Food Security Indicators

Review of Literature

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BC Centre for Disease Control
Provincial Health Services Authority

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Drona Rasali, Director, Population Health Surveillance & Epidemiology, BCCDC, Provincial Health Services Authority

Authors:

Barbara Seed, PhD, B. Seed Consulting

Contributing Authors:

Melanie Kurrein, MA, RD, Provincial Manager, Food Security, Population & Public Health, BCCDC, Provincial Health Services Authority
Cayley Velazquez, PhD, Consultant
Karen Rideout, PhD, Consultant
Caitlin Dorward, M.Sc., A.Ag., Consultant

Resource team:

Cayley Velazquez, PhD, Consultant
Karen Rideout, PhD, Consultant
Caitlin Dorward, M.Sc., A.Ag., Consultant
Mary-Doug Wright, B.Sc., MLS, Apex Information (research librarian)

Acknowledgements:

Melanie Kurrein, Provincial Manager Food Security, Population & Public Health, BCCDC, Provincial Health Services Authority

Drona Rasali, Director, Population Health Surveillance & Epidemiology, BCCDC, Provincial Health Services Authority

Rita Zhang, Epidemiologist, Population Health Surveillance & Epidemiology, BCCDC, Provincial Health Services Authority

Crystal Li, Surveillance Biostatistician, Population Health Surveillance & Epidemiology, BCCDC, Provincial Health Services Authority

Daniel Fong, Manager, Knowledge Translation and Communications, Population & Public Health, BCCDC, Provincial Health Services Authority

Henry Lau, Coordinator, Healthy Eating and Food Security, Population & Public Health, BCCDC, Provincial Health Services Authority

Advisory Committee:

Jennifer Black, University of British Columbia
Sylvia El Kurdi, Interior Health Authority
Maritia Gully, Island Health Authority
Ashley Henry, First Nations Health Authority
Dee Hoyano, Island Health Authority
Eleni Kefalas, Vancouver Coastal Health Authority
Jong Kim, Northern Health Authority
Charles Levkoe, Lakehead University
Catherine Mah, Dalhousie University
Kent Mullinix, Kwantlan Polytechnic University
Elaine Power, Queen's University
Ingrid Tyler, Fraser Health Authority
Anna Wren, Ministry of Health
Kathleen Yung, First Nations Health Authority

BCCDC contact:

This report can be found at: http://www.bccdc.ca/our-services/service-areas/population-public-health

For further information contact:
BC Centre for Disease Control
Population & Public Health
655 West 12th Avenue
Vancouver, B.C. V5Z 4R4
melanie.kurrein@bccdc.ca

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Executive Summary

Developing food security indicators in B.C.

In 2009, six food security indicators were developed to monitor the 2006 model core program on food security in B.C. However, during the 2014 revision of the *Model Core Program Paper: Food Security*, the health authorities and the BC Ministry of Health (MOH) identified the need to update the food security indicators as they no longer reflected the current literature or the context and breadth of food security work occurring in B.C.

This report focuses on the indicator literature review process and findings, as part of a multi-phased project to develop an evidence-based set of indicators that are useful and feasible for the health authorities and the MOH. The indicators will:

- Reflect food security priorities identified by the MOH and health authorities.
- Be relevant to the goals and objectives of the 2014 *Model Core Program Paper: Food Security*.
- Inform practice and policy by demonstrating the current state of food security/household food insecurity in B.C.; demonstrating the impact of food security initiatives; and highlighting where gaps exist and further work is needed to improve food security.

Literature review

The objective of this literature review is to identify indicator areas[i] for potential food security indicators and to show the availability and quality of evidence linked to food security and/or health outcomes. This review will guide the next phase of the project where BC Centre for Disease Control (BCCDC) will work with health authorities and the MOH to prioritize the defined indicator areas, which will be further refined into indicators.

To guide the process to update the indicators, BCCDC developed a conceptual framework for food security indicators (herein referred to as the Framework). This Framework demonstrates where public health can influence food security and outlines the causal relationships between indicators. Health authorities and the MOH were asked to identify priority food security themes and subthemes from the Framework to inform the current literature review. Four overarching themes and several subthemes emerged and are summarized in the table below (*Summary of themes and subthemes identified as priorities*). During the literature review, the researchers further refined the subthemes based on the available evidence.

i These are indicator topic areas that will need to be further refined to become specific, measurable indicators.

Summary of themes and subthemes identified as priorities

Theme	Subthemes
Health and food insecurity (e.g. mental health, physical health, malnutrition)	1. Rates of household food insecurity (HFI) 2. HFI and fruit and vegetable consumption 3. Rates of HFI compared to illness (chronic disease, e.g. diabetes), obesity and breastfeeding
Food affordability (food cost as a proportion of income)	1. Food cost as a proportion of income
Food system response to shocks and disturbances (such as forest fires) (e.g. food self-sufficiency, level of local food production)	1. Food self-sufficiency: number of people food self-sufficient; local food production; actively farmed land; import vs grown local 2. Connection between shocks/disturbances in B.C. communities and availability of food 3. Food plans as part of emergency preparedness (e.g. plans to respond to shocks and disturbances)
Access to human/society produced food environments (e.g. grocery stores, healthy food, food delivery services, farmers markets/food markets)	1. Availability of, and distance to, grocery stores 2. Access to healthy food – specific to the amount of healthy food in stores 3. Spatio-temporal access to grocery stores (especially in rural communities and lower income neighbourhoods) 4. Zoning for food availability 5. Community approaches to addressing access to healthy food
Influencing food security or food insecurity (income) policy	1. Participation in policy change and policy implementation 2. Advocacy methods

Methods

The literature review drew on both peer-reviewed and grey literature, as well as consultation with subject-matter experts on the advisory committee and the research team. Based on the scope of the project and the limited evidence on food security indicators, the research team used a structured method for reviewing and assessing the literature followed by a snowballing approach rather than a systematic approach. The review explored both the evidence for use of the indicator area (e.g. a review of food security indicators) and also the association between an indicator area and food security and/or health outcomes. The former relied more heavily on grey literature, as little peer-reviewed literature exists, while the latter drew more heavily from peer-reviewed literature.

Summary of findings

The literature was summarized into four themes: household food insecurity (both "health and food insecurity" and "food affordability"), food environments, food system resilience (response to shocks and disturbances) and influencing food security policy.

Household food insecurity

Household food insecurity (HFI) is based on the Household Food Security Survey Module (HFSSM) that is part of the Canadian Community Health Survey (CCHS). HFSSM is a validated scale of the severity of food insecurity that measures inadequate or insecure access to food due to financial constraints, and has been used extensively in research and grey literature. This review examined the use of HFI as part of composite indicators associated with fruit and vegetable (FV) intake, health conditions and food cost/affordability. The review found no examples of HFI and FV or HFI and chronic conditions as a composite indicator.

- Fruit and vegetable intake was measured as either servings or frequency and overall the evidence suggests that HFI is associated with lower FV intake (whether it be servings or frequency) in both adults and children.
- The evidence review examined a number of health outcomes in relation to HFI including diabetes, cardiovascular disease, breastfeeding rates and duration, and mental health. Overall the evidence suggests that HFI is associated with more negative health outcomes.
- Food cost/affordability is used as an indicator in the literature; however, there was considerable variability amongst the proposed combination of variables. Evidence examining the relationship between an indicator for food cost/affordability together with HFI suggests that living with lower income or experiencing HFI is associated with:
  - A lesser ability to afford a healthy diet
  - A greater proportion of income spent on food than families at the median income level
  - Not having enough funds for a healthy diet after other expenses are paid

Food environments

Research on food environments and health and food security has emerged quickly over the past decade. However, there remains a lack of evaluation research to assess effectiveness of built environment interventions. Inconsistent settings, measurement tools and findings across the literature are major limitations in evaluating potential indicators. There is a significant gap in knowledge of food environments in Indigenous communities and rural/remote northern communities. Food deserts (defined as "neighbourhoods that are simultaneously materially deprived and have low geographic access to nutritious affordable food sources") are a major focus of US-based research, however, there is no evidence of widespread food deserts in Canada.

- Zoning bylaws are a common way to influence food environments. Bylaws have the potential to impact food access and availability for all residents of an area (i.e. equity) and the ability to target areas most in need of food environment improvements. Zoning bylaws typically relate to smaller geographic areas (provincial/territorial or local) and are therefore potentially of use for vulnerable neighbourhoods or regions; these may also be easier to evaluate. However, evidence to assess effectiveness or impact on diet is limited.
- Geographic indicators measure the availability of more/less healthy food outlets based on proximity (i.e. distance from a fixed point), density (i.e. number within a fixed area) or variety (i.e. ratio of more/less healthy outlets). These measures use a number of sources to identify the location and number of food outlets by type. Evidence suggests some relationship between diet and geographic access to food. Some evidence suggests that disadvantaged neighbourhoods in Canada may have more fast food outlets.
  - Density of food outlet types may have a greater impact on diet than proximity, possibly due to other factors that are reflected in spatio-temporal indicators. Despite inconsistent research with links to health outcomes, geographic measures have value because access is necessary (if not sufficient) for healthy eating and food security.
  - Variety indicators like the modified Retail Food Environment Index (mRFEI), provide a more complete picture of food availability than simply measuring access to healthy or less healthy food outlets.
  - Spatio-temporal access (e.g. normal movement patterns, time schedules, transportation mode and availability) is important to consider with respect to geographic food access—this is a strengthening area of research.
- Consumer food environment assessments measure availability and/or price of specific foods or types of foods inside retail food outlets (e.g. supermarkets, corner stores, greengrocers). Validated tools are available, but they are labour-intensive and require manual data collection.
- Evidence related to community-oriented programs, which improve diet and access, suggests that gardens and garden programs impact food literacy, skills and familiarity with different foods.

Food system resilience

Resilient food systems can be described as the food system's ability to adapt to changing conditions, withstand disasters and mitigate the impact of shocks and disturbances. Flexibility, diversity, redundancy, adaptability as well as the capacity of individuals and organizations to monitor and manage risks and vulnerabilities are characteristics of resilient food systems. These characteristics are reflected in the indicator categories and areas included in the findings from the literature. Measuring these characteristics can be challenging except for economic profitability where data is available from Statistics Canada.

- Vulnerability of food system infrastructure to natural disasters compares the location of food system infrastructure (including food transportation infrastructure, warehousing and retail buildings, and food production locations) to locations vulnerable to natural disasters such as floods, landslides, earthquakes and forest fires. This indicator is used across the literature and

does show that resilience is reduced when food system infrastructure is in places vulnerable to natural disasters.

- Diversity across all aspects of the food system (i.e. supply chain) is a central element in creating more resilient food systems. Strong evidence suggests that plant diversity and complexity in farming systems can reduce vulnerability to extreme climatic events.
- Sustainability, security or resilience of the systems or inputs upon which food production depend (e.g. seeds, water, energy and nutrients) emerged strongly from the evidence as critical to the resilience of food systems themselves.
- Numerous indicators of the economic profitability or performance of the agriculture sector were important considerations for food system resilience. Regional/local food production is critical for food system resilience, although complete reliance on local food sources gives no greater resilience than complete reliance on imports. The connection between food self-reliance and increased resilience were not well supported by the evidence. Knowledge transfer/exchange between different food system actors (e.g. producer-producer, producer-consumer, consumer-government) is important in creating social networks that confer food system resilience.

Influencing policy

Influencing policy is a broad indicator theme related to capacity—it measures how public health practitioners influence policy (development, change and implementation) and methods used for advocacy. There is very little published or grey literature to support the theme of influencing food security-related policy, however, the literature suggests that establishing a theory of change is a fundamental starting point for evaluating advocacy and policy change. Two theories of change guided the work for this section: the first ("Policy window" theory) prepares for a window of opportunity to influence policy by clearly defining the problem and identifying solutions; and the second ("Grassroots" theory) occurs when communities self-organize to address an issue that directly affects them—this aligns well with the goals of the Community Food Action Initiative (CFAI). The strategies and outcomes described within these theories formed the indicator categories for this section (i.e. framing the problem, developing a strategy, mobilizing community, training, etc.).

There was only one peer-reviewed study that addressed the subtheme of using the National Nutritious Food Basket (NNFB) as an advocacy tool to influence policy, which reported that the NNFB is used in multiple ways for health advocacy in Ontario.

Conclusions and next steps

The literature review focused on the four key themes identified by the health authorities and the MOH. The level of evidence available for each of the four themes varied. Household food insecurity is a validated measure in Canada and there was substantial literature showing that HFI is associated with lower fruit and vegetable consumption and poorer health outcomes. Food environments (especially those examining geographic access and zoning) is prominent in the literature, however, there are inconsistencies across studies in findings, measurement, tools, etc. Food system resilience literature focuses on characteristics to support resilience such as diversity, sustainability and economic

profitability. There was very little literature specific to the theme of influencing food security policy and supporting advocacy and more work will need to done within this theme once the priorities have been narrowed down (see next steps). Overall, the literature reviewed illustrated support for moving forward with the themes identified by the health authorities and the MOH.

The next steps are to narrow down the number of indicator areas. BCCDC and the MOH will work to develop indicator prioritization criteria and engage food security experts in the health authorities and the MOH to prioritize the indicator areas. After the first round of prioritization, key decision makers/ leaders will also have the chance to prioritize indicator areas. Following the prioritization, the indicator areas will be refined. This may require further review of the literature, developing clear definitions and measures for the selected indicators and stakeholders' input.

Project background

Food security is complex in both content and governance and is therefore challenging to measure. In 2009, the Provincial Health Services Authority (PHSA), in collaboration with the regional health authorities and the BC Ministry of Health (MOH), developed six food security indicators to monitor the 2006 *Model Core Program Paper: Food Security*. During the revision of the *Model Core Program Paper: Food Security* in 2014, the health authorities and the MOH identified the need to update the 2009 food security indicators as they no longer represented the current literature or the breadth of food security work occurring in B.C. As such, the indicators did not accurately reflect the B.C. food security context. The MOH supported moving forward with updating the food security indicators.

The purpose of this project is to develop an evidence-based set of indicators that are useful and feasible for the health authorities and the MOH. The indicators will:

- Reflect food security priorities identified by the MOH and health authorities and will be relevant to the goals and objectives of the model core program paper on food security.
- Inform practice and policy by demonstrating the current state of food security/household food insecurity in B.C., reflecting the impact of food security initiatives and highlighting where gaps exist and further work is needed to improve food security.

Project overview

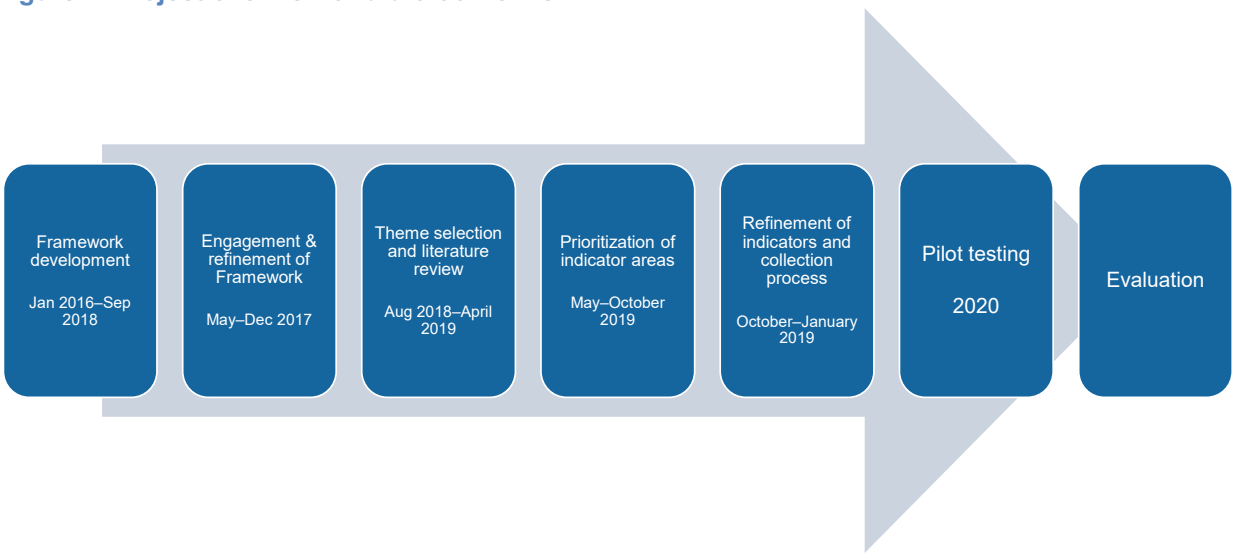
This is a multi-phased project that began with the development of a conceptual framework for food security indicators (herein referred to as the Framework) to guide the indicator process. The Framework document can be found on the BCCDC website. The purpose of the Framework is to help demonstrate where public health can influence food security, and the causal relationship and interconnectedness between indicators. The Framework describes three key elements of food security, as well as several sub-elements. The key elements are household/individual food insecurity, food systems and capacity.

The current phase of the project involved two steps: identification of priority food security topics from the Framework and a literature review on the identified topics. A consulting firm was hired to develop, administer and assess a written survey to narrow down the number of areas for researching during the literature review. The survey was completed by seven groups: the five regional health authorities, the First Nations Health Authority (FNHA) and the MOH. The consulting firm developed a short report to present the aggregated results, which can be accessed through the Provincial Manager of Food Security at BCCDC.

Four overarching themes emerged from the survey: household food insecurity (both “health and food insecurity” and “food affordability”), food environments, food system resilience (response to shocks and disturbances) and influencing food security policy (sub-themes were also identified) (see Appendix 1). These four themes directed the literature review and proposal of possible indicator areas. This report focuses on the literature review process and findings.

This work will be used to guide the next phase of the project where health authorities and the MOH will have to prioritize and finalize the food security indicators for the province (see Figure 1 for an overview of the indicator development process).

Figure 1. Project overview and draft timeline



Literature review

The outcome of the literature review is to identify a suite of possible food security indicator areas (which will be refined in future phases) and to clearly demonstrate the existence/quality of the evidence in relation to food security and/or health outcomes for each of the proposed indicator areas. The review of literature was led by the research coordinator and her research team in collaboration with Provincial Manager of Food Security, an epidemiologist, a surveillance biostatistician, and Director, Population Health Surveillance & Epidemiology, from the Population and Public Health team at BCCDC in consultation with an advisory committee (see Figure 2).

Figure 2. Schematic of individuals informing the literature review

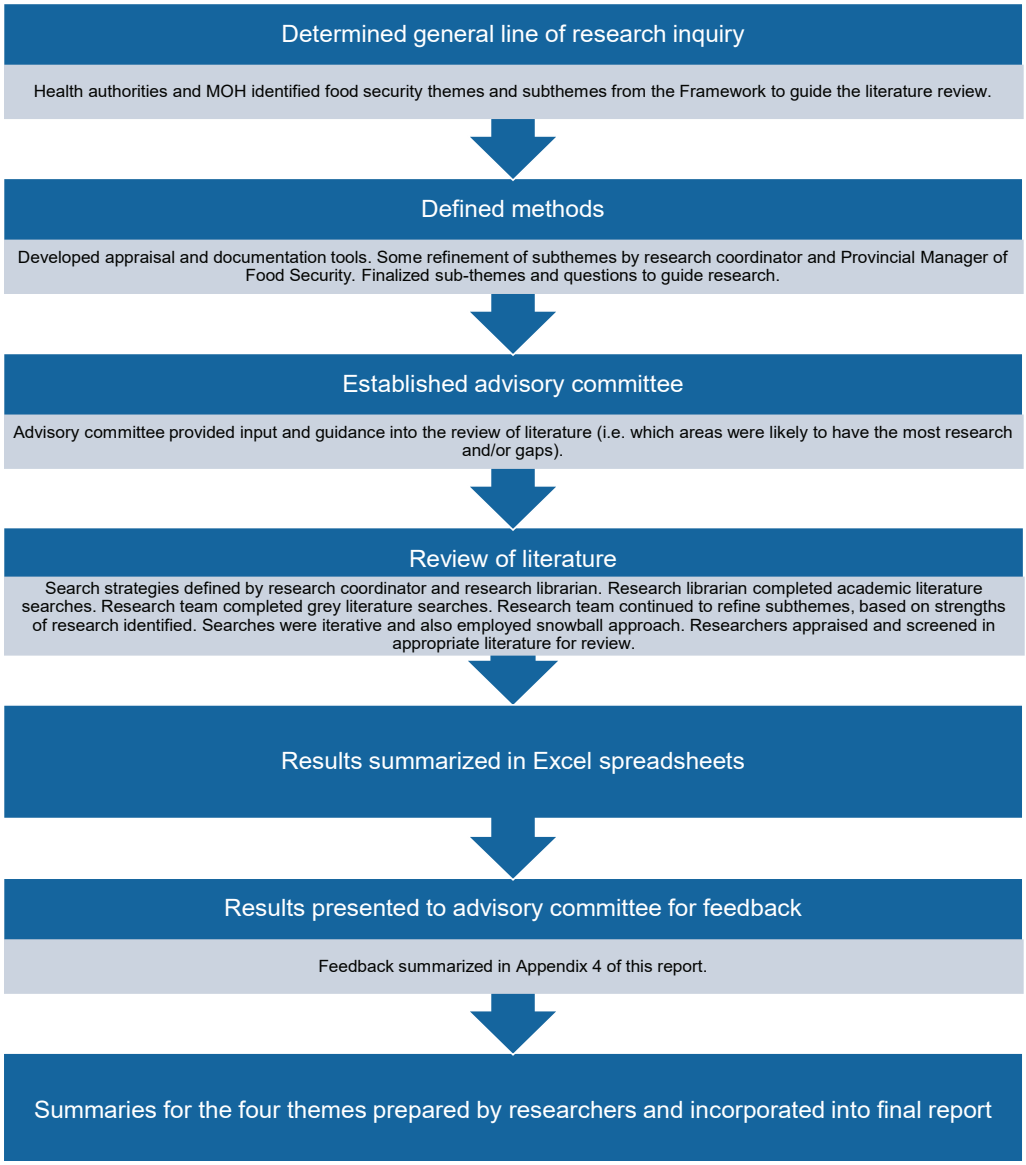
Methods

Methods overview

The literature review consisted primarily of a review of published and grey literature, supplemented by information provided by the advisory committee and the research team of consultants. Figure 3 provides an overview of the steps of the review of literature.

The team used a structured method for reviewing and assessing the literature that followed a snowballing rather than a systematic approach. A balance was struck between covering the research as thoroughly as possible, while not doing a systematic review.

Figure 3. Overview and sequence of approach to review of literature



The research coordinator drafted research methods which were informed and approved by the PPH team at BCCDC. It included research strategies and steps, priorities and questions to guide research, appraisal and reporting documents, and inclusion/exclusion criteria. Further details are provided within subsequent sections.

Scope of literature review and research questions

The initial step of the literature review was to establish the desired outcomes, scope and research questions to guide the review process. The PPH team identified the following desired outcomes:

- Collate a suite of food security indicator areas that are used in other jurisdictions or have been proposed for use in the literature.
- Where possible, document evidence supporting a relationship between the indicator and food security and/or health outcomes (e.g. income and household food insecurity).
- Where no indicators were found within a theme (e.g. influencing policy change), propose a mix of quantitative and qualitative indicator areas and provide a rationale.

The scope of the literature review was narrowed to focus on the four themes selected by the health authorities and the MOH. The research coordinator and the Provincial Manager of Food Security developed a set of guiding research questions for each of the themes (see Appendix 1) and refined the themes and questions based on input from the advisory and the initial literature search done by the research team.

Advisory committee

PPH established an advisory committee composed of academics; Medical Health Officers and epidemiologists from the health authorities; and a food security representative from the First Nations Health Authority and the MOH. The purpose of the advisory was to support the PPH team and the researcher team to develop evidence-based indicator areas by providing expert knowledge, guidance and input into relevant literature and final draft suite of indicator areas. The advisory committee provided information within their subject areas of expertise, including priority areas where they knew of evidence-based relationships between indicators and health and/or food security outcomes, indicators that are currently collected but are not related to health and/or food security through the evidence, relevant documents, and data sources and gaps within the priority areas. This information was collected primarily through interviews with the research coordinator and also through a questionnaire that was circulated via e-mail. A brief summary of the advisory's discussions and suggestions can be found in Appendix 4.

Data collection

Researchers collected, examined and reported on both academic and grey literature.

In approaching the academic literature, the research coordinator and researchers collaborated with a research librarian to determine appropriate research terms and databases. Inclusion criteria included:

- Types of studies (secondary research: systematic reviews, meta-analyses and reviews; primary research when secondary not available);
- Jurisdictions with similar health systems: Canada, United States, European Union, Australia, international (excluding literature from the Global South and developing countries);
- Languages: English;
- Dates: published 2008-present.

Criteria varied slightly between research themes, depending on quality, quantity and relevance of literature found.

Search terms fell under three main search themes: household food insecurity, food environment and food resilience. Search terms, databases and methods varied slightly within each theme, depending on the information found. The academic literature search was progressive, beginning with secondary sources (e.g. meta-analysis, systematic reviews and reviews) and moving to primary literature where secondary sources were not available. As per the scope of the project, searches in all topic areas were not exhaustive.

The librarian performed the searches of the academic literature. She generated lists of documents which were downloaded and imported results into an EndNote database to facilitate removal of duplicates and article screening. She also recorded the research strategies for each theme.

Individual researchers examined grey literature in each theme. The research coordinator, in collaboration with the advisory committee, generated grey literature reference lists. The research librarian and research coordinator developed a strategy for researching grey literature. Grey literature was particularly important in identifying reports and research collaboratives specifically about indicators, including where they have been proposed for use, where they are collected and data sources.

For both the academic and grey literature, the literature searches were iterative, depending on the quantity and quality of information found. A snowball approach was used to identify other relevant studies and information. See Appendix 2 for details of the literature search strategy for each theme.

There were two exceptions to the above process. First, for the theme “influencing policy”, the research coordinator developed a different approach because there was no clear scope or definition for this priority theme and very little published research was available in this subject area. As such, the research coordinator and the Provincial Manager of Food Security identified a theoretical model to help guide the research process for this theme. The second exception was for household food insecurity (HFI). Since HFI is a well-established indicator in Canada (e.g. Health Canada has a household food

security survey module as part of the Canadian Community Health Survey), the PPH team and the research coordinator decided that it was unnecessary to put it through the same review process. However, it did go through the same literature review process when used as composite measures, such as HFI and fruit and vegetable intake.

Researchers screened in and appraised documents according to appraisal criteria and tools developed by the research coordinator in collaboration with the PPH team. The research coordinator adapted and abridged the tools from the Qualitative Research from the Critical Appraisal Skills Programme[1], AMSTAR 2 and Charis Management Consulting.

The researchers summarized their findings in a standardized Excel workbook. Table 1 describes the information captured in the Excel spreadsheets. The researchers then developed written summaries to highlight key findings to be included in this report (see next section).

Table 1: Descriptions of spreadsheet columns

Column	Name		Description
A	**Indicator category**		Generated from themes identified by health authorities, and narrowed down by research coordinator, Provincial Food of Security Manager and individual researchers.
B	**Existing or new?**		Specifies whether the indicator has been used (in grey or academic literature) or if it is a new indicator area proposed by the research team.
C	**Indicator area**		More specific than indicator categories in "A", but still need to be narrowed down to generate specific indicators once priority areas are chosen.
D	**Brief summary of evidence for use of this as indicator**		Lists evidence for use of this area as an indicator. As there is a paucity of this literature, sometimes this column includes a study or report where the indicator was used rather than the evidence to support the indicator. Note the difference from Column "F".
E	**Where are indicator areas used?**		Ideally, this column includes reports or organizations who use these indicators on an ongoing basis. Due to the paucity of literature, also included are individual studies and/or grey literature where the indicators may not be used on an on-going basis.
F	**Evidence supporting a relationship between indicator and food security/ health outcomes**		This is the only column in the spreadsheet that doesn't specifically examine indicators per se. Instead, it illustrates the link between the indicator area and food security and/or health outcomes.
G	**What are the data sources?**	Methods of collection/ calculation.	There are 3 columns related to data sources. Column "G" notes method of calculation for the indicator.
H		Frequency of reporting.	Column "H" notes how frequently the data sources are made available.
I		Where can data be found? Level of reporting (e.g. provincial, etc.).	Column "I" notes where data can be found, and at what level (e.g. provincial, regional, etc.) "G", "H" and "I" are all based on the grey literature.
J	**Strengths and limitations of evidence for proposed indicator area (where available).**		Refers both to strengths and limitations noted in the literature, or as noted by the research team.
K	**Other comments**		

Results: Summary of indicator areas

The literature review focused on the four overarching themes identified by the health authorities and the MOH. The themes include household food insecurity, influencing food security policy, food environments and food system resilience. Within the themes, the health authorities and MOH also identified subthemes. The researchers further refined the subthemes during the literature review based on the available evidence (see Appendix 1). Two subthemes were not included in the literature review due to limited data or documentation on the topic and/or they did not fit within the scope of the project. The two subthemes were health care costs relative to HFI and information regarding food as a component of emergency planning in B.C.

As discussed in the methods section, the literature review explored both the evidence for use of the indicator category as an indicator (i.e. a review of food security indicators) and the evidence supporting an association between an indicator category and food security and/or health outcomes. The former relied more heavily on grey literature as little published literature exists for this area, while the latter drew more heavily from published literature.

This section presents the findings from the literature review for each of the four themes. See Appendix 3 for summarized tables of the proposed indicator areas and corresponding literature. The results presented for each of the four themes may look somewhat different from each other. This is in part due to the fact that a different research consultant worked on and wrote the findings for each theme and because each theme has varying degrees of literature. The results summarize the literature and provide strengths and gaps for each theme. These are high-level summaries; more detailed information on the literature review findings can be obtained from the Provincial Manager of Food Security.

Theme: Individual and household food insecurity

Household food insecurity

Household food insecurity (HFI) is based on the Household Food Security Survey Module (HFSSM) (collected as either core or optional content depending on the year) that is part of the Canadian Community Health Survey (CCHS) conducted by Statistics Canada. HFSSM is a validated scale of the severity of food insecurity that measures inadequate or insecure access to food due to financial constraints; the module and methods used to combine responses were adapted from methods developed in the United States (US).[2-4] These methods have been used to monitor food security in the US since 1995, and have been used extensively in research and grey literature in Canada.[5-8]

Strengths of this indicator include that it is based on a validated scale and has been used extensively in combination with other variables (see below). Limitations of HFSSM include the fact that it does not take

into account the use of traditional foods, harvesting practices and/or food-sharing systems, nor does it provide the frequency or duration of food insecurity experiences.[9] The CCHS sample is limited in that certain groups are excluded (e.g. on-reserve Indigenous Peoples and people who are homeless – both of which are groups where the potential for experiencing food insecurity is quite high).[8] Additionally, users of this indicator should be mindful of the thresholds that define HFI, as these levels vary based on the organization that is analyzing the data. For example, Health Canada classifies food insecurity as either moderate or severe whereas PROOF (and other organizations including PHSA)[10] classifies HFI as marginal, moderate or severe.[11]

Household food insecurity and fruit and vegetable intake

Documents illustrating HFI with fruit and vegetable (FV) intake together as an indicator were not found, however, there was support in the research literature for looking at these two variables together.[9, 10, 12-17]

For the HFI component of the composite indicator, HFI based on HFSSM was proposed (five studies),[9, 10, 12-14] as was household income (two studies)[15, 16] and hunger (one study).[17] The FV component of the composite indicator was noted as either FV servings (proportion of population that eats five or more servings of FV per day) (five studies)[9, 12-15] or FV frequency (proportion of the population that eats FV five or more times per day) (three studies).[10, 16, 17] Generally, evidence suggests that HFI (and its proxy measures) are associated with lower FV intake, whether it be servings or frequency.[9, 10, 12-17]

Strengths of this composite include the validated HFI measure. In addition, evidence suggests that FV intake can serve as a proxy for healthy eating habits.[18] Using household income may serve as a proxy for HFI given that financial challenges may limit one's ability to have consistent access to food. However, hunger should not be used as a proxy for HFI as it is a single measure not likely to capture all who experience HFI.[17] Even though individuals who experience severe food insecurity have a greater likelihood of hunger, the two are not synonymous.[19] Hunger includes "the sensations of discomfort, weakness, pain or sickness experienced by an individual that result from an extended period of not having enough to eat".[19(p4)] Thus, hunger is thought to be more reflective of severe food insecurity rather than moderate or marginal food insecurity. Limitations also include potential issues with accuracy of dietary recall and the fact that using FV frequency does not provide an assessment of the quantity of food eaten.

Household food insecurity and health outcomes

Documents illustrating HFI and various health outcomes together as indicators were not found, however, there was support in the research literature for looking at the validated HFI measure and various other health-related variables together (e.g. breastfeeding initiation, mental health, etc.). Seventeen out of 19 studies used HFI,[20-36] where the remaining two used hunger.[37, 38]

The health conditions that were examined were:

- Maternal/Child Health: Breastfeeding, cognition (academic achievement), body mass index (BMI), diabetes, mental health (hyperactivity/inattention, depression and suicide ideation) and general health (perceived)
- Adult Health: General health (perceived), mortality (all cause), BMI, diabetes, cardiovascular disease (CVD) and mental health (service utilization, risk and prevalence of adverse outcomes).

While no significant differences in breastfeeding initiation between food insecure and food secure women were seen in a Canadian 2018 study, relative to women with food security, those with marginal, moderate and severe food insecurity had significantly lower odds of exclusive breastfeeding to four months.[20] For children, there is some evidence to suggest an association between food insecurity and a lower likelihood of meeting academic expectations.[21] There is also evidence that HFI is associated with overweight and obesity,[22, 23] diabetes[24] and mental health (persistent hyperactivity/inattention).[25] Hunger was associated with a higher odds of depression and suicide ideation among youth,[39] as well as poorer self-reported general health.[38] For adults, research suggests that HFI is associated with diabetes,[29-32] heart disease[30] and mental health (e.g. odds of service utilization, risk of adverse mental health outcomes, prevalence of mental health outcomes).[10, 14, 34-36] Only one study examined the association between HFI and obesity in Canada. Findings from this study differed based on the use of self-report height and weight (e.g. rates of obesity were significantly higher among food insecure individuals) versus measured height and weight (e.g. almost no significant differences in obesity by food security status).[28] Generally, evidence suggests that HFI is associated with more negative health outcomes.

Strengths of this composite are that they include the validated HFI measure and the availability of administrative databases reporting on diagnosed health conditions. Self-reported health status has been demonstrated as a valid measure for some variables (e.g. mental health),[40] but less so for others (e.g. overweight and obesity).[41] Thus, using administrative databases to obtain diagnosed health conditions may be preferable.[29] Again, hunger should not be used as a proxy for HFI as it is a single measure not likely to capture all children who experience HFI.[17]

Food cost/affordability

Documents providing evidence for the use of food cost/affordability as indicators were found,[5, 42-45] however, there was considerable variability amongst the combination of variables proposed. Five out of 12 studies proposed using HFI; three with the cost of the National Nutritious Food Basket (NNFB) as a percentage of basic expenses[5, 46, 47]; one with household economic resources after tax and after rent income[48]; and one with satisfaction related to the ability to find foods that one can afford.[49] Other documents proposed the use of percent who could not afford balanced meals[42] or percent of students who went to bed hungry because there was not enough money to buy food,[43] whereas others focused on annual household spending on food.[45] Looking specifically at a focus on the cost of NNFB, documents fell into three themes: (1) HFI and Cost of NNFB as a percent of basic expenses;[5, 46, 47] (2) annual cost of NNFB, as a proportion of income;[16] and (3) cost of NNFB as a percent of basic expenses and proportion of income allocated to shelter.[50, 51]

Evidence examining the relationship between an indicator for food cost/affordability and HFI suggests that living with lower income or experiencing HFI is associated with a lesser ability to afford a healthy diet,[48, 49] a greater proportion of income spent on food than families at the median income level[16] and not having enough funds for a healthy diet after other expenses are paid.[5, 46, 47]

Strengths of this composite include the validated HFI measure and that NNFB is used across Canada to assess the affordability of a healthy diet. Limitations of NNFB are summarized in the *Food Costing in BC 2017: Assessing the Affordability of Healthy Eating report*,[52] and include such things as the tool being from 2008 and the items and/or sizes perhaps no longer reflecting what is currently sold in the marketplace; and the tool only being used in full-service grocery stores, which excludes small, remote and Indigenous communities without full-service grocery stores.[52]

Theme: Food environments

The overall body of research evidence about food environments and health/food security has been emerging quickly over the past 10 to 15 years. However, there remains a lack of evaluation research to assess effectiveness of built environment interventions, especially with respect to food. Heterogeneity in measurement tools and inconsistent findings across studies and settings is a major limitation in assessing health outcomes and evaluating potential indicators.[53] There is also a lack of research focusing on rural areas and Indigenous communities.[54] As per the methods, this review focused on review articles, many of which assess food environments without making a link to health, food security or diet.

Food deserts (defined as "neighbourhoods that are simultaneously materially deprived and have low geographic access to nutritious affordable food sources" [54(peS4)]), which are closely connected to geographic access to retail food sources, are a major focus of US-based research. Because food environments and food access issues differ in important ways across geographic and political boundaries, this review focused on Canada-specific research. Although prevalent in the US, there is no evidence of widespread food deserts in Canada.[55] Three studies (in Hamilton, London and Saskatoon) found evidence of food deserts, whereas 10 studies found lower socio-economic status (SES) areas to have as good or better geographic access to nutritious foods than higher SES areas.[56] However, it is also worth noting that the majority of food access research in Canada has taken place in urban areas. There is a significant gap in knowledge of food environments in rural and remote communities, and more work needs to be done to examine whether food deserts exist there. US–Canadian differences with respect to racially segregated neighbourhoods, as well as the links between race and SES, also impact transferability of the research. However, some US reviews were included where there was a specific link between geographic access and health outcomes or diet.

Zoning (prohibitive and proactive)

Most efforts to use zoning to influence food environments rely on bylaws. Prohibitive bylaws limit unhealthy food sellers, while proactive bylaws provide incentives to ensure availability of grocers. Both have been used in Canada and other countries. Land use bylaws are most common, but other bylaw types, such as vehicle idling laws to prohibit drive-throughs, have also been implemented.[57] Municipal

tax incentives can also be used to influence the location and availability of food outlets.[ii] Most reports of zoning indicators focus on areas around schools and suggest a link between proximity to or density of less healthy food outlets and consumption of those foods.[58-61]

Strengths of zoning include a potential to have a real impact on food access and availability for all residents of an area (i.e. equity) and the ability to target areas deemed most in need of food environment improvements. Zoning bylaws typically relate to smaller geographic areas (e.g. provincial/territorial or local)[62] and are therefore potentially of use for vulnerable neighbourhoods or regions, which are also easier to manage and evaluate.[58] However, evaluation evidence to assess effectiveness or impact on diet is limited. Users should consider the range of factors that influence food acquisition, such as income, demographics and travel patterns. For example, if healthier outlets are incentivized, will people use them, and if there aren't unhealthy outlets, will people simply go elsewhere to access those food items? Users should also ensure there are no legal contraints[63] and consider the possibility of resistance from the business community.[64]

Geographic access (proximity, density and variety)

Geographic indicators measure availability of more/less healthy food outlets based on proximity (i.e. distance from a fixed point),[53, 65-67] density (i.e. number within a fixed area)[53, 65, 66, 68] or variety (i.e. ratio of more/less healthy outlets).[53, 65, 68] These measures use census data, GIS mapping, industry classification codes, health inspection data and business registry data to identify the location and number of food outlets by type. Heterogeneity of measurement tools complicates assessment of the links between retail food access and diet or other outcomes of interest, but overall evidence suggests some relationship between diet and geographic access to food.[54, 56, 69, 70] There is also evidence that disadvantaged neighbourhoods in Canada may have an excess of fast food outlets.[60] Density of food outlet types may have a greater impact on diet than proximity,[70] possibly due to other factors that are reflected in spatio-temporal indicators.

Despite equivocal research for health outcomes, geographic measures have value because access is necessary, if not sufficient, for healthy eating and food security. Variety indicators[iii] such as the modified Retail Food Environment Index (mRFEI), sometimes referred to as relative density, provide a more complete picture of food availability than simply measuring access to healthy or less healthy food outlets.[53] They can account for food swamps (defined as "neighbourhoods that are both materially deprived and have high geographic access to food retailers perceived as promoting mainly minimally nutritious food options such as fast food outlets and convenience stores" [54(peS4)], which may be relevant for disadvantaged neighbourhoods or areas around schools. All three geographic indicator types can be measured using multiple data sources, protocols and tools available, which permits comparisons with other regions due to broad use by projects such as INFORMAS/FoodEPI, Report Card (Alberta) and APHEO (Ontario). They can also be used in conjunction with other indicators such as consumer food environment assessments, demographic data[53] or used as part of spatio-temporal measures. Due to reliance on pre-defined census boundaries, these indicators are more suited to urban areas and may not provide meaningful data in smaller communities or rural areas where people typically travel farther to shop.

ii Additional examples of zoning measures may be found in the World Cancer Research Fund International NOURISHING database.

iii Variety indicators refer to the relative mix of food outlet types in an area.

Consumer food environment assessment

Consumer food environment assessments measure availability and/or price of specific foods or types of foods inside retail food outlets (e.g. supermarkets, corner stores and greengrocers). Although indoor food environments were out of scope for this review, indoor food environments provide more information than store type, for example, convenience stores typically sell different things than greengrocers, and can address classification errors that occur with geographic indicators.[69] Such measures also reflect pricing and availability differences inside stores in different neighbourhoods.[58, 60]

This type of indicator is part of the international INFORMAS Food Environment Policy Index, which provides tools as well as potential for data comparisons over time and across geographic regions.[65,71] There are multiple validated tools available,[65, 71-75] the most common being the Nutrition Environment Measures Survey (NEMS).[72, 73, 76] A major limitation of these measures is that they are labour-intensive and require manual data collection.[53] Users should keep in mind that, like geographic measures, availability does not guarantee consumption, so more outcomes/evaluation research is needed (note that Fraser Health is doing a pilot). Price, promotion and marketing will be important considerations.[65, 77]

Spatio-temporal access (includes transportation)

Recent research articles provide clear indication that normal movement patterns, time schedules (individuals and retailers), transportation mode and availability, etc. are important considerations with respect to geographic food access and multiple measures should be used in conjunction where possible.[69, 70, 78, 79] This seems to be the direction that geographic access is moving, as it incorporates life circumstances that might account for some of the variability in previous research. This was tested with some success in Montreal, where urban travel data was available.[80] Transportation (mode, connectivity and availability) is a particularly important influencer of realized geographic food access and thus an essential component of spatio-temporal access to food. Personal vehicles and daily movement patterns make proximity less important.

Although there are no existing tools or indicators, work is forthcoming from CANUE.[iv] The CANUE tool is expected to have limited use in rural areas because it relies on large dissemination areas, but the developers are hoping it will function in towns and smaller cities, if not very rural or remote regions where people normally travel longer distances to purchase food. In future, the measures could be adjusted for rural regions using longer radial distances. This tool will not account for mobility or time schedules but will describe retail food environment exposure for areas in which people might spend time (e.g. if you spend time in area X, this is your food retail availability).

Transportation access may be a particularly valuable indicator (or component of spatio-temporal access) in smaller communities where distances are greater and access to public or active transportation is limited because of low population base and rural/remote living.[69, 81]

iv Sample data or tools may be available from Michael Widener with CANUE in future.

Community food programs

There are numerous community-oriented programs designed to improve diet or food access. Those considered in scope for this review focused on community or school gardens and programs that increase relative affordability of healthier foods (e.g. subsidies that reduce the retail price of fruits and vegetables). Evidence from the *Healthy Built Environment Linkages Toolkit* suggests that gardens and garden programs impact food literacy, skills and familiarity with different foods.[82, 83] These outcomes may be more important than the actual quantity of food that comes from the gardens.

Although food taxes and pricing were deemed out of scope, affordability programs were included because affordability influences whether consumers can take advantage of geographic food access. Subsidies and price incentives have been shown to increase fruit and vegetable intake and reduced chronic disease risks.[84-88]

Theme: Food system resilience

Resilient food systems can be understood as the food system's ability to adapt to changing conditions, withstand disasters and mitigate the impact of shocks and disturbances.[89] Attention has been given to resilience in terms of the production of food, however understanding and measuring resilience in terms of whole food systems is an emerging area.[90-92] Our food system is complex, dynamic and uncertain both horizontally across the supply chain (e.g. production, distribution and consumption), as well as vertically (local, regional, national and global scales).[92] Flexibility, diversity, redundancy, adaptability as well as the capacity of individuals and organizations to monitor and manage risks and vulnerabilities are characteristics of resilient food systems.[89] The strength of the findings varies between the indicator categories. For example, while there are an increasing number of urban food system vulnerability assessments available, the information required to recreate these at a provincial level is difficult to access and assess. And while sustainability appeared to be an important factor to assess, suggested metrics were not available.

Access/consumption: Household food insecurity

Six of the articles retrieved[89, 91-95] identified household food insecurity (HFI) as a factor affecting the ability of individuals to be resilient to food system shocks and therefore as an important factor contributing to overall resilience of the food system. Note that because HFI was covered extensively in the first theme, it was not the focus of the literature review for this theme. Therefore, it's unlikely that the six articles retrieved represent the breadth of the research on this indicator as it relates to resilience. A strength of this indicator is that it is cross-cutting, with metrics also being relevant to other food system theme areas.

System wide: Vulnerability of food system infrastructure to rapid onset hazards

This indicator category compares the location of built/physical food system infrastructure (including food transportation infrastructure, warehousing and retail buildings, and food production locations) to locations vulnerable to natural disasters such as floods, landslides, earthquakes, forest fires, etc. The indicator was used in ten of the articles retrieved,[89, 96-104] including the food system vulnerability assessments of five North American municipalities. Two case studies of food system performance after a natural disaster provided specific evidence that in instances where food system infrastructure was located in places vulnerable to a natural disaster, resilience to rapid onset hazards was reduced.[96, 98]

A strength of this indicator is its use across peer-reviewed literature and grey literature (i.e. the five food system vulnerability assessments referred to above). However, it may be difficult to assess at the B.C. scale as it requires considering specific, local-scale locations. An approach may be to focus on measuring this indicator for urban areas that serve as food distribution hubs for the rest of the province, as a disaster there would have a ripple effect of food supply chain issues across the province.

Supply chain (diversity/redundancy) and production (agricultural diversity/redundancy across scales)

Throughout the literature and in-keeping with resilience theory more generally,[105] diversity was reported to be a central element in creating more resilient food systems.

Four of the articles retrieved[96, 102, 106, 107] specifically referred to the importance of diversity in the supply chain, including one[106] review of over 50 food system resilience articles which found nine articles that referred to the importance of supply chain diversity. As with the above indicator (vulnerability of food system infrastructure), it may be challenging to measure this indicator at the B.C. scale.

Fifteen of the articles retrieved[97, 108-113, 107, 114-120] referred to the importance of diversification at the production stage of the food system. As a whole, these articles provide evidence that enhancing plant diversity and complexity in farming systems reduces vulnerability to extreme climatic events. They state that these observations have bolstered recognition that biodiversity and crop diversification strategies are important resilience strategies for agroecosystems. The strength of this indicator is in the rich set of evidence-based, scientific literature that the retrieved articles referred to in support of their claims (note it was beyond the scope of this study to review the supporting literature itself).

Production: Agricultural input sustainability, security or self-sufficiency

Twelve of the articles retrieved[4, 8, 17, 24, 28 120-126] suggested that the sustainability, security, or resilience of the systems or inputs upon which food production depend on (e.g. seeds, water, energy and nutrients) is critical to the resilience of food systems themselves. However, although this indicator category emerged strongly from the literature as an important factor contributing to food system resilience, none of the articles retrieved applied it specifically or provided metrics or data sources that could be used to measure it. It may be challenging to develop new indicators and metrics to assess this indicator category for B.C., but doing so could set a precedent that other areas may look to.

Production: Economic performance

Numerous indicators of the economic profitability or performance of the agriculture sector were referred to in the literature as important considerations for food system resilience, including the ability of farmers to maintain a livelihood and invest in the future, and the attractiveness of farming as a reasonably profitable career choice. A total of eight of the retrieved articles included this indicator category.[90, 95, 106, 111, 119, 127-129] Data to measure this indicator is collected annually by Statistics Canada and available at no cost, lending to the strength of this indicator and ease with which it can be measured.

Note that this indicator category is differentiated from the economic ability of consumers to purchase sufficient food, which is covered under the HFI theme.

Production: Capacity for local/regional food production

Five of the articles retrieved[98, 111, 127 130, 131] argued that local/regional food production is critical for food system resilience. Importantly, they typically linked this to the concept of diversity and emphasized that complete reliance on local food sources confers no greater resilience than complete reliance on imports. Links drawn between food self-reliance and increased resilience were not well supported by evidence. For example, Ruhf[127(p653)] states that "food system resilience ... means: reduced dependence on food imported from outside the region", but does not provide data driven evidence to support this position.

Province/system-wide: Social capital and food system planning

Six of the articles retrieved[106, 111, 129, 132-134] referred to the importance of knowledge transfer/exchange between different food system actors (e.g. producer-producer, producer-consumer, consumer-government) in creating social networks that confer food system resilience in times of crisis. Often this

was characterized as building human capital or social capital that people can fall back on in a crisis, and that increasing knowledge improves flexibility to adapt to changing conditions.

Two of the articles retrieved referred to robust, locally adapted food system and/or food resilience strategies in place to ensure preparedness in the event of a natural disaster or hazard.[98, 106]

Despite these themes appearing strongly in the literature, no specific indicators to measure them were apparent.

Theme: Influencing policy

The indicator theme of "influencing policy" is related to capacity – measuring how public health professionals influence policy (development, change and implementation) and methods used for advocacy.[v] Within this theme, the research coordinator and Provincial Manager of Food Security identified three areas of focus: measuring food security policy efforts, using the National Nutritious Food Basket (food costing in B.C.) as an advocacy tool to influence policy, and measuring policy and advocacy efforts specific to the Community Food Action Initiative (CFAI) objective of building community capacity to influence food security. The capacity element from the Framework cuts across the other two elements (HFI and Food System) and will therefore overlap with the other three themes (food environment, resilience and household food insecurity).

There is very little published or grey literature to support the theme of influencing policy; however, the literature consistently identifies the importance of "knowing the policy process" as an important aspect of influencing food security policy.[135, 136, 137] Building on this, in *A guide to measuring advocacy and policy*, Organizational Research Services[138] suggests that establishing a theory of change is a fundamental starting point for evaluating advocacy and policy change. As such, the Provincial Manager of Food Security and the research coordinator sought a theories of change model for which to situate the indicator areas for this theme.

The Organizational Research Services suggests a number of theories of change for informing advocacy and policy change efforts.[139] The two theories used to organize the three main concepts included in this theme are:

- The "Policy window" theory of change (the foundation for the first two areas)
- The "Grassroots" theory of change (the foundation for the third area)

The research coordinator used the strategies and outcomes described within the theory of change models to create the broad indicator categories. Due to a paucity of evidence found for this theme, the approach focused more on sources of information for informing the indicator areas. These sources focused on theoretical use of indicators to influence policy (not specific to food security) and the grey literature on food security indicators. The research coordinator also took into consideration some initial scoping work where health authorities reported on current food security indicators being collected in

v Upon initial review, indicator categories under this theme may not appear to correspond to the capacity element from the 2018 Conceptual Framework for Food Security Indicators in BC (where policy and advocacy are included). This is due to the fact that influencing policy and advocacy for policy change is only one lens of capacity building.

their health authority and the type of indicators of interest to them (this will be referred to as the 2018 PHSA indicator scan).[140]

This theme requires further work and refinement that will occur after the health authorities narrow down their areas of interest, which will happen in the next phase of the project. The sections that follow focus more on the theories of change used to organize the literature review than on the possible indicator areas (suggested indicator areas can be found in Appendix 3).

Influencing policy using the National Nutritious Food Basket

The theory of change used for this theme is the "policy windows" theory (also known as agenda setting theory) a theory developed by John Kingdon.[141] While a systemized review of the use of "policy window" theory in public health was not conducted, many examples of its use in public health exist in the literature.[142-147] Other research identified "policy window theory" as one of a select few potential models used in nutrition[148] and proposed for use in social determinants of health[149] policy research. Cullerton et al.[148] note that there is limited research into the nutrition policy process in high income countries.

Policy window theory identifies three streams related to the policy system, including problems (framing the problem, research, and indicator tracking), policies (development of policy solutions) and politics (influencing the political climate). The theory purports that in order to reach the policy agenda or to receive significant attention, at least two of the streams need to converge within a critical moment or "policy window" ("windows of opportunity that arise when there is the possibility for policy change").[139(p7)] The theory identifies four strategies which align with the streams:

1. Define the problem
2. Develop policy solutions
3. Strengthen organizational capacity (includes relationships, ability to identify policy window)
4. Influence the political climate (e.g. coalition building, advocacy efforts)[139(p8)]

The theory suggests that these four strategies lead to intermediate outcomes (e.g. shift in social norms, strengthened organizational capacity, strengthened alliances and strengthened base of support), finally resulting in longer term outcomes (e.g. policy changes and impacts on conditions). These nine aspects of strategy and outcomes within the theory comprise the indicator categories for influencing food policy and using the NNFB to influence food policy.

The research coordinator identified indicator areas from the grey literature. Some of the indicator areas are drawn from the menu of outcomes for advocacy and policy work within *A guide to measuring advocacy and policy*.[138] As noted above, other indicator areas come from adaptations from existing indicators and a 2018 PHSA indicator scan.[140] Sample proposed indicator areas for influencing policy (general) are outlined in Table 8 in the appendices.

In applying this model specifically to influencing food policy with the NNFB, the research coordinator drew extensively on the only research found to be completed in this area – a 2018 study examining the use of the NNFB for health equity advocacy in Ontario.[150] In support of using NNFB as a policy advocacy tool, Power found that the:

> NNFB is used in multiple ways for health advocacy including: educating within the public health unit and community, building strong public health-community partnerships, supporting board of health to write advocacy letters to provincial ministries, developing province-wide campaigns for health equity in professional associations and network.[150(p8)]

Sample proposed indicator areas are outlined in Table 9 in the appendices.

Community capacity for advocacy and policy in Community Food Action Initiative (CFAI)

Rather than the "policy window" theory of change used in the previous indicator areas, the research coordinator and the Provincial Manager of Food Security chose the "Grassroots" theory of change because the focus is on capacity building around advocacy and policy. Grassroots theory recognizes that capacity building is an important part of advocacy and policy work at the grassroots level, but notes that policy change may or may not be the result. This aligns with the work supported by CFAI as not all food security groups, organizations or networks in the province have the capacity to, or the goals of, influencing policy. There is some overlap with the indicator categories and areas in the previous two areas.

Sample proposed indicator areas are outlined in Table 10 in the appendices.

Conclusion and next steps

The purpose of this literature review is to inform the development of a suite of evidence-based food security indicators that are useful and feasible for the B.C. health authorities and the Ministry of Health.

The literature review drew on both peer-reviewed and grey literature, as well as consultation with subject-matter experts on the advisory committee and the research team. The review focused on four overarching food security themes and several subthemes identified by the health authorities and the Ministry of Health. The research team refined the subthemes throughout the literature review based on the available evidence.

The level of evidence available for each of the four themes, and the more specific subthemes, varied. The review focused on examining household food insecurity (HFI) as part of composite indicators associated with fruit and vegetable consumption, health conditions and food affordability. HFI is a well-established measure in Canada and the evidence suggests that HFI is associated with lower fruit and vegetable intake and with more negative health outcomes.

Research on food environments has emerged quickly over the past decade, however, there are inconsistencies in measurement tools, settings and findings, which is a limitation when assessing potential indicators. The review focused on topics such as zoning, consumer food environments and geographic indicators. The impact of zoning by-laws may be easier to measure, however, there is limited evidence as to their impact on diet. There is some evidence to suggest a relationship between diet quality and geographic access such as proximity to stores, the number of food outlets in an area and variety of healthy food to less healthy food outlets. Evidence is emerging for spatio-temporal measurement which looks beyond food outlets to transportation, movement patterns and time schedules. Tools do exist to measure price and availability of foods inside retail food outlets but this is labour-intensive.

With regards to food system resilience the literature review focused on characteristics of resilient food systems. The location of food systems infrastructure (e.g. food transport, warehouses, etc.) compared to locations vulnerable to natural disaster is an indicator used across the literature and shows that resilience is reduced when infrastructure is in places vulnerable to natural disasters. Diversity across the food system within both the supply chain and diversity in plants and farming as a key element of resilience is well supported by the literature, however, there are few examples of existing indicators for supply chain. The evidence shows that local/regional food production is critical for food system resilience, however, complete reliance on local food sources gives no greater resilience than complete reliance on imports. The connection between food self-reliance and increased resilience were not well supported by the evidence.

The theme of advocacy and influencing policy had limited evidence and will require further work once the prioritization process occurs in the next steps.

The literature review will help inform the next step in the indicator development process, which is to prioritize the food security indicator areas. BCCDC and the MOH will work to develop prioritization criteria to support food security experts in the health authorities and the Ministry of Health to prioritize the indicator areas. Following the prioritization process with food security experts, key decision makers/ leaders will also be asked to prioritize the indicator areas. Indicator areas will then need to be further refined to create specific indicators at which point further work will need to be done to develop clear definitions and measures for each of the selected indicators.

Appendices

Appendix 1: Indicator themes, priority areas and questions to guide research

Food security element from indicator framework	Theme	Subthemes[a]	Questions to guide research
Individual and household food insecurity	**Health and food insecurity (e.g. mental health, physical health, malnutrition)**	1. Rates of HFI (household food insecurity)[b] 2. HFI and fruit and vegetable consumption 3. Rates of HFI compared to illness (chronic disease, e.g. diabetes), obesity and breastfeeding[c]	A. What indicators have been collected in #2 & #3? B. Does an evidence-based relationship exist between: HFI and fruit and veg consumption? HFI and health conditions?
	Food affordability (food cost as a proportion of income)	1. Food cost as a proportion of income	A. In what ways has cost of eating/ food affordability been reported as an indicator? (one way is food cost as a proportion of income)

Food security element from indicator framework		Theme	Subthemes[a]	Questions to guide research
Food Systems	**i. Resilient**	**Food system response to shocks and disturbances (such as forest fires) (e.g. food self-sufficiency, level of local food production)**	1. Food self-sufficiency: number of people food self-sufficient; local food production; actively farmed land; import vs grown local 2. Connection between shocks/disturbances in BC communities and availability of food 3. Food plans as part of emergency preparedness (e.g. plans to respond to shocks and disturbances)	A. What indicators have been collected about resilient food systems? B. What does the evidence say about the relationship between [robust] local/ regional food systems and vulnerability to disturbances (or disruption)[d]/ or recovery from disturbances? C. What does the evidence say about the relationship between [robust] local/ regional food systems and resilience?
	ii. Health Promoting	**Access to human/ society produced food environments (e.g. grocery stores, healthy food, food delivery services, farmers markets/food markets)**	1. Availability of, and distance to, grocery stores 2. Access to healthy food – specific to the amount of healthy food in stores 3. Spatio-temporal access to grocery stores (especially in rural communities and lower income neighbourhoods) 4. Zoning for food availability 5. Community approaches to addressing access to healthy food	A. Does the evidence demonstrate a relationship between (human built) food environments and access to healthy food? B. Does the evidence demonstrate that community food programs can impact health (e.g. social connectedness, mental health, etc.)? C. What indicators have been collected in these areas?
Capacity		**Influencing food security or food insecurity (income) policy**	1. Participation in policy change and policy implementation 2. Advocacy methods	A. Has "food cost" (relative to income, cost of living, etc.) been used as a tool to influence food security (income) policy? B. i. Can participation or advocacy be linked to change in policy? B. ii. Have any indicators been developed to measure methods used to influence food security or food systems policy? (food policy general)? If no, can indicators be generated based on a theory of change related to advocacy and policy change?

a. The health authorities and the Ministry of Health were asked what information was most important to measure within each theme. These are solely based on stakeholder input and are not necessarily reflective of the literature.
b. No search required. Just record CCHS indicators.
c. Literature from 2016-2018 only to be reviewed for 3.B. as information prior available in: PHSA Priority health equity indicators household food insecurity indicator report (2016)
d. To be defined by researcher (e.g. disruption vs disturbance). Refers to short term issues such as transportation blockages, emergencies, etc.

Appendix 2: Literature search strategies

Household food insecurity

We ran the searches for HFI and FV/health together. Medline was searched first, returning 141 records (after duplicates were removed); 56 records for HFI and FV and 85 records for HFI and health. After some discussion, an expanded search for HFI and health was run to include "perceived health", "child development" and the United States. The expanded search resulted in an additional 262 records (after duplicates were removed), for a total of 403 records. The food affordability search was run in Medline via Ovid and Sociological Abstracts, returning 164 records (after duplicates were removed). Overall, 567 unique records were retrieved.

To narrow down the records, the title and abstract were scanned for relevance based on pre-determined inclusion criteria. From this, 40 articles were reviewed in full for HFI and FV/health and 24 articles for food affordability. Grey literature sources were collected from online searches using the same terms as those used for the peer-reviewed literature search. Snowball methods, which is pursuing the references of references, for both grey literature and peer-reviewed sources was also done. Overall, eight grey literature sources were reviewed for use as documents focusing on indicators. Six grey literature sources (three of which also focused on indicators) and 29 peer-reviewed sources were screened in for use as documents focusing on the relationship to FV, health or food affordability.

Food environment

We used an iterative process to refine the search strategy for peer-reviewed literature. The researcher began by reviewing the priority areas identified by the working group and scanning the grey literature and review articles provided. She also discussed the current state of the science and some forthcoming metrics with Dr. Michael Widener (CANUE project, University of Toronto). She then drafted an initial list of search terms and databases for each of the following priority areas: 1) Availability of, and distance to, grocery stores; 2) Access to healthy food—Amount of healthy food in stores; 3) Spatio-temporal access to grocery stores; 4) Zoning for food availability; 5) Community approaches to addressing access to healthy food.

The researcher refined the terms following discussion and test searches by the information specialist. Medline and Urban Studies Abstracts were searched for all priority areas; these databases provide comprehensive coverage of health and built environment literature. Social Sciences Citation Index, Social Work Abstracts, and PsychINFO were searched in relation to community approaches to capture articles from the community development and social sciences literature.

After duplicates were removed, a total of 767 bibliographic records were retrieved from all databases. A title and abstract scan eliminated records that did not fit the a priori inclusion criteria. Typical examples of eliminated articles were focused on taxation, clinical nutrition, pharmaceutical research and school nutrition policy that did not relate to the physical environment. The remaining bibliographic records were coded for priority area and country. The Canada studies were further coded to identify review articles and articles about measures and indicators. Seventy-seven articles were retrieved as full text but supplemented with additional articles from bibliographic review.

The researcher searched the grey literature to identify where indicators were being used. This involved a Google search for <"food environments" and (indicator or measure)>. The Individual Source Assessment spreadsheet from the Linkages Toolkit Food Systems review (July 14, 2016) was scanned for additional review articles, which were included in the evidence summary based on the information obtained from this spreadsheet. The original articles were not reviewed due to time constraints, but the researcher was involved in supervising the Linkages Toolkit literature review and was confident of the quality of the search and summary in this spreadsheet.

Search terms specifically related to indicators were not used, as we anticipated that those articles would be identified by the topical search terms. When the researcher noticed that some key studies were being identified in the bibliographic review, an additional search of Medline and Google Scholar using the keywords <"food environments" and "Canada" and "indicators"> was done but did not identify any additional sources.

Ultimately, 30 sources were reviewed as indicated. An additional 42 articles were categorized, but not followed up (due to time and resource constraints, lack of relevance to local context and where deemed out of scope) except where a direct link to health or food security outcomes was also measured. A list of individual studies that were scanned but not reviewed in detail due to scope or time constraints is organized according to priority topic area in a supplementary document provided.

Food resilience

First, the researcher collected grey literature from online searches using the potential key terms, and a snowball method with literature already known by the researcher as a starting point. A total of 35 grey literature reports were retrieved. From the 35 grey literature reports, key terms were further refined for use in searching academic databases.

The search strategy for peer-reviewed literature through academic databases was iterative. Web of Science (WOS) was searched first, with 1,257 records retrieved (after duplicates removed). The search strategy was then slightly modified to search CAB, where an additional 1,882 records were retrieved (after duplicates were removed). Together, 3,139 bibliographic records were retrieved from both databases.

To narrow down the records retrieved from WOS and CAB, the researcher reviewed the title and abstract for relevance to the topic area and fit with pre-determined inclusion criteria. Based on the review of title and abstract, 122 articles were downloaded.

Next, she examined the 35 grey literature reports and the 122 articles from WOS and CAB in more detail through an iterative process. First, articles were scanned in full and either for indicator themes that emerged, or eliminated if found not to be relevant. A total of 75 articles that were found to not fit with the theme or the pre-determined inclusion criteria were eliminated. One common example of articles eliminated would be those focused on the contribution of local food systems to the resilience of a community/region/household, rather than on what contributes to the resilience of those food systems themselves. Another group of articles eliminated were those that used the term "resilience" as a synonym for "sustainability" but did not delve into the concept or attributes of a resilient system more deeply.

After articles were scanned and coded for indicator themes, the researcher identified logical groupings of these themes. These theme groupings ultimately became the "indicator categories" presented in the final indicator summary spreadsheet. After indicator categories were established, articles relating to each indicator category were reviewed in more detail to determine specific indicators and to populate corresponding information into the indicator summary spreadsheet. Ultimately, a total of 46 documents, including 34 peer reviewed studies, were screened in for use.

Influencing policy

Unlike other themes where the research librarian conducted an academic search of publications, the research coordinator completed both grey and academic literature searches for this theme. She approached it this way, as: i) a theoretical foundation model for policy influence was first required, ii) a clear scope or definition for this theme area had not been determined and iii) very little published research is available in this area.

The search was iterative and moved back and forth between the grey and the academic literature. She began the review with an examination of theory of change policy models. Once the "policy window" theory was chosen as the initial theoretical framework—to ensure relevancy—a Google Scholar search was completed to search for examples of its use in the literature in public health and nutrition policy and advocacy. The research coordinator sent a request to the advisory committee for grey literature related to this area, and a key paper was provided by Elaine Power on influencing policy with the National Nutritious Food Basket.

Appendix 3. Results: indicator summary tables

Table 2. Results: Household food insecurity summary

Indicator Category (association between)	Existing or New?	Indicator Area (association between)	High quality evidence supporting the area as an indicator	Evidence supporting a relationship between indicator and food security/ health outcomes
Household Food Insecurity	Existing	Prevalence of HFI	Bickel, Nord, Price et al., 2000; Hamilton, Cook, Thompson et al., 1997a, 1997b; Nord & Bickel, 2002	

Table 3. Results: Household food insecurity and fruit and vegetables indicator summary

Indicator Category (association between)	Existing or New?	Indicator Area (association between)	High quality evidence supporting the area as an indicator	Evidence supporting a relationship between indicator and food security/ health outcomes
HFI and FV Servings	Existing	HFI and Number of FV Servings per Day (proportion of population that eats 5 or more servings of fruits and vegetables per day)		Kirkpatrick et al., 2008; Miewald et al., 2012; MHMC, 2016; Huet et al., 2012
HFI and FV Frequency	Existing	HFI and FV frequency (proportion of population that eats fruits and vegetables 5 or more times per day)		PHSA, 2016
Household Income and FV Servings	Existing	Income Quintiles and Number of FV Servings (proportion of population that eats 5 or more servings of fruits and vegetables per day)		Tarasuk et al., 2010
Household Income and FV Frequency	Existing	Income Quartiles relative to Low Income Cut Off (LICO) and FV Frequency (proportion of population that eats fruits and vegetables 5 or more times per day)		PHSA, 2010
Hunger and FV Frequency (Child)	Existing	Hunger (prevalence of ever experiencing hunger because run out of food or money to buy more/ frequency of experiencing hunger) and FV Frequency		Findlay et al., 2013

Table 4. Results: Household food insecurity and health conditions summary

Indicator Category (association between)	Existing or New?	Indicator Area (association between)	High quality evidence supporting the area as an indicator	Evidence supporting a relationship between indicator and food security/ health outcomes
HFI and Breastfeeding	Existing	A) HFI and Breastfeeding Initiation B) HFI and Duration of Exclusive Breastfeeding		Orr et al., 2018
HFI and Cognition (child)	Existing	HFI and likelihood of meeting academic expectations		Faught et al., 2017
HFI and BMI (child)	Existing	A) HFI and Prevalence of Obesity B) HFI and Likelihood (Odds) of Being Overweight/Obese		Mark et al., 2012; Bhawra et al., 2017
HFI and Diabetes (child)	New	Prevalence of HFI among Diabetics		Marjerrison et al., 2011
HFI and Mental Health (child)	Existing	A) HFI and Likelihood of Persistent Hyperactivity/Inattention B) Hunger and Child Symptoms of Depression and Suicide Ideation		Melchoir et al., 2012; McIntyre et al., 2013
Hunger and General Health (child)	Existing	A) Hunger (prevalence of ever experiencing hunger because run out of food or money to buy more/ frequency of experiencing hunger) and Prevalence of Perceived General Health B) Hunger (prevalence of ever experiencing hunger because run out of food or money to buy more/ frequency of experiencing hunger) and Likelihood (odds) of Chronic Conditions		Kirkpatrick et al., 2010
HFI and General Health	Existing	HFI and Prevalence of Perceived General Health		PHSA, 2016; MHMC, 2016; Willows et al., 2011
HFI and Mortality	Existing	HFI and All Cause Mortality		Gundersen et al., 2018
HFI and BMI	Existing	HFI and Prevalence of Obesity		PHSA, 2016; Lyons, 2008

Indicator Category (association between)	Existing or New?	Indicator Area (association between)	High quality evidence supporting the area as an indicator	Evidence supporting a relationship between indicator and food security/ health outcomes
HFI and Diabetes	Existing	A) HFI and Incidence of Diabetes B) HFI and Prevalence of Diabetes		Tait et al., 2018; Tarasuk et al., 2013; Galesloot et al., 2012; Gucciardi et al., 2009
HFI and Cardiovascular Disease	Existing	A) HFI and Prevalence of Heart Disease B) HFI and Presence of Cardiovascular Disease (CVD) Risk Factors		Tarasuk et al., 2013; Fowokan et al., 2018
HFI and Mental Health	Existing	A) HFI and Likelihood (Odds) of Mental Health Care Service Utilization B) HFI and Risk of Adverse Mental Health Outcomes C) HFI and Prevalence of Mental Health Outcomes		Tarasuk et al., 2018; Jessiman-Perreault et al., 2017; Martin et al., 2016; PHSA, 2016

Table 5. Results: Household food insecurity and food cost/affordability summary

Indicator Category (association between)	Existing or New?	Indicator Area (association between)	High quality evidence supporting the area as an indicator	Evidence supporting a relationship between indicator and food security/ health outcomes
HFI and Food Affordability (% income spent on food)	Existing	HFI and cost of National Nutritious Food Basket (NNFB) as % of basic expenses	Alberta Health Services, 2015	Alberta Health Services, 2015; Williams et al., 2006; FoodARC, 2015
Food Affordability and Income	Existing	Annual cost of national nutritious food basket (NNFB), as a proportion of income		PHSA, 2010
HFI and Household Economic Resources	Existing	A) HFI and household after-tax income B) HFI and after rent income		St-Germain et al., 2017
HFI and Satisfaction with Food Affordability	New	HFI and satisfaction with ability to find foods that you can afford to buy		Perez et al., 2017
Food Expenditures and After-Shelter Income	Existing	Cost of NNFB (as % of basic expenses) and Proportion of Income Allocated to Shelter		Kirkpatrick et al., 2007; Kirkpatrick et al., 2011
Food Affordability	Existing	A) % could not afford balanced meals B) % ran out of food, with no money for more C) % could not afford to buy enough food D) % students who went to bed hungry because not enough money to buy food		Conference Board of Canada, 2016; OECD, 2014; McCreary Centre Society, 2014
Household Spending on Food	Existing	A) Annual household spending on food from restaurants/stores in Canada B) Annual household spending on food as a percentage of total spending by low income households		Food Counts, 2017

Table 6. Results: Food environment indicator summary

Indicator Category (association between)	Existing or New?	Indicator Area (association between)	High quality evidence supporting the area as an indicator	Evidence supporting a relationship between indicator and food security/ health outcomes
Zoning - prohibitive	Existing	Municipal bylaw constraints to limit the distribution of less healthy options such as fast food stores (e.g., limit number of outlets per square km; limit supply near schools, prohibit new outlets) in a given area or around schools.	Health Canada, 2013; Minaker et al., 2016; Raine et al., 2012; Black et al., 2014; Robitaille, 2009; Food-EPI Canada, 2017	Raine et al., 2012; Black, 2014; Black et al., 2014; Association pour la santé publique du Québec, n.d.
Zoning - proactive	Existing	Municipal bylaws or incentives such as tax shelters to increase the distribution of grocery stores and suppliers of fruits and veg (FV).	Health Canada, 2013; Raine et al., 2012; Black et al., 2011; Black, 2014	Raine et al., 2012
Consumer food environment assessment	New	Food availability inside local retail food outlets (e.g. supermarkets, corner stores, greengrocers, farmers markets, etc.)	Black et al., 2014; Raine et al., 2012	Caspi et al., 2012; Mhurchu et al., 2013; Gustafson et al., 2012; Rose et al., 2009
Geographic access - density	Existing	A) Population-weighted average number of food outlets of a given category within 1000 m of dissemination block (DB) centroids per dissemination area (DA) - or other area of intersest, such as household vicinity (Mahendra et al. 2017). B) No traditional convenience stores or fast food outlets within 500m of schools (Olstad et al. 2014). C) Number of food outlets in a given area.	Health Canada, 2013; Minaker et al., 2016; Mhurchu et al., 2013; Mahendra, Polsky et al., 2017; Ostad et al., 2014	Black et al., 2014; Minaker et al., 2013; Cobb et al., 2015; Black, 2014

Indicator Category (association between)	Existing or New?	Indicator Area (association between)	High quality evidence supporting the area as an indicator	Evidence supporting a relationship between indicator and food security/ health outcomes
Geographic access - proximity	Existing	A) Population-weighted mean network distance (m) between dissemination block (DB) centroids and nearest food outlets of a given category per dissemination area (DA) or other geographic unit of interest (Mahendra et al. 2017). B) Distance to nearest food outlets C) Average distance to an N grouping of food outlets	Health Canada, 2013; Minaker et al., 2016; Mhurchu et al., 2013; Mahendra, Polsky et al., 2017	Black, 2014; Cobb et al., 2015; Caspi et al., 2012
Geographic access - variety	Existing	A) Relative density (aka Modified Retail Food Environment Index, mRFEI) = ratio of unhealthy food retailers to both healthy and unhealthy food retailers within 1000 m of dissemination block (DB) centroids per dissemination area (DA) (or larger geographic area such as census tract, administrative division, or neighbourhood) (Mahendra et al. 2017). B) at least 10 on mRFEI across all census areas and at least 7 across impoverished census areas to indicate "high availability of food stores and restaurants selling primarily healthy foods" (Ostad et al. 2014).	Mhurchu et al., 2013; Mahendra, Polsky et al., 2017; Olstad et al., 2014	Black et al., 2014; Mhurchu et al., 2013

Indicator Category (association between)	Existing or New?	Indicator Area (association between)	High quality evidence supporting the area as an indicator	Evidence supporting a relationship between indicator and food security/ health outcomes
Spatio-temporal access (i.e., activity space access)	New	Spatio-temporal or activity space access = geographic access (theoretical or potential access) + life circumstances related to time and travel patterns (realized or actual access) A) Modified Retail Food Availability Index (forthcoming from CANUE) B) Relative accessibility deprivation indicators (Paez et al 2010): ■ Average distance travelled ■ Accessibility to food services by income status and vehicle ownership ■ Relative access to retail and fast food by income status ■ Relative access to retail and fast food by low-income individuals	Widener et al., 2018; Widener, 2014; Caspi et al., 2012;	WIdener et al., 2018; Cobb et al., 2015; Caspi et al., 2012; Thornton et al., 2010 cited in Caspi; Hillier et al., 2011 & Sharkey, 2009 cited in Caspi; Thornton et al., 2011, cited in Caspi
Geographic access - general	N/A	NOTE: This row includes some general evidence that applies to indicators of geographic food retail access in general, but not to any one specific measure or indicator included in this spreadsheet. I advise considering this evidence in relation to rows 5, 6, and 7 for sure, and possibly to row 2.		Minaker et al., 2016; Caspi et al., 2012; Health Canada, 2013; Cobb et al., 2015
Community food programs	New	Programs to increase relative affordability of healthier foods (e.g., subsidies that reduce the retail price of fruits and vegetables)		An, 2013; Faulkner et al., 2011; Lee et al., 2011; Thow et al., 2014; Mozaffarian et al., 2012
Community food programs	New	Availability of community garden programs		BC Centre for Disease Control, 2018

Indicator Category (association between)	Existing or New?	Indicator Area (association between)	High quality evidence supporting the area as an indicator	Evidence supporting a relationship between indicator and food security/ health outcomes
Community food programs	New	Availability of school garden programs	Davis et al., 2015; Robinson-O'Brien et al., 2009	Davis et al., 2015; Robinson-O'Brien et al., 2009; BC Centre for Disease Control, 2018
Transportation access	New	Availability of public transit or alternatives	Caspi et al., 2012; Hollander Analytical, 2013	Caspi et al., 2012

Table 7. Results: Food system resilience indicator summary

Indicator Category (association between)	Existing or New?	Indicator Area (association between)	High quality evidence supporting the area as an indicator	Evidence supporting a relationship between indicator and food security/ health outcomes
Access/ Consumption Household food security	Existing	N/A - see column K note	James & Friel, 2015	Tyler et al., 2013; Food and Agriculture Organization of the United Nations, 2010; Toth, Rendall, & Reitsma, 2016; Luca, Mane, & Romano, 2008
System-Wide Vulnerability of food system infrastructure to "rapid onset hazards" (e.g. natural disasters/ shocks)	Existing	A) Types and number of food transportation options into urban areas (Freight Analysis Framework) B) Location of food transportation infrastructure (roads, bridges, ports, airports, ferry terminals) relative to expected hazard locations (locations vulnerable to natural shocks including flood, tsunami, landslide, earthquake, sea-level rise, forest fire, heat wave, ice/snow storm) C) Location of urban food facilities (warehouses, grocery stores, shelters and food banks) relative to expected hazard locations (locations vulnerable to natural shocks including flood, tsunami, landslide, earthquake, sea-level rise) D) Location of farming areas relative to expected hazard locations (locations vulnerable to natural shocks including flood, tsunami, landslide, earthquake, sea-level rise)	Dell, 2009; Biehl, Buzogany, Baja, & Neff, 2018[a]; Biehl, Buzogany, Huang, Chodur, & Neff, 2017[a]; City of Toronto Medical Officer of Health, 2018[a]; Zeuli, Nijhuis, & Gerson-nieder, 2018[a]; New York City Economic Development Corporation; NYC Mayor's Office of Recovery & Resiliency, 2016[a]; Zeuli & Nijhuis, 2017[a]; Zeuli, Nijhuis, & Murphy, 2015[a]	Biehl, Buzogany, Baja, & Neff, 2018; Smith, Lawrence, MacMahon, Muller, & Brady, 2016; Smith et al., 2016; Paci-Green & Berardi, 2015; Bonini, 2014

Indicator Category (association between)	Existing or New?	Indicator Area (association between)	High quality evidence supporting the area as an indicator	Evidence supporting a relationship between indicator and food security/ health outcomes
Supply Chain Diversity / Redundancy	New	Ideas/proposed indicators (these will likely need to be refined based on data availability, interest, and capacity as this is a new indicator. See column E for further comments): A) Wholesale and retail suppliers source from a diversity of farms and regions locally, regionally, globally (metric: food self-reliance balance, which is also measured under "Production: Capacity for local/ regional food production") B) Food is distributed and sold in the region via a diversity of food retail and wholesale businesses (metric: nmber of retail and wholesale food providers by region and by business type or size) C) Food is available through emergency food providers in addition to market food providers (metric: # food banks/regional district or municipality)	Holling, 1973; Smith et al., 2016; Vieira, Serrao-Neumann, Howes, & Mackey, 2018	Smith et al., 2016; Schipanski et al., 2016

Indicator Category (association between)	Existing or New?	Indicator Area (association between)	High quality evidence supporting the area as an indicator	Evidence supporting a relationship between indicator and food security/ health outcomes
Production Agricultural diversity/ redundancy across scales	Existing	A) FARM SCALE: - On-farm ecological diversity (# farms certified organic, # farms with environmental farm plan) B) REGIONAL SCALE: Spatial heterogeneity of rural areas (rural areas exhibit a mix of agricultural and natural landscapes) C) PROVINCIAL SCALE: - Economic diversification of the agriculture sector; numerous successful ag commodities/industries are present rather than a few dominating (ag sector revenue by crop type or by industry) -Diversity of farm sizes (# farms by size) - Diversity of production - Shannon Index (see citation for this in column E)	Holling, 1973; Altieri, Nicholls, Henao, & Lana, 2015; Ashkenazy et al., 2018; Bullock et al., 2017; Cabel & Oelofse, 2012; Dell, 2009; International Sustainability Unit, 2011; Jones et al., 2013; McDonald & Stukenbrock, 2016; Peterson, Eviner, & Gaudin, 2018; Schipanski et al., 2016, Worstell & Green, 2017; Ciccarese & Silli, 2016; Green et al., 2017; Peterson et al., 2018; Standing Committee on Agriculture and Agri-Food, 2018; Toth et al., 2016; Dell, 2009	Remans, Wood, Saha, Anderman, & DeFries, 2014; Altieri, Nicholls, Henao, & Lana, 2015
Production Agricultural input sustainability, security or self-sufficiency	New	Specific metrics were not able to be identified (see spreadsheets for more information). Ideas/Important Components/Themes - Water availability Nutrient availability (phosphorous, nutrient cycling) Energy security Seed security	Vernooy, Sthapit, Otieno, Shrestha, & Gupta, 2017; De Amorim et al., 2018; Vieira et al., 2018	Dell, 2009

Indicator Category (association between)	Existing or New?	Indicator Area (association between)	High quality evidence supporting the area as an indicator	Evidence supporting a relationship between indicator and food security/ health outcomes
Production Economic performance	Existing	A) Economic status of farm owner operators (indicator: farm revenue vs. operating expenses) B) Economic status of farm workers (indicator: average farm worker wages vs. living wage) C) Farming is an attractive career to a new generation of farmers (Farms with written succession plans; average age of farmers)	Ruhf, 2015; Seekell et al., 2017; Cabel & Oelofse, 2012; Toth et al., 2016; Vieira et al., 2018; Tendall et al., 2015; Chiu & Polasub, 2014; Knickel et al., 2018	N/A
Production Capacity for local/regional food production	Existing	A) Urban Food Production: - Area available for urban agriculture over time (e.g. area or # community gardens or # community garden plots, measured annually) B) Rural Food Production: - Agricultural land availability, annually (# hectares) -Agricultural land utilization for food production, annually (# hectares) C) Food Self-Reliance Balance -Local food production vs. demand -quantity of food imports -production of healthy foods Need to convey that a balance must be struck (e.g. 100% self-reliance is not resilient)	Barthel, Parker, & Ernstson, 2015; Ruhf, 2015; Paci-Green & Berardi, 2015; Cabel & Oelofse, 2012	Ruhf, 2015

Indicator Category (association between)	Existing or New?	Indicator Area (association between)	High quality evidence supporting the area as an indicator	Evidence supporting a relationship between indicator and food security/ health outcomes
Province/System-Wide Social capital	New	Theme Areas: A) knowledge translation, mobilization, dissemination B) social equity	Blay-Palmer, Sonnino, & Custot, 2016; Bulla & Steelman, 2016; Cabel & Oelofse, 2012; a et al., 2018; Milestad, Westberg, Geber & Bjorklund, 2010; Vieira et al., 2018	N/A
Province/System-Wide Food system planning	New	Specific metrics were not able to be identified (see spreadsheets for more information). Concept: Food systems are given consideration in the planning process and governance Potential indicator: Number of local gov'ts that have one or more of the following in place: food system plan/ policy, food system vulnerability assessment, disaster preparedness plan addressing food, staff dedicated to food systems planning, staff dedicated to emergency preparedness	Paci-Green & Berardi, 2015; Vieira et al., 2018	N/A

a. Note these references demonstrate that the indicators are used in vulnerability assessments.

Table 8. Results: Influencing food policy general

Indicator Category (association between)	Existing or New?	Indicator Area (association between)	High quality evidence supporting the area as an indicator	Evidence supporting a relationship between indicator and food security/ health outcomes
Strategy: Define the problem (includes framing the problem, research, and indicator tracking)	Existing (A,C,D,E) New (B)	A) % communities with a food security needs and assets assessment B) % communities with vulnerability assessment C) #/ type collaborations with research institutions (including Universities and colleges) D) # food charters developed and adopted E) Presence of a mechanism for assembling and analysing data to monitor/ evaluate and inform policy making (could indicate different levels, e.g. provincial, municipal)	Provincial Health Services Authority, 2008; Milan Urban Food Policy Pact, 2018; Levkoe, Lefebvre & Blay-Palmer, 2017; Seed, 2018	MacRae & Donahue, 2013; Organizational Research Services, 2007; Field, Gauld & Lawrence 2016
Strategy: Develop policy solutions	Existing (A) New (B-E)	A) Presence of food/food security in policy or strategy and/ or action plans B) Development of policy proposals C) Educational briefings to government leadership	Milan Urban Food Policy Pact, 2018; Organizational Research Services, 2007	Cullerton et al., 2016
Strategies: Strengthen internal organizational capacity (includes relationships, credibility, ability to identify policy window, ability to "couple" streams).	Existing (A) New (B-D)	A) Actions taken by organizations in identifying and acting upon policy windows. B) #/ type of policy change skill development C) Presentations/ reports/ communication of problem/ solution within Health Authorities (Board; MHOs; management)	Organizational Research Services, 2007; Milan Urban Food Policy Pact, 2018	Sherb et al., 2012; Cullerton et al., 2016; Seed et al., 2014

Indicator Category (association between)	Existing or New?	Indicator Area (association between)	High quality evidence supporting the area as an indicator	Evidence supporting a relationship between indicator and food security/ health outcomes
Strategies: Influence the political climate through coalition building	Existing (A,D,E,F) New (B,C,G)	A) Proportion of communities where community food coalition building is supported through the CFAI. B) Increased number of partners C) Increased level of collaboration D) # municipal food policy coalitions E) # food system networks F) % communities with intersectoral food councils G) Improved alignment of partnership efforts (e.g. Collective Impact objectives)	Provincial Health Services Authority: Population and Public Health, 2010; Organizational Research Services, 2007; Levkoe, Lefebvre & Blay-Palmer, 2017; Milan Urban Food Policy Pact, 2018; Provincial Health Services Authority, 2008.	Levkoe, 2015; BC Healthy Communities Society et al., 2013; Cullerton et al., 2016; Seed et al., 2013; Schiff, 2008; Gupta et al., 2018
Strategies: Influence the political climate (advocacy efforts)	Existing (A,B) New (C)	A) #/ type policy related activities (policy brief; testimony; meeting with policy maker) B) # and type media events (print story; radio or tv broadcast; press release; interview; news briefing) C) Campaign to engage public	White Mountain Research Associates, 2009; Organizational Research Services, 2007	Cullerton et al., 2016
Intermediate term outcomes: shift in social norms	New	Increased agreement on definition of problem	Organizational Research Services, 2007	
Intermediate term outcomes: change in capacity (increased ability to create/ recognize/ respond to policy window effectively)	Existing (B) New (A,C,D)	A) Increased number of partners B) Increased level of collaboration (i.e. 1.networking; 2. cooperation; 3. coordination; 4. coalition; 5. collaboration) C) Improved alignment of partnership efforts (e.g. Collective Impact). D) Strategic alliances with important partners	Organizational Research Services, 2007; White Mountain Research Associates, 2009	MacRae & Donahue, 2013

Indicator Category (association between)	Existing or New?	Indicator Area (association between)	High quality evidence supporting the area as an indicator	Evidence supporting a relationship between indicator and food security/ health outcomes
Intermediate term outcomes: strengthened base of support	New	A) Increased public involvement B) Increased level of actions taken by champions C) Increased breadth of partners (e.g. unlikely allies) D) Increased media coverage E) Increased awareness of campaign principles and messages among selected groups (e.g. policy makers, general public, opinion leaders) F) Increased visibility of campaign message (e.g. presence of campaign message in media) G) Changes in public will	Organizational Research Services, 2007	Cullerton et al., 2016; MacRae & Donahue, 2013

Indicator Category (association between)	Existing or New?	Indicator Area (association between)	High quality evidence supporting the area as an indicator	Evidence supporting a relationship between indicator and food security/ health outcomes
Longer term outcomes: policy changes	Existing (A,B,Eii, F) New (C, D, Ei))	A) Presence of food policy that supports food security within health authorities B) # food charters developed and adopted C) # OCPs containing FS initiatives D.i) Policy development; policy adoption; policy implementation; policy enforcement D.ii) Policy events (Changed law; Changed regulation; Changed policy; Used to inform new policy/program design and/or practice; Used to modify existing policy/program design and/or practice; Used to provide general background information; Led to or contributed to evidence-based guidelines; Influenced policy process; Influenced enforcement; Influenced policy implementation; Used to allocate resources for programs/interventions; Other policy impact type, please specify:) See “K” for definition of “policy event”) Level of policy impact (National; Provincial; Regional; Local; Private Company/Corporation; Nonprofit organization; University/ college; Schools or school systems; Judicial/legal; Other level, please specify	Provincial Health Services Authority: Population and Public Health, 2010; Seed, 2018; Organizational Research Services, 2007; White Mountain Research Associates, 2009	BC Healthy Communities Society et al., 2013

Indicator Category (association between)	Existing or New?	Indicator Area (association between)	High quality evidence supporting the area as an indicator	Evidence supporting a relationship between indicator and food security/ health outcomes
Longer term outcomes: changes in social and/ or physical conditions	New and existing	Improved social and physical conditions (e.g. access to food during emergencies; improved income if looking a HFI at provincial/federal level)		

Table 9. Results: Influencing food policy with National Nutritious Food Basket

Indicator Category (association between)	Existing or New?	Indicator Area (association between)	High quality evidence supporting the area as an indicator	Evidence supporting a relationship between indicator and food security/ health outcomes
Strategies: Define the problem (includes framing the problem, research, and indicator tracking)	New	A) Completion of yearly NNFB (research) B) # Health Authorities/ organizations framing food insecurity as arising from income inadequacy C) #/ type collaborations with research institutions (including Universities and colleges)	Organizational Research Services, 2007; Levkoe, Lefebvre & Blay-Palmer, 2017	Power, 2018; Field, Gauld & Lawrence, 2016; Nova Scotia Nutrition Council and Atlantic Health Promotion Research Centre, 2005
Strategies: Develop policy solutions	New	A) # Health Authorities/ organizations communicating income as the solution. B) Development of policy proposals C) Educational briefings to government leaders	Organizational Research Services, 2007	Nova Scotia Nutrition Council and Atlantic Health Promotion Research Centre, 2005

Indicator Category (association between)	Existing or New?	Indicator Area (association between)	High quality evidence supporting the area as an indicator	Evidence supporting a relationship between indicator and food security/ health outcomes
Strategies: Strengthen internal organizational capacity (includes relationships, credibility, ability to identify policy window, ability to "couple" streams)	New	A) # presentations/ reports/ communication of NNFB research (including problem and policy solutions) within Health Authorities (Board; MHOs, Management) B) Actions taken by organizations in identifying and acting upon policy windows. C) #/ type of policy change skill development for advocates	Organizational Research Services, 2007	Power, 2018; Seed et al., 2014; Cullerton et al., 2016
Strategies: Influence the political climate (coalition building)	New	A) # organizations endorsing NNFB B) # coalitions using NNFB as a standard indicator (?)/ # publications citing provincial NNFB results C) Partnerships established with priority partners D) Website activity for NNFB on Gateway site	Organizational Research Services, 2007	Cullerton et al., 2016; Seed et al., 2013
Strategies: Influence the political climate (advocacy efforts)	New	A) #/ type policy related activities (policy brief; testimony; meeting with policy maker). B) # and type media events (print story; radio or tv broadcast; press release; interview; news briefing)	White Mountain Research Associates, 2009; Organizational Research Services, 2007	Power, 2018
Intermediate term outcomes: shift in social norms	New	Shift in framing food insecurity as arising from income inadequacy, as measured by: i. survey results; ii. media scan	Organizational Research Services, 2007	

Indicator Category (association between)	Existing or New?	Indicator Area (association between)	High quality evidence supporting the area as an indicator	Evidence supporting a relationship between indicator and food security/ health outcomes
Intermediate term outcomes: change in capacity (increased ability to create/ recognize/ respond to policy window effectively)	New	A) Identification, creation of or responding to policy window B) Increased level of collaboration with external organizations (i.e. 1.networking; 2. cooperation; 3. coordination; 4. coalition; 5. collaboration)	Organizational Research Services, 2007	
Intermediate term outcomes: strengthened base of support	New	A) Increased public involvement B) Increased level of actions taken by champions C) Increased breadth of partners (e.g. unlikely allies) D) Increased media coverage E) Increased awareness of campaign principles and messages among selected groups (e.g. policy makers, general public, opinion leaders) F) Increased visibility of campaign message (e.g. presence of campaign message in media) G) Changes in public will	Organizational Research Services, 2007	Nova Scotia Nutrition Council and Atlantic Health Promotion Research Centre, 2005

Indicator Category (association between)	Existing or New?	Indicator Area (association between)	High quality evidence supporting the area as an indicator	Evidence supporting a relationship between indicator and food security/ health outcomes
Longer term outcomes: policy changes	New	A) Policy development; policy adoption; policy implementation; policy enforcement. B) # poverty reduction strategies citing NNFB C) Policy events where NNFB was used (Changed law; Changed regulation; Changed policy; Used to inform new policy/program design and/or practice; Used to modify existing policy/program design and/or practice; Used to provide general background information; Led to or contributed to evidence-based guidelines; Influenced policy process; Influenced enforcement; Influenced policy implementation; Used to allocate resources for programs/ interventions; Other policy impact type, please specify:) See "K" for definition of "policy event" D) Level of policy impact (Federal; State; Local; Private Company/ Corporation; Nonprofit organization; University/ college; Schools or school systems; Judicial/legal; Other level, please specify)	Organizational Research Services, 2007; White Mountain Research Associates, 2009	
Longer term outcomes: impacts on conditions	New	Improved social and physical conditions (e.g. poverty, health, other outcome measures?)	Organizational Research Services, 2007	

Table 10. Results: Influencing food policy with Community Food Action Initiative

Indicator Category (association between)	Existing or New?	Indicator Area (association between)	High quality evidence supporting the area as an indicator	Evidence supporting a relationship between indicator and food security/ health outcomes
Strategies: Capacity building and mobilization	Existing (A) New (B-D)	A) Proportion of communities where community food coalition building is supported through the CFAI. B) # food security or food policy coalitions C) % communities with intersectoral food councils D) # grants available in HA area to strengthen organizational capacity in food security organizations	Provincial Health Services Authority: Population and Public Health, 2010; Levkoe, Lefebvre & Blay-Palmer, 2017; Milan Urban Food Policy Pact, 2018; Provincial Health Services Authority, 2008	BC Healthy Communities Society et al., 2013; Levkoe, 2015; Schiff, 2008; Gupta et al., 2018
Strategies: Training for capacity building	New	A) Leadership training B) Advocacy skills training	Milan Urban Food Policy Pact, 2018; Organizational Research Services, 2007	Cullerton et al., 2016
Strategies: Action research	Existing	A) Involvement in food security assessment in local area (e.g. needs, assets or vulnerability assessments) B) Involvement in research projects C) # food charters developed and adopted	Provincial Health Services Authority, 2008; Milan Urban Food Policy Pact, 2018; Levkoe, Lefebvre & Blay-Palmer, 2017; Seed, 2018	Organizational Research Services, 2007; Field, Gauld & Lawrence, 2016
Intermediate term outcomes: shift in social norms (increase awareness; increased agreement; increased sense of power)	New	A) Increased alignment of partnership efforts B) Changes in public will C) Perception of individual and group power	Organizational Research Services, 2007	

Indicator Category (association between)	Existing or New?	Indicator Area (association between)	High quality evidence supporting the area as an indicator	Evidence supporting a relationship between indicator and food security/ health outcomes
Intermediate term outcomes: Increased capacity to engage in process	Existing (B) New (A,C,D, E, F, G)	A) Increased number and breadth (e.g. unlikely allies) of partners B) Increased level of collaboration (i.e. 1.networking; 2. cooperation; 3. coordination; 4. coalition; 5. collaboration) C) Improved alignment of partnership efforts (e.g. Collective Impact). D) Strategic alliances with important partners E) Champions/ leaders in place F) Advocates trained G) Presentations/ reports/ communication of problem/ solution (issue?) with decision-makers OR public	Organizational Research Services, 2007; White Mountain Research Associates, 2009	MacRae & Donahue, 2013
Intermediate term outcomes: Increase public involvement in issue	New	A) Increased public involvement B) Increased level of actions taken by champions C) Increased media coverage D) Increased awareness of campaign principles and messages among selected groups (e.g. general public, opinion leaders) E) Increased visibility of campaign message (e.g. presence of campaign message in media) F) Meetings with [government] decision makers	Organizational Research Services, 2007	Cullerton et al., 2016

Appendix 4. Advisory committee feedback

Looking first to HFI, advisory committee members pointed out the importance of clarifying the intent of the indicators. In many of these instances, we are proposing that a prioritized indicator is linked to other indicators (e.g. HFI with fruit and vegetable consumption, health condition). The group discussed the need to be clear that we are looking at associations between the two indicators and not suggesting that there is a casual relationship between them. On the other hand, while we may not have identified causation studies between HFI and health outcomes, others believe that there is strong evidence to suggest there are some causal mechanisms that link HFI and health outcomes. It was suggested that Valerie Tarasuk would be a good person to offer insights into this question.

A concern was noted about using the indicator of fruit and vegetable consumption, as this measure has also been critiqued for pushing fruit and vegetables onto populations who may not traditionally eat them. Concern about the use of body mass index was expressed, given the emerging evidence questioning the efficacy of using weight as a measure of health.

In relation to the food environment theme, the committee discussed the quality of food at food banks, which was not within the identified sub-themes for this project. While the quality of food in these programs is important, use of food bank and other food programs are not necessarily reflective of food insecurity in the community. The group discussed the idea of a broad indicator to assess where people are getting their food as a way of looking at where/how vulnerable populations are accessing food. This could extend to school breakfast/lunch programs. A discussion was also held about the inclusion of Indigenous food environments and the Regional Health Survey data used to capture food insecurity on-reserve.

The discussion of food resilience pointed to gaps, including indicators around harvesting which could include subcategories such as fishing and forest foods, labour (e.g. shortage in primary production), post-production capacity (e.g. not enough processing facilities), resource availability and competition (i.e. water, land) and the health of these resources, and farming method (in relation to physical and ecological resilience). Even if the gaps cannot all be addressed, noting where the gaps exist is an important step. Further economic performance (and maybe longevity) of food retails could be useful, querying what additional indicators could be used to capture resiliency through boom-bust cycle in resource-industry dependent communities.

On the theme of influencing food policy, there was no strong consensus either supporting or not supporting the use of the policy models as a foundation for the development of indicators for this theme. A score card methodology (e.g. where health authorities can check if certain policies exist in municipalities) was suggested. One member underscored the importance of not putting undue pressures on health authorities to influence things where they do not have much influence.

Looking at the indicator themes as a whole, advisory members noted that there are often nuances in indicators which can impact how they are interpreted. As an example, if you live in a food desert and a big box grocery store comes in, it could be considered a good thing as there is now food access. However, the store could have low wage practices which could actually contribute to greater food insecurity. Using a combination of indicators or incorporating qualitative data could help to address this issue. Another academic noted that it may be helpful to note contraindications for each indicator.

The issue of relevance of the "effect" aspect of the impact indicator category[vi] in the Framework was questioned mostly in relation to HFI and the variables included in composite indicator areas; there was concern that these represent association but not causality. There was discussion that some research does show causality. This is an area that will need to be addressed/clarified for all the final indicators.

Finally, it was expressed that we need to ensure our work is aligned with provincial messaging.

vi Impact indicators in the framework can include both "exposure" indicators and "effect" indicators. Exposure indicators are any factors that may be associated with an outcome of interest (e.g. % of population exposed to hunger due to lack of income). Effect indicators describe a wide range of health such as morbidity and mortality rates.

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