REVIEW ARTICLE

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

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**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, is an important social determinant of health, associated with a number of adverse health outcomes, even at marginal levels. Other aspects of food security, such as the availability of and physical access to healthy foods, are uniquely challenging to achieve in remote regions.

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). Remote circumpolar communities include people of all demographics, but many were created or populated as a result of the forced relocation of Indigenous Peoples. 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%.

Food systems in remote circumpolar communities consist of a combination of purchased market foods and traditional foods, harvested and shared locally and sometimes regionally. “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. 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. Market food is often imported on airfreights that are vulnerable to the impact of increasing fuel costs and unpredictable weather.

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. 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. 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.

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
‘Food sovereignty’ is a framework for transforming food and agriculture to ensure food security and strengthen self-sufficiency, social equity, and self-determination. This emphasizes the need to place more control into the hands of those who have been systematically excluded from the formulation of food policy. 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. As such, food sovereignty can assist with creating localized food systems and tackling the food insecurity crisis that remote Indigenous populations face within Canada.

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.

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 and the PRISMA reporting guidelines for scoping reviews. The review protocol was registered to Open Science Framework prior to data collection.

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. 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) and included health databases Ovid MEDLINE(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, to June 2022. A grey literature search was conducted according to the methods described by Godin et al.

(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

Box 1: Groups constituting Indigenous Peoples.

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.
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, using PRISMA guidelines for scoping reviews. 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), Risk of Bias 2 for randomized controlled trials, or Risk of Bias in non-randomized exposure studies 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 (Fig 1).

![Figure 1: PRISMA diagram for scoping review.](image)

**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>
<thead>
<tr>
<th>Country</th>
<th>Total (n)</th>
<th>Initiative (n)</th>
<th>Exposure factor (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>8</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Australia/New Zealand</td>
<td>27</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Canada</td>
<td>48</td>
<td>15</td>
<td>36</td>
</tr>
<tr>
<td>Greenland</td>
<td>7</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Norway/Sweden/Finland</td>
<td>3</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

1 Four studies included both initiatives and exposure factors.

2 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 Canada36-39 and one in the US40. All five included a food component, such as a school snack37-39 or local traditional foods40. The implementation of all five programs was associated with significant positive changes in food security outcomes. These included improved diet quality36-40 and nutrient intake38,39, 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 storage39. 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 size37. Though all of these programs were associated with improvements to food security outcomes, improvements did not always reach dietary adequacy recommendations36,37.

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 sales41,42. The low impact of these programs was attributed to factors including store staffing challenges and limited infrastructure in a study with low risk of bias41, as well as the small discount size in a study with high risk of bias42. A 20% discount, with an additional in-store educational component, was applied during the SHOP@RIC intervention in Australia43-46. This level of discount was associated with increases in fruit and vegetable purchasing in two studies, both of which had low risk of bias43,45, though no significant change in diet quality44,46. The majority of the change in purchasing was associated with the discount program, rather than the education component43.

In Canada, the implementation of the Food Mail Program, a national food shipping subsidy, was associated with lower food costs and higher food shipment volumes47,48, though was underused due to challenges related to accessibility and visibility49. The program was replaced with Nutrition North Canada (NNC) in 2011, a tiered subsidy program based on level of remoteness49. 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 bias50-53. Additionally, HFI levels in NNC-eligible communities increased after implementation of the program51. 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 eating50 and the benefits of traditional foods40, 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 intake54. A second Australian initiative involved healthy eating and physical activity sessions, targeted at diabetic Indigenous adults, showed no significant changes in dietary habits55. 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 events56. Significant changes were observed in the intervention group, including increased consumption of promoted healthy foods56 and increased consumption of healthy foods from baseline57. 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 nutrient58.

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 population59. 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 program59. 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 services60. 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 access60. 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 supplementation61,62.

Exposure factors
Exposure factors were divided into nine categories and compared to food security outcomes (Fig 2). 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 (Fig 2). 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. Studies from both Canada and Greenland found that larger communities had lower levels of HFI than smaller remote communities in the same regions, however, two studies located in Canada found no relationship between community size and food security or cost. 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.

![Figure 2: Summary of exposure factors associated with improved food security outcomes.](image)

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, and micronutrients, such as zinc. Greater traditional food availability was associated with lower HFI rates in studies located in the USA and Canada. However, eating traditional food at more than 50% of meals was not associated with HFI in two studies located in Canada. This lack of association was attributed to the nutritional transition from traditional food to market foods in the younger generations.

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 or a harvester in the household, greater harvest diversity and traditional harvesting practices, and those reporting stronger harvester skills. 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. Having a harvester in the household was correlated with lower rates of HFI and higher traditional food consumption. Learning subsistence skills as a child was associated with larger harvests and participation in harvesting was associated with higher traditional food consumption.

Income/socioeconomic status: In most studies assessing the relationship between income and socioeconomic status, 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 or below C$20,000 (A$21,900). 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. Studies from Canada, Australia, and Greenland found that having lower income or being on income assistance was associated with higher rates of HFI, fewer hunters in the household, higher frequency of traditional food consumption, reduced dietary quality and diversity (based on Australian recommendations for children <2 years old), and receiving more shared food.

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, have a less diverse diet, and share food, though food sharing was more strongly correlated with harvesting-related factors, such as having a hunter in the household, than with employment status. In studies located in both Canada and Australia, employment status was not associated with other outcomes including the number of hunters per household, and the percentage expenditure on discretionary food. 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.
Housing: Housing status, including household size, crowding, and repair needs, was associated with food security outcomes in the majority \( \left(n = 9/12\right) \) 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\(^{100,104,118}\). 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 \( \left(n = 9/14\right) \) 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\(^ {116,120,122}\). 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\(^ {99}\).
Table 2: Studies evaluating food security and sovereignty initiatives in remote and isolated regions

<table>
<thead>
<tr>
<th>Country</th>
<th>Description</th>
<th>Year</th>
<th>Remote study setting</th>
<th>Study design</th>
<th>Study population/ sample</th>
<th>Population/ sample n</th>
<th>Measured outcome</th>
<th>Overall risk of bias</th>
<th>Author (ref.)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SCHOOL BASED PROGRAMS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canada</td>
<td>Harvest sharing program to increase consumption of spring snow goose</td>
<td>2011</td>
<td>Remote James Bay community</td>
<td>Pre- and post-study</td>
<td>School-attending youth in grades 6-8</td>
<td>73</td>
<td>Macro- and micronutrient intake</td>
<td>High</td>
<td>Gales, et al. (36)</td>
</tr>
<tr>
<td>Canada</td>
<td>School snack program, including daily morning snack to all students and afternoon snack to all elementary (pre-kindergarten to grade 6) students</td>
<td>2004-2007</td>
<td>Fort Albany, Ontario</td>
<td>Longitudinal</td>
<td>Students in grades 6-10</td>
<td>115</td>
<td>Intake of healthy foods</td>
<td>Moderate</td>
<td>Skinner, et al. (37)</td>
</tr>
<tr>
<td>Canada</td>
<td>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</td>
<td>1998-1999</td>
<td>Sandy Lake, Ontario</td>
<td>Pre- and post-study</td>
<td>Students aged 7-14 years</td>
<td>122</td>
<td>Nutrient intake</td>
<td>High</td>
<td>Saksug, et al. (38)</td>
</tr>
<tr>
<td>Canada</td>
<td>A snack program, including at least one daily serving from the vegetables and fruit and milk and alternatives food groups in Kashakwehun and a milk provision program in Atikallaq</td>
<td>2009-2010</td>
<td>Kashakwehun and Atikallaq, Ontario</td>
<td>Pre- and post-study</td>
<td>Students in grades 6-8</td>
<td>129</td>
<td>Milk and alternatives intake</td>
<td>High</td>
<td>Gales, et al. (39)</td>
</tr>
<tr>
<td>US</td>
<td>Serving locally harvested salmon, experimental lessons about the benefits of traditional foods and community events celebrating traditional foods</td>
<td>2018</td>
<td>Two remote Alaskan communities</td>
<td>Quasi- experimental</td>
<td>Middle and high school students</td>
<td>76</td>
<td>Diet quality</td>
<td>High</td>
<td>Bersman, et al. (40)</td>
</tr>
</tbody>
</table>

**GREENHOUSE STUDIES**

| Canada | Community greenhouse | 2016-2017 | Kusogak, Nunavut | Modeling | Community greenhouse | N/A | Modeled vitamin intake | N/A | Lamalice, et al. (50) |

**TRADITIONAL FOODS PROGRAMS**

| Canada | The Nelson House Community Food Program: a distribution program for wild foods, re-establishment of caribou near the reserve, a country food processing centre, and community freezer | 2008-2009 | 14 Northern Manibook communities | Cross- sectional with control | Community Households | 534 | Food insecurity | High | Thompson, et al. (59) |

**MARKET SUBSIDIES**

| Australia | The Healthy Choice Rewards (HCR) program: AS$16 fruit and vegetable voucher after minimum spend on fruit and vegetables | 2015 | Very remote stores 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, refrigerated, and Fevergoose product; (2) fresh fruit and vegetable point of sale sales; (3) fresh fruit and vegetables at landed cost, (4) diet soft-drink discount | 2010 | 5 communities in Northern Territory and Western Australia | Pre- and post-study | Outback stores | 18 | Food/ beverage sales | High | Ferguson, et al. (42) |
| Australia | Modelling 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 | 168 | Cost of meals Probability of food stress | N/A | Landigian, et al. (120) |

**Northern Air Stage/Flight Mail Program**

| Canada | Food Mail Program - subsidizing transport costs for certain foods in remote communities not accessible by year-round road | 1890s-2011 | Remote northern communities | Pre- and post-study | Community-level data | 20 | Price of Northern Nutritious Food Basket | High | Lavin, et al. (47) |
| Canada | Food Mail eligible communities | | | Modeling | Community-level data | 140 | Food volume | N/A | Government of Canada (48) |

**NORTH CANADA (NNC)**

| Canada | Nutrition North Canada: Primarily a food subsidy program, with a community nutrition education component; Currently expanded to include harvest support grants and community food programs. | 2011- present | Remote northern communities | Pre- and post-study | Community-level data | 125 | RHF prices | Low | Galloway (50) |
| Canada | Remote Nunavut communities | | | Modeling | Community-level data | 25 | Cost through rate for food subsidy | N/A | Naylor, et al. (127) |
| Canada | 10 Nunavut communities | | | Intercultural time series | Community households | 252 | Food insecurity | Moderate | St-Germain, et al. (51) |
| Canada | Remote Manibook communities | | | Cross- sectional with control | Store data | 26 | Price of milk | Moderate | Waingan, et al. (128) |
| Canada | All participating remote communities in Canada | | | Cross- sectional with control | Community households | 103 | Grocery expenditures | High | Eng Research Group (53) |
| Canada | Garden Hill First Nation, Manitoba | | | | Community households | 26 | Price of RHF | Moderate | Puzyrevsky (52) |

**STORES HEALTHY OPTIONS PROGRAM IN REMOTE INDIGENOUS COMMUNITIES (BRIEF)FIGURE**

| Australia | A 20% discount on fresh fruit, fresh/frozen vegetables, eggs, and bottled water for all participants, and in- store consumer education program half of participants | 2013-2014 | 20 remote communities in the Northern Territory | Stepped wedge controlled trial | Community residents of all ages | 651 | Fruit and vegetable consumption | Low | Magnus, et al. (43) |
| Australia | Three remote Indigenous communities | | | Modeling | Aboriginal population living in remote Australia | 2638 | Energy and sodium intake | N/A | Magnus, et al. (44) |
| Australia | Communities in remote Indigenous Australia | | | Stepped wedge controlled trial | Store data | 20 | Purchases of food, fruit and vegetables | High | Birimblecombe, et al. (45) |
| Australia | Four remote communities in Northern Territory | | | Longitudinal | Indigenous adults living in Northern Territory | 73 | Intake of fruits and vegetables, food security | High | Birimblecombe, et al. (45) |

**EDUCATION INITIATIVES**

| Australia | Food Sensations for Adults (FSA): a four-season, experiential nutrition education program, lesson plans divided into modules targeted 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 | Daintar, et al. (54) |

**HEALTHY FOODS NORTH (PFN)**

| 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 messaging, posters, shelf labels), and community events | 2008 | Kikinna, 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 | Koladosz, et al. (50) |
| Canada | Communities in Nunavut and the Northwest Territories | | | Quasi- experimental | One indigenous adult per household, not pregnant | 557 | Frequency of healthy and less healthy food acquisitions | High | McAl, et al. (57) |

**OTHER**

| Australia | Income management program by the government, requiring 50% of income support be used for items considered expenses, including food | 2006-2009 | 10 stores remote Northern Territory | Interrupted time series | Community- level data | 10 | Fruit and vegetable sales | Low | Birimblecombe, et al. (82) |
| Australia | Undifferentiated initiatives in remote communities conducted between 1998 and 2014, including subsidies on market foods, requirement for recording of prices and transparency, school garden project, recipe calendar, and health promotion materials in stores | 1998-2014 | Seven Anangu Pitjantjärpa Yankunytjarra Lands | Pre- and post-study | Community stores | 7 | Cost and availability of healthy foods | High | Lee, et al. (129) |
| Australia | Good Food Systems Good Food for All Project (GFS) Annual planning meeting and the appraisal of the Good | 2004-2013 | Four Indigenous communities | Longitudinal multi-site | Community-level data | N/A | Community diet | High | Birimblecombe, et al. (83) |
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\textsuperscript{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\textsuperscript{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\textsuperscript{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\textsuperscript{109,116} and noted socioeconomic status is a significant determinant of food security\textsuperscript{30,106}.

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\textsuperscript{132}. A 2019 study documented 36 community gardens and 17 greenhouses in remote northern Canada, though very few quantitative evaluations have been published\textsuperscript{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\textsuperscript{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\textsuperscript{41,43,45} and NNC\textsuperscript{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\textsuperscript{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\textsuperscript{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 GPS study noted that outcomes such as food quality and access may have been impacted but were not measured\textsuperscript{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\textsuperscript{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\textsuperscript{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\textsuperscript{85-87}. Programs that increased traditional food access and affordability help to create sustainable livelihoods, in communities that otherwise rely on market foods\textsuperscript{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\textsuperscript{36,38,40,56,60}. Three studies also noted the integral role of local champions or coordinators\textsuperscript{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\textsuperscript{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\textsuperscript{51,60}.
Due to limitations in size, this study did not include qualitative outcomes. Quantitative 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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