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REVIEW ARTICLE

Initiatives and exposures associated with food security in remote and isolated communities: a scoping review

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ETHICS APPROVAL

This is a review article, and therefore does not include ethics permissions.

ABSTRACT:

Introduction: Chronic household food insecurity (HFI) and lack of food availability and accessibility in isolated communities are longstanding public health crises. This review aims to paint a more fulsome picture of food security initiatives in remote and isolated communities by examining programs across circumpolar countries, Australia, and Aotearoa New Zealand. This synthesis of research will contribute to an understanding of what types of initiatives exist and aid in the identification of best practices.

Methods: The authors conducted a scoping review identifying articles that include either (1) an evaluation of an initiative with a quantitative food security outcome in remote and isolated communities, or (2) quantitative associations between exposure factors with food security outcomes. Inclusion criteria included English and French articles focused on remote and isolated communities in Canada, the US, Australia, New Zealand, Sweden, Norway, Finland, Greenland, and Russia from January 1997 to July 2022.

Results: The article search yielded 1882 results, of which 96 fulfilled the inclusion criteria, including 26 studies evaluating initiatives, 66 studies evaluating exposure factors, and four studies that included both initiatives and exposure factors. The majority of the studies included in this review were conducted in Canada and Australia. No initiative studies conducted in Russia, Greenland, Norway, Finland, or Sweden fulfilled the criteria for inclusion in this review. The most common types of initiatives evaluated included school-based programs, market subsidies, and education initiatives, though a small number (<5) of other programs were evaluated, including traditional food programs and greenhouses. Though multiple programs resulted in lower food costs or increases in healthy food consumption in remote regions, the cost of a healthy diet in these areas remained high, as do levels of HFI. Factors associated with improved food security outcomes included higher income level, access to adequate housing, higher education level, access to transportation for harvesting, and the level of remoteness of a community. The studies included in this review also stressed the importance of access to and affordability of harvesting traditional foods in these regions.

Conclusion: Those living in remote and isolated communities are particularly vulnerable to food insecurity and lack of access and availability of healthy foods, which are compounded by a variety of socioeconomic factors. This study highlights the lack of quantitative evaluations of food security initiatives in remote and isolated communities, as well as the wide variety in measured outcomes. Authors of several of the included articles note that community-led initiatives, with strong partnerships and local champions, were recommended in these populations, given the culturally and geographically diverse groups living in remote and isolated areas.

Keywords:

food cost, food security, Indigenous, interventions, isolated, traditional foods.

FULL ARTICLE:

Introduction

Chronic household food insecurity (HFI) and lack of food availability and accessibility in isolated communities are longstanding public health crises. HFI, which describes inadequate food access, availability, and utilization due to insufficient financial resources[1], is an important social determinant of health, associated with a number of adverse health outcomes, even at marginal levels[2]. Other aspects of food security, such as the availability of and physical access to healthy foods, are uniquely challenging to achieve in remote regions[3].

Though this review focuses on all community members in remote communities, it is noteworthy that HFI prevalence is higher in some population groups, including those who identify as Indigenous (see Box 1)[1]. Remote circumpolar communities include people of all demographics, but many were created or populated as a result of the forced relocation of Indigenous Peoples[4,5]. Colonial, political, and environmental forces have contributed to deep inequities in food security. For example, the 2007–2008 Inuit Health Survey within Canada found that 69% of Inuit adults living in remote northern regions were food insecure compared to the national average of 9.2%[6].

Food systems in remote circumpolar communities consist of a combination of purchased market foods and traditional foods, harvested and shared locally and sometimes regionally[4,5]. 'Traditional food' is the term more commonly used by First Nations and Métis communities, while 'country food' is generally the preferred term of Inuit. In this review, we use the term 'traditional food' to refer to traditional/country foods that are locally harvested, unless the specific study or citation being referred to exclusively uses the term 'country food'. Deep inequities have resulted in elevated levels of food insecurity in remote and Indigenous communities[7]. Further degradation of food systems has resulted due to nutritional and dietary shifts away from traditional food to highly processed store-bought foods, and have continued to perpetuate food insecurity[8,9]. Market food is often imported on airfreights that are vulnerable to the impact of increasing fuel costs and unpredictable weather[10].

The increasing costs of supplies for fishing and hunting have led to difficulties in procuring traditional foods, reducing the supply of nutritious foods in some communities as well as the ability to share this food across family and social networks[11-13]. These challenges are evidenced by a decrease in harvesting activities within the past two decades by working-age Indigenous adults in remote communities within Canada[14]. This decrease has been partially attributed to climate change, which has altered access to traditional harvesting areas, safety for harvesters while on the land, migration patterns of animals, harvest size, and contaminant levels in traditional foods[14,15].

A variety of initiatives and programs have been designed to improve food security in remote communities. Many of these initiatives are government-led, which continues to perpetuate the

negative history of Indigenous–governmental relationships[16,17]. The narrow scope of many of these initiatives may not address the systemic issues affecting food security[16]. As a result, researchers, including Indigenous scholars, have argued for a move from a discussion of food security to a dialogue focused on food sovereignty, and localized community-based initiatives to mitigate food insecurity[18,19].

'Food sovereignty' is a framework for transforming food and agriculture to ensure food security and strengthen self-sufficiency, social equity, and self-determination[20]. This emphasizes the need to place more control into the hands of those who have been systematically excluded from the formulation of food policy[21]. Beyond the components of food security, food sovereignty focuses on community involvement in food systems, and, in Indigenous populations, looks at the availability of culturally appropriate foods[22]. As such, food sovereignty can assist with creating localized food systems and tackling the food insecurity crisis that remote Indigenous populations face within Canada[23,24].

This scoping review synthesizes initiatives addressing, and modifiable factors associated with, food security in remote and isolated communities across circumpolar countries and other affluent countries with similar colonial histories and remote communities. The primary objectives of this review were to inform policy development by (1) summarizing primary research and grey literature on food security initiatives and exposure factors in remote and isolated communities across multiple countries and (2) identifying research gaps and future areas of inquiry.

Box 1: Groups constituting Indigenous Peoples[4].

According to the United Nations, Indigenous Peoples include (ref. 4):

> *the descendants – according to a common definition – of those who inhabited a country or a geographical region at the time when people of different cultures or ethnic origins arrived. The new arrivals later became dominant through conquest, occupation, settlement or other means.*

'Indigenous Peoples' is a broad term, and includes groups with different cultures and histories. Within Canada, Indigenous Peoples include First Nations, Métis, and Inuit Peoples.

Methods

A scoping review method was selected to determine the breadth of food security initiatives and outcomes in remote and isolated communities. This review was guided by the process outlined by Arksey and O'Malley[25] and the PRISMA reporting guidelines for scoping reviews[26]. The review protocol was registered to Open Science Framework prior to data collection[27].

Eligibility criteria

This review aims to inform policy development within northern Canada. Due to the small number of studies evaluating food security initiatives in remote communities within Canada, other jurisdictions facing similar challenges were included. These include the US, Finland, Sweden, Norway, Greenland, and Russia, all of which are circumpolar countries with remote and isolated communities. Additionally, studies from Australia and Aotearoa New Zealand, two affluent countries with similar Anglo-European colonial histories with primarily Indigenous remote communities, were included. Though these countries are higher income on average, conditions within these countries can be unequal.

This review focused on communities classified as remote and/or isolated. The Canadian Public Health Working Group on Remote and Isolated Communities defines a community as remote or isolated if it is more than 350 km from the closest service centre that has all-weather, year-round land or water access[28]. For the purposes of this review, included communities were classified by their government and/or self-defined as remote or isolated, and/or do not have year-round road access.

To fulfill the inclusion criteria, the study must have included a *quantitative* measurement of a food security or sovereignty outcome (see Supplementary table 1). Qualitative outcomes were not included within this review, though are recommended for a future companion review, in the interest of limiting this review's length and scope. In addition to validated scales, outcomes may have included self-reported experiences or perceptions of food security, food purchasing practices, food costs, traditional food consumption or access, and diet diversity. Participant satisfaction towards the initiative/exposure factor was also included to quantify the acceptability of programs. Toxicological and food contamination studies were excluded if there was no food security or sovereignty outcome. This review includes studies evaluating both *initiatives* and *exposure factors* that could be modified through local, regional, or national policy:

- *Initiatives*, or interventions, were designed by either the researchers or another organization and applied to address food security or sovereignty.
- *Exposure factors* are naturally determined (eg in observational studies) factors, which were included if they could be modified or addressed through local, regional, or national policy. Examples of these factors might include education level, household income, or the number of grocery stores in the community. Some examples of exposure factors that cannot be modified through policy that were excluded in this review are sex, gender, age, and race.

Studies evaluating the effects of climate change and/or the global agricultural supply chain were excluded.

Search strategy

The search strategy (Supplementary table 2) underwent Peer Review Electronic Search Strategy (PRESS)[29] and included health databases Ovid MEDLI(R), PsycINFO, and Embase, SCOPUS, food science database Food Science and Technology Abstracts, and economics database EconLit. The review included studies published in English and French from January 1997, after a definition of food security was established and universally agreed upon[30,31], to June 2022. A grey literature search was conducted according to the methods described by Godin et al[32] (Supplementary table 2). Articles were screened from the first 10 pages of Google results and targeted websites, and were also identified from reference lists of reviews and published works of

identified experts.

Study selection

Identified citations were uploaded into DistillerSRV2.43.0 and screened using pre-piloted forms (Supplementary table 1). Titles and abstracts were screened by two independent reviewers. An article was included if one screener determined that it fit the inclusion criteria, and excluded if both reviewers determined that it did not fit the inclusion criteria. At the full-text stage, reviewers reached consensus for study inclusion and exclusion at the answer level.

Data extraction

Data extraction followed the process outlined by Arksey and O'Malley[25], using PRISMA guidelines for scoping reviews[26]. Two reviewers independently extracted data using a pre-piloted form. Inconsistencies in extracted data were resolved through consensus. Study risk of bias was assessed as part of data extraction. Though risk of bias is not a requirement for scoping reviews, the authors included study quality appraisal to provide additional context for policymakers when reviewing the evidence. Risk of bias was assessed using either Risk of Bias in non-randomized Intervention Studies (ROBINS-I)[33], Risk of Bias 2 for randomized controlled trials[34], or Risk of Bias in non-randomized exposure studies[35] tools, based on study design. Risk of bias was not assessed for studies with modeled outcomes.

Stakeholder consultation

In February 2022, the authors were invited to present the results of this scoping review to an expert panel in support of a meeting discussing northern food systems. The panel consists of community members, academics, and other experts in the field of food security within northern Canada, and consists of both a majority of Indigenous Peoples and a majority of people living in northern communities. Panel members provided verbal feedback regarding review results, which has been incorporated throughout.

Results

Literature search

The database review identified 1882 studies from the indexed search and 180 studies in the grey literature, of which 96 were included in this review (Fig1).

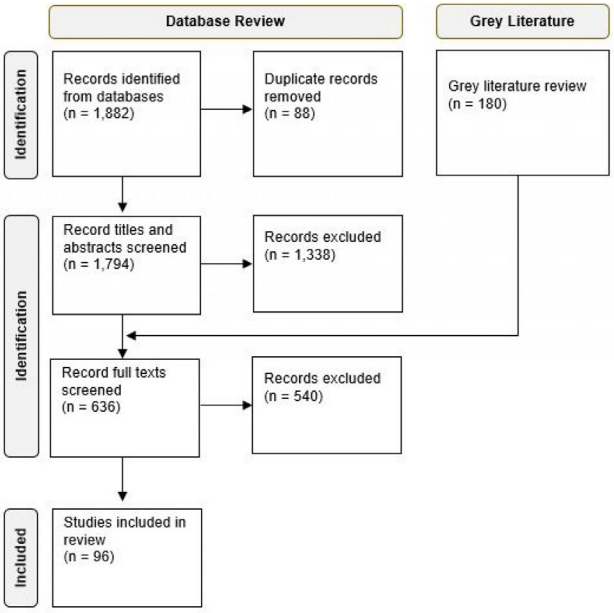


Figure 1: PRISMA diagram for scoping review.

Countries of study

The majority of the studies included in this review were conducted within Canada (50%) and Australia (28%) (Table 1). No initiative studies conducted in Russia, Greenland, Norway, Finland, or Sweden fulfilled the inclusion criteria.

Table 1: Countries of study included in scoping review

Country	Total (*n*)	Initiative (*n*)	Exposure factor (*n*)
All†	96	30	70
Canada¶	48	15	36
Australia/New Zealand	27	14	14
Russia¶	8	0	8
Greenland¶	7	0	7
US¶	6	1	5
Norway/Sweden/Finland	3	0	3

† Four studies included both initiatives and exposure factors.
¶ One exposure factor study was conducted across multiple countries, including Canada, the US, Greenland, and Russia, and was counted in all three.

Outcomes

A variety of quantitative food security outcomes were identified, including HFI, food or nutrient intake, food sales, food costs/spending, dietary quality, traditional food yields, and food sharing. No quantitative measure of food sovereignty was identified, and no studies quantitatively measured participant satisfaction.

Initiatives

Thirty studies evaluating 20 different initiatives were included (Table 2). The majority of these were either pre and post (*n*=9) or modeling (*n*=6) studies. Most included studies had high risk of bias (Supplementary table 3), primarily due to confounding or outcome measurement. However, four of the market subsidy initiatives had low risk of bias for all domains.

School-based initiatives: Five school-based initiatives were evaluated in the included studies; four in Canada[36-39] and one in the US[40]. All five included a food component, such as a school snack[37-39], or local traditional foods[36,40]. The implementation of all five programs was associated with significant positive changes in food security outcomes. These included improved diet quality[36,40] and nutrient intake[38,39], though overall risk of bias in these studies was high due to factors outcome measurement, missing data, and confounding. The changes observed in an Ontario snack program were not sustained over the long term due to insufficient funding, and lack of infrastructure and storage[39]. A study evaluating a snack program in northern Ontario showed increased healthy food intake, and had moderate risk of bias due to confounding, which may be a result of the small sample size[37]. Though all of these programs were associated with improvements to food security outcomes, improvements did not always reach dietary adequacy recommendations[36,37].

Market subsidies: Six different market subsidy programs were evaluated across 15 studies. Both a food voucher program and a 10% grocery discount program in Australia showed no association with fruit and vegetable sales[41,42]. The low impact of these programs was attributed to factors including store staffing challenges and limited infrastructure in a study with low risk of bias[41], as well as the small discount size in a study with high risk of bias[42]. A 20% discount, with an additional in-store educational component, was applied during the SHOP@RIC intervention in Australia[43-46]. This level of discount was associated with increases in fruit and vegetable purchasing in two studies, both of which had low risk of bias[43,45], though no significant change in fruit and vegetable consumption or diet quality[44,46]. The majority of the change in purchasing was associated with the discount program, rather than the education component[43].

In Canada, the implementation of the Food Mail Program, a national food shipping subsidy, was associated with lower food costs and higher food shipment volumes[47,48], though was underused due to challenges related to accessibility and visibility[49]. The program was replaced with Nutrition North Canada (NNC) in 2011, a tiered subsidy program based on level of remoteness[49]. The implementation of NNC was associated with a decrease in food prices, but those prices have remained generally stable since the program's inception in 2011, including in one study with low risk of bias[50-53]. Additionally, HFI levels in NNC-eligible communities increased after implementation of the program[51]. The majority of the studies evaluating the NNC program had moderate risk of bias, primarily due to lack of controlling for confounders or the possibility of post-exposure interventions.

Education initiatives: Several of the interventions evaluated as part of this study (eg NNC, SHOP@RIC) included an education component, though the impact of this component was either minimal, in the case of SHOP@RIC, or not evaluated independently, in the case of NNC. Education components, including lessons on healthy eating[38] and the benefits of traditional foods[40] were also included as part of two of the school-based interventions, though not differentiated during analysis.

In Australia, the Food Sensations for Adults program, which included lessons on meal planning, cooking, and food literacy, was associated with a significant increase in fruit and vegetable intake[54]. A second Australian initiative involved healthy eating and physical activity sessions, targeted at diabetic Indigenous adults, showed no significant changes in dietary habits[55]. In Canada, the Healthy Foods North (HFN) program was created in partnership with six northern communities, and included both store-based and community-based educational events[56]. Significant changes were observed in the intervention group, including increased consumption of promoted healthy foods[56] and increased consumption of healthy foods from baseline[57]. All education initiative evaluations had high risk of bias, primarily due to lack of controlling for confounders, which may not be possible due to small sample size, and possible bias by evaluators due to their knowledge of the participant's participation.

Greenhouses, traditional food programs, and other: Several initiative types were evaluated in only one article. A greenhouse in Kuujjuaq, Nunavik had a modeled output that could meet the nutrient requirements for between 1 month and 1 year, depending on the nutrient[58].

The Nelson House Country Food Program is a Manitoba traditional food program that includes food distribution, processing, and freezer storage, and the re-establishment of a local caribou population[59]. The community had significantly lower rates of HFI than other similarly sized remote communities in Manitoba, and community members attributed the lower rates to the program[59]. The evaluation of this program had high risk of bias, due to the presence of other post-exposure initiatives in the comparison communities.

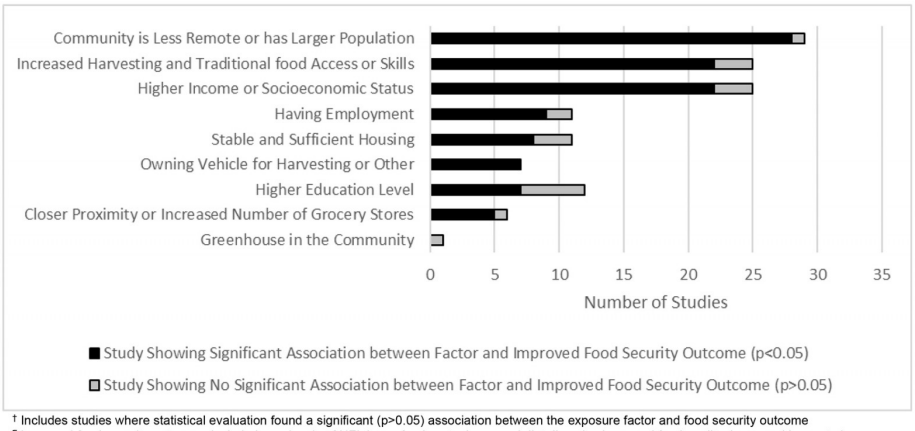
The Good Food Systems Good Food for All Project (GFS) was a community-led program in four remote Australian communities involving annual planning meetings and evaluation of traditional food production, market food business, and community services[60]. The implementation of this program was not associated with a change in food sales, though authors noted that the program was intended to affect a broader set of outcomes that were not evaluated, including food quality and access[60]. This study was at low risk of bias for all domains with the exception of confounding, due to the lack of controlling level of remoteness or price differences between communities. Other articles evaluated Australian programs, including dietary modeling, and income supplementation[61,62].

Exposure factors

Exposure factors were divided into nine categories and compared to food security outcomes (Fig2). Half of the studies (*n*=35/70)

evaluated more than one exposure factor and were therefore included in the summary figure multiple times. Four studies included both an initiative and exposure factor and have been included in both results sections.

Remoteness and community size: Remoteness and community size were significantly associated with food security outcomes in 28/29 studies (Fig2). Remoteness was categorized differently depending on the jurisdiction or research question, and therefore level of remoteness cannot be compared between studies. Remote communities located in Canada, Australia, Scandinavia, Greenland, and Russia had higher levels of food insecurity, higher food costs, and lower food availability and quality than major cities[63-77]. Studies from both Canada and Greenland found that larger communities had lower levels of HFI than smaller remote communities in the same regions[78-80]; however, two studies located in Canada found no relationship between community size and food security or cost[81,82]. Food security associations related to remoteness and community size may not apply to traditional food harvesting patterns, as one Russian study found that remote communities had higher traditional harvest yields than rural towns[83].



† Includes studies where statistical evaluation found a significant (p>0.05) association between the exposure factor and food security outcome
¶ Improved food security outcomes include lower levels of HFI, lower food costs, increased diet diversity, improved food quality, increased harvest size, increased food consumption, increased food sharing

Figure 2: Summary of exposure factors associated† with improved¶ food security outcomes.

Harvesting and traditional food: Traditional food intake and availability were associated with food security outcomes in 7/10 studies. Half of these studies evaluated dietary intake, reporting that community members in remote communities within Canada and Greenland who consumed more traditional foods had higher intakes of macronutrients, particularly protein[36,84-86], and micronutrients, such as zinc[36,85,87]. Greater traditional food availability was associated with lower HFI rates in studies located in the USA and Canada[88,89]. However, eating traditional food at more than 50% of meals was not associated with HFI in two studies located in Canada[90,91]. This lack of association was attributed to the nutritional transition from traditional food to market foods in the younger generations[90].

Harvesting factors, such as having a harvester in the household, harvesting skills, harvest sharing, and harvest diversity and size were correlated with food security in 14/18 studies. The most common outcome measured in these studies was out-degree food sharing (44%), which measures the number of food sharers, while in-degree food sharing measures the number of food recipients. Out-degree sharing was higher in households with larger harvests[92] or a harvester in the household[93], greater harvest diversity and traditional harvesting practices[94,95], and those reporting stronger hunter skills[96,97]. Unlike out-degree sharing, in-degree sharing, which measures receiving shared foods, was not correlated with harvest size in one study of a remote Inuit community[98]. Having a harvester in the household was correlated with lower rates of HFI[99-101] and higher traditional food consumption[102]. Learning subsistence skills as a child was associated with larger harvests[103] and participation in harvesting was associated with higher traditional food consumption[104,105].

Income/socioeconomic status: In most studies assessing the relationship between income and socioeconomic status (*n*=23/26), higher income households had lower rates of HFI. Two studies located in Canada each found that HFI levels were higher when household income levels were below the national median[78] or below C$20,000 (A$21,900)[81]. Similar trends were observed in Greenland, where houses with the lowest asset scores were more likely to be food insecure than houses with the highest scores[80,106]. Studies from Canada, Australia, and Greenland found that having lower income or being on income assistance was associated with higher rates of HFI[90,91,106-108], fewer hunters in the household[109], higher frequency of traditional food consumption[102], reduced dietary quality and diversity (based on Australian recommendations for children <2 years old)[110-115], and receiving more shared food[98,116].

Employment: Employment status was significantly associated with food security outcomes in the majority (*n*=11/13) of included studies. In Canada and Greenland, those without jobs were more likely to be food insecure[78,90,91,106,108,117], have a less diverse diet[118], and share foods[93], though food sharing was more strongly correlated with harvesting-related factors, such as having a hunter in the household, than with employment status[93]. In studies located in both Canada and Australia, employment status was not associated with other outcomes including the number of hunters per household[109], and the percentage expenditure on discretionary food[119]. One study located in Canada found that those in desirable workplaces, including those with better pay, benefits, and hours, had higher levels of food sharing than those in less desirable workplaces[98].

Housing: Housing status, including household size, crowding, and repair needs, was associated with food security outcomes in the majority (*n*=9/12) of studies. Four studies located within Canada found that HFI levels were higher in homes in need of major repairs or characterized as public housing[81,90,99], or in overcrowded homes (more than one person per room)[78,81]. In Canada and Australia, larger households were more likely to be food insecure, and less likely to meet adequate meal frequency[110,116,120]. Household size was also not significantly correlated with food sharing in both a Canadian[116] and Russian[96] study. In Canada, housing status correlated with income, and the association between food security outcomes with income, was stronger than the association with housing status[98,116].

Vehicle ownership and access: Ownership or access to vehicles for harvesting or other uses was significantly associated with food security outcomes in all seven included studies. Though vehicles may not be necessary for in-community transportation, they can be important harvesting tools[92]. Owning a vehicle for harvesting was associated with lower HFI rates[116,120] and greater out-degree food sharing[92,98,121] within Canadian and Russian communities. Similarly for market foods, Australian households with more transport modes were more likely to achieve adequate vegetable consumption[122], and Manitoba communities with public transport had lower HFI rates[89]. Though vehicle ownership and access allows for greater food access, this variable was not always retained in models that included income[116].

Education level: The majority (*n*=9/14) of the articles evaluating education level as an exposure factor associated with food security used a threshold of having completed high school/secondary school. Six of seven studies conducted in Canada and Greenland showed a relationship between higher education levels and food security[78,81,90,91,99,106], while three, conducted in Canada and Australia, did not[116,120,123]. Other outcomes associated with a higher education level included lower spending on, and consumption of, traditional foods, and higher spending on fruits and vegetables[102,124]. One of these studies found that, though the correlation between education and HFI was not significant, higher levels of education were associated with higher income levels, which were significantly associated with HFI[120].

Stores: Six studies, primarily from Australia (67%) evaluated store factors, such as the number of stores in a community, the distance to a store, and the frequency of food delivery. These studies found that communities with more stores, or where community members felt the number of stores was adequate, were more likely to be food secure[89] and had greater diet diversity (total number of different items eaten)[118] and vegetable consumption[122]. However, these studies did not control for population size, a possible factor affecting the number of community stores. One study conducted in Australia found that more food was purchased immediately following loading days[125]; however, another Australian study did not find that an association between food delivery frequency and diet quality[119].

Number of greenhouses: One study found no significant association between the number of greenhouses in remote Manitoba communities and HFI, though greenhouses were found to increase the length of the growing season in the community[59].

Table 2: Studies evaluating food security and sovereignty initiatives in remote and isolated regions[36-48,50-62,126-129]

Country	Description	Year	Remote study setting	Study design	Study population/ sample	Population/ sample *n*	Measured outcome	Overall risk of bias[†]	Author (ref.)
SCHOOL-BASED PROGRAMS									
Canada	Harvest sharing program to increase consumption of spring snow goose	2011	Remote James Bay community	Pre- and post-study	School-attending youth in grades 6–8	73	Macro and micronutrient intake	High	Gates, et al. (36)
Canada	School snack program, including daily morning snack to all students and afternoon snack to all elementary (kindergarten to grade 8) students	2004–2007	Fort Albany, Ontario	Longitudinal	Students in grades 6–10	113	Intake of healthy foods	Moderate	Skinner, et al. (37)
Canada	Curriculum (healthy eating, physical activity, and diabetes education), family component (informing curriculum messages), peer role models, banning unhealthy snack foods in the schools, and a healthy school meal	1998–1999	Sandy Lake, Ontario	Pre- and post-study	Students aged 7–14 years	122	Nutrient intake	High	Saksvig, et al. (38)
Canada	A snack program, including at least one daily serving from the vegetables and fruit and milk and alternatives food groups in Kashechewan and a milk provision program in Attawapiskat	2009–2010	Kashechewan and Attawapiskat, Ontario	Pre- and post-study	Students in grades 6–8	129	Milk and alternatives intake Calcium intake	High	Gates, et al. (39)
US	Serving locally harvested salmon, experiential lessons about the benefits of traditional foods and community events celebrating traditional foods	2018	Two remote Alaska communities	Quasi-experimental	Middle and high school students	76	Diet quality Fish intake	High	Bersamin, et al. (40)
GREENHOUSE STUDIES									
Canada	Community greenhouse	2016–2017	Kuujjuaq, Nunavik	Modeling	Community greenhouse	N/A	Modeled vitamin intake	N/A	Lamalice, et al. (58)
TRADITIONAL FOOD PROGRAMS									
Canada	The Nelson House Country Food Program: a distribution program for wild foods, re-establishment of caribou near the reserve, a country food processing centre, and community freezers	2008–2009	14 Northern Manitoba communities	Cross-sectional with control	Community Households	534	Food insecurity	High	Thompson, et al. (59)
MARKET SUBSIDIES									
Australia	The Healthy Choice Rewards (HCR) program: A$10 fruit and vegetable voucher after minimum spend on fruit and vegetables	2015	Very remote store in Queensland	Pre- and post-study	Community store staff and customers	28	Fruit and vegetables sales and consumption	Low	Brown, et al. (41)
Australia	10% food/beverage discount strategies: (1) grocery: a reduced mark-up on shelf, refrigerator, and freezer grocery products, (2) fresh fruit and vegetable point of sale scales, (3) fresh fruit and vegetables at landed cost, (4) diet soft-drink discount	2010	18 communities in Northern Territory and Western Australia	Pre- and post-study	Outback stores	18	Food/ beverage sales Fruit and vegetable sales	High	Ferguson, et al. (42)
Australia	Modeling comparing four GST scenarios: (1) status quo; (2) increase GST to 15%; (3) expand base to include exempt foods at 10% GST; and (4) expand base to include exempt foods and increase tax to 15%	2013	'Very remote' Western Australia stores	Modeling	Grocery stores	156	Cost of meals Probability of food stress	N/A	Landrigan, et al. (126)
Northern Air Stage/Food Mail Program									
Canada	Food Mail Program - subsidizing transport costs for certain foods in remote communities not accessible by year-round road	1960s–2011	Remote northern communities	Pre- and post-study	Community-level data	20	Price of Northern Nutritious Food Basket	High	Lawn, et al. (47)
			Food Mail eligible communities	Modeling	Community-level data	140	Food volume shipped Food affordability	N/A	Government of Canada (48)
Nutrition North Canada (NNC)									
Canada	Nutrition North Canada: Primarily a food subsidy program, with a community nutrition education component. Currently expanded to include harvester support grants and community food programs.	2011–present	Remote northern communities	Pre- and post-study	Community-level data	128	RNFB prices	Low	Galloway (50)
			Remote Nunavut communities	Modeling	Community-level data	25	Pass-through rate for food subsidy	N/A	Naylor, et al. (127)
			10 Nunavut communities	Interrupted time series	Community households	3250	Food insecurity	Moderate	St-Germain, et al. (51)
			Remote Manitoba communities	Cross-sectional with control	Store data	26	Price of milk	Moderate	Wendimu, et al. (128)
			All participating remote communities in Canada	Cross-sectional with control	Community households	103	Grocery expenditures Food availability	High	Enrg Research Group (53)
			Garden Hill First Nation, Manitoba	Longitudinal	Community households	26	Price of RNFB	Moderate	Puzyreva (52)
Stores Healthy Options Project in Remote Indigenous Communities (SHOP@RIC)									
Australia	A 20% discount on fresh fruit, fresh/frozen vegetables, soft drinks and bottled water for all participants, and in-store consumer education program for half of participants	2013–2014	20 remote communities in the Northern Territory	Stepped wedge controlled trial	Community residents of all ages	8515	Fruit and vegetable consumption	Low	Magnus, et al. (43)
			Three remote Indigenous communities	Modeling	Aboriginal population living in remote Australia	2638	Energy and sodium intake	N/A	Magnus, et al. (44)
			Communities in remote Indigenous Australia	Stepped wedge controlled trial	Store data	20	Purchases of food, fruit and vegetables	High	Brimblecombe, et al. (45)
			Five remote communities in Northern Territory	Longitudinal	Indigenous adults living in Northern Territory	73	Intake of fruits and vegetables, food security	Low	Brimblecombe, et al. (46)
EDUCATION INITIATIVES									
Australia	Food Sensations for Adults (FSA): a four-session, experiential nutrition education program, lesson plans divided into modules mapped to four domains (Planning and Management, Selection, Preparation and Cooking, and Eating) and 11 components of food literacy carbohydrate and increasing consumption of fresh vegetables and fruit	2016–2018	Remote regional Australia community Western Australia	Pre- and post-study	Program participants aged 18 years or more adults living in the Looma community	451	Intake of fruit and vegetables	High	Dumont, et al. (54)
Healthy Foods North (HFN)									
Canada	Community-based initiative including an environmental component (increase healthy food availability in local stores), activities (community-wide and point-of-purchase taste tests and cooking demonstrations), media (eg radio ads, posters, shelf labels), and community events	2008	Kitikmeot, Nunavut, and the Beaufort Delta, Northwest Territories	Quasi-experimental	The main shopper in a household, not pregnant or lactating people	331	Food frequency of consumption and portion size	High	Kolahdooz, et al. (56)
			Communities in Nunavut and the Northwest Territories	Quasi-experimental	One Inuit/Inuvialuit adult per household, not pregnant	557	Frequency of healthy and less healthy food acquisitions	High	Mead, et al. (57)
OTHER									
Australia	Income management program by the government, requiring 50% of income support be used for items considered essential, including food	2006–2009	10 stores remote Northern Territory	Interrupted time series	Community-level data	10	Fruit and vegetable sales	Low	Brimblecombe, et al. (62)
Australia	Undifferentiated initiatives in remote communities conducted between 1986 and 2014, including subsidies on market foods, requirement for reporting of prices and transparency, school garden project, recipe calendar, and health promotion materials in stores	1986–2014	Seven Anangu Pitjantjatjara Yankunytjatjara Lands communities	Pre- and post-study	Community stores	7	Cost and availability of healthy foods Dietary intake	High	Lee, et al. (129)
Australia	Good Food Systems Good Food for All Project (GFS): Annual planning meeting and the appraisal of the Good	2009–2013	Four Indigenous communities	Longitudinal multi-site	Community-level data	N/A	Community diet	High	Brimblecombe, et al. (60)

	Food Planning Tool			case study					
Australia	Dietary modeling, optimising for nutrient intake	2011	Three remote communities in the Northern Territory	Modeling	Community-level data	N/A	Price of daily diet	N/A	Brimblecombe, et al. (61)

† Risk of bias was calculated using either the ROBINS-E, ROBINS-I, or ROB-2 tool (see Methods and Supplementary table 3). 'Moderate' was used in place of 'Some concerns' for the ROBINS-E, and 'High' was used in place of 'Serious' for the ROBINS-I, for consistency of ratings. Overall risk of bias was 'Low' if risk of bias was low in all domains, 'Moderate' if moderate or low for all domains, and 'High' if high in at least one domain. Modelling studies were not assessed for risk of bias.
GST, goods and services tax. N/A, not available, RNFB, revised Northern Food Basket.

Discussion

This scoping review identified studies conducted in remote and isolated communities, which was made challenging by the use of different terminology and standards in different jurisdictions. For instance, Australia classifies communities based on road distance to service centres in towns of different sizes[130], while the other jurisdictions in this review do not have standardized classification systems. Therefore, this study's authors used other indicators, including access or self-describing as remote. These factors also differed between jurisdictions, resulting in the underrepresentation of some countries that have year-round rail and road networks, such as those in Scandinavia. A standard remoteness indicator could facilitate future evaluation studies and help to identify high priority communities for initiatives.

Most of the studies included in this review found significant associations between food security outcomes and exposure factors including level of remoteness, income, housing, education, employment, vehicle ownership, and traditional food and harvesting practices. These factors can be interrelated, particularly with income. For instance, in Australia, increased remoteness was associated with decreased income and increased income disparity between Indigenous groups and non-Indigenous groups[131]. Studies within both Canada and Greenland showed that though education level and vehicle ownership were significantly associated with food security, these outcomes did not retain significance in models where income was included[80,116]. Though not evaluated quantitatively, the general conclusions of studies located in Canada and Greenland stressed the importance of sufficient income for both market and traditional food acquisition[109,116] and noted socioeconomic status is a significant determinant of food security[80,106].

The results of this scoping review have identified significant data gaps in food security research in remote regions. In particular, a variety of initiatives being applied in these settings, such as greenhouses, community freezers, and traditional food programs, have not been evaluated[132]. A 2019 study documented 36 community gardens and 17 greenhouses in remote northern Canada, though very few quantitative evaluations have been published[58,133,134]. In some cases, large-scale national programs lack evaluation, particularly for community-led initiatives and for food sovereignty outcomes. For instance, the effect of the Harvesters Support Grant, a funding program for traditional food harvesting established by NNC in Canada in 2019, has not been evaluated[135].

The small community size and nature of these initiatives also results in challenges in interpreting the impact/effect size of initiatives due to risk of bias. The majority of initiative studies had high risk of bias in at least one domain. Challenges including small community size, where confounders cannot be adjusted for in statistical analysis, and the inability to blind participants to programs such as school snacks or education initiatives, results in possible bias in outcome measurement. Several market subsidy studies evaluating Australian programs[41,43,45] and NNC[50] had low risk of bias in all domains. Despite changes in food pricing and sales associated with these initiatives, authors stressed the limited impact of these programs in isolation[41,43,45]. The impact of NNC, in particular, on HFI has plateaued since its inception in 2011, and the program has been criticized due to its lack of transparency and community control[50,136].

The majority (n=28/30) of the initiative studies measured a single component of food security, such as diet quality, food cost, or spending on food. Inconsistency in outcomes leads to challenges when comparing the initiative effectiveness for decision-making. Outcome selection is critical for ensuring that the most important success indicators, particularly those that are important to the impacted communities, are being measured. For instance, authors of the Australian GFS study noted that outcomes such as food quality and access may have been impacted but were not measured[60]. Outcome selection may also result in the misclassification of a program as successful when the full picture is more complicated. For example, the NNC program has primarily been evaluated based on food cost and subsidy pass-through rates, both of which improved since program implementation. However, HFI levels in eligible communities increased during the same period[51].

Despite the small number of evaluations and the inconsistency in measured outcomes, several trends were observed in terms of recommendations for initiatives in remote communities. The importance of traditional foods for First Nations, Métis, and Inuit people was noted in both initiative and exposure factor studies[36,40,56-59]. Traditional food consumption is an important determinant of food security in remote communities, both due to the nutrient density of these foods and the importance of these foods in achieving food sovereignty[85-87]. Programs that increased traditional food access and affordability help to create sustainable livelihoods, in communities that otherwise rely on market foods[59].

The importance of community engagement and community-led initiatives was stressed in 20% of initiative studies. Culturally adapted, including the application of Indigenous methodologies selected by the impacted community, and collaborative implementation may result in faster implementation and longer program sustainability, and may reduce health risk[36,38,40,56,60]. Three studies also noted the integral role of local champions or coordinators[37-39]. Strong community partnerships allow for the integration of local knowledge, and ensure that initiatives are both addressing the needs identified by, and evaluating outcomes relevant to, the community[24].

Limitations

Due to the small number of studies, and the diversity of outcomes, direct comparison of the impact of these initiatives is neither feasible nor desirable. HFI was measured in only 19% of the included studies and most studies measured other outcomes, such as food cost, dietary changes, nutrient intake, and food sharing. These outcomes represent individual components rather than a full picture and may not measure the full impact of a program[51,60].

Due to limitations in size, this study did not include qualitative outcomes. Qualitative data can provide essential information about the acceptability, feasibility, and effectiveness of initiatives, and are often the only data available in the evaluation of initiatives in remote communities. The authors recommend conducting a companion review summarizing qualitative results, which will provide policymakers with important contextual information and evaluation data.

The study settings described in included studies vary significantly, in terms of factors such as culture, traditional food harvesting, and environmental constraints. Though multiple jurisdictions were included to provide broad observations about remote settings, some of the observed differences between studies may result from these community differences.

Conclusion

Remote communities are particularly vulnerable to food insecurity, and lack of access and availability of healthy foods, compounded by factors including income, housing, education, transportation, and community infrastructure. These factors are often interrelated and can be challenging to differentiate for program development. Additionally, these regions often rely on the harvesting of traditional foods for subsistence, health, and cultural wellbeing. Traditional food harvesting can be an important determinant of food security. The studies included in this review stressed the importance of harvesting accessibility and access to traditional foods.

Though only a small number of initiatives in these regions have been evaluated using quantitative outcomes, broader trends were still observed. Variability in measured outcomes results in an incomplete picture of program impact. Initiatives, including greenhouses, freezers, school programs, and harvesting and traditional food programs, are being implemented across remote areas, but with minimal evaluation. It is recommended that future evaluations consider outcomes identified by the impacted community, or multiple factors contributing to food security, for a deeper understand of program effectiveness. Studies evaluating community-led initiatives noted that strong community partnerships resulted in faster implementation and longer program stability. This is particularly important when working with the culturally and geographically diverse groups living in remote areas. Despite the implementation of multiple initiatives throughout remote communities, the cost of a healthy diet remained high, as do levels of HFI. Further work is required to improve food security in remote regions.

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Conflicts of interest

The authors declare no conflicts of interest.

REFERENCES:

1 Tarasuk V, Li T, St-Germain A. *Household food security in Canada 2021*. Toronto, ON: University of Toronto, 2021.

2 Cook J, Black M, Chilton M, Cutts D, Ettinger de Cuba S, Heeren T, et al. Are food insecurity's health impacts underestimated in the U.S. population? Marginal food security also predicts adverse health outcomes in young U.S children and mothers. *Advances in Nutrition* 2013; **4(1):** 51-61. DOI link, PMid:23319123

3 Schiff R, Brunger F. Northern food networks: Building collaborative efforts for food security in remote Canadian Aboriginal communities. *Journal of Agriculture, Food Systems, and Community Development* 2013; **3(3).** DOI link

4 Organ J, Castleden H, Furgal C, Sheldon T, Hart C. Contemporary programs in support of traditional ways: Inuit perspectives on community freezers as a mechanism to alleviate pressures of wild food access in Nain, Nunatsiavut. *Health & Place* 2014; **30:** 251-259. DOI link, PMid:25460908

5 Harder M, Wenzel G. Inuit subsistence, social economy and food security in Clyde River, Nunavut. *Arctic* 2012; **65(3):** 245-366. DOI link

6 Rosol R, Huet C, Wood M, Lennie C, Osborne G, Egeland GM. Prevalence of affirmative responses to questions of food insecurity: International Polar Year Inuit Health Survey, 2007-2008. *International Journal of Circumpolar Health* 2011; **70(5):** 488-497. DOI link, PMid:22005728

7 Council of Canadian Academies. *Aboriginal food security in Northern Canada: an assessment of the state of knowledge*. Ottawa, ON: Council of Canadian Academies. 2014.

8 Ramirez Prieto M, Ratelle M, Laird BD, Skinner K. Dietary Intakes of traditional foods for Dene/Métis in the Dehcho and Sahtú regions of the Northwest Territories. *Nutrients* 2022; **14(2):** 378. DOI link, PMid:35057559

9 Kuhnlein HV, Receveur O. Local cultural animal food contributes high levels of nutrients for Arctic Canadian Indigenous adults and children. *The Journal of Nutrition* 2007; **137(4):** 1110-1114. DOI link, PMid:17374689

10 Public Health Agency of Canada. *Key health inequalities in Canada - a national portrait*. Ottawa, ON: Public Health Agency of Canada, 2018.

11 Beaumier MC, Ford JD. Food insecurity among Inuit women exacerbated by socio-economic stresses and climate change. *Canadian Journal of Public Health* 2010; **101(3):** 196-201. DOI link, PMid:20737808

12 Ford JD, Smit B, Wandel J, Allurut M, Shappa KIK, Ittusarjuat H, et al. Climate change in the Arctic: current and future vulnerability in two Inuit communities in Canada. *The Geographical Journal* 2008; **174(1):** 45-62. DOI link

13 Randazzo M, Robidoux MA. Looking to the land: local responses to food insecurity in two rural and remote First Nations.

The Canadian Journal of Native Studies 2018; **38(1).**

14 Kumar MB, Furgal C, Hutchison P, Roseborough W, Kootoo-Chiarello S. *Harvesting activities among First Nations people living off reserve, Métis and Inuit: Time trends, barriers and associated factors.* Ottawa, ON: Statistics Canada, 2019.

15 Downing A, Cuerrier A. A synthesis of the impacts of climate change on the First Nations and Inuit of Canada. *Indian Journal of Traditional Knowledge* 2011; **10(1):** 55-70.

16 Robin T. Our Hands at Work: Indigenous food sovereignty in Western Canada. *Journal of Agriculture, Food Systems, and Community Development* 2019; **9(B).** DOI link

17 Daigle M. Tracing the terrain of Indigenous food sovereignties. *Journal of Peasant Studies* 2017; **46(2):** 297-315. DOI link

18 Delormier T, Marquis K. Building healthy community relationships through food security and food sovereignty. *Current Developments in Nutrition* 2019; **3(2):** 25-31. DOI link

19 Wittman H, Desmarais A, Wiebe N. *Food sovereignty in Canada: Creating just and sustainable food systems.* Halifax and Winnipeg: Fernwood Publishing, 2011.

20 Cote C. 'Indigenizing' food sovereignty. Revitalizing Indigenous Food practices and ecological knowledges in Canada and the United States. *Humanities* 2016; **5(3).** DOI link

21 Richmond C, Kerr R, Neufeld H, Steckley M, Wilson K, Dokis B. Supporting food security for Indigenous families through the restoration of Indigenous foodways. *The Canadian Geographer / Le Géographe canadien* 2021; **65(1):** 97-109. DOI link

22 Jernigan V, Maudrie T, Nikolaus C, Benally T, Johnson S, Teague T, et al. Food sovereignty indicators for Indigenous community capacity building and health. *Frontiers in Sustainable Food Systems* 2021; **5.** DOI link

23 Skinner K, Hanning R, Desjardins E, Tsuji LJ. Giving voice to food insecurity in a remote indigenous community in subarctic Ontario, Canada: traditional ways, ways to cope, ways forward. *BMC Public Health* 2013; **13.** DOI link, PMid:23639143

24 Domingo A, Charles K, Jacobs M, Brooker D, Hanning R. Indigenous community perspectives of food security, sustainable food systems and strategies to enhance access to local and traditional healthy food for partnering Williams Treaties First Nations (Ontario, Canada). *International Journal of Environmental Research and Public Health* 2021; **18.** DOI link, PMid:33919110

25 Arksey H, O'Malley L. Scoping studies: towards a methodological framework. *International Journal of Social Research Methodology* 2005; **8(1):** 19-32. DOI link

26 Tricco A, Lillie E, Zarin W, O'Brien K, Colquohoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): checklist and explanation. *Annals of Internal Medicine* 2018; **169(7):** 467-473. DOI link, PMid:30178033

27 Drysdale M, Idzerda L. Addressing food insecurity, access, affordability, and sovereignty in remote and isolated communities: A scoping review. *Open Science Framework* 2022.

28 Public Health Working Group on Remote and Isolated Communities. *Recommended definition for remote and isolated communities.* Ottawa, ON: Government of Canada, 2020.

29 McGowan J, Sampson M, Salzwedel D, Cogo E, Foerster V, Lefebvre C. PRESS Peer Review of Electronic Search Strategies: 2015 Guideline Statement. *Journal of Clinical Epidemiology* 2016; **75:** 40-46. DOI link, PMid:27005575

30 Hussein K. Food security: Rights, livelihoods and the World Summit – Five years later. *Social Policy & Administration* 2002; **36(6):** 626-647. DOI link

31 Bussey C. Food security and traditional foods in remote Aboriginal communities: A review of the literature. *Australian Indigenous Health Bulletin* 2013; **13(2).**

32 Godin K, Stapleton J, Kirkpatrick S, Hanning R, Leatherdale S. Applying systematic review search methods to the grey literature: a case study examining guidelines for school-based breakfast programs in Canada. *Systematic Reviews* 2015; **4(138).** DOI link, PMid:26494010

33 Sterne JAC, Hernán MA, Reeves BC, Savović J, Berkman ND, Viswanathan M, et al. ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions. *BMJ* 2016; **355:** i4919. DOI link, PMid:27733354

34 Sterne JAC, Savović J, Page MJ, Elbers RG, Blencowe NS, Boutron I, et al. RoB 2: a revised tool for assessing risk of bias in randomised trials. *BMJ* 2019; **366.** DOI link, PMid:31462531

35 Higgins J, Morgan R, Rooney A, Taylor K, Thayer K, Silva R, et al. A tool to assess risk of bias in non-randomized follow-up studies of exposure effects (ROBINS-E). *Environment International* 2024; **186.** DOI link

36 Gates A, Hanning RM, Gates M, Tsuji LJS. The food and nutrient intakes of First Nations Youth living in Northern Ontario, Canada: Evaluation of a harvest sharing program. *Journal of Hunger and Environmental Nutrition* 2016; **11(4):** 491-508. DOI link

37 Skinner K, Hanning RM, Metatawabin J, Martin ID, Tsuji LJ. Impact of a school snack program on the dietary intake of grade six to ten First Nation students living in a remote community in northern Ontario, Canada. *Rural and Remote Health* 2012; **12(3):** 2122. DOI link, PMid:22909226

38 Saksvig BI, Gittelsohn J, Harris SB, Hanley AJ, Valente TW, Zinman B. A pilot school-based healthy eating and physical activity intervention improves diet, food knowledge, and self-efficacy for native Canadian children. *Journal of Nutrition* 2005; **135(10):** 2392-2398. DOI link, PMid:16177202

39 Gates M, Hanning RM, Gates A, McCarthy DD, Tsuji LJ. Assessing the impact of pilot school snack programs on milk and alternatives intake in 2 remote First Nation communities in northern Ontario, Canada. *Journal of School Health* 2013; **83(2):** 69-76. DOI link, PMid:23331265

40 Bersamin A, Izumi BT, Nu J, O'Brien DM, Paschall M. Strengthening adolescents' connection to their traditional food system improves diet quality in remote Alaska Native communities: Results from the Neqa Elicarvigmun Pilot Study. *Translational Behavioral Medicine* 2019; **9(5):** 952-961. DOI link, PMid:31570921

41 Brown C, Laws C, Leonard D, Campbell S, Merone L, Hammond M, et al. Healthy choice rewards: A feasibility trial of incentives to influence consumer food choices in a remote Australian Aboriginal community. *International Journal of Environmental Research and Public Health* 2019; **16(1).** DOI link, PMid:30609836

42 Ferguson M, O'Dea K, Holden S, Miles E, Brimblecombe J. Food and beverage price discounts to improve health in remote Aboriginal communities: mixed method evaluation of a natural experiment. *Australian and New Zealand Journal of Public Health* 2017; **41(1):** 32-37. DOI link, PMid:27868342

43 Magnus A, Cobiac L, Brimblecombe J, Chatfield M, Gunther A, Ferguson M, et al. The cost-effectiveness of a 20% price discount on fruit, vegetables, diet drinks and water, trialled in remote Australia to improve Indigenous health. *PLoS ONE* 2018; **13(9):** e0204005. DOI link, PMid:30260984

44 Magnus A, Moodie M, Ferguson M, Cobiac L, Liberato S, Brimblecombe J. The economic feasibility of price discounts to improve diet in Australian Aboriginal remote communities. *Australian and New Zealand Journal of Public Health* 2016; **40(Suppl 1):** S36-S41. DOI link, PMid:26122947

45 Brimblecombe J, Ferguson M, Chatfield M, Liberato S, Gunther A, Ball K, et al. Effect of a price discount and consumer education strategy on food and beverage purchases in remote Indigenous Australia: a stepped-wedge randomised controlled trial. *Lancet Public Health* 2017; **2(2):** 82-95. DOI link, PMid:29253401

46 Brimblecombe J, Ferguson M, Barzi F, Brown C, Ball K. Mediators and moderators of nutrition intervention effects in remote Indigenous Australia. *British Journal of Nutrition* 2018; **119(12):** 1424-1433. DOI link, PMid:29845901

47 Lawn J, Robbins H, Hill F. Food affordability in air stage communities. *International Journal of Circumpolar Health* 1998; **57(Suppl 1):** 182-188.

48 Indian and Northern Affairs Canada, Evaluation, Performance Measurement, and Review Branch, Audit and Evaluation Sector. *Summative evaluation of INAC's Food Mail Program.* Ottawa, ON: Government of Canada. 2009.

49 Burnett K, Skinner K, LeBlanc J. From Food Mail to Nutrition North Canada: Reconsidering federal food subsidy programs for northern Ontario. *Canadian Food Studies* 2015; **2(1).** DOI link

50 Galloway T. Canada's northern food subsidy Nutrition North Canada: a comprehensive program evaluation. *International Journal of Circumpolar Health* 2017; **76(1):** 1279451. DOI link, PMid:28151097

51 St-Germain AF, Galloway T, Tarasuk V. Food insecurity in Nunavut following the introduction of Nutrition North Canada. *CMAJ* 2019; **191(20):** E552-E558. DOI link, PMid:31113784

52 Puzyreva M. *Harnessing the potential of social enterprise in Garden Hill First Nation.* Winnipeg, MB: Canadian Centre for Policy Alternatives, 2017.

53 Enrg Research Group. *Northern Food Retail data collection & analysis.* Report No. 1415647437. Ottawa, ON: Government of Canada, 2014.

54 Dumont C, Butcher LM, Foulkes-Taylor F, Bird A, Begley A. Effectiveness of foodbank Western Australia's Food Sensations for Adults food literacy program in regional Australia. *International Journal of Environmental Research and Public Health* 2021; **18(17).** DOI link, PMid:34501510

55 Rowley K, Daniel M, Skinner K, Skinner M, White G, O'Dea K. Effectiveness of a community-directed 'healthy lifestyle' program in a remote Australian Aboriginal community. *Australian & New Zealand Journal of Public Health* 1999; **24(2):** 136-144. DOI link, PMid:10790932

56 Kolahdooz F, Pakseresht M, Mead E, Beck L, Corriveau A, Sharma S. Impact of the Healthy Foods North nutrition intervention program on Inuit and Inuvialuit food consumption and preparation methods in Canadian Arctic communities. *Nutrition Journal* 2014; **13(1).** DOI link, PMid:24993180

57 Mead EL, Gittelsohn J, Roache C, Corriveau A, Sharma S. A community-based, environmental chronic disease prevention intervention to improve healthy eating psychosocial factors and behaviors in indigenous populations in the Canadian Arctic. *Health Education & Behavior* 2013; **40(5):** 592-602. DOI link, PMid:23239767

58 Lamalice A, Haillot D, Lamontagne MA, Herrmann TM, Gibout S, Blangy S, et al. Building food security in the Canadian Arctic through the development of sustainable community greenhouses and gardening. *Ecoscience* 2018; **25(4):** 325-341. DOI link

59 Thompson S, Gulrukh A, Ballard M, Beardy B, Islam D, Lozeznik V, et al. Is community economic development putting healthy food on the table? Food sovereignty in Northern Manitoba's Aboriginal communities. *Journal of Aboriginal Economic Development* 2011; **7(2).** DOI link

60 Brimblecombe J, Bailie R, van den Boogaard C, Wood B, Liberato SC, Ferguson M, et al. Feasibility of a novel participatory multi-sector continuous improvement approach to enhance food security in remote Indigenous Australian communities. *SSM – Population Health* 2017; **3:** 566-576. DOI link, PMid:29349246

61 Brimblecombe J, Ferguson M, Liberato SC, O'Dea K, Riley M. Optimisation modelling to assess cost of dietary improvement in remote Aboriginal Australia. *PloS ONE* 2013; **8(12):** e83587. DOI link, PMid:24391790

62 Brimblecombe J, McDonnell J, Barnes A, Dhurrkay J, Thomas D, Bailie R. Impact of income management on store sales in the Northern Territory. *Medical Journal of Australia* 2010; **192(10):** 549-554. DOI link, PMid:20477726

63 Batal M, Chan HM, Fediuk K, Ing A, Berti PR, Mercille G, et al. First Nations households living on-reserve experience food insecurity: prevalence and predictors among ninety-two First Nations communities across Canada. *Canadian Journal of Public Health* 2021; **112:** 52-63. DOI link, PMid:34181224

64 Brustad M, Parr CL, Melhus M, Lund E. Childhood diet in relation to Sami and Norwegian ethnicity in northern and mid-Norway – The SAMINOR study. *Public Health Nutrition* 2008; **11(2):** 168-175. DOI link, PMid:17610754

65 Ferguson M, O'Dea K, Chatfield M, Moodie M, Altman J, Brimblecombe J. The comparative cost of food and beverages at remote Indigenous communities, Northern Territory, Australia. *Australian and New Zealand Journal of Public Health* 2016; **40:** S21-S26. DOI link, PMid:25902766

66 Harrison MS, Coyne T, Lee AJ, Leonard D, Lowson S, Groos A, et al. The increasing cost of the basic foods required to promote health in Queensland. *Medical Journal of Australia* 2007; **186(1):** 9-14. DOI link, PMid:17229024

67 In: Ilyin SI (Ed.). Food security in Arctic Uluses; Issues of local agricultural production. *IOP Conference Series: Earth and Environmental Science.* Vladivostok: IOP Publishing, 2021. DOI link

68 Kenny T-A, Fillion M, MacLean J, Wesche SD, Chan HM. Calories are cheap, nutrients are expensive – the challenge of healthy living in Arctic communities. *Food Policy* 2018; **80:** 39-54. DOI link

69 Lee A, Patay D, Herron LM, Parnell Harrison E, Lewis M. Affordability of current, and healthy, more equitable, sustainable diets by area of socioeconomic disadvantage and remoteness in Queensland: insights into food choice. *International Journal for Equity in Health* 2021; **20(1):** 153. DOI link, PMid:34193163

70 Pollard C. Selecting interventions for food security in remote indigenous communities. In: Q Farmar-Bowers, V Higgins, J Millar (Eds). *Food Security in Australia: Challenges and Prospects for the Future.* Boston, MA: Springer US. 2013. 97-112. DOI link

71 Pollard CM, Landrigan TJ, Ellies PL, Kerr DA, Lester ML, Goodchild SE. Geographic factors as determinants of food security: a Western Australian food pricing and quality study. *Asia Pacific Journal of Clinical Nutrition* 2014; **23(4):** 703-713.

72 In: Ruiga IR, Kovzunova ES, Bugaeva SV, Ovchinnikova II, Sivtsova EK (Eds). Assessment of food security in the regions of the Arctic zone of the Russian Federation. *IOP Conference Series: Earth and Environmental Science.* 2021; **848:** 012194. DOI link

73 Schwoerer T, Schmidt JI, Holen D. Predicting the food-energy nexus of wild food systems: informing energy transitions for isolated Indigenous communities. *Ecological Economics* 2020; **176:** 106712. DOI link

74 Watson ZA, Shanks CB, Miles MP, Rink E. The grocery store food environment in Northern Greenland and its implications for the health of reproductive age women. *Journal of Community Health* 2018; **43(1):** 175-185. DOI link, PMid:28689340

75 Zahariuk S. *Food Insecurity within the Island Lake First Nation Communities in Northern Manitoba.* Winnipeg, MB: University of Manitoba. 2014.

76 Saskatchewan Government. *The cost of healthy eating in Saskatchewan.* Saskatoon, SK: Saskatchewan Government, 2017.

77 Schembri V. *Planting the seeds of local food capacity in Northern, Provincial Canada: a case study of community and market gardening initiatives in Cumberland House, Saskatchewan.* Thunder Bay, ON: Lakehead University, 2021.

78 Arriagada P. *Food insecurity among Inuit living in Inuit Nunangat.* Ottawa, ON: Government of Canada, 2017.

79 Chan L, Batal M. *FNFNES final report for eight Assembly of First Nations regions: draft comprehensive technical report.* Ottawa, ON: Assembly of First Nations, 2019.

80 Niclasen B, Petzold M, Schnohr CW. Adverse health effects of experiencing food insecurity among Greenlandic school children. *International Journal of Circumpolar Health* 2013; **72.** DOI link, PMid:23984271

81 Huet C. *Prevalence and correlates of food insecurity in Inuit communities.* Montreal, QC: McGill University, 2016.

82 Wendimu M, Desmarais A, Martens T. Access and affordability of "healthy" foods in northern Manitoba? The need for Indigenous food sovereignty. *Canadian Food Studies* 2018; **5(2):** 44-72. DOI link

83 Vladyshevskiy DV, Laletin AP, Vladyshevskiy AD. Role of wildlife and other non-wood forest products in food security in central Siberia. *Unasylva* 2000; **51(202):** 46-52.

84 Egeland GM, Johnson-Down L, Cao ZR, Sheikh N, Weiler H. Food insecurity and nutrition transition combine to affect nutrient intakes in Canadian Arctic communities. *Journal of Nutrition* 2011; **141(9):** 1746-1753. DOI link, PMid:21753059

85 Nakano T, Fediuk K, Kassi N, Kuhnlein HV. Food use of Dene/Metis and Yukon children. *International Journal of Circumpolar Health* 2005; **64(2):** 137-146. DOI link, PMid:15945283

86 Jeppesen C, Bjerregaard P. Consumption of traditional food and adherence to nutrition recommendations in Greenland. *Scandinavian Journal of Public Health* 2012; **40:** 475-481. DOI link, PMid:22821228

87 Rosol R, Powell-Hellyer S, Chan HM. Impacts of decline harvest of country food on nutrient intake among Inuit in Arctic Canada: impact of climate change and possible adaptation plan. *International Journal of Circumpolar Health* 2016; **75:** 31127. DOI link, PMid:27388896

88 Schmidt JI, Johnson B, Huntington HP, Whitney E. A framework for assessing food-energy-water security: A FEW case studies from rural Alaska. *Science of the Total Environment* 2022; 821. DOI link, PMid:35093360

89 Thompson S, Kamal A, Alam M, Wiebe J. Community development to feed the family in Northern Manitoba communities: evaluating food activities based on their food sovereignty, food security, and sustainable livelihood outcomes. *Canadian Journal of Nonprofit and Social Economy Research* 2012; **3(2):** 43-66. DOI link

90 Guo Y, Berrang-Ford L, Ford J, Lardeau MP, Edge VL, Patterson K, et al. Seasonal prevalence and determinants of food insecurity in Iqaluit, Nunavut. *International Journal of Circumpolar Health* 2015; **74.** DOI link, PMid:26248959

91 Huet C, Ford JD, Edge VL, Shirley J, King N, Harper SL. Food insecurity and food consumption by season in households with children in an Arctic city: a cross-sectional study. *BMC Public Health* 2017; **17.**

92 Ready E. Sharing-based social capital associated with harvest production and wealth in the Canadian Arctic. *PLoS ONE* 2018; **13(3):** e0193759. DOI link, PMid:29529040

93 Collings P, Marten MG, Pearce T, Young AG. Country food sharing networks, household structure, and implications for understanding food insecurity in Arctic Canada. *Ecology of Food and Nutrition* 2016; **55(1):** 30-49. DOI link, PMid:26595315

94 Scaggs SA, Gerkey D, McLaughlin KR. Linking subsistence harvest diversity and productivity to adaptive capacity in an Alaskan food sharing network. *American Journal of Human Biology* 2021; **33(4):** e23573. DOI link, PMid:33554415

95 Brinkman T, Charles B, Stevens B, Wright B, John S, Ervin B, et al. Changes in sharing and participation are important predictors of the health of traditional harvest practices in Indigenous Communities in Alaska. *Human Ecology* 2022; **50:** 681-695. DOI link

96 Ziker JP, Fulk KS. Paying it forward or giving back? Women's sharing networks in Siberia. *Cross-Cultural Research: The Journal of Comparative Social Science* 2019; **53(3):** 272-290. DOI link

97 Ziker J, Schnegg M. Food sharing at meals: Kinship, reciprocity, and clustering in the taimyr autonomous okrug, Northern Russia. *Human Nature* 2005; **16(2):** 178-211. DOI link, PMid:26189622

98 Ready E, Power EA. Why wage earners hunt: Food sharing, social structure, and influence in an Arctic mixed economy. *Current Anthropology* 2018; **59(1):** 74-97. DOI link

99 Huet C, Rosol R, Egeland GM. The prevalence of food insecurity is high and the diet quality poor in Inuit communities. *Journal of Nutrition* 2012; **142(3):** 541-547. DOI link, PMid:22323760

100 Islam D, Berkes F. Indigenous peoples' fisheries and food security: a case from northern Canada. *Food Security* 2016; **8(4):** 815-826. DOI link

101 Goldhar C, Ford JD, Berrang-Ford L. Prevalence of food

insecurity in a Greenlandic community and the importance of social, economic and environmental stressors. *International Journal of Circumpolar Health* 2010; **69(3):** 285-303. DOI link, PMid:20519090

102 Noreen W, Johnson-Down L, Jean-Claude M, Lucas M, Robinson E, Batal M. Factors associated with the intake of traditional foods in the Eeyou Istchee (Cree) of northern Quebec include age, speaking the Cree language and food sovereignty indicators. *International Journal of Circumpolar Health* 2018; **77(1):** 1536251. DOI link, PMid:30360700

103 Berman M. Household harvesting, state policy, and migration: Evidence from the survey of living conditions in the Arctic. *Sustainability (Switzerland)* 2021; **13(13).** DOI link

104 Ross AB, Johansson A, Vavruch-Nilsson V, Hassler S, Sjölander P, Edin-Liljegren A. Adherence to a traditional lifestyle affects food and nutrient intake among modern Swedish Sami. *International Journal of Circumpolar Health* 2009; **68(4):** 372-385. DOI link, PMid:19917189

105 Nilsson LM, Dahlgren L, Johansson I, Brustad M, Sjölander P, Van Guelpen B. Diet and lifestyle of the Sami of southern Lapland in the 1930s-1950s and today. *International Journal of Circumpolar Health* 2011; **70(3):** 301-318. DOI link, PMid:21631968

106 Bjerregaard P, Olesen I, Larsen CVL. Association of food insecurity with dietary patterns and expenditure on food, alcohol and tobacco amongst indigenous Inuit in Greenland: results from a population health survey. *BMC Public Health* 2021; **21(1).** DOI link, PMid:34098910

107 Lawn J, Harvey D. *Nutrition and food security in Kugaaruk, Nunavut: Baseline survey for the food mail pilot project.* Ottawa, ON: Government of Canada, 2003.

108 Ruiz-Castell M, Muckle G, Dewailly E, Jacobson JL, Jacobson SW, Ayotte P, et al. Household crowding and food insecurity among Inuit families with school-aged children in the Canadian Arctic. *American Journal of Public Health* 2015; **105(3):** e122-e132. DOI link, PMid:25602890

109 Lysenko D, Schott S. Food security and wildlife management in Nunavut. *Ecological Economics* 2019; **156:** 360-374. DOI link

110 Leonard D, Aquino D, Hadgraft N, Thompson F, Marley JV. Poor nutrition from first foods: A cross-sectional study of complementary feeding of infants and young children in six remote Aboriginal communities across northern Australia. *Nutrition & Dietetics* 2017; **74(5):** 436-445. DOI link, PMid:29027330

111 Wycherley T, Pekarsky B, Ferguson M. Fluctuations in money availability within an income cycle impacts diet quality of remote Indigenous Australians. *Public Health Nutrition* 2016; **20(8):** 1431-1440. DOI link, PMid:28069086

112 Erber E, Beck L, Hopping BN, Sheehy T, De Roose E, Sharma S. Food patterns and socioeconomic indicators of food consumption amongst Inuvialuit in the Canadian Arctic. *Journal of Human Nutrition and Dietetics* 2010; **23:** 59-66. DOI link, PMid:21158963

113 Hopping BN, Erber E, Mead E, Sheehy T, Roache C, Sharma S. Socioeconomic indicators and frequency of traditional food, junk food, and fruit and vegetable consumption amongst Inuit adults in the Canadian Arctic. *Journal of Human Nutrition and Dietetics* 2010; **23:** 51-58. DOI link, PMid:21158962

114 Bjerregaard P, Larsen CVL. Social determinants of dietary patterns, food basket costs and expenditure on alcohol and tobacco amongst Greenland Inuit. *Public Health Nutrition* 2021; **24(15):** 4975-84. DOI link, PMid:33461645

115 Tonkin E, Kennedy D, Hanieh S, Biggs BA, Kearns T, Gondarra V, et al. Dietary intake of Aboriginal Australian children aged 6–36 months in a remote community: A cross-sectional study. *Nutrition Journal* 2020; **19(1).** DOI link, PMid:32295575

116 Ready E. *Food, sharing, and social structure in an Arctic mixed economy.* Palo Alto, CA: Stanford University, 2016.

117 Ford JD, Lardeau MP, Blackett H, Chatwood S, Kurszewski D. Community food program use in Inuvik, Northwest Territories. *BMC Public Health* 2013; **13(1).** DOI link, PMid:24139485

118 Chiu A, Goddard E, Parlee B. Caribou consumption in northern Canadian communities. *Journal of Toxicology and Environmental Health A* 2016; **79(16-17):** 762-797. DOI link, PMid:27556568

119 Wycherley T, van der Pols J, Daniel M, Howard N, O'Dea K, Brimblecombe J. Associations between community environmental-level factors and diet quality in geographically isolated Australian communities. *International Journal of Environmental Research and Public Health* 2019; **16(11).** DOI link, PMid:31159330

120 Ready E. Challenges in the assessment of Inuit food security. *Arctic* 2016; **69(3).** DOI link

121 Ziker JP. Subsistence and food sharing in Northern Siberia: Social and nutritional ecology of the Dolgan and the Nganasan. *Ecology of Food and Nutrition* 2007; **46(5-6):** 445-467. DOI link

122 Godrich SL, Lo J, Davies CR, Darby J, Devine A. Which food security determinants predict adequate vegetable consumption among rural Western Australian children? *International Journal of Environmental Research and Public Health* 2017; **14(1):** 40. DOI link, PMid:28054955

123 Godrich S, Lo J, Davies C, Darby J, Devine A. Prevalence and socio-demographic predictors of food insecurity among regional and remote Western Australian children. *Australian and New Zealand Journal of Public Health* 2017; **41(6):** 585-590. DOI link, PMid:28906569

124 Pakseresht M, Lang R, Rittmueller S, Roache C, Sheehy T, Batal M, et al. Food expenditure patterns in the Canadian Arctic show cause for concern for obesity and chronic disease. *International Journal of Behavioral Nutrition and Physical Activity* 2014; **11:** 51. DOI link, PMid:24739761

125 Scelza BA. Food scarcity, not economic constraint limits consumption in a rural Aboriginal community. *Australian Journal of Rural Health* 2012; **20(3):** 108-112. DOI link, PMid:22620473

126 Landrigan TJ, Kerr DA, Dhaliwal SS, Savage V, Pollard CM. Removing the Australian tax exemption on healthy food adds food stress to families vulnerable to poor nutrition. *Australian and New Zealand Journal of Public Health* 2017; **41(6):** 591-597. DOI link, PMid:28898477

127 Naylor J, Deaton BJ, Ker A. Assessing the effect of food retail subsidies on the price of food in remote Indigenous communities in Canada. *Food Policy* 2020; **93.** DOI link

128 Wendimu M, Desmarais A. *Why is milk so expensive in First Nations communities? Access to and Affordability of Milk in Northern Manitoba.* Winnipeg, MB: Canadian Centre for Policy Alternatives, 2018.

129 Lee A, Rainow S, Tregenza J, Tregenza L, Balmer L, Bryce S, et al. Nutrition in remote Aboriginal communities: lessons from Mai

Wiru and the Anangu Pitjantjatjara Yankunytjatjara Lands. *Australian and New Zealand Journal of Public Health* 2016; **40:** S81-S88. DOI link, PMid:26260761

130 Lee A, Darcy A, Leonard D, Groos A, Stubbs C, Lowson S, et al. Food availability, cost disparity and improvement in relation to accessibility and remoteness in Queensland. *Australian and New Zealand Journal of Public Health* 2002; **26(3):** 266-272. DOI link, PMid:12141624

131 Australian Government. *Indigenous income and finance*. Canberra: Australian Government. 2021.

132 Ramirez Prieto M, Sallans A, Ostertag S, Wesche S, Kenny TA, Skinner K. Food programs in Indigenous communities within northern Canada: A scoping review. *Canadian Geographies* 2023; **July.** DOI link

133 Skinner K, Hanning R, Metatawabin J, Tsuji LJ. Implementation of a community greenhouse in a remote, sub-Arctic First Nations community in Ontario, Canada: A descriptive case study. *Rural and Remote Health* 2014; **14(2):** 2545. DOI link

134 Chen A, Natcher D. Greening Canada's Arctic food system: Local food procurement strategies for combating food insecurity. *Canadian Food Studies* 2019; **6(1):** 140-154. DOI link

135 Government of Canada. *Support for hunting, harvesting and community-led food programs.* Ottawa, ON: Crown-Indigenous Relations and Northern Affairs Canada – Government of Canada, 2022.

136 Pagaduan J, Lazarescu C, Vallieres E, Skinner K, Zuckerman A, Idzerda L. The impacts of the Nutrition North Canada program on the accessibility and affordability of perishable, nutritious foods among eligible communities: a scoping review. *International Journal of Circumpolar Health* 2024; **83(1).** DOI link, PMid:38346231

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