

Strengthening food security policy and practice: can systems approaches improve surveillance data?

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Executive Summary

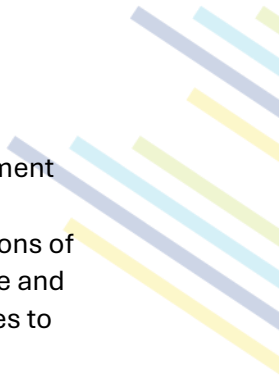
Background: Household food insecurity is commonly used as a surveillance indicator to inform policy and practice in Canada. However, this indicator does not capture the complex array of social (e.g., housing, education, income) and structural (e.g., climate change, globalization, conflict) causes of food security, which ultimately limits the scope and reach of policy and programming decisions for food security. Governance structures and processes for surveillance systems will need to be highly coordinated across sectors to develop a shared understanding of the complex drivers of food insecurity in communities. Systems thinking provides a suite of approaches and methods that considers the interconnected nature of the drivers of food security. Systems approaches have the potential to model complex problems and expand governance systems in ways that better addresses data needs and improves how data is collected and analyzed to inform policy and practice for complex social issues such as food insecurity.

Project objectives: Through a collaborative partnership with the British Columbia Centre for Disease Control (BCCDC), this project explored the practical application of systems thinking to governance systems of data and evidence that inform food security policy and practice. BCCDC aims to lead and facilitate collaboration for policy and practice across government, health authorities and non-government sectors to support food security programs, influence changes in policy and practice, and uphold Indigenous food sovereignty. Specific project objectives were to:

1. Learn from the literature: Synthesize existing applications of systems theories and methods on surveillance systems that inform policy and practice of complex public health and social issues;
2. Align with the local context: Corroborate local perspectives, experiences, and takeaways in applying systems approaches and methods to the governance of food security policy and practice; and
3. Knowledge mobilization: Co-develop the project approach and contextualize the evidence-based guidance with partners and knowledge users.

Methods: A knowledge synthesis approach was co-developed with BCCDC to develop guidance and best practices on the application of systems approaches and methods to food security surveillance. Initial discussions were held with key informants at BCCDC to understand governance gaps of food security surveillance systems in British Columbia. A broad evidence search was conducted to identify case study examples of applying systems approaches and methods to surveillance of any complex social or public health issue. Informed by these case study examples, dialogue sessions were conducted with knowledge users to gather their perspectives and experiences on the potential application of systems approaches and methods to food security surveillance systems in British Columbia. Findings from the evidence search and dialogue session were synthesized using thematic analysis to inform guidance on best practices for the application of systems approaches and methods to support governance of food security surveillance systems.

Results: The evidence search identified a range of systems approaches and methods that were applied to surveillance systems to either: (1) improve their overall structure and design; or (2) support modelling of a complex problem using surveillance data. The applications of systems approaches and methods were corroborated by knowledge users of food security data in British



Columbia. These methods were viewed as an opportunity to improve cross-sectoral engagement across sectors and communities relevant to food security (e.g., health, agriculture, rural, underserved groups), provide an inclusive data approach to better understand interconnections of social and structural determinants of food security, and made complex data more accessible and understandable to diverse audiences. Potential barriers of implementing systems approaches to food security surveillance systems in British Columbia were also identified, including: data fragmentation, limited capacity and resources to support the sustainability of current surveillance systems, institutional knowledge and relationship losses due to role turnover, and poor collaborative mechanisms for cross-sectoral partnerships.

Implications and significance: There is global recognition that an inter-sectoral governance approach to policy and practice is needed to support food security. A systems-informed approach to governance that embeds data on the social and structural drivers of food security, alongside existing knowledge of economic determinants, will help to expand the current scope of food security policy and practice. For government and non-government organizations, this report shares practical guidance for assessing whether the strengths of systems approaches and methods can support their own surveillance activities. A decision aid is provided to guide organizations in selecting a systems method based on their needs related to food security surveillance. Future research is needed to examine the long-term impact of governance changes to surveillance systems that have been informed by systems approaches and methods.

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Background

Food security is a critical policy and practice priority in Canada.¹ Food security is defined as “ensuring everyone has equitable access to food that is affordable, culturally preferable, nutritious and safe; and everyone has the agency to participate in, and influence food systems.”² Currently, to inform food security policy and practice, household food insecurity is used as an indicator to measure economic and physical access to food.^{3,4} In Canada, data from the *2022 Statistics Canada Canadian Income Survey* revealed 6.9 million Canadians experience economic constraints when purchasing food,^{4,5} with 16.2% of people in British Columbia reporting experiences of household food insecurity.⁶

While household food insecurity provides critical information about the economic and physical availability of food, these measures are limited in their ability to provide data and evidence about other dimensions of food security (e.g., availability, food utilization, stability). Measures of household food insecurity do not capture the complex array of social (e.g., housing, education, income)⁷⁻¹⁰ and structural (e.g., globalization, climate change, and conflict) determinants,¹¹⁻¹³ despite their known causal pathways to outcomes related to human and planetary health.¹³⁻¹⁶ For instance, the British Columbia Centre for Disease Control (BCCDC) reported those with the highest rate of concern for food security in British Columbia in 2023 were Indigenous peoples and some racialized groups, recent immigrants, lone-parent families, and single adults under 65 living alone or with roommates.¹⁷ At a structural level, the global food system and commercial determinants are drivers of food security, which are key contributors to health outcomes such as poor dietary intake^{18,19} and the climate crisis.^{20,21} A surveillance system that captures this social and structural context will require coordinated and collective action across sectors to understand how food security impacts communities.

Why does governance matter for surveillance systems?

Governance structures and processes for food security surveillance will need to go beyond economic measures of household food insecurity and instead, embed data and evidence about social, environmental, and structural drivers of food security to inform policy and practice.²²⁻²⁴ Recent theories define governance as a structural determinant of health where action can come from self-organising networks of institutions and actors from within and beyond government.^{25,26} From this perspective, governance systems that inform policy for complex public health and social issues are characterized by how structures, processes, and rules of a self-organizing network shape these policies and decisions, including the types of data and evidence that is collected and analyzed to inform policy and practice.^{25,26}

Surveillance systems can be conceptualized as a system of governance structures and processes to support data and evidence used to inform policy and practice. **Figure 1** is an adapted conceptualization of public health surveillance systems from the Public Health Agency of Canada.²⁷ Public health surveillance systems are centered around practitioners and professionals who collaborate with partners across different settings (e.g., local to global level) and organizations (e.g., government, academic, civil society) to collect, manage, analyze, interpret, and communicate data to inform policy and practice.²⁷ These systems can be conceptualized as a process with components that enable surveillance activities.

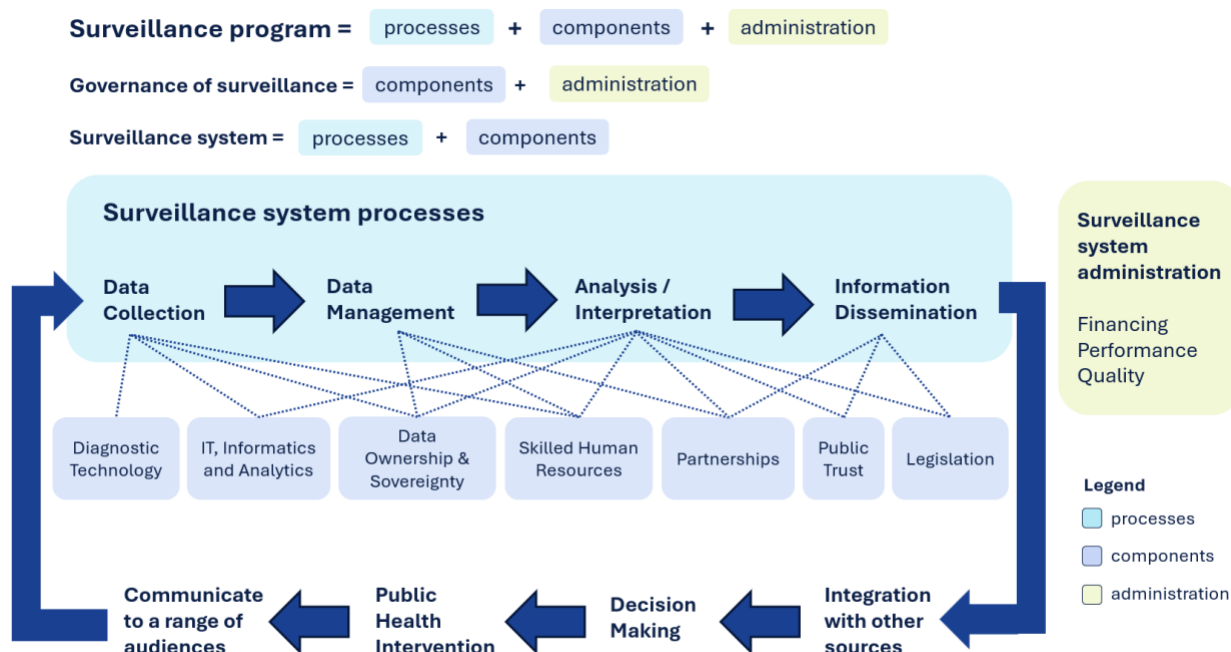


Figure 1. Conceptual framework of surveillance systems (adapted from Public Health Agency of Canada, 2023)²⁷

Improving the way surveillance systems are designed and finding opportunities for collaboration can change the data that is collected, analyzed, and used for policy and practice. Characteristics of governance for a surveillance system include:^{28,29}

1. Engagement across sectors and communities to capture multiple perspectives, such as:
 - a. Interest holders and knowledge users from different sectors (e.g., agriculture, health, economics); and
 - b. Communities and marginalized groups (e.g., First Nations, Inuit and Métis Peoples, Black and Asian communities, 2SLGBTQIA+) to co-develop approaches for data ownership and sovereignty, as well as ensure their participation in the surveillance process by integrating their perspectives on how data is collected, analyzed, and interpreted.
2. Applying an inclusive data approach where a range of data types (e.g., qualitative) and sources (e.g., community stories) are collected.
3. Using methods to interpret the social and structural context of complex issues (e.g., linking data from different sectors, bringing in community stories).
4. Knowledge mobilization to inform decisions and action to a range of audiences (e.g., general public, non-profit organizations, decision-makers, academics).

What is the potential of systems thinking for food security surveillance?

Systems thinking provides a suite of approaches and methods that considers the interconnected nature of social and structural drivers. These approaches have the potential to expand governance systems in ways that better addresses data needs and improves how data is collected and analyzed to better inform policy and practice of complex social issues.^{30–32} Systems approaches focus on understanding the dynamic interconnections of actors and drivers within and between systems. Systems thinking has been increasingly used as a perspective to understand the complexity and nuance of food security within the context of the broader food system.^{30,32–34} However, less is understood on the potential application of systems approaches to model complex issues using surveillance data and improve governance of surveillance systems. Evidence from a growing body of literature suggests that surveillance can be conceptualized as a complex system with a set of activities centered around practitioners and organizations with their own structures and processes to collect, analyze, and interpret data.^{27,35–37}

Government and non-government organizations are currently challenged by existing governance structures that limit the availability of data and evidence for food security policy and practice. There is a need to understand how systems approaches and methods can improve surveillance systems, bridge data gaps across sectors, and unpack underlying social and structural drivers of food security. Identifying opportunities to use systems methods can increase engagement and lay the groundwork for addressing governance gaps in food security policy and practice.

Objectives

This project explored the practical application of systems thinking to governance systems of data and evidence that inform food security policy and practice. The project identified the needs, benefits, and drawbacks of applying systems approaches and methods to the structure and function of current governance systems that identify indicators, collect data, conduct analysis, and interpret social and structural drivers of food security. The project objectives were to:

1. Learn from the literature: Synthesize existing applications of systems theories and methods to surveillance systems that inform policy and practice of complex public health and social issues;
2. Align with the local context: Corroborate perspectives, experiences, and takeaways in applying systems approaches and methods to governance of food security policy and practice; and
3. Knowledge mobilization: Co-develop the project approach and contextualize the evidence-based best practices with partners and knowledge users.

This project is a collaborative partnership with the British Columbia Centre for Disease Control (BCCDC). BCCDC aims to lead and facilitate collaboration for policy and practice across government, health authorities, and non-government sectors to support food security programs, influence changes in policy and practice, and uphold Indigenous food sovereignty.³⁸ Recognizing that addressing food security requires a coordinated inter-sectoral response, this project directly supported BCCDC's priorities to expand their governance systems in ways that better embed data and evidence about social and structural drivers of food security into policy and practice.³⁸

Methods

A knowledge synthesis approach was co-developed with BCCDC to address the project objectives (**Figure 2**). Initial discussions were held with key informants at BCCDC to understand governance gaps of food security surveillance systems in British Columbia. Since applications of systems approaches to food security surveillance systems are limited, a broad evidence search was conducted to governance gaps and identify case study examples of best practices for applying systems approaches and methods to surveillance systems of any complex social or public health issue. Informed by a set of case study examples, a dialogue session was conducted with knowledge users to gather their perspectives and experiences on the potential application of systems approaches and methods to food security surveillance systems in British Columbia. Findings from the broad evidence search and dialogue session were synthesized using thematic analysis to inform guidance on best practices for the application of systems approaches and methods to support governance of food security surveillance systems.

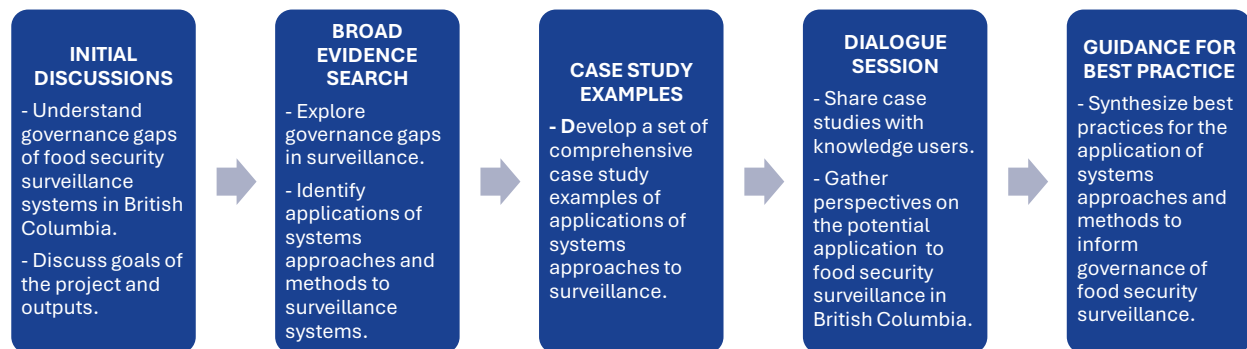


Figure 2. Knowledge synthesis approach to inform evidence-based practices for applying systems approaches and methods to food security surveillance systems

Step 1: Initial discussions to co-develop the knowledge synthesis approach

Group and one-on-one discussion meetings were held with key informants at BCCDC. The meetings aimed to understand governance gaps of food security surveillance systems in British Columbia. The following questions were asked in the initial meetings:

1. What is your role in food security surveillance?
2. How do you conceptualize surveillance? What about food security surveillance?
3. What do you know about systems thinking? How do you understand systems thinking?
4. What are some challenges you face when it comes to food security surveillance?
5. What are you hoping to learn from this project?

Themes from the initial meetings were synthesized and shared back with the team to inform discussions about the knowledge synthesis approach. Building on governance frameworks for food systems, the findings from the initial meetings informed the development of a list of characteristics that demonstrate governance for surveillance systems (**Table 1**).^{28,29}

Table 1. Characteristics of governance for surveillance systems of complex social and public health challenges

Characteristics of governance for surveillance systems	Examples
Characteristic #1: Engaging key groups and perspectives in surveillance processes <i>Did this approach engage interest holders and knowledge users?</i>	• Interest holders and decision-makers from different sectors (e.g., agriculture, health, economics) are involved in the data collection, analysis, and interpretation processes • Communities and groups who face systemic barriers (e.g., First Nations, Inuit and Métis Peoples, Black and Asian communities, 2SLGBTQIA+) are engaged to ensure their participation in the surveillance process, including opportunities to contribute to decisions about data stewardship
Characteristic #2: Applying an inclusive data approach where a range of data types and sources are collected <i>Did this approach support an inclusive data approach?</i>	• Collecting and analyzing quantitative and qualitative data about public health events • Collecting and analyzing data from different sources beyond traditional survey approaches, such as community stories or open-source data • Making data publicly available and accessible where possible • Collaborating with organizations and institutional actors to link databases
Characteristic #3: Using methods to interpret social, environmental, economic, and structural context of complex challenges <i>Did the systems approach support interpretation of multiple contexts?</i>	• Modelling methods using multiple sources of data to interpret population health trends within the broader context • Ensuring participation from different communities, groups, and organizational sectors to contribute their contextual perspectives to policy and program design, implementation, and evaluation
Characteristic #4: Mobilize public health information to a range of audiences to inform policy decision-making and action <i>Did the approach support knowledge mobilization to a wide range of audiences?</i>	• A wide range of strategies and techniques to mobilize public health information to different groups, including the general public and communities, non-profit organizations, decision-makers, and academics • Infographics, dashboards, reports, lay-language publications, social media posts, evidence briefs, engagement workshops, podcasts, and other audio mediums

Step 2: Broad evidence search on applications of systems approaches and methods to surveillance of complex challenges

A broad evidence search was conducted to explore governance gaps in current surveillance systems used to inform policy and practice for complex issues. The search also identified applications of systems approaches and methods to support the governance of surveillance systems for complex social and public health issues. Below describes the approach to searching, screening, and charting of articles for the evidence search.

Identifying the research question

The aim of this evidence search was to identify applications of systems theories and methods to governance systems of data and evidence that inform policy and practice of social issues. The following research questions were developed to inform the development of case studies:

1. What are governance gaps of surveillance systems for complex social and public health issues?
2. What methods informed by systems thinking have been applied to governance of data and evidence to inform social policy and practice? How have these methods been applied?
3. What practical considerations, such as the value, benefits, barriers, and limitations, have been described in applying system thinking methods and approaches to governance of data and evidence to inform social policy and practice?

Searching for relevant studies

Electronic databases (PubMed, Scopus) were systematically searched using a pearl-growing search strategy. A pearl-growing approach to search strategy development can support expansive database searching for knowledge-building reviews.^{39,40} Given the practice-oriented nature of this evidence search, a pearl-growing search strategy was beneficial for identifying a wide range of applications of systems approaches and methods to surveillance systems. The approach encourages identification of key themes from the research question, where insights across intersections of those themes are synthesized to inform evidence-based practice.⁴⁰

The search strategy consisted of a combination of relevant keywords and subject headings related to “surveillance,” “governance,” and “systems thinking” (**Appendix A**). **Table 2** provides a table of definitions for key concepts used for the search strategy. There were no limits on date and language in this evidence search. The search strategy was piloted in PubMed to ensure relevant articles are retrieved and subsequently modified to fit the search parameters for Scopus.

Table 2. Key terms and definitions

Term	Definition
Surveillance	Collection, integration, analysis, interpretation and dissemination of data to inform policy and practice for complex challenges. ^{36,41,42} Surveillance relies on a wide range of activities and data sources that are conducted by a network of key actors across different sectors. ^{27,37}
Governance	Structures, processes, and rules of a self-organizing network may shape policies and decisions, including consideration for the types of data and evidence that is collected and analyzed to inform policy and practice. ^{25,26}
Systems thinking	Systems thinking approaches and methods are characterized by the idea that real-world phenomena exist within complex systems composed of dynamic actors, including people, organisations and other drivers, which evolve in response to each other and their contexts. ⁴³ Complex systems have characteristics such as non-linear relationships, feedback loops and delays, making their behaviour challenging to predict using more conventional methods for generating evidence. We use the systems thinking methods identified in the <i>WHO Guidance for Bringing Systems Approaches into Practice</i> . ⁴⁴

Study selection

Study selection occurred iteratively to inform the case study selection and development. Peer-reviewed records were included if the following criteria were met:

1. The authors self-identified as taking an approach informed by systems thinking or governance lens; and
2. Comprehensively reported on how the systems thinking approach or methods was applied to surveillance of a complex social or public health issue.

Titles and abstracts of peer-reviewed articles were screened on an initial set of 50 articles by two study authors (KML, DZ). Screening results were compared to ensure consistency in the use of the inclusion and exclusion criteria and discrepancies were resolved through discussion. This process was iteratively refined and repeated until an acceptable level of agreement (>85%) was reached. Records were sorted by relevance and the remaining records of the first 50 pages of results were screened by one author (KML) with verification by a second reviewer (DZ). Full texts of included articles were independently screened by two reviewers. Discrepancies were resolved by discussing reasons for inclusion or exclusion amongst the reviewers. In line with the pearl-growing approach for expansive evidence searching, the search strategy was updated to include keywords and themes from the included articles and the process was repeated.⁴⁰ Reference lists of eligible articles were searched for relevant records and screened.

Data charting

Included articles were categorized into two intersections related to the project objectives: (1) governance and surveillance and (2) systems thinking and surveillance. Data charting was conducted using a charting form to inform understanding of governance challenges of current surveillance systems and the development of case study examples (**Table 3**). The form was piloted with five records by two reviewers (KML, DZ) to ensure consistency with the research question. Discrepancies were discussed and the form was iteratively revised to ensure consistency with the research objectives. The remaining records were extracted by one study author (KML or DZ), with verification from a second (DZ or KML).

Table 3. Data charting form of included articles

Article information	Title
	Authors
	Year
Study information	Study objectives
	Summary of methods
	Country
Policy	Policy issue (outcome or risk factor)
	Policy instrument (recommendation, strategy, law, regulation, procedure, administrative action, incentive, voluntary practice)
	Policy level (local, national, regional, global)
Governance	Definition of governance
	Governance framework used
	Rationale for focus on governance
	Limitations of current governance
Surveillance	Surveillance definition

	Surveillance activity
	Data used
	Structures, processes and rules of a surveillance system
	Recommendations for governance of surveillance
Systems thinking	Definition of systems thinking
	Systems thinking framework
	Systems method used, informed by the <i>WHO Guidance for Bringing Systems Approaches into Practice</i> . ⁴⁴
	Rationale for using systems thinking
	Findings or final output
	Tools used (software, kit)
Engagement and knowledge translation	Interest holder or knowledge user engagement involved (yes/no)
	At what stage were interest holders or partners involved (e.g., study design, data collection, analysis, interpretation)
	Who was involved (sectors, organizations, levels, disciplines)
	Knowledge translation product resulting from collaboration
Needs, benefits, drawbacks	Identified need by authors to understand systems or governance perspective
	Benefits of systems approaches from authors
	Drawbacks of using systems approach from authors
	Gaps in using systems approach from authors

Step 3: Developing case study examples

Data from the included studies were narratively synthesized to develop a set of case study examples focusing on: (1) how systems thinking was defined and used for surveillance systems; (2) methods and data sources used; and (3) needs, benefits, drawbacks, and gaps of systems-informed approaches to surveillance of complex challenges. The case study examples served as inputs for the dialogue session with knowledge users (refer Step 4 below). The use and application of systems approaches in case study examples were assessed for their ability to support characteristics of governance for surveillance systems (refer Table 1).

Step 4: Dialogue session with knowledge users of food security surveillance systems in British Columbia

An online dialogue session with partners and knowledge users identified by BCCDC was held to corroborate the case study examples with knowledge user experiences in applying systems thinking to governance of food security policy and practice. The session aimed to: (1) discuss expectations of governance approaches to policy and practice for food security; (2) situate partners to systems approaches and methods for food security surveillance; and (3) sense-check the case studies with first-hand experiences from government and non-government organizations focused on food security policy and practice.

Knowledge users were identified through BCCDC's established partnerships (e.g., BC Regional Health Authorities and Ministries, First Nations Health Authority, Métis Nation BC, Food Banks BC). In the dialogue session, case studies from the evidence search were shared with knowledge users. Using online breakout groups (n=4 groups), participants shared insights on their experiences and knowledge of governance systems to inform policy and practice (**Appendix B**).

Step 5: Synthesis of best practices for the application of systems approaches and methods to surveillance systems

Guidance on the range of systems approaches and methods used to support surveillance systems and best practices for their application was developed. This guidance is complemented by a decision aid which can support government and non-government organizations in selecting a systems method that is appropriate for addressing governance gaps of their surveillance system. Using thematic analysis, themes from the discussions were corroborated with the case study examples to synthesize recommendations for food security surveillance, including: (1) potential benefits, drawbacks, and opportunities when applying systems approaches to surveillance systems; (2) changes to governance processes and data structures needed; and (3) facilitators and barriers for application of systems approaches to governance of food security policy and practice.

Results

Characteristics of the included articles

The included articles are described in **Table 4**. Included studies focused on surveillance systems for a variety of complex health challenges including communicable disease (n=13); animal health (n=6); non-communicable disease (n=2); physical activity (n=2); injury (n=1); community health (n=1); nutrition (n=1); and global health (n=1) surveillance.

Table 4. Descriptive characteristics of included studies (n=27)

Author	Year	Focus of surveillance system	Level of surveillance	Location	Governance framework or systems method used ^a
Articles included at the intersection of governance and surveillance					
Al-Hazzaa et al. ⁴⁵	2025	Physical activity	National	Saudi Arabia	Governance framework: Governance structures and processes
Alkhaldi et al. ⁴⁶	2024	Global health	Global	N/A	Governance framework: Technical Framework in Support of IHR Monitoring and Evaluation
Buback et al. ⁴⁷	2025	Communicable disease	Regional	Middle east and North Africa	Governance framework: World Health Organization Health Systems Strengthening Building Blocks
Conrad et al. ⁴⁸	2010	Community surveillance	Local	Non-specific	Governance framework: Framing as consultative, collaborative, or transformative
Kraus et al. ⁴⁹	2023	Non-communicable disease	National	USA	Governance framework: Multi-State EHR-Based Network for Disease Surveillance

Marshall et al. ⁵⁰	2020	Communicable disease	Local	Florida, USA	Governance framework: World Health Organization Health Systems Strengthening Building Blocks Framework
Moore et al. ⁵¹	2008	Communicable disease	Global	N/A	Governance framework: Conceptual framework and decision aid tool for influenza surveillance
Sadr et al. ⁵²	2025	Communicable disease	Global	N/A	Governance framework: World Health Organization Health Systems Strengthening Building Blocks Framework
Topp et al. ⁵³	2025	Communicable disease	National	Australia	Governance framework: Hardware-software framework
Articles included at the intersection of systems thinking and surveillance					
Arnold et al. ⁵⁴	2024	Communicable disease; anti-microbial resistance	Global	N/A	Systems method: Systems lens to support governance of surveillance
Berezowski et al. ⁵⁵	2019	Animal health	Non-specific	N/A	Systems method: Systems lens to support governance of surveillance
Durski et al. ⁵⁶	2020	Communicable disease	Regional	Sierra Leone, Democratic Republic of Congo, Nigeria	Systems method: Concept mapping/process mapping to support governance of surveillance
George et al. ⁵⁷	2021	Animal health	National	Tanzania	Systems method: Network mapping to support governance of surveillance
Kearney et al. ⁵⁸	2024	Paramedic occupational injury	Non-specific	N/A	Systems method: Network mapping and concept mapping to support governance of surveillance
Kontogiannis ⁵⁹	2021	Communicable disease	Global	N/A	Systems method: Causal loop diagram and system dynamics to model a complex problem
Kruger et al. ⁶⁰	2023	Communicable disease	Regional	Australia, New Zealand	Systems method: Applying a systems lens to support governance of surveillance systems

Lanzas et al. ⁶¹	2015	Animal health	Global	N/A	Systems method: Agent-based modelling to model a complex problem
Li et al. ⁶²	2018	Nutrition	Local	New York City, USA	Systems method: Agent-based modelling to model a complex problem
Lie et al. ⁶³	2016	Animal health	National	Nicaragua	Systems method: System dynamics modelling and group model building to model a complex problem
Littlejohns et al. ⁶⁴	2024	Physical activity	Local	British Columbia, Canada	Systems method: Group model building and causal loop diagram to model a complex problem
Mumba et al. ⁶⁵	2017	Communicable disease	Local	Lundazi and Monze districts of Zambia	Systems method: System dynamics modelling and group model building to model a complex problem
Rich et al. ⁶⁶	2013	Animal health	National	Scotland	Systems method: Using a systems lens, causal loop diagram, system dynamics modelling, and agent-based modelling to support governance of surveillance
Rich et al. ⁶⁷	2018	Animal health	National	Vietnam	Systems method: System dynamics modelling to model a complex problem
Shuldiner et al. ⁶⁸	2022	Non-communicable disease; childhood cancer	Local	Ontario, Canada	Systems method: Using co-design and design thinking (journey maps and personas) to support governance of surveillance
Thystrup et al. ⁶⁹	2025	Communicable disease; foodborne disease	Regional	Nigeria, Tanzania, Mozambique, Ethiopia, and South Africa	Systems method: Causal loop diagram to support governance of surveillance
Ticehurst et al. ⁷⁰	2023	Communicable disease	Regional	Australia, New Zealand	Systems method: Applying a systems lens to support governance of surveillance
Xia et al. ⁷¹	2017	Communicable disease	Global	N/A	Systems method: Using a systems lens and concept mapping to model a complex problem

^a For articles included at the intersection of governance and surveillance, this column describes the governance framework used to frame the study. For articles included at the intersection of systems thinking and surveillance, this column describes the systems method that was applied to the surveillance system. Systems methods can be used to either: (1) improve governance structures and processes of surveillance systems or (2) model a complex problem.

Governance challenges of current surveillance systems for complex health and social issues

Articles at the intersection of governance and surveillance (n=9) provided insights on potential governance challenges of current surveillance systems for complex issues. Across the included studies, authors cited several structural barriers including: (1) data fragmentations caused by structural and operational components of surveillance systems; (2) resource and capacity for maintaining and adapting surveillance systems to respond to future crises; and (3) long-term sustainability of collaborations within surveillance networks.^{45–53} Understanding how surveillance and response functions are governed at different levels is a necessary first step to identifying opportunities for strengthening analysis and related policy and practice for complex issues such as food security.

Studies demonstrated that surveillance systems are experiencing data fragmentation in all public health contexts.^{45–47,51,53} In a case study of public health surveillance and response in Australia, Topp et al.⁵³ observed current surveillance systems often focus on a small set of thematically disparate public health indicators (e.g., oral health, smoking, vaccination). These indicators exist in multiple, siloed, and inaccessible data systems, where there were weak and inconsistent protocols for enabling changes to existing governance processes.⁵³ In a study evaluating elements of influenza surveillance, Moore et al.⁵¹ found strategies to improve surveillance coverage were inherently oriented toward the local level where organizations conducted grassroots surveillance activities. In studies by Alkhaldi et al.⁴⁶ and Al-Hazaa et al.⁴⁵, data fragmentation in surveillance systems was caused by lack of leadership and priority setting in governance of a shared vision for more cohesive surveillance. Mechanisms for sharing experiences and knowledge in how data is collected, analyzed and used across sectors will be an important first step for understanding how surveillance data can be better integrated.⁴⁵ Leveraging strategic partners conducting grassroots, local surveillance can be an opportunity for scaling up data and coverage at national levels.⁵¹

Studies consistently demonstrated barriers related to limitations of resource and capacity to extend surveillance systems beyond their current indicators.^{46,52} In an evaluation of the World Health Organization's leadership in global health governance of surveillance systems, Alkahaldi et al.⁴⁶ observed how inconsistencies produced by poorly-resourced digital solutions can exacerbate the fragmentation of surveillance systems. The data collected and used in low- and middle-income countries that rely on paper-based systems could not be exchanged in electronic reporting data systems.⁴⁶ A clear vision of priorities and resource allocation for existing public health surveillance systems will be critical, particularly to prevent duplication in surveillance efforts for crises that may intersect multiple policy domains.^{46,49,52}

There was consensus across all studies that cross-sectoral collaboration will be critical for improving governance of surveillance systems.^{45–47,51,53} For example, in a study of Florida's response to Zika virus, Marshall et al.⁵⁰ demonstrated community resilience in times of crisis was improved by strong social ties and networks to strengthen surveillance. Cross-sectoral collaboration resulted in timely laboratory testing, surveillance, dissemination of guidance, and coordination of patient care under complex dynamic conditions. Some studies emphasized that collective action will need to be international and multi-sectoral, highlighting the need for greater attention toward implementing collaborative mechanisms that can support ongoing engagement of

interest holders and knowledge users across nation-wide efforts for surveillance.^{45,49,50,52,53}

Frameworks for engaging different knowledge users and building interest and buy-in from multiple institutions and leadership is a starting point for improving collaboration across sectors, however, should be followed by long-term and sustainable collaborative mechanisms for maintaining these relationships.^{45,48} Two studies suggested surveillance systems can be better established through a single, multi-functional governance body that can foster transparency among partner sites and balance perspectives between data contributors and data users.^{45,49} This approach can minimize delays from creating multiple sub-committees and support a shared understanding about the variations in architecture, technology, and regulatory concerns of surveillance systems. Timely, frequent, and transparent communications will be critical in these settings to establish a strong rapport among organizations and solidify relationships among those conducting surveillance; for example, implementing consistent meetings to ensure ongoing engagement of existing and new members.⁴⁹

Assessing current practice in using systems methods for surveillance of complex issues

Across the articles included at the intersection of systems thinking and surveillance (n=28), systems methods were applied to surveillance systems to: (1) to improve the design of a surveillance system as a whole; and (2) to use surveillance data to understand a complex problem. A range of systems methods were used including: applying a systems lens, concept mapping, causal loop diagrams, network mapping, agent-based modelling, system dynamics modelling, group model building, and design thinking strategies (**Table 5; Appendix C for case studies**).

Table 5. Data charting form of included articles focused on applications of systems approaches and methods to surveillance systems

Systems method	Definition of method	Application to surveillance systems	Case study (Appendix C)^a
Applying a systems lens	Conceptualization or evaluation of surveillance systems and complex issues using a systems lens. Surveillance systems are conceptualized by how drivers and actors are connected to contribute to the collection, analysis, and interpretation of data for policy and practice.	• Conceptualizing existing surveillance systems. • Conceptualizing complex problems and how surveillance data may be used to build understanding.	Case study #1 Kruger et al., 2023 ⁶⁰
Concept mapping/Process mapping	Visual representation of how concepts are connected to surveillance and their relationships with each other. Often completed through a review of literature and/or interest holder engagement.	• Mapping elements of surveillance systems to understand their current state and gaps. • Building shared understanding of a complex problem and how surveillance can be used to inform policy and practice.	Case study #2 Durski et al., 2020 ⁵⁶

Causal loop diagram	Visual representation of the causal relationships between elements (e.g., drivers, actors) within a system. Causal loop diagrams are often interpreted by identifying key feedback loops or archetypes of the feedback loops.	- Modelling existing surveillance systems, including potential causal barriers that inhibit collection, analysis, and interpretation of data. - Building shared understanding of a complex problem. - Testing of potential scenarios for improving surveillance or policy.	Case study #3 Thystrup et al., 2025 ⁶⁹
Agent-based modelling	Modelling how individual actors may react to changes within a system.	- Modelling policy scenarios to examine how changes to surveillance systems may affect individual actors within the system (e.g., collectors of data). - Modelling policy scenarios to examine impacts on multiple behavioural outcomes of interest.	Case study #4 Li et al., 2018 ⁶²
System dynamics modelling	Modelling that represents a system's stocks and flows. Models are informed by knowledge user engagement, data, and existing literature.	Modelling policy scenarios to predict the impacts of different policy options on outcomes of interest.	Case study #5 Mumba et al., 2017 ⁶⁵
Group model building	Participatory approach to developing causal loop diagrams. Knowledge user input is typically gathered through participatory workshops.	- Consensus building and user engagement to understand a surveillance system. - Consensus building around a complex problem and how surveillance can inform action. - Developing model visualizations.	Case study #6 Littlejohns et al., 2024 ⁶⁴
Network mapping	Mapping of connections between actors within a surveillance system, including the relationships between individuals or organizations.	- Identifying and mapping actors and organizations, including how they are connected and their roles in the surveillance system. - Understanding how resource and capacity influences actors. - Building multi-sectoral partners.	Case study #7 George et al., 2021 ⁵⁷
Design thinking strategies	Strategies that place the end users at the center of the developing solutions. Some strategies involve user personas and journey making to support sense-making and prototyping of solutions.	- Engaging those affected by the complex problem or involved in surveillance to develop solutions. - Engaging those affected by the complex challenge to develop solutions for policy and practice. - Prototyping solutions and receiving user feedback.	Case study #8 Shuldiner et al., 2022 ⁶⁸

^a Case study examples are in Appendix C. Each case study includes: (1) context about the focus of the surveillance system; (2) description of the systems approach used; (3) benefits and challenges of applying the systems approach; and (4) an assessment of the ability for the systems approach to support governance of surveillance systems.

Systems methods to support design and structure of surveillance systems

The use of systems methods to support the design and structure of surveillance systems supported the characteristics of governance for a surveillance system by enabling engagement across sectors, leveraging multiple data types and sources to interpret social and structural contexts, and by mobilizing knowledge to different audiences (refer Appendix C for case study examples).

Causal loop diagrams, stakeholder mapping, and concept mapping were the most common methods used to improve the design of the whole surveillance system by identifying relationships between drivers and/or actors involved in surveillance. For instance, in a study by Thystrup et al.⁶⁹, causal loop diagrams were used to evaluate the effectiveness of food-borne disease surveillance systems in Africa and to identify barriers within those systems. The causal loop diagrams were informed by participatory workshops and a literature review, as well as system archetypes and leverage point analysis to identify barriers in the current surveillance system.⁶⁹ The causal loop diagrams improved governance of surveillance by enabling engagement of participants from diverse backgrounds in healthcare, research and government. The inclusive data approach combined quantitative and qualitative data on surveillance barriers, and strategies for improving surveillance were shared with knowledge users. In a study by George et al.⁵⁷, network mapping was used to map collaborations between sectors involved in animal health surveillance. Relationships with government practitioners were mapped to examine the impact of resource-based influence and non-resource-based influence of different stakeholders on animal health surveillance. The use of this systems method supported governance of the surveillance system by involving stakeholders in participatory workshops to inform the stakeholder map and interpretation of relationships in the context of social and structural determinants of influence on the surveillance system.

Across studies that used systems methods to improve the overall design of surveillance systems, the methods typically relied on interest holder and knowledge user input using participatory workshops or interviews.^{54–58,60,66,68–70} These insights were often complemented by literature reviews and used to confirm relationships between actors and drivers. Findings of the studies were also shared with participants involved in the process with recommendations on how to improve surveillance systems.

Systems methods using surveillance data to model a complex problem

Across the included studies that used surveillance data to model a complex problem, the use of systems methods supported some characteristics of governance for surveillance systems (see Appendix C for case study examples). Notably, these methods did not aim to improve the governance of surveillance systems but instead focused on understanding or modelling the context of a complex problem. While the use of systems methods to produce this type of evidence does not explicitly focus on components of surveillance systems, shared understanding of a complex problem can help engage relevant actors and inform the direction of surveillance systems (e.g., prioritizing indicators that provide evidence on social and structural determinants).

Agent-based modelling and system dynamics modelling were commonly used to model a complex problem and simulate different policy scenarios to improve outcomes. For instance, in a study by Li et al.⁶², agent-based modelling to analyze neighbourhood-level surveillance data from New York

City on health, environment and geography to explore hypothetical interventions to improve fruit and vegetable consumption. In this study, agent-based modelling supported some characteristics of governance for surveillance systems. The model used quantitative data from multiple population surveys to interpret social and environmental characteristics. Although interest holders and knowledge users were not directly engaged, the models could be used to communicate intervention scenarios to a range of audiences. In another study by Mumba et al.⁶⁵, system dynamics modelling and group model building were used to explore socio-economic and ecological factors that influenced the design and effectiveness of interventions for East Coast Fever in districts of Zambia. This study engaged stakeholders in focus groups to develop the models, after which findings were corroborated using surveillance data with quantitative analyses at a future date. Across studies that used systems methods to model a complex problem, it was unclear how the findings were shared back to communities that were engaged but opportunities exist to mobilize knowledge by re-engaging them.

Added value and benefits of using systems approaches and methods for governance of surveillance systems

Authors discussed how systems approaches and methods filled several needs and gaps of current approaches to improving surveillance systems.^{54–58,60,66,68–70} All studies described how current approaches to surveillance systems were often undertaken through the application of linear thinking (e.g., submission of an incident report, surveillance of a trend). These methods do not translate well for complex public health and social issues where disease mechanisms consist of interactions between multiple causal factors.^{58,60,70} Authors discussed a need for a paradigm shift in approaches to surveillance systems, where appropriate leverage points should be acted upon to enable change in the governance structure of surveillance systems. For example, in the context of foodborne disease surveillance systems, Thystrup et al.⁶⁹ discussed how traditional approaches fail to account for the interconnectedness of social, economic, and environmental factors. Integration of systems approaches and methods emphasizes the importance of local knowledge and practices in surveillance systems, which in turn can inform culturally appropriate interventions and reforming of policies to reflect holistic foodborne disease dynamics. Similarly, Kearney et al.⁵⁸ described a surveillance system of paramedic work-related injury as an interaction of multiple technical and social environments. When systems approaches and methods were used to understand surveillance systems from a broader perspective, surveillance systems can move beyond targeting specific indicators and encourage novel use of methods and dissemination outputs to report on them.^{60,70} This is particularly beneficial for resource-limited settings where identifying deep leverage points within the system can offer long-term improvement and sustainability of surveillance of key public health and social issues.^{57,69}

Studies emphasized the value of knowledge sharing between actors within a surveillance system, including shared understanding of the roles of different actors and how they influence each other within the system to improve collaborative efforts.^{60,70} Among studies focused on modelling a complex problem, systems approaches were described as an opportunity to understand the conditions of future public health and social crises and contributing to preventative policy rather than reactionary measures.⁵⁹ Building shared understanding through systems methods and approaches that map complex factors, barriers, and actor relationships contributing to a surveillance system can help to identify strategic interventions that target structural barriers of surveillance systems, while reducing redundancies in surveillance efforts and maximizing cost-

effectiveness.^{56,60} This shared understanding was often developed as a result of the participatory process involved in some systems approaches and methods and enabled opportunity to incorporate multiple perspectives.^{57,64,69} Other advantages focused on the use of specific methods, for example, the ability to integrate multiple domains (e.g., health, environment, economics) in system dynamics modeling,^{59,63,65} the ability to test multiple policy scenarios and support decision-making in agent-based modelling,⁶² and the potential to support long-term prevention efforts beyond immediate disease threats through causal loop diagrams.^{64,69}

Limitations, barriers, and challenges of using systems approaches and methods for governance of surveillance systems

Authors described several limitations and barriers of using systems approaches and methods to strengthen the governance of surveillance systems. Across studies that used systems approaches and methods to improve the design of surveillance systems, use of these methods were often limited by the inherent restrictions of a purposive sampling strategy.^{57,59,64,69} While efforts were made to be broad and inclusive in the participatory process, participation in these activities were restricted by the resource and capacity available by the knowledge users invited.⁵⁷ This sampling approach limits the generalizability of findings to a broader context, but could guide identification and analysis of interest holders and knowledge users in similar context to inform future studies using these systems approaches and methods. The potential for subjectivity from participant insights or author interpretations was also highlighted as a limitation of using systems approaches and methods for surveillance systems.⁵⁸ Given the participatory nature of the activities focused on experience and interactions with other interest holders and knowledge users, the insights shared by participants could be corroborated with existing literature to better understand the strength of relationships between actors and drivers when developing maps of surveillance systems.^{57,69}

Across all studies, barriers related to cost, time, and capacity need to be considered when implementing systems approaches. Shared understanding of surveillance systems will be developed over time with capacity, but can be facilitated more efficiently by investing in understanding perspectives of multiple sectors and actors throughout the system.^{60,70} Systems methods and approaches were often adapted to reduce the resource-intensity of participatory activities, such as using qualitative interviews in the place of workshops or using online platforms to facilitate workshops. Authors emphasized the benefits of systems approaches and under-resourcing can undermine the long-term cost-effectiveness and long-term sustainability of surveillance systems. Long-term evaluation of surveillance systems will be essential, particularly as behaviour changes in response to different crises over time.^{60,70}

Potential application of systems approaches to food security surveillance: Insights from knowledge users

The dialogue session invited knowledge users (n=45) from British Columbia, ranging from epidemiologists, public health dietitians, and decision-makers from government and non-government organizations at provincial and regional levels. Knowledge users highlighted that their primary barrier for food security policy and practice was limited access to consistent and reliable data, particularly focused on communities within the region. Existing measures and datasets exist at the national level and do not capture perspectives of food security of the communities that knowledge users were serving. Knowledge users were also restricted in their surveillance activities

due to lack of resources for food security, with food security teams often being small and limited in capacity. Knowledge users highlighted that there is no singular, formal surveillance system for food security with poor communication about surveillance activities between sectors. An overarching governance framework to support data accessibility and sovereignty is needed.

Among knowledge users, systems approaches and methods were viewed as an opportunity to understand how structural and social determinants may impact food insecurity, which can in turn be used to inform future directions for surveillance (e.g., indicators, data sources). Knowledge users also discussed the value of systems approaches to improve current governance structures of food security surveillance systems, including to better understand the leverage points that can be addressed to overcome current barriers and gaps of existing food security surveillance systems. Knowledge users were also encouraged by the potential for systems approaches to bridge opportunities to look beyond current measures of household food insecurity toward structural drivers (e.g., cost of food, food procurement, retail food prices).

Knowledge users shared experiences of the current siloed approach to food security surveillance in British Columbia. They appreciated the benefits that systems approaches and methods could bring to improve surveillance-related governance structures within their organizations, as well as to improve collaborative relationships with other related organizations and sectors. For instance, network mapping could be used to help map out different actors within the food security surveillance network and their roles within the system in relation to players that have data control and ownership. These methods can help to reveal nuances of whether the surveillance data and program support are reaching communities and areas that are experiencing greater levels of food insecurity. A few knowledge users emphasized the interconnected nature of their organizational portfolios with food security, suggesting the potential for these approaches to improve surveillance of related challenges with food security, such as climate change and mental health. Using systems approaches to address these interconnections were viewed as a strength for improving funding applications because of the ability to demonstrate relevance to multiple high-priority issues.

A range of concerns related to the implementation of systems approaches and methods were discussed by knowledge users. Some highlighted the limited capacity to apply these approaches, particularly given existing capacity of food security surveillance teams are already quite limited. Additionally, some knowledge users highlighted a transition phase within their organization where food security is often shifted to different departments, which limits the ability to conduct long-term projects. Funding will be required to support the participatory nature of systems approaches and methods, as well as to support continued evaluation of the surveillance system. Some knowledge users highlighted that systems approaches may only go as deep as the diversity of people that are invited to these discussions. To address some of these concerns, knowledge users emphasized the value of an organization to officially hold ownership of this type of work to provide continuity of a systems-informed approach to evaluating food security surveillance systems and to strengthen relationships and advocacy across sectors.

Implications

Findings from the evidence search and dialogue session emphasized the structural barriers in governance of current surveillance systems for complex public health and social issues, including fragmentation of data and inaccessibility to region-level data, limited capacity and resources to support the sustainability of current surveillance systems, and poor collaborative mechanisms to build and maintain cross-sectoral partnerships. A single, multi-sectoral surveillance system was suggested as a potential solution from the evidence search and dialogue session, highlighting the importance of an overarching governance framework and body to manage and support data accessibility and sovereignty of surveillance systems. The evidence search found a range of systems approaches and methods that could address these governance challenges by either: (1) improving their overall structure and design; or (2) supporting modelling of a complex problem using surveillance data. When used to improve the overall structure and design of surveillance systems, systems approaches and methods can promote increased engagement across sectors and communities relevant to food security (e.g., health, agriculture, rural, underserved groups), provide an inclusive data approach to better understand social and structural interconnections of food security, and mobilize knowledge and data to different audiences. Due to the global recognition of the complexity of food security, the applications of systems methods to food security surveillance systems were supported by knowledge users as a potential approach to improve structural barriers in governance. Therefore, a systems approach to food security surveillance systems would expand governance structures and processes that ultimately lead to different approaches for collecting and analyzing data about causal drivers of food security (**Figure 3**).⁷² Policies and practices would be informed by evidence from a wide range of data sources and data types, as well as interpreted by actors from across disciplinary sectors to contextualize the interactions of social and structural drivers.⁷³

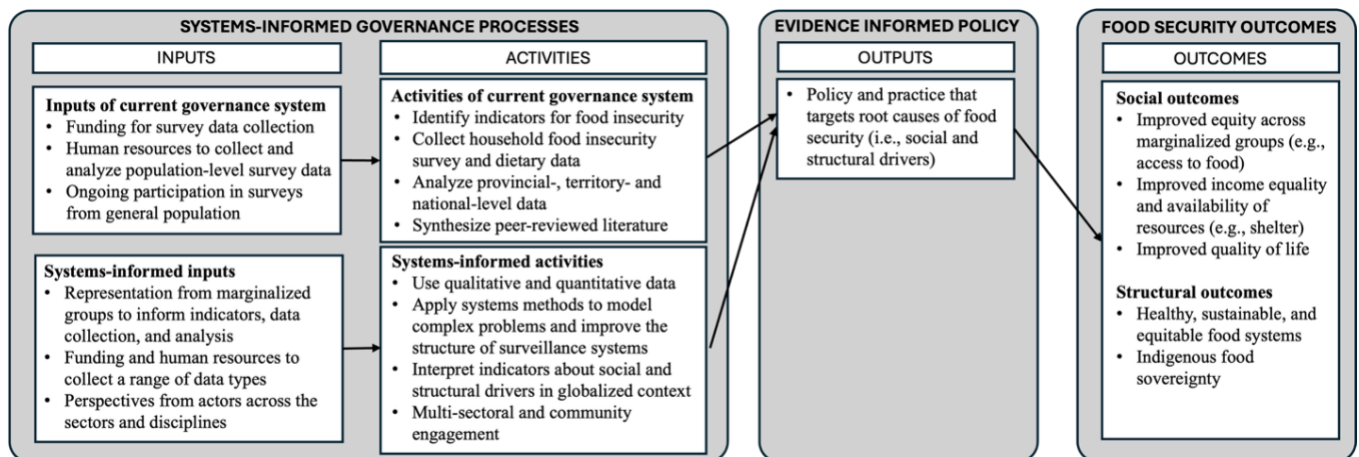


Figure 3. Logic model of systems-informed governance for surveillance systems to inform food security policy and practice

Practical guidance on how to apply systems approaches and methods to support governance of surveillance systems

For organizations and communities involved in surveillance activities, it can be helpful to gain a better understanding of their current surveillance system processes, structures, and data available. This understanding can help determine whether systems approaches and methods will be a useful approach to improve surveillance activities. Organizations and communities will need to assess whether the strengths of systems theories and methods align with the needs of the organization and structuring of their surveillance systems. Given global recognition that food security is a complex systemic challenge, organizations focused on food security may particularly benefit from the use of systems approaches and methods to understand the current state of the surveillance systems and their role within that system. Organizations and communities may conduct a consultation with interest holders and knowledge users by asking the following questions:

1. Does the organization and their knowledge users understand [the complex problem] as a systemic issue?
2. Does the organization and their knowledge users want to use the surveillance system to be able to explore the systemic causes of [the complex problem]?
3. Does the organization and their knowledge users want to integrate different types and sources of data into one causal understanding of the drivers of [the complex problem]?

If consultations demonstrate agreement with the above questions, there is a potential opportunity to explore the utility of systems approaches and methods for improving the governance of the organization's surveillance system. Organizations may consult the same interest holders and knowledge users to understand which attributes of the surveillance system need improvement:

1. Would the organization and knowledge users like to examine their role in surveillance relative to partners or other organizations involved in surveillance of [the complex problem]?
2. Would the organization and knowledge users like a shared understanding of the structural facilitators and barriers of accessing, collecting, or analyzing data about [the complex problem]?
3. Would the organization like a conceptual understanding of the complex factors that contribute to the [complex problem]?
4. Would the organization and knowledge users like to understand how data and evidence can be used to better inform community policy and programming related to [complex problem]?

Based on responses to the above questions, the decision aid (**Figure 4**) can be used to determine the appropriate systems method that aligns with the needs of the organization and knowledge users. The decision aid summarizes potential attributes of the range of systems approaches and methods used to inform governance of surveillance systems or model a complex problem using surveillance data.

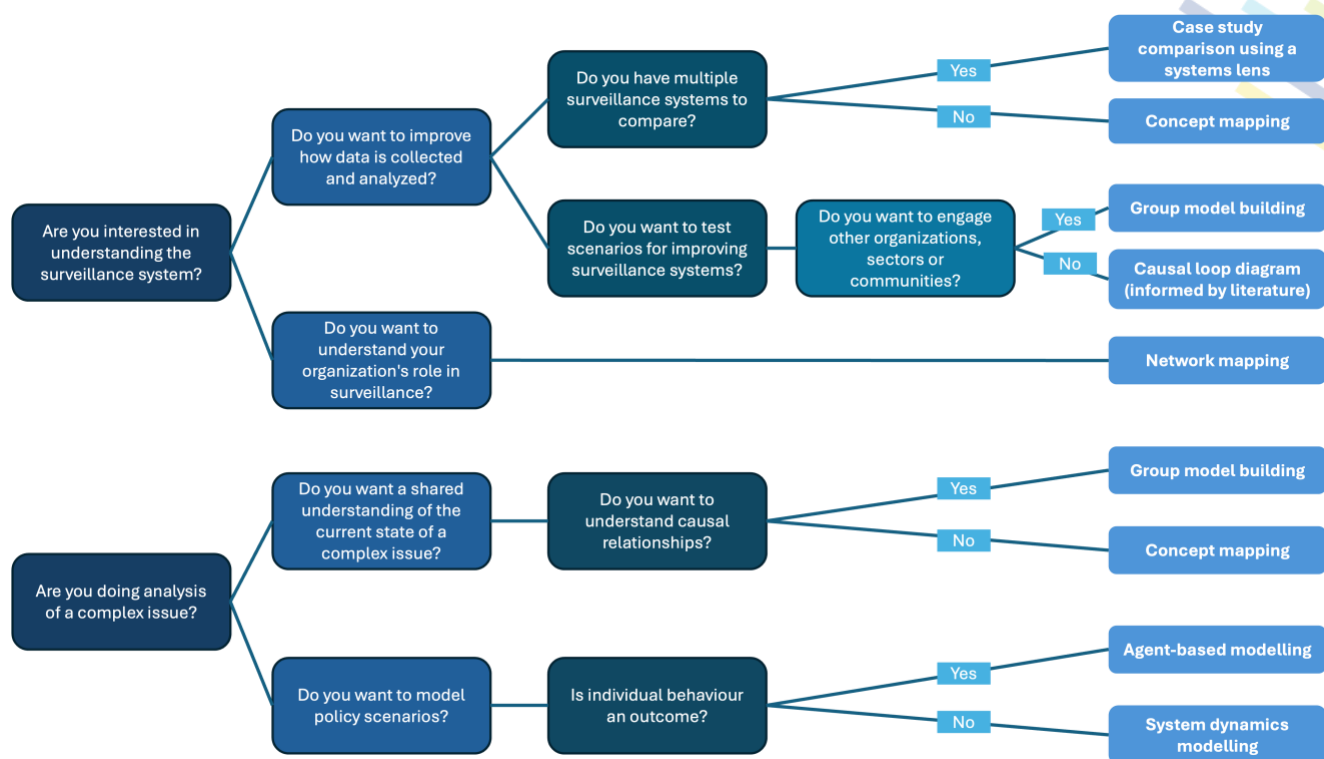


Figure 4. Decision aid to determine the systems method that can address an organization's surveillance needs and priorities

Considerations for surveillance to inform food security policy and practice

While this review found some applications of systems methods and approaches to model complex problems, these models will still be limited by the availability of data provided by the same surveillance systems that need to be strengthened. This suggests a greater application for systems approaches and methods where they are used to improve structural governance gaps of current surveillance systems, including considerations for design and structure. For instance, group model building workshops can convene key interest holders and knowledge users of surveillance systems to develop causal loop diagrams about how governance structures and processes could be improved to ensure food security data is relevant and timely for policy and practice.

Findings from the review and dialogue session demonstrated similar concerns about the application of systems approaches and methods. Integrating systems approaches into surveillance systems will require changes to structures and processes at national and local levels. This includes removing barriers within organizational mandates for cross-sectoral collaboration, investing in opportunities to engage across sectors and disciplines, and strengthening capacity to apply systems thinking approaches and technical skills to complex problems. In cases where organizations are limited by resource and capacity, systems approaches and methods can be adapted to be less resource-intensive and tailored to the context and needs of participants involved. For example, online platforms can be used to either gather participants across geographic regions or engage with participants asynchronously, limiting the need to travel for the same occasion.



While this project found applications of systems approaches and methods to inform strategies for improved surveillance systems, no studies evaluated long-term changes to surveillance systems after implementing these strategies. Resource and capacity will be required to implement the changes to surveillance systems and to support future evaluation of its impact. Regardless of whether a systems-informed approach is used, all surveillance systems will benefit from consistent assessments of governance gaps to ensure alignment with the needs of policy and practice to address complex problems as they continue to evolve.

Conclusions

This project identified existing applications of systems approaches and methods to improve the governance of systems that monitor complex problems, such as food security. Although the direct application of systems approaches and methods to food security surveillance systems was limited, the evidence search found several applications of systems approaches and methods to surveillance of other complex public health and social challenges. The identified studies demonstrated diversity in methods used and their application to understand how governance of surveillance systems can be improved. Knowledge users of food security surveillance systems in British Columbia saw the potential benefit of systems methods to address gaps of the current surveillance system, including improvements to the availability and accessibility of data focused on social and structural determinants of food security and opportunities for cross-sectoral engagement for surveillance activities. The project informed the development of a decision aid that can inform surveillance practitioners on which methods could be applied to improve governance of current surveillance systems, as well as practical insights and considerations for their application. Future research is needed to examine the long-term effects of changes to surveillance systems informed by systems approaches and methods.

Knowledge Mobilization Activities

This project used an integrated knowledge translation and exchange approach to co-develop evidence-based guidance to improve governance of surveillance systems. At the start of the project, initial discussions were led with project partners at BCCDC to understand their interests in systems approaches and methods and gaps in the current food security surveillance system. This early-stage knowledge mobilization activity informed directions for the evidence search, ensuring relevance of the findings to key interest holders and knowledge users. The online dialogue session with partners of BCCDC served as a mid-stage knowledge mobilization activity to promote knowledge uptake of the project and engage in discussion across organizations and sectors about opportunities to improve food security surveillance systems in British Columbia. For end-of-project knowledge mobilization, the findings of this project have been shared in the current report and a complementing evidence brief. This project was also shared at the *Social Sciences and Humanities Research Council Knowledge Mobilization Forum*. The knowledge generated from this project will be further disseminated to BCCDC in a practice-oriented evidence brief and will be presented to key departments in fall 2026. The evidence brief and presentation will focus on systems-informed principles, strategies, and techniques with a practical decision aid to support their decision-making about the potential use of systems approaches and methods to support food security surveillance within their organization.

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Appendix A. Search Strategy

Concepts	Governance	Surveillance	Systems methods and approaches
Keywords	Governance, information governance, data governance, knowledge governance, collaboration, coordination, collective action, collective impact, competition	Surveillance, data, monitoring, monitoring, disease reporting, indicator, indicators, public health reporting, health reporting, benchmark, benchmarking, indicators, data collection, measure, measures, score, decision-making, assessment, measurement, index, indices, assessments, questionnaire, questionnaires, framework, frameworks	Systems theory, systems thinking, systems science, complex system, system model, system dynamics, system lens, system perspective, complexity, complexity theory, complexity science, adaptive system, soft system, intervention level framework, leverage points Systems thinking methods: agent-based model, partial model testing, system heuristics, causal loop diagram, scenario technique, behaviour-over-time, discrete event modelling, group model building, network analysis, feedback loops
Subject headings		Public health surveillance	Systems analysis
Limits	None		
Advanced search (MEDLINE via PubMed) May 30, 2025	BLOCK #1: GOVERNANCE Governance[Title/Abstract] OR “information governance”[Title/Abstract] OR “data governance”[Title/Abstract] OR “knowledge governance”[Title/Abstract] OR “collaboration”[Title/Abstract] OR “coordination”[Title/Abstract] OR “collective action”[Title/Abstract] OR “collective impact”[Title/Abstract] OR “competition”[Title/Abstract] BLOCK #2: SURVEILLANCE surveillance[Title/Abstract] OR monitoring[Title/Abstract] OR “disease reporting”[Title/Abstract] OR indicator*[Title/Abstract] OR “public health reporting”[Title/Abstract] OR “health reporting”[Title/Abstract] OR benchmark*[Title/Abstract] OR measure*[Title/Abstract] OR score*[Title/Abstract] OR “decision making”[Title/Abstract] OR “decision-making”[Title/Abstract] OR assessment*[Title/Abstract] OR index[Title/Abstract] OR indices[Title/Abstract] OR questionnaire*[Title/Abstract] OR framework*[Title/Abstract] OR Public health surveillance[MeSH] BLOCK #3: SYSTEMS METHODS AND APPROACHES “systems theory”[Title/Abstract] OR “systems thinking”[Title/Abstract] OR “systems science”[Title/Abstract] OR “complex system”[Title/Abstract] OR “system model”[Title/Abstract] OR “system dynamics”[Title/Abstract] OR “system lens”[Title/Abstract] OR “system perspective”[Title/Abstract] OR “complexity”[Title/Abstract] OR “complexity theory”[Title/Abstract] OR “complexity science”[Title/Abstract] OR “adaptive system”[Title/Abstract] OR “soft system”[Title/Abstract] OR “agent-based model”[Title/Abstract] OR “agent-based modelling”[Title/Abstract] OR “partial model testing”[Title/Abstract] OR “system heuristics”[Title/Abstract] OR “causal loop diagram”[Title/Abstract] OR “scenario technique”[Title/Abstract] OR “behaviour-over-time”[Title/Abstract] OR “discrete event modelling”[Title/Abstract] OR “group model building”[Title/Abstract] OR “network analysis”[Title/Abstract] OR “feedback loops”[Title/Abstract] OR “Intervention level framework”[Title/Abstract] OR “Intervention-level framework”[Title/Abstract] OR “leverage points”[Title/Abstract] OR Systems analysis[MeSH] Final search: #1 AND #2 AND #3		
Advanced search (Scopus) May 30, 2025	BLOCK #1: INSTITUTIONAL GOVERNANCE OF SURVEILLANCE SYSTEMS TITLE-ABS-KEY (Governance OR “information governance” OR “data governance” OR “knowledge governance” OR “collaboration” OR “coordination” OR “collective action” OR “collective impact” OR “competition”) BLOCK #2: SURVEILLANCE TITLE-ABS-KEY (surveillance OR monitoring OR “disease reporting” OR indicator* OR “public health reporting” OR “health reporting” OR benchmark* OR measure* OR score* OR “decision making” OR “decision-making” OR assessment* OR index OR indices OR questionnaire* OR framework* OR “health decision-making” OR “health decision making”) BLOCK #3: SYSTEMS METHODS AND APPROACHES TITLE-ABS-KEY (“systems theory” OR “systems thinking” OR “systems science” OR “complex system” OR “system model” OR “system dynamics” OR “system lens” OR “system perspective” OR “complexity” OR “complexity theory” OR “complexity science” OR “adaptive system” OR “soft system” OR “agent-based model” OR “agent-based modelling” OR “partial model testing” OR “system heuristics” OR “causal loop diagram” OR “scenario technique” OR “behaviour-over-time” OR “discrete event modelling” OR “group model building” OR “network analysis” OR “feedback loops” OR “Intervention level framework” OR “Intervention-level framework” OR “leverage points”) Final search: #1 AND #2 AND #3		

Appendix B. Dialogue Session Discussion Guide

We are interested in hearing from you about the potential of these approaches for food security surveillance systems. The following are questions that will guide our session.

1. What is the focus of your work for food security monitoring and have you applied systems approaches?
 - Prompts:
 - What are the key indicators that you use? What data sources do you use? How do you use these indicators?
 - Have you heard of systems thinking before? Where/how did you hear about it?
 - What are some challenges related to food security monitoring that you currently face?
2. How do you see systems approaches being applied to monitoring of food security in British Columbia? (currently, or potential to in the future)
 - Prompts:
 - Today we shared some examples of systems thinking methods. What did you think of them? Do you think they would be relevant to your work?
 - Would they be helpful for addressing some challenges that you face with monitoring?
3. What benefits/outcomes do you see to applying systems approaches to monitoring of food security in British Columbia? Challenges?
 - Prompts:
 - Are you interested in implementing systems approaches to monitoring?
 - If so, what would you need to do that? Funding? Capacity and training?
4. Do you think these approaches meet the gaps in current approaches to food security monitoring?
 - Prompts:
 - Do think these approaches could help address some of the challenges that you face with monitoring?
5. What type of support or guidance would you need to apply systems thinking approaches and methods to food security monitoring?

Appendix C. Case Study Examples

Case study #1: Systems thinking for general surveillance programs – practical insights and limiting factors to guide resourcing decisions (Kruger et al., 2023)

Surveillance context: Compared general surveillance programs in the biosecurity sector (animal disease, weeds, marine and fresh waters, lures for beetles, plant health, and Indigenous community engagement)

Objective: Identifying how systems should be configured to make general surveillance programs cost-effective and sustainable and improve return on investment

Country: Australia and New Zealand

Approach: A systems lens was used to compare multiple surveillance systems. A survey was used to identify and collate a list of general surveillance programs in Australia and New Zealand, nine were selected for case studies. Interviews and focus groups were conducted with the full range of stakeholders involved in the selected case studies and representatives of other general surveillance programs. Limiting factors were identified in the areas of program administration, community engagement, monitoring, reporting, identification/diagnosis, data management, data analysis, data use, disease presence and impact, and operating environment. A causal loop diagram was developed to show the interaction between the most common limiting factors and program functions.

- **Specialist skills and knowledge:** Applying systems theory; concept of limiting factors; causal loop diagrams
- **Tools:** NVivo for interviews

Benefits: Understanding limiting factors helps to direct resources where they will deliver the greatest return on investment to ensure a general surveillance program achieves its goals in a cost-effective manner.

Challenges and opportunities: The most limiting factor varies between programs and between stages of a program. Understanding the most limiting factor requires in-depth understanding of a program and open communication between people representing different functions of the program.

Table C.1. Applying a systems lens to support governance of multiple public health surveillance systems

Characteristics of governance for surveillance systems	Did the systems approach support the governance characteristic?	How did the systems approach support the governance characteristic?
Characteristic #1: Engaging key groups and perspectives in surveillance processes	Yes	• Held a multistakeholder workshop with experts in resourcing general surveillance and other biosecurity programs
Characteristic #2: Applying an inclusive data approach where a range of data types and sources are collected	Yes	• Mixed-methods study • Uses survey and published data for quantitative analysis • Uses interviews for qualitative analysis
Characteristic #3: Using methods to interpret social, environmental, economic, and structural context of complex challenges	Yes	• Acknowledged that limiting factors are not universal and can vary across cases and programs
Characteristic #4: Mobilize public health information to a range of audiences to inform policy decision-making and action	Yes	• General Surveillance Guidelines were developed, and a full report was released

Case study #2: Systems thinking for health emergencies: use of process mapping during outbreak response (Durski et al., 2020)

Surveillance context: Outbreak response during health emergencies

Objective: Demonstrate how process mapping can be applied to streamline processes and improve outbreak response

Country: Sierra Leone, Democratic Republic of Congo, Nigeria

Approach: Senior leadership from Ministry of Health and national disease control units were engaged to identify operational challenges, define objectives, select performance indicators, and identify relevant stakeholders. Interviews were conducted with stakeholders to understand their roles and responsibilities, workflows, and barriers within the system that impact the response process. A process map was created using the findings from interviews. A group re-design session was held with stakeholders to validate the process map and co-create solutions to improve outbreak response. Following the group re-design session, proposed solutions were implemented by partners and stakeholders.

- **Specialist skills and knowledge:** Process mapping/concept mapping
- **Tools:** None stated

Benefits: Process mapping is versatile and can be used in many different contexts to strengthen the functioning of systems.

Challenges and opportunities: Re-design of processes following process mapping exercise can be challenging depending on how quickly actions can be taken, as delays can introduce further complexities and interactions that need to be addressed. Processes need to be monitored, evaluated, and adjusted over time to be effective with changing needs, which can be difficult with limited resources.

Table C.2. Use of concept mapping to support governance of surveillance for health emergencies

Characteristics of governance for surveillance systems	Did the systems approach support the governance characteristic?	How did the systems approach support the governance characteristic?
Characteristic #1: Engaging key groups and perspectives in surveillance processes	Yes	• Senior leadership from Ministry of Health and national disease control units were engaged to identify relevant stakeholders within the system • Stakeholders were engaged for interview data collection and process map validation workshop
Characteristic #2: Applying an inclusive data approach where a range of data types and sources are collected	Yes	• Data were collected from different sources who occupied different roles within the system (e.g., incident managers, epidemiologists, data managers, lab specialists, nurses, community engagement experts, etc.)
Characteristic #3: Using methods to interpret social, environmental, economic, and structural context of complex challenges	Yes	• Process mapping exercises were adjusted based on operational contexts of the country, health system, and disease outbreak
Characteristic #4: Mobilize public health information to a range of audiences to inform policy decision-making and action	Yes	• Process maps were co-created with stakeholders and solutions were implemented following the process map group re-design session

Case study #3: Applying a systems thinking approach to evaluating the effectiveness of Africa's foodborne disease surveillance systems (Thystrup et al., 2025)

Surveillance context: Improving governance and design of food-borne disease surveillance

Objective: What are barriers that limit the effectiveness of food-borne disease surveillance? What are some potential strategies to improve the surveillance system?

Country: Multiple countries in Africa

Approach: Causal loop diagrams were developed to identify barriers of surveillance systems and map how the barriers were connected. Diagrams were informed by participatory workshops and a scoping review. CLDs were interpreted using system archetypes, leverage point analysis, and scenario planning. The participatory process built consensus among stakeholders from different sectors. Facilitated evidence-informed decision-making by identifying leverage points within the surveillance system, as well as tested different strategies from improving the surveillance system.

- **Specialist skills and knowledge:** Facilitation skills and knowledge in interpreting system archetypes
- **Tools:** None stated

Benefits: Opportunity to improve understanding of how different components of surveillance systems can interact dynamically, enabling the identification of leverage points to implement sustainable intervention strategies for mitigating the burden of food-borne diseases in African countries.

Challenges and opportunities: The authors identified risk of personal bias and generalization as a challenge when interpreting elements of the surveillance system, however, this was mitigated by corroborating findings with literature. Opportunities exist to tailor the causal loop diagrams to different regions and communities in Africa by using more detailed and context-specific data.

Table C.3. Use of causal loop diagrams to support governance of surveillance for foodborne disease

Characteristics of governance for surveillance systems	Did the systems approach support the governance characteristic?	How did the systems approach support the governance characteristic?
Characteristic #1: Engaging key groups and perspectives in surveillance processes	Yes	Engaged participants in healthcare, research, and government across several countries in Africa to understand different perspectives about barriers to food-borne disease surveillance
Characteristic #2: Applying an inclusive data approach where a range of data types and sources are collected	Yes	- Used quantitative and qualitative data about barriers of effective monitoring - Emphasized the need for different indicators to inform decision-making about food-borne diseases
Characteristic #3: Using methods to interpret social, environmental, economic, and structural context of complex challenges	Yes	Revealed leverage points to improve surveillance, including public trust, food safety, and data sharing
Characteristic #4: Mobilize public health information to a range of audiences to inform policy decision-making and action	Yes	- Strategies to improve surveillance systems were shared with stakeholders - Stories from smaller groups within Africa could be explored further

Case study #4: Assessing the role of access and price on the consumption of fruits and vegetables across New York City using agent-based modeling (Li et al., 2018)

Surveillance context: Dietary behaviours, particularly fruit and vegetable consumption

Objective: Develop and use an agent-based model to identify new insights for increasing fruit and vegetable consumption in residents of New York City, USA

Country: USA

Approach: Using data from the US census, surveys, and previously published studies, an agent-based model was developed to simulate adults in New York City of varying demographic characteristics, preferences, social influence, food access, and price sensitivity, representing population and neighbourhood conditions. The simulated individuals were placed in a baseline scenario and six hypothetical interventions to understand how improved access and reduced prices would affect the proportion of people consuming two or more servings of fruits and vegetables over a three-year period across New York City neighborhoods and boroughs.

- **Specialist skills and knowledge:** Agent-based modelling
- **Tools:** Java

Benefits: An agent-based model can provide a comprehensive way to study complex human behaviors by using existing knowledge and data to simulate how various factors like demographics, environment, and social influence interact to shape behaviour.

Challenges and opportunities: Several assumptions are made when developing agent-based models, thus it is important to understand and consider contextual factors when interpreting results.

Table C.4. Use of agent-based modelling to support governance of surveillance for fruit and vegetable consumption

Characteristics of governance for surveillance systems	Did the systems approach support the governance characteristic?	How did the systems approach support the governance characteristic?
Characteristic #1: Engaging key groups and perspectives in surveillance processes	No	• Stakeholders were not engaged in this study
Characteristic #2: Applying an inclusive data approach where a range of data types and sources are collected	Yes	• Data were gathered from various sources including the census, surveys, and published studies to create the model
Characteristic #3: Using methods to interpret social, environmental, economic, and structural context of complex challenges	Yes	• The model was developed accounting for different characteristics, degrees of social influence and food access – allowing • The model was developed to be representative of the New York City population and may not be applicable in other contexts
Characteristic #4: Mobilize public health information to a range of audiences to inform policy decision-making and action	Unclear	• It's unclear how the findings were shared, however there is room for the authors to share insights with public health practitioners and policymakers to support the design of effective interventions for improving dietary behaviours

Case study #5: Application of system dynamics and participatory spatial group model building in animal health: A case study of East Coast Fever interventions in Lundazi and Monze districts of Zambia (Mumba et al., 2017)

Surveillance context: East Coast Fever (ECF) in Lundazi and Monze districts of Zambia

Objective: Explore how dynamic socio-economic and ecological factors influence the design and effectiveness of ECF interventions, and demonstrate the usefulness of system dynamics and spatial group model building in addressing complex animal health challenges

Country: Zambia

Approach: Stakeholders from the beef value chain were engaged to gain a broader understanding of the issue. Participatory focus group sessions were held for a spatial group model building (SGMB) exercise where stakeholders mapped actors and processes and created behavior-over-time graphs to illustrate how key factors within the ECF system change and interact over time. The exercise allowed stakeholders to generate insights on socio-economic, cultural, and ecological dynamics affecting the system. System dynamics modelling was used to visually represent relationships and feedback loops among key factors. System models were analyzed to identify leverage points that could be used to inform more effective and sustainable policy interventions.

- **Specialist skills and knowledge:** System dynamics modelling, spatial group model building
- **Tools:** Stella Professional, LayerStack

Benefits: Group model building increases awareness among stakeholders, and spatial group model building's visual approach improves the efficiency and quality of data collection. Systems approaches can improve buy-in from stakeholders for bottom-up led interventions.

Challenges and opportunities: Validating system dynamics models can be resource intensive as parameterization can require several iterations of meetings including additional key informant interviews, and a literature review.

Table C.5. Use of system dynamics modelling to support governance of surveillance for animal health

Characteristics of governance for surveillance systems	Did the systems approach support the governance characteristic?	How did the systems approach support the governance characteristic?
Characteristic #1: Engaging key groups and perspectives in surveillance processes	Yes	Stakeholders in the beef value chain from two different systems were engaged
Characteristic #2: Applying an inclusive data approach where a range of data types and sources are collected	Yes	Qualitative models were created and additional steps were taken with the intention of conducting quantitative analyses in future
Characteristic #3: Using methods to interpret social, environmental, economic, and structural context of complex challenges	Yes	Socio-economic, cultural and ecological contexts were considered
Characteristic #4: Mobilize public health information to a range of audiences to inform policy decision-making and action	Unclear	Unclear how findings were shared, however there is opportunity to share the identified leverage points with beef value chain stakeholders

Case study #6: Follow the Arrows: Using a Co-Created Causal Loop Diagram to Explore Leverage Points to Strengthen Population Physical Activity Promotion in British Columbia, Canada (Littlejohns et al., 2024)

Surveillance context: Reviewing system of activities that contribute to physical activity promotion

Objective: Identify strategies to improve multi-sector coordination of population physical activity promotion in British Columbia, Canada

Country: Canada

Approach: A group-model building workshop was held with stakeholders from the public sector and non-profit sector to co-create a systems map of how different parts of the population physical activity promotion system in British Columbia interact, using an adapted version of the Attributes Framework. Participants in three different groups identified feedback loops that influence coordination challenges and developed causal loop diagrams. Authors consolidated the three causal loop diagrams and identified leverage points to intervene and address coordination challenges.

- **Specialist skills and knowledge:** Attributes Framework, Systems mapping, Group-model building, Causal loop diagram
- **Tools:** Vensim PLE software

Benefits: Identifying feedback loops and leverage points can help direct the development of targeted interventions for impactful systems change.

Challenges and opportunities: Conducting group-model building workshops to inform causal loop diagrams can be time consuming and limit iterative stakeholder engagement. Identified leverage points can change depending on changing priorities.

Table C.6. Use of group model building to support governance of surveillance for physical activity

Characteristics of governance for surveillance systems	Did the systems approach support the governance characteristic?	How did the systems approach support the governance characteristic?
Characteristic #1: Engaging key groups and perspectives in surveillance processes	Yes	Held a group model building workshop with stakeholders from public and non-profit sectors across different levels
Characteristic #2: Applying an inclusive data approach where a range of data types and sources are collected	Yes	Although the study only use qualitative data, the methodology ensured that participants represented various sources and incorporated diverse perspectives
Characteristic #3: Using methods to interpret social, environmental, economic, and structural context of complex challenges	Yes	Participants were recruited from multiple levels (provincial, regional, local) across different sectors to provide input from different contexts
Characteristic #4: Mobilize public health information to a range of audiences to inform policy decision-making and action	Unclear	Unclear how findings were shared, however there is opportunity to share the final causal loop diagram with stakeholders who participated in the group-model building workshop

Case study #7: Leveraging Sub-national Collaboration and Influence for Improving Animal Health Surveillance and Response: A Stakeholder Mapping in Tanzania

Surveillance context: Improving governance and design of animal health surveillance

Objective: Who are the stakeholders involved in animal health surveillance and what is their relationship with existing government practitioners?

Country: Tanzania

Approach: Stakeholder mapping of collaborations and influences, informed by workshops. Stakeholder analysis and mapping was conducted to understand the collaborations and of stakeholder relationships among surveillance actors and existing government practitioners, including assessing their interest and influence in the system.

- **Specialist skills and knowledge:** Stakeholder mapping and analytical skills
- **Tools:** USAID collaboration mapping tool

Benefits: Identified areas of shared interest and potential cooperation to avoid duplication of efforts within the surveillance system, recognizing that interrelationships between actors and the influence of those actors can improve or constrain activities within the surveillance system.

Challenges and opportunities: Stakeholder mapping focused on three districts in Tanzania, making it difficult to generalize findings to a larger country. Stakeholder analysis alone may not target systems change and should be paired with other systems approaches to identify the causal drivers that can improve the governance structures of a surveillance system, including clear operational processes, constant engagement, and coordination and incentivization of stakeholders.

Table C.7. Use of network and stakeholder mapping to support governance of surveillance for animal health

Characteristics of governance for surveillance systems	Did the systems approach support the governance characteristic?	How did the systems approach support the governance characteristic?
Characteristic #1: Engaging key groups and perspectives in surveillance processes	Yes	Engaged government animal health practitioners in Sumbawanga, Sikonge, and Kilombero districts of Tanzania.
Characteristic #2: Applying an inclusive data approach where a range of data types and sources are collected	Yes	Used qualitative and quantitative data to map connections about stakeholders
Characteristic #3: Using methods to interpret social, environmental, economic, and structural context of complex challenges	Yes	Stakeholder maps showed which sectors have greater resource-based and non-resource-based influence on the surveillance system
Characteristic #4: Mobilize public health information to a range of audiences to inform policy decision-making and action	Unclear	- Unclear how stakeholder maps were communicated - Opportunities exist to re-engage the workshop participants to develop opportunities for coordination

Case study #8: Developing a Provincial Surveillance and Support System for Childhood Cancer Survivors: Multiphase User-Centered Design Study (Shuldiner et al., 2022)

Surveillance context: Surveillance of late effects in adult survivors of childhood cancer

Objective: Design a provincial support system as an intervention to influence surveillance adherence for late effects in survivors of childhood cancer

Country: Canada

Approach: Barriers and enablers to completing surveillance tests were identified using thematic analysis of qualitative interview data from a previous study. Personas and journey maps were created based on the analysis. A co-creation workshop was held with survivors, physicians, and health system partners to validate findings and collaboratively generate ideas for the surveillance system's design and content. User-centered design methodology was used to iteratively refine the intervention material prototypes and gain further feedback via interviews.

- **Specialist skills and knowledge:** Design thinking, personas, journey maps
- **Tools:** None stated

Benefits: Co-creating systems with relevant stakeholders and users can improve usability and usefulness as barriers and enablers can be addressed by learning directly from the source of those experiencing it.

Challenges and opportunities: Iterative design changes require multiple rounds of feedback and can be time-consuming. It can be challenging to navigate prioritizing divergent feedback, and balancing user preferences with system constraints.

Table C.8. Use of design thinking methods to support governance of surveillance for childhood cancer

Characteristics of governance for surveillance systems	Did the systems approach support the governance characteristic?	How did the systems approach support the governance characteristic?
Characteristic #1: Engaging key groups and perspectives in surveillance processes	Yes	• Study was conducted in partnership with childhood cancer survivors, family physicians, and health system partners
Characteristic #2: Applying an inclusive data approach where a range of data types and sources are collected	Yes	• Although the study only used qualitative data, data were collected from various sources • Data collection was done iteratively to inform the design process
Characteristic #3: Using methods to interpret social, environmental, economic, and structural context of complex challenges	Yes	• Both users and service delivery personnel were included in the design process, allowing for feedback from multiple perspectives
Characteristic #4: Mobilize public health information to a range of audiences to inform policy decision-making and action	Unclear	• Unclear how findings were shared, however there is opportunity to share insights with health system partners and stakeholders who participated in the design process