A Scoping Review of the Use of Indigenous Food Sovereignty Principles for Intervention and Future Directions

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ABSTRACT

Indigenous food sovereignty (IFS) represents a community-led movement with potential to reduce health inequities, but no scoping review of the impact of taking an IFS approach on intervention research has been conducted. This review sought to: 1) describe intervention studies that employ IFS principles, and 2) describe the impact of studies using IFS principles on food access, eating patterns, diet quality, physical activity, and health. Through a literature review, 4 IFS principles were identified: 1) community ownership, 2) inclusion of traditional food knowledge, 3) inclusion and promotion of cultural foods, and 4) environmental/intervention sustainability. Twenty intervention studies published between January 1, 2000 and February 5, 2020 were included. Most of the studies that scored high in IFS principles saw a positive impact on diet. This review found evidence supporting the value of IFS principles in the development, implementation, and evaluation of health interventions for Indigenous communities.

Introduction

Food sovereignty was defined by the first global Forum for Food Sovereignty as “the right of peoples to healthy, culturally appropriate food produced through ecologically sound and sustainable methods, and their right to define their own food and agriculture systems”(1). More specifically, Indigenous Food Sovereignty shares some of these principles but generally moves beyond just food access to incorporate complex relations between Indigenous peoples, the land, and sacred food knowledge (2–6). IFS can be defined as a rights-based approach to land, food, and the ability to control a production system that emphasizes accountability to holding culturally, ecologically, and spiritually respectful relations (with plants, animals, environment, and surrounding communities) within those systems (7, 8). Common guiding principles of IFS may be summarized as: 1) community ownership, 2) inclusion of cultural food knowledge, 3) promotion of traditional and local foods, and 4) environmental changes to promote access to land, food, and maintain intervention sustainability (8–10). In the United States and Canada Indigenous peoples experience disproportionately high rates of type 2 diabetes, obesity, and food insecurity (11–18). These important health inequities rooted, in large part, in dietary disparities (19), highlight the need for interventions and programs that promote access to, and consumption of, traditional and culturally appropriate healthy foods among Indigenous peoples. IFS is an important way in which communities are able to improve access to healthy, culturally appropriate foods and diet quality, while facilitating cultural connections, and ultimately improving community wellness.

In recent years, intervention studies that aim to address inequities in health, nutrition, and food security among Indigenous Nations or communities have explicitly or implicitly employed some of the guiding principles of food sovereignty to design, implement, and/or evaluate their interventions. However, to our knowledge, no reviews have systematically assessed how IFS principles have been applied to the development, implementation, and evaluation of interventions or what has been their impact on health-related outcomes (20, 21). The primary goals of this study were to systematically review evidence regarding: 1) the level of application of IFS principles in the design, implementation, and evaluation of nutrition and food interventions; 2) how these
interventions impacted food access, healthy eating, diet quality, physical activity, and health outcomes; and 3) what are the gaps in current research and priorities going forward.

**Methods**

This study undertook a scoping literature review of published gray and peer-reviewed literature regarding intervention studies that aimed to impact food and nutrition outcomes in Indigenous communities in North America (the United States and Canada). This scoping review intended to clarify key concepts and definitions of IFS for intervention research and examine how research interventions that use principles of IFS are conducted, goals that are well aligned with the purposes of a scoping review (22).

**Search and sampling strategy**

Two researchers (TLM, UC-R) searched for food, nutrition, or food system intervention trials that reported on psychosocial, food access, behavioral, or health outcomes among Indigenous Nations and Indigenous communities in North America. In consultation with a Johns Hopkins Welch Medical Library informationist, the searches were conducted using PubMed (Medline), Embase, Scopus, and Web of Science to identify peer-reviewed articles using the following search strategy: ["American Indian∗" OR "Native Americans∗" OR "Alaska Native∗" OR "Indigenous Peoples∗" OR "First Nations∗" OR "North American Indian∗") AND ("Food" OR "Nutrition" OR "Cultural Foods" OR "Traditional Food∗") AND ("Intervention")]. The search strategy followed Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for the reporting of systematic reviews (23). **Figure 1** presents the PRISMA flow diagram demonstrating the selection process for article/study inclusion.

**Trial selection criteria and process**

The titles and abstracts of studies pertaining to interventions were searched to identify if articles met the following inclusion criteria.
Inclusion criteria.
The following inclusion criteria were used for each potential trial study: 1) reported in the English language; 2) >50% of the study population included Indigenous Nations or Indigenous communities either in the United States or in Canada; 3) presented impact findings of intervention or program designed to improve nutritional status (i.e., undernutrition, overnutrition, breastfeeding), diet-related health status, or direct underlying determinants of nutritional status (i.e., dietary intake, food security, psychosocial factors, food access, other behavioral outcomes); 4) the intervention occurred after the year 2000 and was published between January 1, 2000 and February 5, 2020; and 5) included ≥1 core IFS principles at a level of 1.5 or higher. These inclusion criteria were carefully chosen to aid in selecting interventions that represent the state of food and nutrition research in Indigenous communities over the past 20 years. To provide a more detailed review of the application of food sovereignty principles to intervention research, included interventions required a minimal demonstration (score of 1.5) of ≥1 principle of food sovereignty.

Exclusion criteria.
Trials were excluded if: 1) there was no published information about their impact on diet-related health, nutritional status, or underlying determinants of nutritional status as specified above; 2) they focused on diet-related chronic disease or infectious disease but did not intervene on diet, nutrition, or food; or 3) they did not include ≥1 core principles of IFS at a score of 1.5.

Study selection and screening processes.
After titles and abstracts were independently screened by the 2 reviewers (TLM and UC-R), any discrepancies were resolved by an adjudicator (JG). Then each primary reviewer (TLM, UC-R) independently examined if the full-text met the inclusion criteria using the Covidence systematic review tool (24). Disagreements regarding eligibility of studies were resolved by discussion and consensus. Of the 420 studies considered during the title and abstract review, 360 were excluded. Of the 60 remaining studies for full-text screening, 40 were excluded, leaving a final sample of 20 studies.

When the researchers agreed that a trial study fit the selection criteria, they then searched for additional relevant documents about the trial (i.e., community reports, news articles, etc.) using PubMed, Google Scholar, and Google. The references of relevant articles were also reviewed to identify any additional articles of interest.

IFS scoring system.
Consistent with the guiding principles of IFS previously discussed (2, 8–10), a 4-part definition was used in the assessment of IFS in this review (Table 1): 1) community ownership, 2) inclusion of traditional food knowledge, 3) inclusion and promotion of cultural and traditional foods, and 4) environmental and intervention sustainability. This scoring system was created to operationalize the application of IFS principles to intervention research and has potential to be used in other evaluations of intervention research in Indigenous communities. Table 1 was used to score interventions for each principle, as well as to provide an overall IFS score for each intervention. Each principle was scored as high, medium, low, or none (3, 2, 1, and 0, respectively). Detailed descriptions of criteria for meeting each level of IFS scores can be found in Table 1.

The first principle in the context of research interventions relates to the degree to which the community is involved in the intervention. In line with community-based participatory research (CBPR) principles ideally, the community is involved in the initiation, development, implementation, and sustainability efforts of an intervention (25). The second principle relates to the degree to which traditional food knowledge is emphasized as part of the intervention. This includes generational knowledge passed down from Elders and other knowledge keepers, storytelling, and honoring Indigenous ways of planting, cultivating, harvesting, processing, and preparing indigenous foods. The third principle relates to how traditional and cultural foods are included in the intervention. Traditional and cultural foods are important to the identities of many Indigenous peoples. Additionally, traditional foods are nutrient dense and can be supportive of a healthy diet. Promoting traditional and cultural foods can be important for ensuring that the foods promoted through the intervention are relevant and culturally acceptable to the communities engaged in the intervention. Further, promoting cultural and traditional foods has potential to garner further demand for foods produced by grassroots food sovereignty movements. The second and third principles are closely related but differ in that an intervention can promote consumption of traditional foods (principle 3) without acknowledging the relationality and traditional knowledge associated with growing, harvesting, and preparing these foods (principle 2). The fourth principle relates to the ecological responsibility of Indigenous peoples to grow and process foods in an environmentally responsible way, as well as the responsibility of the researchers to conduct research in a sustainable way. Interventions representing this principle promote sustainable change to food systems and build community capacity to continue implementing activities that support IFS principles after the intervention is complete.

Data extraction and analysis
The 2 primary reviewers (TLM, UC-R) independently reviewed full-text articles and any relevant documents from the gray literature for each trial study and extracted data using standardized data abstraction tables. These tables included the author and year in which the study was published, the name of the tribe/community (if provided) and state/country, institutional review board (IRB) or tribal approvals, study topic, study design, theory or behavior change framework used (if applicable), study goal, study sample, description of the intervention, process evaluation information, how it was evaluated, impacts at different levels, and the level of agreement with each of the 4 principles of IFS (high = 3, medium = 2, low = 1, none = 0), and overall agreement with IFS based on a 12-point scale (3 points possible for each of the 4 characteristics). Finally, a third reviewer (JG) resolved any discrepancies between the 2 primary reviewers, compared scores for each trial study, and provided an average score for each study trial for each of the 4 IFS principles.

Results
IFS principle scores
Among IFS components, ownership ranked highest (2.0), followed by knowledge (1.8), environment (1.4), and traditional foods (1.3). The
TABLE 1  Principles of indigenous food sovereignty, with scoring criteria

| IFS principle | 0: None | 1: Low | 2: Medium | 3: High |
|---------------|---------|--------|-----------|---------|
| Principle 1: community ownership | No evidence that any level of community ownership was part of the trial design/implementation | Mention little evidence of community involvement, or community involvement/consultation only in planning and/or dissemination | Offers evidence that community involved in planning and implementation of intervention | Community involved in every aspect of the project—planning, implementation, evaluation, dissemination (ongoing engagement) |
| Principle 2: inclusion of cultural knowledge | No evidence of cultural appropriateness/adaptation/relevance in the intervention strategies (indicators: no FR of any kind; imposition of existing approaches and strategies on new communities) | Minor evidence of cultural appropriateness/adaptation/relevance in intervention strategies (indicators: minor FR (e.g., a few focus groups only, adaptation of existing materials from other settings)) | Moderate evidence of cultural appropriateness/adaptation/relevance in the intervention strategies (indicators: substantial multistage FR, iterative adaptation with community feedback using multiple methods; some use of cultural food knowledge (concepts, categories), some use of local communication channels; limited creation of new approaches and strategies for a specific community) | High evidence of cultural appropriateness/adaptation/relevance in the intervention strategies (indicators: substantial multistage FR, intervention demonstrates substantial community-specific cultural food knowledge, cultural nutrition education, stories; heavy use of appropriate local communication channels; strong evidence of creation of new approaches and strategies for specific communities) |
| Principle 3: inclusion of traditional foods | No evidence of inclusion of local/traditional and healthy foods in the intervention | Intervention promotes healthy foods, but not local/traditional or intervention says it promotes traditional foods but limited description of the traditional foods or promotion efforts in a limited manner (e.g., lip service) | Heavily promotes healthy local/traditional foods via multiple approaches as part of an intervention | Promotion of traditional foods is the central focus of the intervention |
| Principle 4: environmental sustainability of intervention | No mention of efforts to make intervention sustainable or policy implications required to reconcile indigenous food practices with dominant society economic practices | Briefly mentions sustainability efforts or policy implications for interventions, but does not offer specific action plan and/or does not mention land rights or land connections | Significant detailed description of intervention sustainability, policy implications along with some recommendations and/or food sustainability, but some mention (activities with land) of connection to land or land rights | Central focus on intervention sustainability, impact and importance of traditional foods on local environment, or policy changes to sustain or implement healthy environment changes |

FR, formative research; IFS, indigenous food sovereignty.

third reviewer then added these scores together to create an overall IFS score. These scores are intended to provide an indication of the degree to which an intervention is providing supporting for food sovereignty in the community (or communities) they are working with. Overall IFS scores ranged from 3 to 11.5, with a mean of 6.6. Based on these scores, we categorized studies into high (>7), medium (6, 7), and low (<6). The IFS scores for each intervention are presented in Table 2A–C.

Description of studies

Tables 3 and 4 present the description of the studies’ populations, objectives, theoretical frameworks (Table 3A–C) and study design,
Review of indigenous food sovereignty principles

TABLE 2A  IFS principles score, overall IFS score1

| Project name       | Healthy Children Strong Families 1 | Nega Elicarvigmun (Fish to School) | Healthy Foods North | Iron Deficiency Anemia Infants | THRIVE | Healthy Children Strong Families 2 | Medicine Wheel children |
|--------------------|-----------------------------------|------------------------------------|--------------------|--------------------------------|--------|------------------------------------|------------------------|
| IFS1: Ownership    | 3                                 | 2.5                                | 2.5                | 3                              | 3      | 3                                 | 1.5                    |
| IFS2: Knowledge    | 3                                 | 3                                  | 2.5                | 2.5                            | 2      | 2                                 | 2.5                    |
| IFS3: Traditional Foods | 3                              | 3                                  | 2.5                | 3                              | 1.5    | 2                                 | 2.5                    |
| IFS4: Environment  | 2.5                               | 2.5                                | 2.5                | 1.5                            | 2      | 1.5                               | 1                      |
| IFS score          | 11.5                              | 11                                 | 10                 | 8.5                            | 8.5    | 7.5                               |                        |

1IFS, indigenous food sovereignty; THRIVE, Tribal Health and Resilience in Vulnerable Environments.

TABLE 2B  IFS principles score, overall IFS score1

| Project name       | Apache Healthy Stores | Medicine Wheel Adults | Navajo Healthy Stores | Earthbox | OPREVENT | Traditions of the Heart | Generations Health | Journey to Native Youth Health |
|--------------------|-----------------------|-----------------------|-----------------------|----------|----------|-------------------------|--------------------|-----------------------------|
| IFS1: Ownership    | 2                     | 1.5                   | 2.5                   | 2        | 1.5      | 1.5                     | 1                  | 2.5                         |
| IFS2: Knowledge    | 1                     | 2                     | 1                     | 1        | 2        | 2.5                     | 2                  | 2                           |
| IFS3: Traditional Foods | 1.5                 | 2.5                   | 1                     | 1.5      | 1        | 2                       | 2                  | 0.5                         |
| IFS4: Environment  | 2.5                   | 1                     | 2.5                   | 2        | 2        | 0.5                     | 1                  | 1                           |
| IFS score          | 7                     | 7                     | 7                     | 6.5      | 6.5      | 6.5                     | 6                  | 6                           |

1IFS, indigenous food sovereignty; OPREVENT, Obesity Prevention and Evaluation of Intervent Effectiveness in NaTive North Americans.
through community reports and other multimedia materials (including YouTube videos).

The second principle, cultural food knowledge, was supported through intervention activities that were tribally or regionally specific and included activities such as: berry picking, gardening, harvesting, and cooking lessons/demonstrations. These activities promote the transmission of cultural food and nutrition knowledge throughout the community and support intergenerational food system resilience.

The third principle, promotion and inclusion of traditional foods, was demonstrated in interventions through specific promotion of tribally and culturally specific traditional foods and made explicit the connection between cultural values and traditional foods. One intervention, Fish to School, promoted access to and consumption of fish (a traditional food) as the primary intervention goal.

The final IFS principle, environmental sustainability, was supported through the planning of sustainable intervention activities, as well as activities that supported cultural connections to land and water. Whereas the activities that supported this principle varied by intervention topic, the interventions that scored highly on this principle tended to focus on addressing environmental barriers to healthy food access through creation of community gardens, food distribution programs, or other similar mechanisms to sustainably improve access to healthy foods.

Process evaluation.
Some form of process evaluation was reportedly conducted in just over half of the studies (11/20), but in 2 cases these results were not reported.

Outcome assessment methods and impact.
Table 5A–C presents assessment and impact for the following outcomes: food environment/policy, diet and food intake/acquisition, physical activity/sedentary behaviors, psychosocial factors, and health.

Food environment/policy assessment and impact.
Only 7/20 studies reported an assessment of the food environment (such as availability of healthy foods in stores), but of those, almost half (3/7) did not report the actual outcome of the intervention on the food environment.

Diet(food intake or acquisition impact.
Various methods were used to assess dietary outcomes or food consumption: 10/20 studies used dietary screeners; and 8/20 studies used multiple 24-h dietary recalls or FFQs that were either adapted for the population targeted or created specifically for the target population. The majority (5/7) of studies that scored high in IFS used screeners or an FFQ (that had not been adapted to the population) to assess dietary outcomes. The majority of the studies that scored high on IFS (5/7) observed a positive impact on dietary intake (e.g., diet quality) based on the intervention, compared with 3/7 studies that assessed diet in those studies with medium IFS scores. Although the majority of studies that scored low on IFS and assessed diet (4/5) also reported an impact on diet, only 1 of these studies had an RCT design.

Physical activity/sedentary behaviors assessment and impact.
The majority of the studies assessed physical activity and sedentary behavior or screen time activity (12/20) with a variety of tools (accelerometers, surveys, diaries, or recalls), but only 11/12 studies reported whether or not there was an impact. Of those, 6/12 studies reported an improvement in physical activity, with an additional study reporting effects on adults, but no impact on children. Nonetheless, only 2 of those studies had an RCT design or a control design.

Psychosocial factors assessment and impact.
The majority of studies included psychosocial factors (15/20); 5/15 included self-efficacy, and the others included constructs such as knowledge, perceptions, preferences, intentions, and social support.

Health outcomes assessment and impact.
Health outcomes—defined as anthropometric measures or other indicators of chronic disease (anthropometry, biomarkers, self-reported disease)—were assessed in the majority of studies (13/20). Of the studies that assessed some form of health outcome, 8/13 found ≥1 positive impact, whereas 5/13 did not. The majority of the studies that found health impacts were in the low-scoring IFS studies (4/5 studies assessed health outcomes and showed some benefits in health outcomes including weight, hypertension, and fasting blood glucose). Most of the studies that scored high in IFS did not assess health impacts but assessed dietary intake and food environments (4/7).

Discussion
This scoping review sought to operationalize IFS principles to evaluate interventions and the impact of these interventions. This article is, to the best of our knowledge, the first attempt to develop principles of IFS to aid the systematic evaluation of IFS interventions, based on the previous conceptualizations and definitions of IFS. After developing the 4
**TABLE 3A** Study goals and overall IFS score (high scores 7.5–11.5)

| Project name                              | Healthy Children Strong Families 1 | Nega Elicarvigmun (Fish to School) | Healthy Foods North | Iron Deficiency Anemia Infants | THRIVE | Healthy Children Strong Families 2 | Medicine Wheel Children |
|-------------------------------------------|-----------------------------------|-----------------------------------|--------------------|--------------------------------|--------|-----------------------------------|------------------------|
| Data sources                              | Published: (26–31) Other: (36–38)| Published: (39–46) Other: (47)    | Published: (48)    | Published: (49–56)             | Published: (57–62) Other: (63) |
| Name of tribe/location                    | 4 AI tribes (Menominee, Lac du Flambeau, Bad River, and Oneida); Wisconsin | Yup’ik peoples; SW Alaska | Inuit, Inuvialuit communities; Canadian Arctic | James Bay Cree; Northern Quebec | Chickasaw and Choctaw Nations; Oklahoma |
| IRB/tribal and community approvals        | University of Wisconsin-Madison’s Health Sciences IRB; and approval was obtained from each tribal council and Head Start Program | University of Alaska Fairbanks; and Human Subjects Committee at the Yukon Kuskokwim Health Corporation | Committee on Human Studies at the University of Hawaii; Office of Human Research Ethics at the University of North Carolina at Chapel Hill; Beaufort Delta Health and Social Services Authority Ethics Review Committee; and Nunavut Research Institute and the Aurora Research Institute | Ethical Review Committee at McGill University | University of Oklahoma Health Sciences Center IRB; Chickasaw Nation IRB; and Choctaw Nation of Oklahoma IRB |
| Model                                     | Social cognitive theory, family systems theory | Social cognitive theory | Social cognitive theory, stages of change | Social marketing theory | Social cognitive theory | Social cognitive theory; family systems theory | Medicine Wheel model |
| Study goals                                | To reduce overweight in young children through a home visit intervention | To improve diet, fish intake, and psychosocial factors regarding traditional foods | To address nutrition transition using culturally sensitive approaches (e.g., increase traditional food consumption) | To promote knowledge and behaviors to reduce IDA in infants | To improve the food environment by designing, implementing, and evaluating a food store intervention | To determine if a mailed home-based healthy lifestyle intervention can reduce child overweight | To determine if culturally relevant knowledge improves child FV intake |
| IFS score                                  | 11.5 | 11 | 10 | 10 | 8.5 | 8.5 | 7.5 |

1AI, American Indian; FV, fruit and vegetable; IDA, iron deficiency anemia; IFS, indigenous food sovereignty; IRB, institutional review board; NA, Native American; SW, southwest; THRIVE, Tribal Health and Resilience in Vulnerable Environments.
| Project name | Apache Healthy Stores | Medicine Wheel Adults | Navajo Healthy Stores | Earthbox | OPREVENT | Traditions of the Heart | Generations Health | Journey to Native Youth Health |
|--------------|-----------------------|-----------------------|-----------------------|----------|-----------|------------------------|-------------------|-----------------------------|
| Data sources | Published: (66–70)    | Published: (68, 73, 74) | Published: (77, 78)   | Published: (80–87) | Published: (89–93) | Published: (95) | Published: (96–98) |
| Name of tribe/region | White Mountain Apache and San Carlos Apache; Arizona | Cheyenne River Sioux; South Dakota | Navajo Nation; New Mexico | First Nations Reserve; Alberta, Canada | 2 Navajo communities, Okhay Owingeh, Keweenaw Bay Indian Community, Halkomelem Potawatami; Michigan and New Mexico | Alaskan Natives; Anchorage, AK | NA reservation; Northern Plains | Two NA reservations; Montana |
| IRB/tribal and community approvals | Johns Hopkins Bloomberg School of Public Health Committee on Human Research; and San Carlos and White Mountain Apache tribal approval | Aberdeen Area Indian Health Services IRB; South Dakota State University IRB; and Cheyenne River Sioux Tribal Council Health Committee | Johns Hopkins IRB; and Navajo Nations Human Research Review Board | University of Alberta ethics review board; and research steering committee for the study composed of researchers, community Elders, educators, health workers, and individuals from community departments | Johns Hopkins IRB; Indian Health Service IRB; and Navajo Nation Human Research Review Board | Alaska Area and the Centers for Disease Control and Prevention IRB; and Southcentral Foundation Board of Directors Tribal Approval | Salish-Kootenai College IRB | University of Montana IRB; tribal councils and health committees; and local community advisory boards |
| Model | Social cognitive theory, theory of planned behavior | Medicine Wheel model | social cognitive theory, theory of planned behavior | Social cognitive theory | Social cognitive theory, social ecological model | Stages of change | Ecological model of physical activity | Transtheoretical model of change, stages of change |
| Study goals | To improve the food environment and diet in communities | To determine if culturally relevant dietary care results in improved diabetes control | To improve healthy food access and consumption and reduce risk of obesity | To improve FV consumption and preferences among children | To reduce obesity among adults | To use Native traditions/community strengths to improve diet, activity, and reduce tobacco use and stress | To assess impact of out-of-school program on child behavior and health | To modify the DPP for Native youth, leading to healthy weight and improved diet and PA |
| IFS score | 7 | 7 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 |

1 DPP, diabetes prevention program; FV, fruit and vegetable; IFS, indigenous food sovereignty; IRB, institutional review board; NA, Native American; OPREVENT, Obesity Prevention and Evaluation of Interventions Effectiveness in Native North Americans; PA, physical activity.
### TABLE 3C Study goals and overall IFS scores (low scores 3.5–5.5)\(^1\)

| Project name                        | Together on Diabetes                  | Diabetes Prevention Demo Project (Special Diabetes Program) | Strong in Body and Spirit (Urban DPP) | Healthy Food Labels | Native American Weight Loss Movement |
|-------------------------------------|---------------------------------------|-------------------------------------------------------------|---------------------------------------|---------------------|---------------------------------------|
| Data sources                        | Published: (99–101)                  | Published: (102–108)                                        | Published: (109–113)                   | Published: (114)    | Published: (115)                       |
| Name of tribe/region                | 3 Navajo, 1 Apache; state(s) not specified | 80 NA tribes; 18 states                                      | Urban settings; Southwest USA         | Rosebud Sioux tribe; South Dakota | 4 NA communities (Lawrence, Kansas, Kansas City); Kansas University of Kansas |
| IRB/tribal and community approvals  | Johns Hopkins IRB; Navajo Nation Human Research Review Board; White Mountain Apache Tribal Health Board and Tribal Council; Phoenix Area Indian Health Service IRB | University of Colorado Anschutz Medical Center IRB; and National Indian Health Service IRB | University of New Mexico Health Sciences Center Human Research Review Committee; and regional Indian Health Service IRB | University of Nebraska-Lincoln IRB; and Rosebud Sioux tribal authorities | University of Kansas Human Subjects Committee; and tribal councils |
| Model                               | Social ecological model, social cognitive theory | Health belief model                                          | Social cognitive theory                | Behavioral economics | Stages of change, social cognitive theory |
| Study goals                         | To prevent and manage diabetes through... | To assess impact of a modified DPP lifestyle program in weight among at-risk adults | To assess effectiveness of a low-intensity diabetes prevention intervention on diet | To use behavioral economics to enhance label effectiveness in promoting healthy food choices | To modify DPP to improve weight loss |
| IFS score                           | 5.5                                   | 3.5                                                         | 3.5                                   | 3                   | 3                                    |

\(^1\)DPP, diabetes prevention program; IFS, indigenous food sovereignty; IRB, institutional review board; NA, Native American.
| Project name | Healthy Children Strong Families 1 | Nega Elicarvigmun (Fish to School) | Healthy Foods North | Iron Deficiency Anemia Infants | THRIVE | Healthy Children Strong Families 2 | Medicine Wheel children |
|---------------|----------------------------------|------------------------------------|-------------------|-------------------------------|--------|----------------------------------|------------------------|
| Study design  | RCT                              | Multilevel community intervention  | Quasi-experimental | Pre-post, no comparison group | Cluster RCT | RCT, modified crossover | RCT                   |
| Study sample  | 98 families with child, 2–5 y    | 76 adolescents, middle school and high school | 378 adults | 45 mothers of infants | 8 food stores, 1637 shoppers | 450 parent-child dyads, children ages 2–5 y Home: 12-lesson mailed educational materials; social media | 33 elementary school children, 3rd graders Schools: 6 classroom lessons |
| Intervention strategies | Home visiting by trained NA community mentors (year 1) Newsletters (year 2) | Schools: classroom lessons in 2 school districts, food service (fish served weekly) Community events | Food stores: stocking promoted foods, posters, shelf labels, interactive sessions TV/radio ads; visual materials Increased PA opportunities (walking clubs) 7-phase intervention (14 mo) | Group sessions on cooking Visual materials (posters, pamphlets, newsletters, grocery store displays) Radio dialogues | Food stores: placement of healthy foods in accessible locations, signage, pricing discounts | |
| Process evaluation results | Medium Not reported None None High Not reported | Medium Fair None None | None None None None |
| IFS score     | 11.5 11 10 10 8.5 8.5 7.5 |

1IFS, indigenous food sovereignty; NA, Native American; PA, physical activity; RCT, randomized controlled trial; THRIVE, Tribal Health and Resilience in Vulnerable Environments.
| Project name          | Apache Healthy Stores | Medicine Wheel Adults | Navajo Health Stores | Earthbox | OPREVENT | Traditions of the Heart | Generations Health | Journey to Native Youth Health |
|-----------------------|-----------------------|-----------------------|----------------------|----------|----------|------------------------|-------------------|-------------------------------|
| Study design          | Quasi-experimental, comparison areas | RCT | Group (store region) RCT | Pre-post, no comparison | Community RCT | Pre-post design | Individual RCT | RCT |
| Study sample          | 176 adult respondents | 114 adults with T2DM | 145 adults | 76 children, grades 1–6 | 424 adults, 18–75 y | 269 Alaska Native women | 22 children (52% NA), ages 6–9 y | 64 children, ages 10–14 y |
| Intervention strategies | Food stores: increased stocking of healthy promoted foods, visual materials (posters, shelf labels); cooking demonstrations and taste tests, educational displays | Group counseling, individualized meal plans | Food stores: increase stocking healthy foods, interactive sessions, handouts, giveaways, posters, shelf labels, booklets, Radio announcements | Schools: classroom garden, healthy snack program, educational curricula | Food stores: increase stocking healthy foods, posters, shelf labels, booklets, interactive sessions | Group counseling (weekly) | Individual counseling Incentives Maintenance program | Group sessions Home: assignments to complete at home with family |
|                        | Newspaper cartoons | Radio announcements | Radio announcements | Radio announcements | Radio announcements | Radio announcements | Radio announcements | Radio announcements |
| Process evaluation     | High | None | Medium | None | None | High | Low | Low | Low | High | Low | Low | Medium |
| Process evaluation results | Good–excellent | None | Good | None | Good | Fair | Fair | Fair | Fair |
| IFS score              | 7 | 7 | 7 | 6.5 | 6.5 | 6.5 | 6 | 6 |

1 IFS, indigenous food sovereignty; MVPA, moderate to vigorous physical activity; NA, Native American; OPREVENT, Obesity Prevention and Evaluation of Intervention Effectiveness in Native North Americans; RCT, randomized controlled trial; T2DM, type 2 diabetes mellitus.
TABLE 4C

| Project name                      | Study design | Process evaluation results | IFS score |
|-----------------------------------|--------------|----------------------------|-----------|
| Together on Diabetes              | Pre-post, no comparison | None                      | Low       |
| Diabetes Prevention Demo Project  | Pre-post, no comparison | None                      | Fair      |
| (Special Diabetes Program)        | RCT, by FBG  | None                       | 3         |
| Strong in Body and Spirit         | Choice experiment | None                      | 3.5       |
| (Urban DPP)                       | Pre-post, no comparison | None                      | 3.5       |
| Healthy Food Labels               | Pre-post, no comparison | None                      | 3         |
| Native American Weight Loss       | Pre-post, no comparison | None                      | 3         |
| Movement                          | RCT, by FBG  | None                       | 3         |

1DPP, diabetes prevention program; FBG, fasting blood glucose; IFS, indigenous food sovereignty; RCT, randomized controlled trial.

principles, this systematic review found 20 interventions across the United States and Canada that followed IFS principles to varying degrees. The majority of these studies took place in the United States and targeted adults. Overall, interventions that scored high on IFS principles were more likely to assess change in psychosocial constructs, assess outcomes in children/youth (<18 y old), report process evaluation results, target adiposity or dietary outcomes, and demonstrate impact on dietary intake compared with interventions with medium or low scores. Higher-scoring IFS interventions were also more likely to employ an RCT study design, less likely to use individual counseling or individual educational approaches, and have interventions taking place in food stores. Most intervention trials did not assess changes to the food/policy environments or impact on physical activity.

Interventions that scored high on IFS principles were more likely to assess psychosocial impacts and demonstrate impact on diet quality. However, the sustained effects of any of these psychosocial or behavioral changes are unknown; previous research has questioned the long-term effects of changes in psychosocial determinants of behavior relative to environmental or systemic determinants of behaviors (116). The effectiveness of high IFS–scoring interventions on diet quality is consistent with previous research describing the association between traditional food intake and diet quality (117–120). Future interventions should consider engaging with Indigenous food systems at multiple levels such as increasing access to traditional and cultural foods in food access points (food retail venues, etc.) as well as promoting knowledge transmission about traditional food production, preparation, and dietary properties.

Because the interventions that scored highly on IFS principles rarely measured health outcomes (e.g., BMI, weight), we were unable to draw conclusions about IFS principles and overall impact on health. Future research is needed to fully understand how use of IFS principles can play a role in intervention impact. Future IFS interventions should consider soliciting community feedback about measuring and evaluating short-term (food acquisition, dietary intake) health behaviors and long-term health outcomes as part of their design and impact assessment. This is particularly important to advance the evidence base in support of IFS interventions, because these interventions hold such promise in addressing the root causes for Indigenous health inequity. Indigenous peoples continue to face disproportionately high rates of food insecurity and insufficient access to healthy foods, both of which are important drivers of poor diet quality and chronic diseases, like cardiovascular disease and type 2 diabetes. Food sovereignty holds great potential to build community capacity to address healthy food access, as well as food insecurity, while facilitating connection to culture and community. IFS movements have great potential to build community capacity to address health inequities, particularly those related to diet, and future research should consider evaluating the effects of grassroots IFS movements.

Community engagement in intervention design, implementation, and evaluation could lead to more culturally acceptable—and therefore more effective—interventions. Our results suggest that community ownership is associated with the use of other IFS principles because studies that scored high in community ownership also scored higher in traditional knowledge, traditional foods, and impact on policy and environment (IFS principle 4). Community ownership and involvement throughout the research could foster community advocacy for culturally grounded strategies, including the inclusion of traditional...
| Project name                  | Healthy Children Strong Families 1 | Nega Elicarvigmun (Fish to School) | Healthy Foods North | Iron Deficiency Anemia | THRIVE | Healthy Children Strong Families 2 | Medicine Wheel children |
|------------------------------|-----------------------------------|-----------------------------------|---------------------|------------------------|--------|-----------------------------------|------------------------|
| Food environment/policy assessment methods | Not assessed | Not assessed | Store stocking data collected | Sales of iron-rich foods | Availability of health foods (modified NEMS-TCS) | Not assessed | Not assessed |
| Food environment/policy assessment impact | Not assessed | Not assessed | Not reported | Increased sales of iron-rich foods | No impact | Not assessed | Not assessed |
| Diet/food assessment methods | Three 24HR; block FFQ to assess diet and PA | Single 24HR; nitrogen stable isotope ratio to assess fish and marine mammal intake | Healthy/unhealthy food acquisition questionnaire; FFQ; food preparation methods questionnaire | Questionnaire (unclear) | Brief diet screener, emphasizing FV | Diet screener; nutrition survey (Family Nutrition and PA Screening Tool) | Block FFQ to assess diet and PA |
| Diet/food assessment impact | By treatment: no impact | By pre-post (combined): increased child FV servings | By treatment: no impact on healthy/unhealthy food acquisition patterns | No impact | Increased trial of iron-rich foods | No impact | Improved vegetable intake |
| PA methods | TV screen time; accelerometry | Not assessed | Not assessed | Not assessed | Not assessed | PA questionnaire for adults; child screen time/sleep questionnaire | Not assessed |

Table 5A: Food environment/policy assessment methods, health impact, and overall IFS score (high scores 7.5–11)
| Project name                                      | Healthy Children Strong Families 1 | Nega Elicarvigmun (Fish to School) | Healthy Foods North | Iron Deficiency Anemia | THRIVE | Healthy Children Strong Families 2 | Medicine Wheel children |
|--------------------------------------------------|-----------------------------------|-----------------------------------|---------------------|------------------------|--------|-----------------------------------|------------------------|
| PA impact                                        | By treatment: no impact           | Not assessed                       | Not reported        | Not assessed           | Not assessed | Adults: increased MVPA             | Not assessed           |
|                                                  | By pre-post (combined): decreased TV watching |                                   |                     |                        |        | Child screen time, sleep: no impact |                       |
| Psychosocial factors assessment methods          | Self-efficacy                     | Traditional food perceptions; enculturation | Self-efficacy, behavioral intentions, and outcome expectations | Survey | Perceived healthier food access | Adults only: Knowledge, Health Behavior Efficacy; cultural involvement scale; stress; cultural identity; readiness to change | Nutrition knowledge |
| Psychosocial factors impact                      | By treatment: no impact           | Increased perceptions of benefits of traditional foods and having cultural skills | Improved self-efficacy and intentions | Increased knowledge, self-confidence in preparing infant foods | Perceived improvements in healthier food access (varied by Nation) | Adults only: improved readiness to change, perceived stress, quality of life | Improved nutrition knowledge |
| Health assessment methods                        | Adult and child BMI and WC       | Not assessed                       | Height, weight, BMI | Not assessed           | Not assessed | BMI                                | Not assessed           |
| Health impact                                    | By treatment: no impact           | Not assessed                       | Not reported        | Not assessed           | Not assessed | No impact                          | Not assessed           |
| By pre-post: reduced BMI in obese children only  |                                   |                                   |                     |                        |        |                                   |                       |
| IFS score                                        | 11.5                              | 11                                | 10                  | 10                     | 9      | 8.5                               | 7.5                    |

1. FV, fruit and vegetable; IFS, indigenous food sovereignty; MVPA, moderate to vigorous physical activity; NEMS-TCS, Nutrition Environment Measures Survey-Tribal Convenience Stores; PA, physical activity; SSB, sugar-sweetened beverage; THRIVE, Tribal Health and Resilience in Vulnerable Environments; WC, waist circumference; 24HR, 24-h dietary recall.
| Project name                        | Together on Diabetes | Diabetes Prevention Demo Project (Special Diabetes Program) | Strong in Body and Spirit (Urban DPP) | Healthy Food Labels | Native American Weight Loss Movement |
|------------------------------------|----------------------|-------------------------------------------------------------|--------------------------------------|---------------------|---------------------------------------|
| Food environment/policy assessment methods | Home food availability | Not assessed                                                  | Not assessed                         | Not assessed        | Not assessed                          |
| Food environment/policy assessment impact | Not reported         | Not assessed                                                  | Not assessed                         | Not assessed        | Not assessed                          |
| Diet/food assessment methods       | Adapted block FFQ    | Adapted NCI FFQ                                               | Block FFQ + SW Foods                 | Food choice assessment | Dietary patterns assessed using questions from Behavioral Risk Factor Survey |
| Diet/food assessment impact        | No impact            | Healthy food intake increased                                 | Increased vegetable and fruit intake with more exposure | Increased healthy product selection with cultural and generic labels | Reduced fast food intake |
| PA methods                         | 3-d PA recall        | Rapid 9-item assessment of PA                                 | Modifiable PA questionnaire; submaximal bicycle ergometry | Not assessed        | PA questionnaire                      |
| PA impact                          | Increased PA         | Increased aerobic activity                                     | No impact on PA                      | Not assessed        | No impact                             |
| Psychosocial factors assessment methods | Quality of life questionnaire; depression screening; knowledge | Not assessed                                                  | Not assessed                         | Not assessed        | Perceived stress, depression           |
| Psychosocial factors impact        | Improved knowledge   | Decreased depression                                          | Improved quality of life             | Not assessed        | Not reported                          |
| Health assessment methods          | Height; weight; point of care HbA1c; WC, blood pressure, hypertension; diabetes screening report | BMI; weight; blood lipids, glucose; blood pressure | Blood glucose; insulin; lipid panels; blood pressure; BMI; hip and waist circumference; bioelectrical impedance | Not assessed        | Height; weight; blood pressure; waist circumference; BMI; HbA1c; blood glucose; total cholesterol |
| Health impact                      | Reduced mean BMI z-score | Reduced weight, BMI FBG associated with higher healthy food intake and with lower unhealthy food intake | Improved FBG, trends for impact on BMI, weight, blood pressure | Not assessed        | Reduced weight                         |
| IFS score                          | 5.5                  | 3.5                                                          | 3.5                                  | 3                   | 3                                     |

1DPP, diabetes prevention program; FBG, fasting blood glucose; FV, fruit and vegetables; HbA1c, glycated hemoglobin; IFS, indigenous food sovereignty; NCI, National Cancer Institute; PA, physical activity; SW, southwest; WC, waist circumference.
| Project name | Apache Healthy Stores | Medicine Wheel Adults | Navajo Healthy Stores | Earthbox | OPREVENT | Traditions of the Heart | Generations Health | Journey to Native Youth Health |
|--------------|-----------------------|-----------------------|-----------------------|----------|----------|------------------------|------------------|-----------------------------|
| **Food environment/policy assessment methods** | Sales reports from supermarkets | Not assessed | Healthy food availability | Not assessed | Food store stocking of healthier items | Not assessed | Not assessed | Not assessed |
| **Food environment/policy assessment impact** | Increased sales of some targeted foods | Not assessed | No impact | Not assessed | Not reported | Not assessed | Not assessed | Not assessed |
| **Diet/food assessment methods** | Healthy food purchasing frequency | 24HR | FFQ; healthy food purchasing; healthy food preparation methods | Self-reported home FV consumption | FFQ; 24HR | Dietary risk assessment questions | 24HR | 24HR; assisted food record |
| **Diet/food assessment impact** | Improved healthy food purchasing | No impact | FFQ not reported | Improved healthy food purchasing | Decreased soda consumption | Improved “nutrition scores” | No impact | No impact |
| **PA methods** | Not assessed | PA diary | Not assessed | Not assessed | Culturally modified IPAQ | PA questions; energy expenditure questions | Accelerometry | Accelerometry; self-reported PA |
| **PA impact** | Not assessed | No impact | Not assessed | Not assessed | Increased low to moderate PA levels | Increased PA and energy expenditure (dissertation) | Increased MVPA | Increased sleep |
| **Psychosocial factors assessment methods** | Promoted food knowledge, food self-efficacy, and food intentions | Not assessed | Promoted food-related knowledge, self-efficacy, and intentions | FV knowledge; FV preferences | Knowledge, self-efficacy, intentions, social support | Perceived barriers to healthy behaviors | Food knowledge | Nutrition knowledge |

(Continued)
ecological knowledge. This finding is consistent with other literature that suggests that CBPR methodologies are associated with more impactful interventions in Indigenous Nations and communities (121–125). A systematic review to understand the outcomes of CBPR research interventions with American Indian communities found that interventions had improved participatory research outcomes, such as better adherence to CBPR principles, improved knowledge translation, or development of long-term community partnerships (126). This can explain how promoting community ownership can improve traditional knowledge and sustainability of interventions, because the goal of CBPR is to shift power from the researchers to the participating community members. Existing measures, including those offered by Heard, Wetherill, Salvatore, and Jernigan (36), could be adapted to evaluate the CBPR approaches in IFS interventions (126). CBPR could be a promising approach to improve scores of cultural food knowledge, traditional food intake, and the long-term sustainability of the intervention, and future IFS interventions should include meaningful assessments for adherence to CBPR principles.

Whereas both individual- and community-level interventions used IFS principles, the studies that scored high in IFS principles typically included the whole community/multipronged interventions, with primary settings in schools, home (addressing families), and/or stores. Studies that scored low in IFS principles typically targeted individuals at risk of diabetes or overweight/obesity and focused mostly on imparting disease-prevention knowledge via education in the form of counseling sessions/materials that already existed for other populations. Most low-scoring IFS studies were able to see an impact on health outcomes, physical activity, and diet but had weaker study designs (e.g., pre-post only, with no comparison). A previous systematic review of diabetes prevention programs concluded that lifestyle interventions significantly impacted psychosocial and physiological outcomes (127). However, lifestyle interventions alone are unable to address the systemic barriers to health that Indigenous populations face, including healthy food access, and multilevel interventions are needed to impact the social determinants of health (128, 129). One possible explanation for our results could be intensity of delivery of the intervention, with lower IFS-scoring studies delivered intensively in small groups to highly motivated individuals resulting in greater behavioral impacts, whereas higher IFS-score interventions were more passively delivered at the community level (130). Another explanation for these results is that the majority of the high IFS-scoring studies used a comparison group, whereas the low IFS-scoring studies were more likely to use pre-post assessments in only 1 group.

Lessons learned and recommendations
This review found that high-scoring IFS trials had stronger study designs and were more likely to report impact on diet quality than low-scoring trials; nonetheless, it also identified important gaps in the existing literature from which we draw recommendations below.

First, many of the IFS intervention strategies were focused on individual-level (via individual/group counseling, home/school-based curricula) rather than whole-community strategies. This raises an important question about how to define IFS—can individual-level interventions (via individual/group counseling, home/school-based curricula) be considered IFS interventions if they do not engage the whole community or attempt to change the food system or access to food?

| Project name                           | Health impact | Psychosocial factors impact | IFS score | Health assessment methods | Health assessment | Data collection | Project name | Data collection | Project name | Health impact | Psychosocial factors impact | IFS score | Health assessment methods | Health assessment | Data collection | Project name | Data collection | Project name | Health impact | Psychosocial factors impact | IFS score | Health assessment methods | Health assessment | Data collection |
|----------------------------------------|---------------|-----------------------------|-----------|---------------------------|-------------------|-----------------|--------------|--------------|--------------|--------------|-----------------------------|-----------|---------------------------|-------------------|-----------------|--------------|-------------------|--------------|---------------------|-------------------|-----------------|
Secondly, it raises questions about how to measure and weight the different IFS guiding principles: for example, should more weight be given to community ownership compared with environmental sustainability? This review found that the environmental sustainability of the intervention (principle 4) was seldom incorporated into the design of interventions or in the discussion of results in the studies reviewed, which is not atypical given the timeline in development and implementation of health policies compared with short trial intervention research (131). A recent review of obesity prevention interventions highlighted common factors for sustaining such programs (132).

Second, the reliance on standard health outcome and behavioral measures might not capture the sphere of influence of studies that implement IFS principles. An important consideration is that IFS guiding principles are intended to address the social and structural determinants of diet-related health inequities in Indigenous communities; however, limiting the assessment of effectiveness of a IFS trial to the standard health and behavioral outcomes can miss out on crucially important potential mediators in the social and structural dimensions of dietary inequities in contemporary food systems. High-scoring IFS study trials could be impacting important underlying determinants of diet behaviors, nutritional status, and diet-related health outcomes that are not captured by standard measures in public health. These could include: people’s perceptions of their right to define their own food systems; cultural and language revitalization; and promotion of healthy ecological relations, which can be direct outcomes of interventions that apply IFS guiding principles. Based on the results of our review, we found that few studies measured traditional food intake, traditional or cultural food knowledge, or positive mental health outcomes (e.g., connection to culture, land, or community), all of which can be improved through engagement with each IFS principle. Future interventions should consider designing evaluation measures in direct collaboration with communities, and grassroots food sovereignty movements. Although ultimately the impact must be measured in a public health outcome, the timeline of trial implementation could be too short to see an impact on these standard outcomes within the trial. However, if the use of CBPR and IFS guiding principles has an impact on engagement and advocacy to change food systems in these communities, this could result in an expansion of the sphere of influence of these nutrition intervention trials. To better ascertain this, future research must adapt existing behavioral frameworks that take into consideration potential mediating outcomes in IFS guiding principles that could very well be on the pathway of influence to impact health outcomes eventually.

Limitations and strengths

This review has several limitations. Due to the diversity and complexity of food sovereignty, there is no single agreed definition that can capture the breadth and intricacies of all IFS initiatives. To combat this, we created our own definition, made specifically to characterize 4 IFS principles in the context of research interventions. However, this definition was developed by researchers for the purpose of this systematic review and not informed by community input. We acknowledge the importance of community ownership in IFS, and Indigenous Nations and communities must have a role in identifying and refining the key principles of IFS. Future research could develop a community-informed conceptualization for IFS and its principles. Second, although the environment principle of IFS that we developed included both environmental and program maintenance aspects of sustainability, the literature on this topic states that these are different concepts (133). Future research could consider these 2 principles of IFS separately so that both of these concepts are considered. Third, IFS is not intended to be a research method and so these principles are not always systematically reported. It is possible that the IFS scores of studies included in this review could vary based on the information gleaned from publications. Four of the trials included were developed in part by 1 of the review’s authors (JG) and although we used a relatively objective process, we had a greater understanding of those trials. Future work should look to consistently report on IFS principles across studies, building on the CBPR principles. Fourth, there are limitations to applying such a concept to the scientific literature, because much of the IFS work has been led outside of the academy. Our gray literature and peer-reviewed literature searches revealed that a significant amount of the IFS interventions was not published in peer-reviewed literature and that many initiatives were not conducted in the context of a research intervention, and could have been missed in this review. Fifth, the lack of data on health outcome and process measures of intervention trials impeded systematic assessment of how well each trial was implemented. Future researchers could report on their program’s score on our proposed principles in addition to process evaluation dimensions. Lastly, we did not evaluate research bias for authors that designed, implemented, and evaluated their own interventions.

This review is the first, to our knowledge, to attempt to understand how IFS principles have been applied in existing nutrition and food interventions. The definition of IFS we have offered is a novel way to operationalize IFS in research interventions. These principles can be used as a blueprint for future intervention studies that wish to incorporate IFS principles in the planning, implementation, and evaluation of research interventions. Our review of interventions included gray literature and community dissemination reports, which helped to create a more holistic understanding of each intervention. Researchers using IFS should consider planning for community engagement by publishing in both the peer-reviewed and gray literature.

Conclusions

In the last 20 y there has been a surge of interventions promoting IFS, and studies are using it as the foundation for interventions addressing the chronic disease inequities disproportionately affecting Indigenous peoples in the United States and Canada. This review addresses a gap in the literature by operationalizing the core principles of IFS to evaluate research interventions in Indigenous communities. This post hoc assessment found evidence supporting the value of IFS principles in the development, implementation, and evaluation of health interventions for Indigenous communities. Intervention trials that are based on these principles from the outset are greatly needed to support the effectiveness of this approach.

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References

1. Declaration of Nyeleni [Internet]. February 2007 [cited 2020 Mar 6]. Available from: https://nyeleni.org/spip.php?article290.
2. Mihesuah D, Hoover E. Indigenous food sovereignty in the United States: restoring cultural knowledge, protecting environments and regaining health. Norman (OK): University of Oklahoma Press; 2019.
3. Kühnlein HV, Erasmus B, Spigeliski D. Indigenous peoples’ foods systems: the many dimensions of culture, diversity and environment for nutrition and health. Rome: Food and Agriculture Organization of the United Nations; 2009.
4. Kamal AG, Linklater R, Thompson S, Dipple J, Committee IM. A recipe for change: reclaimation of Indigenous food sovereignty in O-Pipon Na-Piwin Cree Nation for decolonization, resource sharing, and cultural restoration. Globalizations 2015;12(4):559–75.
5. Morrison D. Indigenous food sovereignty: a model for social learning. In: Food sovereignty in Canada: creating just and sustainable food systems. Halifax, Black Point, Nova Scotia, Winnipeg (Canada): Fenwood Publishing; 2011. p. 97–113.
6. Morrison D. BC Food Systems Network—Working Group on Indigenous Food Sovereignty: final activity report. Vancouver (BC): BC Food Systems Network; 2008.
7. Indigenous Peoples’ Consultation on the Right to Food: A Global Consultation. In: Declaration of Atitlán, Atitlán, Sololá (Guatemala): International Indian Treaty Council; 2002.
8. Indigenous Food Systems Network. Indigenous food sovereignty [Internet]. [cited 2020 Feb 2]. Available from: https://www.indigenousfoodsystems.org/food-sovereignty.
9. Hoover E, Mihesuah DA. Introduction. In: Mihesuah DA, Hoover E, editors. Indigenous food sovereignty in the United States. University of Oklahoma Press; 2019. p. 1–20.
10. Hoover E. “You can’t say you’re sovereign if you can’t feed yourself”: defining and enacting food sovereignty in American Indian community gardening. In: Hoover E, Mihesuah DA, editors. Indigenous food sovereignty in the United States. University of Oklahoma Press; 2019. p. 57–93.
11. Jernigan VBB, Huysr KR, Valdes J, Simonds VW. Food insecurity among American Indians and Alaska Native Nations: a national profile using the current population survey—food security supplement. J Hunger Environ Nutr 2017;12(1):1–10.
12. Arias E, Xu J, Jim MA. Period life tables for the non-Hispanic American Indian and Alaska Native population, 2007–2009. Am J Public Health 2014;104(Suppl 3):S312–S19.
13. Cobb N, Espey D, King J. Health behaviors and risk factors among American Indians and Alaska Natives, 2000–2010. Am J Public Health 2014;104(Suppl 3):S581–S59.
14. Batal M, Decelles S. A scoping review of obesity among Indigenous peoples in Canada. J Obesity 2019;2019:1–20.
15. Bullock A, Sheff K, Moore K, Manson S. Obesity and overweight in American Indian and Alaska Native children, 2006–2015. Am J Public Health 2017;107(9):1502–7.
16. Skinner AG, Ravananbht SN, Skelton JA, Perrin EM, Armstrong SC. Prevalence of obesity and severe obesity in US children, 1999–2016. Pediatrics 2018;141(3):e20173459.
17. Public Health Agency of Canada. Diabetes in Canada: facts and figures from a public health perspective. Ottawa, 2011. Ottawa, Ontario (Canada): Public Health Agency of Canada; 2011.
18. Turin TC, Saad N, Jun M, Tonelli M, Ma Z, Barnabe CCM, Manns B, Hemmelgarn B. Lifetime risk of diabetes among First Nations and non-First Nations people. Can Med Assoc J 2016;188(16):1147–53.
19. Satia JA. Diet-related disparities: understanding the problem and accelerating solutions. J Am Diet Assoc 2009;109(4):610.
20. Jones AD, Fink Shapiro L, Wilson ML. Assessing the potential and limitations of leveraging food sovereignty to improve human health. Front Public Health 2015;3:263.
21. Weiler AM, Hergesheimer C, Brisbois B, Wittman H, Yassi A, Spiegel JM. Food sovereignty, food security and health equity: a meta-narrative mapping exercise. Health Policy Plan 2015;30(8):1078–92.
22. Munn Z, Peters MD, Stern C, Tufanaru C, McArthur A, Aromatasis E. Systematic review or scoping review? Guidance for authors when choosing between a systematic or scoping review approach. BMC Med Res Method 2018;18(1):1–7.
23. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. Syst Rev 2015;4(1):1–9.
24. Covidence systematic review software, Veritas Health Innovation, [Internet]. Melbourne, Australia. Available from: www.covidence.org.
25. Israel BA, Schulz AJ, Parker EA, Becker AB. Review of community-based research: assessing partnership approaches to improve public health. Annu Rev Public Health 1998;19:173–202.
26. Gittelsohn J, Davis SM, Stuckler A, Ethelbah A, Clay T, Metcalfe L, Rock BH. Pathways: lessons learned and future directions for school-based interventions among American Indians. Prev Med 2003;37:S107–S12.
27. Bersamin A, Zidenberg-Cherr S, Stern JS, Luik BR. Nutrient intake are associated with adherence to a traditional diet among Yupik Eskimos living in remote Alaska native communities: the CANHR study. Int J Circumpolar Health 2007;66(1):62–70.
28. Kühnlein HV. Benefits and risks of traditional food for Indigenous peoples: focus on dietary intakes of Arctic men. Can J Physiol Pharmacol 1995;73(6):765–71.
29. Receveur O, Boulay M, Kühnlein HV. Decreasing traditional food use affects diet quality for adult Dene/Metis in 16 communities of the Canadian Northwest Territories. J Nutr 1997;127(11):2179–86.
30. Johnson-Down L, Egedal GM. Adequate nutrient intakes are associated with traditional food consumption in Nunavut Inuit children aged 3–5 years. J Nutr 2010;140(7):1311–16.
31. Jumper-Reeves L, Dustman PA, Hartunian ML, Kulis S, Brown EF. American Indian cultures: how CBPR illuminated intertribal cultural elements fundamental to an adaptation effort. Prev Sci 2014;15(4):547–56.
32. Thomas LR, Rosa C, Forcichimes A, Donovan DM. Research partnerships between academic institutions and American Indian and Alaska Native tribes and organizations: effective strategies and lessons learned in a multisite CTN study. Am J Drug Alcohol Abuse 2011;37(5):333–8.
33. Rasmus SM. Indigenizing CBPR: evaluation of a community-based and participatory research process implementation of the Elluam Tungiin (towards wellness) program in Alaska. Am J Community Psychol 2014;54(1–2):170–9.
34. Banna J, Bersamin A. Community involvement in design, implementation and evaluation of nutrition interventions to reduce chronic diseases in indigenous populations in the US: a systematic review. Int J Equity Health 2018;17:116.
35. Teufel-Shone NI. Promising strategies for obesity prevention and treatment within American Indian communities. J Transcult Nurs 2006;17(3): 224–9.
36. Heard JB, Wetherill MS, Salvatore AL, Jernigan VBB. Community-based participatory intervention research with American Indian communities: what is the state of the science? Curr Dev Nutr 2019;3(Suppl 2):39–52.
37. Dong Y, Collado M, Branscum P. Native American diabetes prevention: a review of challenges and opportunities in multilevel, participatory intervention research with American Indian communities. J Transcult Nurs 2006;17(3):224–9.
38. Teufel-Shone NI. Promising strategies for obesity prevention and treatment within American Indian communities. J Transcult Nurs 2006;17(3): 224–9.
39. Ewart-Pierce E, Ruiz MJM, Gittelsohn J. “Whole-of-Community” obesity prevention: a review of challenges and opportunities in multilevel, multicomponent interventions. Curr Obesity Rep 2016;5(3):361–74.
40. Rose G. Sick individuals and sick populations. Int J Epidemiol 2001;30(3):427–32.
41. Tetroe JM, Graham ID, Foy R, Robinson N, Eccles MP, Wensinck M, Durieux P, Légaré F, Nielsen CP, Adilly A. Health research funding agencies' support and promotion of knowledge translation: an international study. Milbank Q 2008;86(1):125–55.

42. Whelan J, Love P, Millar L, Allender S, Bell C. Sustaining obesity prevention in communities: a systematic narrative synthesis review. Obes Rev 2018;19(6):839–51.

43. Shediak-Rizkallah MC, Bone LR. Planning for the sustainability of community-participation. J Prim Prev 2012;33(4):175–85.

44. LaRowe TL, Adams AK, Jobe JB, Cronin KA, Vannatter SM, Prince RJ. Dietary intakes and physical activity among preschool-aged children living in rural American Indian communities before a family-based healthy lifestyle intervention. J Am Diet Assoc 2010;110(7):1049–57.

45. LaRowe TL, Wubben DP, Cronin KA, Adams AK, Vannatter SM. Peer reviewed: development of a culturally appropriate, home-based nutrition and physical activity curriculum for Wisconsin American Indian families. Prev Chronic Dis 2007;4(4):A109.

46. Adams AK, Scott JR, Prince R, Williamson A. Using community advisory boards to reduce environmental barriers to health in American Indian communities, Wisconsin, 2007–2012. Prev Chronic Dis 2014;11:E160–E.

47. Adams AK, LaRowe TL, Cronin KA, Prince RJ, Wubben DP, Parker T, Jobe JB. The Healthy Children, Strong Families intervention: design and community participation. J Prim Prev 2012;33(4):175–85.

48. Xu P, Fong Q, Bersamin A, Izumi BT. Examining the quality and student acceptability of school lunches in a Title 1, Alaska Native serving school district: findings from the Neqa Elicarvigmun Pilot Study. Trans Behav Med 2019;9(5):952–61.

49. Bersamin A, Niles K, Izumi B. Examining the quality and student acceptability of school lunches in a Title 1, Alaska Native serving school district: findings from the Neqa Elcarigmun study. FASEB J 2015;29(1 Supp):LB394.

50. Frisch L. Fish in school lunch. University of Alaska Fairbanks News. November 30, 2015.

51. Frisch L. Fish to school program will increase local salmon in school lunches. Sea Grant Alaska. November 25, 2015.

52. Bersamin A. Fish-to-schools: a model to enhance health and food security in Alaska Native communities [Internet]. Center for Alaska Native Health Research; 2017 [cited 2020 Mar 6]. Available from: https://www.canhr.uaf.edu/research/past-canhr-projects/fisheries-school-prog ram-promoting-health-and-food-security-alaska-native-communities/.

53. Sharma S, Gittelsohn J, Rosol R, Beck L. Addressing the public health burden caused by the nutrition transition through the Healthy Foods North nutrition and lifestyle intervention programme. J Hum Nutr Diet 2010;23:120–7.

54. Sharma S, DeRoose E, Cao X, Pokiak A, Gittelsohn J, Corriveau A. Dietary intake in a population undergoing a rapid transition in diet and lifestyle: the Inuvialuit in the Northwest Territories of Arctic Canada. Can J Public Health 2009;100(6):442–8.

55. Pakseresht M, Kolahdooz F, Gittelsohn J, Roache C, Corriveau A, Sharma S. Improving vitamin A and D intake among Inuit and Inuvialuit in Arctic Canada: evidence from the Healthy Foods North study. J Epidemiol Community Health 2015;69(5):453–9.

56. Pakseresht M, Mead E, Gittelsohn J, Roache C, Sharma S. Awareness of chronic disease diagnosis amongst family members is associated with healthy dietary knowledge but not behaviour amongst Inuit in Arctic Canada. J Hum Nutr Diet 2010;23:100–9.

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 Educ Behav 2013;40(5):592–602.

58. 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 J 2014;13(1):68.

59. Gittelsohn J, Roache C, Kratzmann M, Reid R, Ogina J, Sharma S. Participatory research for chronic disease prevention in Inuit communities. Am J Health Behav 2010;34(4):453–64.

60. Bains A, Pakseresht M, Roache C, Beck L, Sheehy T, Gittelsohn J, Corriveau A, Sharma S. Healthy Foods North improves diet among Inuit and Inuvialuit women of childbearing age in Arctic Canada. J Hum Nutr Diet 2014;27:175–85.

61. Watson E. Healing pathways: art therapy for American Indian cancer survivors. J Cancer Educ 2012;27(5):S47–56.

62. Verrall T, Napash L, Leclerc L, Mercure S, Gray-Donald K. Community-based communication strategies to promote infant iron nutrition in Northern Canada. Int J Circumpolar Health 2006;65(1):65–78.

63. Wetherill MS, Williams MB, Hartwell ML, Salvatore AL, Jacob T, Cannady TK, Standridge J, Fox J, Spiegel J, Anderson N. Food choice considerations among American Indians living in rural Oklahoma: the THRIVE study. Appetite 2018;128:14–20.

64. Wetherill MS, Williams MB, Taniguchi T, Salvatore AL, Jacob T, Cannady T, Grammar M, Standridge J, Fox J, Spiegel J. A nutrition environment measure to assess tribal convenience stores: the THRIVE study. Health Promot Pract 2020;21(3):410–20.

65. Salvatore AL, Noonan CJ, Williams MB, Wetherill MS, Jacob T, Cannady TK, Standridge J, Grammar M, Fox J, Wiley A. Social support and physical activity among American Indians in Oklahoma: results from a community-based participatory research study. J Rural Health 2019;35(3):374–84.

66. Love CV, Taniguchi TE, Williams MB, Noonan CJ, Wetherill MS, Salvatore AL, Jacob T, Cannady TK, Standridge J, Spiegel J. Diabetes and obesity associated with poor food environments in American Indian communities: the Tribal Health and Resilience in Vulnerable Environments (THRIVE) study. Curr Nutr Rev 2019;3(Suppl 2):63–8.

67. Blue Bird Jernigan V, editor. Healthy makeovers in rural tribal convenience stores as part of the Tribal Health and Resilience in Vulnerable Environments (THRIVE) study. In: 143rd APHA Annual Meeting and Exposition; Chicago, Illinois, October 31 to November 4, 2015.

68. Jernigan VBB, Williams M, Wetherill M, Taniguchi T, Jacob T, Cannady T, Grammar M, Standridge J, Fox J, Wiley A. Using community-based participatory research to develop healthy retail strategies in Native American-owned convenience stores: the THRIVE study. Prev Med Rep 2018;11:148–53.

69. Blue Bird Jernigan V, Salvatore AL, Styne DM, Winkleby M. Addressing food insecurity in a Native American reservation using community-based participatory research. Health Educ Res 2012;27(4):645–55.

70. Tomayko EJ, Prince RJ, Cronin KA, Kim K, Parker T, Adams AK. The Healthy Children, Strong Families 2: a randomized controlled trial improved healthy behaviors in American Indian families with young children. Curr Dev Nutr 2019;3(Suppl 2):63–83.

71. Tomayko EJ, Prince RJ, Cronin KA, Parker T, Kim K, Grant VM, Sheche JN, Adams AK. Healthy Children, Strong Families 2: a randomized controlled
trial of a healthy lifestyle intervention for American Indian families designed using community-based approaches. Clin Trials 2017;4(2):152–61.

78. Berns RM, Tomayko EJ, Cronin KA, Prince RJ, Parker T, Adams AK. Development of a culturally informed child safety curriculum for American Indian families. J Prim Prev 2017;38(1-2):195–205.

79. Grant VM, Tomayko EJ, Prince RJ, Cronin K, Adams A. Understanding correlates of physical activity in American Indian families: the Healthy Children Strong Families-study. J Phys Act Health 2018;15(11):866–73.

80. Adams AK, Tomayko EJ, Cronin KA, Prince RJ, Kim K, Carmichael L, Parker T. Predictors of overweight and obesity in American Indian families with young children. J Nutr Educ Behav 2019;51(2):190–8.

81. Blake KD, Ottenbacher AJ, Finney Rutten LJ, Grady MA, Kobrin SC, Jacobson RM, Hesse BW. Predictors of human papillomavirus infection and knowledge in 2013: gaps and opportunities for targeted communication strategies. Am J Prev Med 2015;48(4):402–10.

82. Conti KM. Diabetes prevention in Indian country: developing nutrition models to tell the story of food-system change. J Transcult Nurs 2006;17(3):234–45.

83. Govula C, Kattelman K, Ren C. Culturally appropriate nutrition lessons increased fruit and vegetable consumption in American Indian children. Top Clin Nutr 2007;22(3):239–45.

84. Vastine A, Gittelsohn J, Ethelbah B, Anliker J, Caballero B. Formative research and stakeholder participation in intervention development. Am J Health Behav 2005;29(1):57–69.

85. Sharma S, Cao X, Gittelsohn J, Ethelbah B. Nutritional composition of commonly consumed traditional Apache foods in Arizona. Int J Food Sci Nutr 2008;59(1):1–10.

86. Sharma S, Yacavone M, Cao X, Pardilla M, Qi M, Gittelsohn J. Dietary intake and development of a quantitative FFQ for a nutritional intervention to reduce the risk of chronic disease in the Navajo Nation. Public Health Nutr 2010;13(3):350–9.

87. Gittelsohn J, Anliker JA, Sharma S, Vastine AE, Caballero B, Ethelbah B. Psychosocial determinants of food purchasing and preparation in American Indian households. J Nutr Educ Behav 2006;38(3):163–8.

88. Curran S, Gittelsohn J, Anliker J, Ethelbah B, Blake K, Sharma S, Caballero B. Process evaluation of a store-based environmental obesity intervention on two American Indian Reservations. Health Educ Res 2005;20(6):719–29.

89. Gittelsohn JQM, Suratkul S. Understanding the impact of food assistance programs: protocol for a randomised controlled trial. J Nutr Educ Behav 2015;47(4):S82.

90. Redmond LC, Jock B, Gittelsohn J, Swartz M, Pardilla S, Swartz J, Platero H, Caulfield LE, Gittelsohn J, OPREVENT (Obesity Prevention and Evaluation of Interventions) in a Multi-ethnic Community: design of a multi-level, multi-component obesity intervention for American families. J Nutr Ed Behav 2013;15(2):169–75.

91. Grant V, Swaney G, Harris KJ, Burdeau Z, Brown B. Assessing barriers and enhancers to increasing physical activity during the school day in children on an American Indian Reservation: a qualitative research study. Health Behav Policy Rev 2016;3(3):429–38.
116. Brown B, Noonan C, Harris KJ, Parker M, Gaskill S, Ricci C, Cobbs G, Gress S. Developing and piloting the journey to native youth health program in Northern Plains Indian communities. Diabetes Educ 2013;39(1):109–18.

117. Chambers RA, Rosenstock S, Neault N, Kenney A, Richards J, Begay K, Blackwater T, Laluk O, Duggan C, Reid R. A home-visiting diabetes prevention and management program for American Indian youth: the Together On Diabetes trial. Diabetes Educ 2015;41(6):729–47.

118. Chambers R, Rosenstock S, Walls M, Kenney A, Begay M, Jackson K, Nelson L, Neault N, Goklish N, Van De Mheen D. Peer reviewed: engaging Native American caregivers in youth-focused diabetes prevention and management. Prev Chronic Dis 2018;15:170521.

119. Kenney A, Chambers RA, Rosenstock S, Neault N, Richards J, Reid R, Nelson L, Begay M, Grass R, Parker S. The impact of a home-based diabetes prevention and management program on high-risk American Indian youth. Diabetes Educ 2016;42(5):585–95.

120. Teufel-Shone NI, Jiang L, Beals J, Henderson WG, Acton KJ, Roubideaux Y, Manson SM. Changes in food choices of participants in the Special Diabetes Program for Indians—Diabetes Prevention Demonstration Project, 2006–2010. Prev Chronic Dis 2015;12:E193.

121. Pratte KA, Johnson A, Beals J, Bullock A, Manson SM, Jiang L. Regression to normal glucose regulation in American Indians and Alaska Natives of a diabetes prevention program. Diabetes Care 2019;42(7):1209–16.

122. Moore K, Jiang L, Manson SM, Beals J, Henderson W, Pratte K, Acton KJ, Roubideaux Y. Case management to reduce cardiovascular disease risk in American Indians and Alaska Natives with diabetes: results from the Special Diabetes Program for Indians Healthy Heart Demonstration Project. Am J Public Health 2014;104(11):e158–e64.

123. Jiang L, Chang J, Beals J, Bullock A, Manson SM, Special Diabetes Program for Indians Diabetes Prevention Demonstration Project. Neighborhood characteristics and lifestyle intervention outcomes: results from the Special Diabetes Program for Indians. Prev Med 2018;111:216–24.

124. Jiang L, Johnson A, Pratte K, Beals J, Bullock A, Manson SM. Long-term outcomes of lifestyle intervention to prevent diabetes in American Indian and Alaska Native communities: the Special Diabetes Program for Indians Diabetes Prevention Program. Diabetes Care 2018;41(7):1462–70.

125. Jiang L, Huang H, Johnson A, Dill EJ, Beals J, Manson SM, Roubideaux Y. Special Diabetes Program for Indians Diabetes Prevention Demonstration Project. Socioeconomic disparities in weight and behavioral outcomes among American Indian and Alaska Native participants of a translational lifestyle intervention project. Diabetes Care 2015;38(11):2090–9.

126. Jiang L, Manson SM, Beals J, Henderson WG, Huang H, Acton KJ, Roubideaux Y. Special Diabetes Program for Indians Diabetes Prevention Demonstration Project. Translating the diabetes prevention program into American Indian and Alaska Native communities: results from the Special Diabetes Program for Indians Diabetes Prevention Demonstration Project. Diabetes Care 2013;36(7):2027–34.

127. Thompson JL, Allen P, Helitzer DL, Qualls C, Whyte AN, Wolfe VK, Herman CJ. Reducing diabetes risk in American Indian women. Am J Prev Med 2008;34(3):192–201.

128. Thompson JL, Herman CJ, Allen P, Helitzer DL, Wilson ND, Whyte AN, Perez GE, Wolfe VK. Associations between body mass index, cardiorespiratory fitness, metabolic syndrome, and impaired fasting glucose in young, urban Native American women. Metab Syndr Relat Disord 2007;5(1):45–54.

129. Helitzer DL, Peterson AB, Sanders M, Thompson J. Relationship of stages of change to attendance in a diabetes prevention program. Am J Health Promot 2007;21(6):517–20.

130. Helitzer D, Bobo Peterson A, Thompson J, Fluder S. Development of a planning and evaluation methodology for assessing the contribution of theory to a diabetes prevention lifestyle intervention. Health Promot Pract 2008;9(4):404–14.

131. Allen P, Thompson JL, Herman CJ, Whyte AN, Wolfe VK, Qualls C, Helitzer DL. Peer reviewed: impact of periodic follow-up testing among urban American Indian women with impaired fasting glucose. Prev Chronic Dis 2008;5(3):A76.

132. Gustafson CR, Prate MR. Healthy food labels tailored to a high-risk, minority population more effectively promote healthy choices than generic labels. Nutrients 2019;11(10):2272.

133. Daley CM, Hale JW, Bointy S, Berryhill K, LeMaster J, Gajewski BJ. Native American weight loss movement: pilot test of a culturally tailored weight loss program for American Indians. J Health Dispar Res Pract 2018;12(1):1–18.