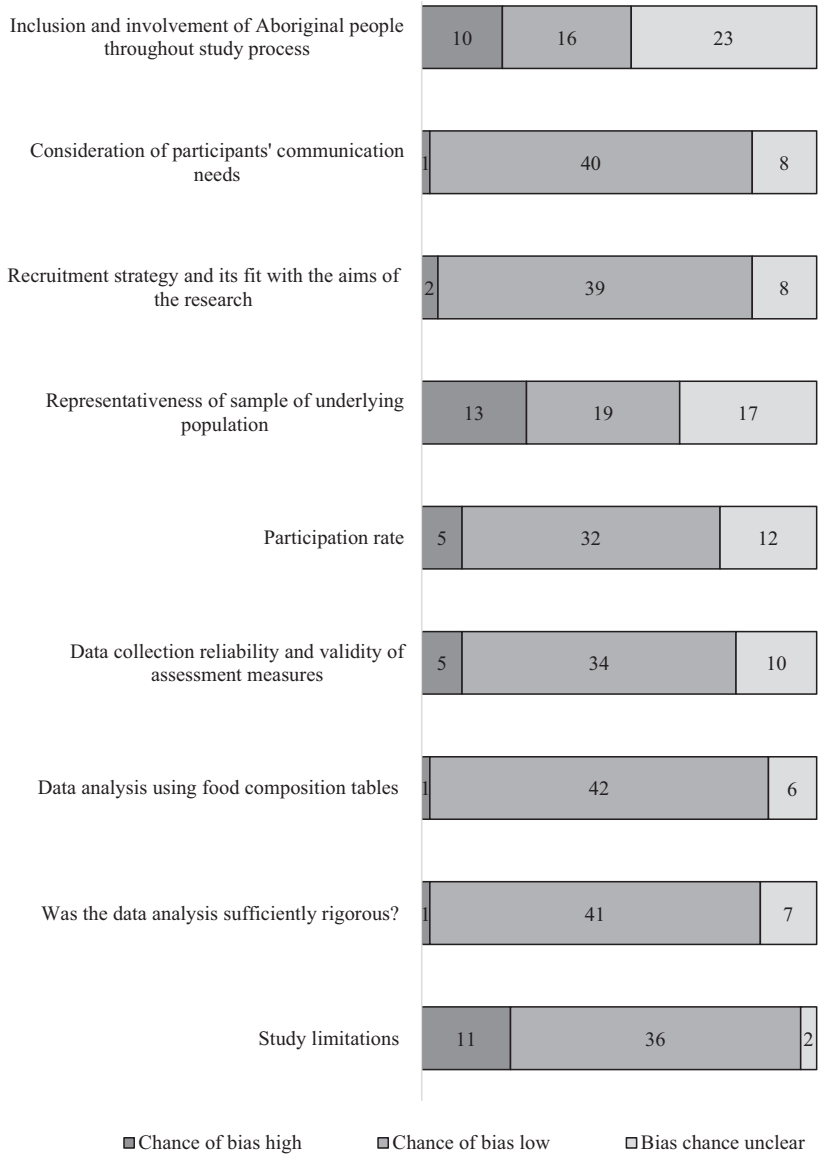

FIGURE 2 Quality assessment: number of studies related to potential bias.

mitigating such risks (100). In Canada, changes in ice breakup or freezing as well as erosion have reduced wildlife species abundance (101). Unsafe travel to areas of harvest due to weather changes and shorter seasons is a significant barrier faced by Indigenous populations and has impacted food security (101). The implications of environmental degradation and climate change for Indigenous Peoples' traditional food practices are far-reaching globally. Indigenous Peoples' leadership and participation in research and policy development for climate change mitigation and adaptation is paramount (93).

This review critiqued the quality of the methods used to assess dietary intake of traditional foods among Indigenous population groups of North America (Canada and the United States including Hawaii and Alaska), New Zealand, Australia, and Scandinavian countries. The risk-of-bias and quality assessment was based on the authors' judgment of information provided in study reporting and associated materials sourced (e.g., protocol papers).

Indigenous Peoples' direction and input in research decision making is an important aspect of Indigenous Peoples' rights and impacts on the quality of data collection (102–105). While 23 studies had unclear reporting of involvement of Indigenous Peoples in the conception and design of studies, conduct of research and collection, and distribution of results, clearer reporting of this became more prominent in more recent years. The involvement of Indigenous Peoples when developing FFQs, which assess a prespecified list of foods, impacts their accuracy as a dietary assessment tool (106). Extensive knowledge around the specifics of animal and plant species available, seasonality changes, and procurement techniques in addition to appropriate data collection procedures is needed to ensure reliable data collection (107). Some studies included

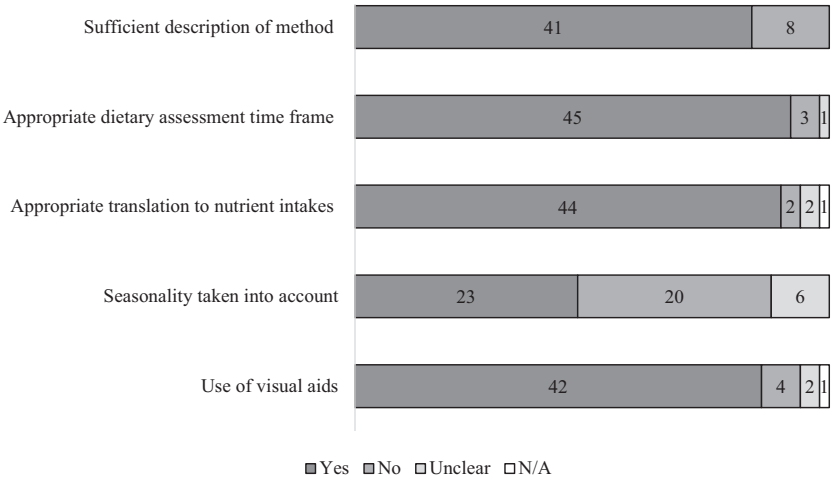

FIGURE 3 Quality assessment: number of studies related to dietary tools criteria. N/A, Not Applicable.

in this review, however, lacked involvement of Indigenous Peoples, with many only consulting the population after conception of the study or for data collection, which poses a question around the validity and reliability of data. Guidance from Indigenous Peoples is also essential in preventing assumptions about food items, animal parts, and preparation techniques considered as traditional. For example, 1 study in this review included store-bought foods such as tea, sugar, and flour in their reporting of traditional foods (35). Different countries have developed guidelines for the ethical conduct of research with Indigenous Peoples that can guide the inclusion of local knowledge and participation of Indigenous Peoples in dietary assessment tool development and testing (108, 109). There is also mounting Indigenous scholarship on the leadership and involvement of Indigenous Peoples in research that is shaping the appropriate conduct of research with Indigenous Peoples (110).

Primarily, studies used 24-h dietary recall and FFQs to measure whole diets and the majority of studies were rated low risk of bias for use of a dietary assessment tool that had been validated and/or tested for reliability. Few studies, however, rigorously assessed the reliability and validity of reported dietary intakes or used a tool that had been previously found to have good validity and/or reliability. Indeed, 1 FFQ used by 7 studies and rigorously tested against 24-h dietary recall had been previously found to overestimate nutrient intake (111). Such an overestimation, however, may not impact estimation of traditional food to energy if the FFQ overestimates traditional food and store-bought food intake equally. Issues regarding the reporting of validity and reliability of dietary assessment methods do, however, highlight the importance of the use of robust assessment methods and reporting of factors that may limit the accuracy of the assessment (35).

Self-reported measures also tend to underreport energy intake, particularly foods considered to be less healthy such as store-bought confectionaries and sweetened beverages (112). Memory-recall limitations can also impact the accuracy of dietary assessment. The reference periods in dietary assessment instruments, such as FFQs that aim to measure usual intake, can vary in length—for example, from 30 d to 12 mo—which can result in recall bias and skewed estimations of participants' actual consumption patterns, and thus lead to inaccuracies in estimating whole diets (113). Intentional or unintended omission or addition of foods may further skew data—for example, FFQs may be limited in terms of species coverage. Using visual aids and food models can assist in prompting memory and may reduce under- or overreporting (114, 115); 42 studies in this review reported the use of these. Food-composition tables utilized in articles were indicated by authors to exclude various food-preparation methods of traditional food and were limited in terms of different species covered, which limits the accuracy of dietary analysis findings. This review highlights the need for comprehensive nutrient-composition data that adequately capture the diversity of plant and animal species and food-preparation techniques used by Indigenous Peoples to more accurately assess nutrient intake from traditional foods.

Food items included in an FFQ such as beverages and condiments are difficult to measure precisely (107). In addition to this, the sharing of food is a common custom in many Indigenous population groups, and difficulty can be experienced when recalling the amount of food consumed when communally shared (116). Methods such as weighed food records and duplicate diet samples, used in 2 studies included in this review (18, 71), are more accurate and have the potential to minimize this risk of bias when measuring traditional food consumption. These dietary assessment methods, however, are more intensive, with greater participant burden, limiting their feasibility in population-wide studies. A more standardized method of assessing traditional food intake is needed in order to draw reliable conclusions about traditional food consumption for different Indigenous population groups and globally.

Seasonality impacts importantly on the availability of traditional food and therefore impacts its contribution to dietary energy and estimation of intake (41). Approximately half of the studies ($n = 23$) took seasonality into account—for example, by including traditional food items available across seasons in an FFQ or by repeating 24-h dietary recalls across multiple seasons of the year. Of those studies that did not do this, 6 discussed it as a limitation. Some studies specifically chose to conduct a 24-h recall in the fall season as this was recognized as a time of plentiful traditional food availability (38, 61).

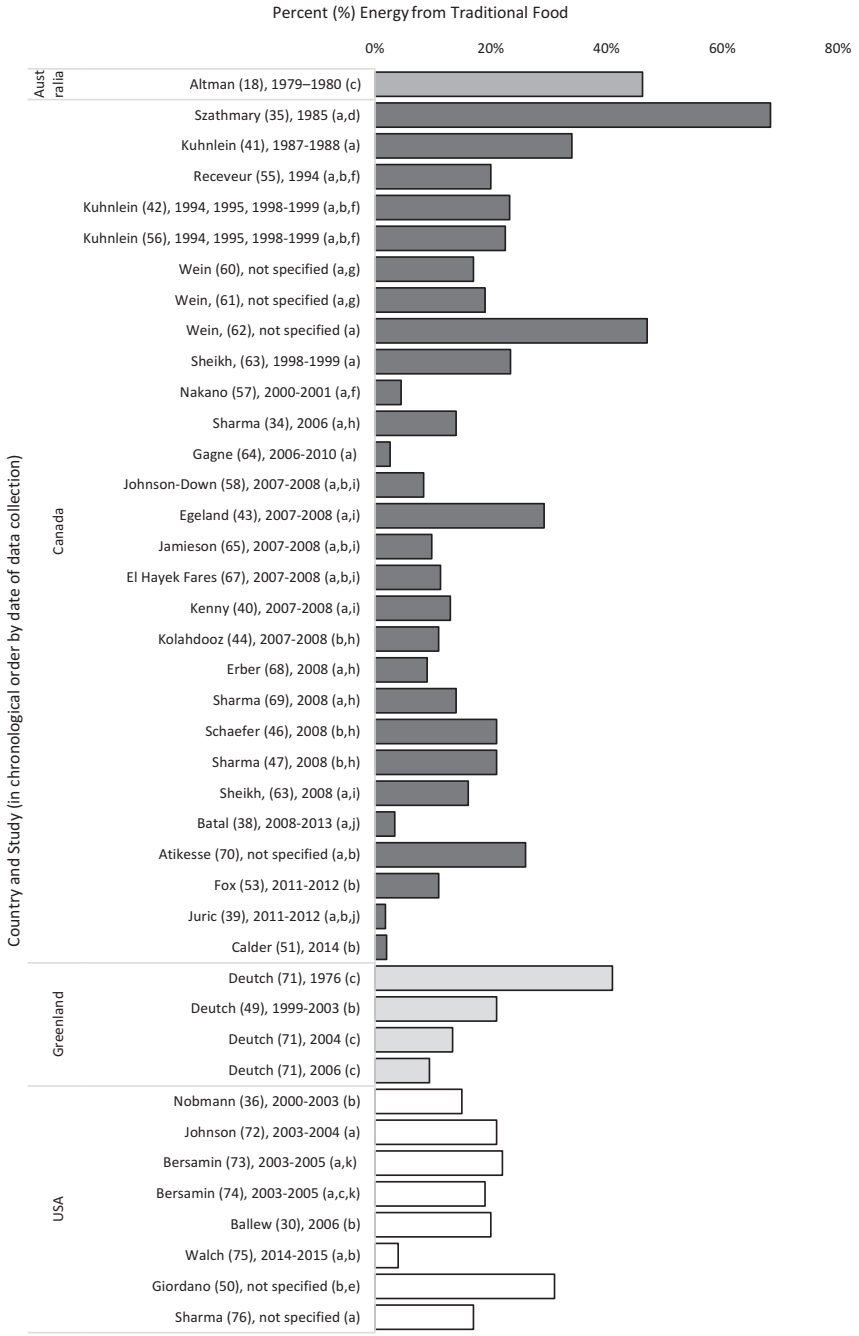

FIGURE 4 Percentage of energy contribution of traditional food to the total diet, by date of data collection. (a) Twenty-four-hour recall. (b) Food-frequency questionnaire. (c) Other method of dietary assessment. (d) Store-bought foods included in reporting of traditional food. (e) Dietary assessment was retrospective, 20–40 y. (f) Studies report on the research program of the Indian and Northern Affairs Canada Northern Contaminants Program. (g) Studies report from the same study. (h) Studies report on the Healthy Foods North Program. (i) Studies report on Canadian International Polar Year Inuit Health Survey 2007–2008 data. (j) Studies report from the same study. (k) Studies report from the same study.

Limitations

Caution must be applied in making generalizations about the utilization and consumption of traditional foods in the countries where there is a scarcity of data. Most eligible studies originated from Canada and the United States. No publications for New Zealand, Hawaii, or mainland Scandinavian countries met the inclusion criteria, and only 1 study published in 1984 met the criteria for Australia. Yet, traditional food is known to contribute significantly to the diet of many Indigenous Peoples groups in these countries (77, 117–119). Gray literature and non–peer-reviewed work were not included in this review, which limited

its scope as unpublished work may have an important contribution to the topic. Limiting the search to high-income, settler-colonized countries of North America (Canada and the United States including Hawaii and Alaska), New Zealand, Australia, and/or Scandinavian countries excludes studies among Indigenous populations in other high-income countries such as those in the Caribbean, South Pacific, Asia, South America, and Africa that have experienced colonization. The countries included in this review, however, have access to similar resources to address these effects. The populations sampled in the studies included were not representative of all the Indigenous Peoples of the countries chosen, with articles focusing on discrete areas or locations that cannot be extrapolated to whole-country populations in order to draw conclusions. The articles included within this review were heterogeneous with regard to reporting outcomes, dietary assessment methods, and different Indigenous population groups studied, thus precluding commentary pertaining to the change in global traditional food consumption over time. A meta-analysis was not feasible due to this heterogeneity; in most studies, there were not sufficient data to calculate the variance of a sample, with just 3 studies reporting SDs for the primary outcome measure. The heterogeneity in dietary assessment methods and definitions of traditional food also precluded comparison between the energy contributions of different types or species of traditional foods—for example, animal compared with plant foods or land compared with sea species—which may have offered new and interesting insights. The assessment of risk of bias and quality assessment is a subjective assessment made by the review authors based on reported information. It is hoped that the reporting of this assessment can inform the methodological conduct of future studies.

The primary outcome used to select studies for this review was a robust measure that enabled comparison across 49 studies. This choice of outcome measure, however, excluded other studies that investigated traditional food intake from the review. For example, countries with less representation in this specific review (Australia and mainland United States) have produced studies regarding frequency of traditional food intake (117, 120) and on the importance of traditional food intake (121). Traditional foods are nutrient-dense and consuming even small amounts can contribute importantly to dietary quality. In addition to this, investigating the caloric contribution of traditional food alone fails to consider other important spiritual, cultural, economic, physical, social, and mental well-being benefits of traditional food to Indigenous populations.

Conclusions

This review has endeavored to investigate the contribution of traditional food energy intake in the context of whole diets among Indigenous Peoples in high-income countries of North America (Canada and the United States including Hawaii and Alaska), New Zealand, Australia, and Scandinavia that have experienced settler colonialism. A wide contribution of traditional food to dietary energy was found across studies and countries. The specific primary outcome measure has limited this review's scope in describing the extent of change in the consumption of traditional food among Indigenous Peoples globally. Broadly, however, this review has recognized a decline in traditional food consumption and provides a perspective on changes that have occurred in the past 4 decades among Indigenous Peoples groups in Canada, the United States, and Greenland in particular. Patterns of intake were seen across studies in this review, with traditional food consumption generally more prevalent in older age groups, and a decline in consumption attributed by the authors to factors such as urbanization, environmental contamination of traditional food sources, and decreased accessibility. This review highlights the need for guidelines developed with Indigenous Peoples for dietary measurement of traditional food. More comprehensive global research in this area is needed to support alternative pathways to redress a decline in traditional food consumption, due to its beneficial outcomes for Indigenous populations and the planet.

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