

## CAPTURING THE COMPLEXITY OF EVALUATIONS OF HEALTH PROMOTION INTERVENTIONS: A SCOPING REVIEW

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**Abstract:** Evaluation designs that can capture the complexity of health promotion (HP) interventions are needed. Our objective was to assess if such evaluations use a Complex Adaptive Systems (CAS) perspective, by using a scoping review of evaluations of HP interventions concerning alcohol and tobacco use in the peer-reviewed (PR) and grey literature (GL). We developed indicator questions to assess CAS aspects. Our study revealed that none of the 45 PR and 9 GL evaluations that we reviewed explicitly used a CAS perspective; however, most indirectly assessed complexity aspects. Our indicator questions are a step toward addressing the challenges of the practical application of a CAS perspective.

**Résumé :** Les devis de recherche évaluative doivent réfléchir la complexité des interventions de promotion de la santé. L'objectif est de déterminer si des évaluations utilisent une perspective de systèmes complexes adaptatifs (CAS), en se servant d'une revue de documents évalués par les pairs (EP) et de la littérature grise (LG) portant sur l'évaluation d'interventions de promotion de la santé concernant l'alcool et le tabac. Nous avons développé des indicateurs des aspects des CAS. Les résultats indiquent qu'aucune des évaluations (45 EP, 9 LG) n'utilisait explicite-

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ment une perspective de CAS; cependant la plupart jugeaient indirectement ses aspects. Nos indicateurs peuvent faciliter l'application de la perspective de CAS.

## INTRODUCTION

Health promotion (HP) enables individuals and communities to increase control over factors that influence health, thereby creating opportunities for health improvement (World Health Organization [WHO], 1986). However, HP interventions are often complex (Van Beurden, Kia, Zask, Dietrich, & Rose, 2011), as they frequently take an ecological approach and consider the diverse and multifaceted factors that impact health and the complex ways in which such factors interrelate (Green, Richard, & Potvin, 1996; McLaren & Hawe, 2005; Vollman, Anderson, & McFarlane, 2007). At the population level, health promotion focuses on the underlying causes of health and aims to directly address the social determinants of health (Commission of the Social Determinants of Health [CSDH], 2008; Public Health Agency of Canada [PHAC], 2003). Inherent in HP theory is an emphasis on the complex interconnections between individuals and their environment, which is composed of physical, political, economic, sociocultural, and biological components (Vollman et al., 2007). The complexity of HP interventions also arises from dealing with issues for which there is often limited agreement among stakeholders about viable solutions or strategies to achieve predefined outcomes; additionally, there may be a high degree of uncertainty about the outcomes that may be achieved (Patton, 2011). HP interventions often require multiple levels or stages of development and redevelopment (adaption) before implementation and uptake can take place within real-life settings (Pawson & Tilley, 1997; Van Beurden et al., 2011).

Evaluation approaches of HP interventions should adequately capture and reflect this complexity. Such evaluations can facilitate the generation of favourable outcomes by promoting an accurate understanding of the complex reality within which the interventions function (Patton, 2011; Van Beurden et al., 2011). The utility of a complexity perspective for evaluators is that it facilitates contemplation of multiple dimensions, levels, and aspects. Such an approach enables evaluators to consider not only outcome variables predetermined as important, but also to gain a broader and more comprehensive understanding of the impact of an intervention—at the stages of development, application, possible end points, and sustainability.

The shift in conceptualization of HP interventions from simple to complex is apparent in the evaluation field. This is exemplified, for example, in developmental evaluation (Patton, 1994, 2011), the realist evaluation approach (Pawson & Tilley, 2004), and the Cynefin Framework (Van Beurden et al., 2011).

*Developmental evaluations* are suited to emerging (HP) programs or interventions that are continuously adjusted or adapted as new information becomes available. According to Patton (2011), this type of evaluation is most applicable when the intervention is at an early stage of development and implementation; the evaluation design is therefore flexible in nature and actively focuses on identifying the unexpected and unfolding outcomes. *Realist evaluations* are theory driven and recognize the intervention being evaluated as embedded within contexts that impact outcomes. They aim to answer the question, “What works for whom, under what circumstances, and how?”, expanding beyond the traditional experimental focus of either “Does it work?” or “What works?” (Pawson & Tilley, 2004). The *Cynefin Framework* introduces key concepts of complex adaptive systems (CAS) and reviews the emergence and implications of complex approaches within health promotion. It can be used as a framework for categorizing issues and strategies within specific HP project or a program of research. It is also used as a “sense-making” tool for understanding systems (e.g., projects) that are constantly changing and in flux (Van Beurden et al., 2011).

We aim to contribute to the discussion about capturing the complexity of HP interventions by “deconstructing” complexity concepts in such a way that they can support the development of well-designed, comprehensive HP evaluations. More specifically, we aimed to operationalize the properties of complex adaptive systems to facilitate the ability of evaluators (and other stakeholders) to “see” the theoretical and abstract concepts and make them useful in the design of HP evaluations.

In this article we focus on HP interventions as complex adaptive systems, as CAS is increasingly used to inform health and health care research (McDaniel, Lanham, & Anderson, 2009; Rouse, 2008; Van Beurden et al., 2011). Complex adaptive systems are “a collection of individual agents who have the freedom to act in ways that are not always totally predictable, and whose actions are interconnected so that one agent’s actions changes the context for other agents” (Plsek & Greenhalgh, 2001, p. 625). Thus, a CAS is defined by its component

parts or properties, the relationships between these properties, and the behaviours of the system as a whole (Eoyang & Berkas, 1999). Our research addressed properties that are commonly used in discussions of CAS, including agents, interrelationships, self-organization, co-evolution, emergence, and unpredictable dynamic patterns (McDaniel et al., 2009). Working definitions of these properties are summarized in Table 1. Based on these properties, CAS is characterized in this review by individuals (agents) who learn, are interconnected, self-organize, and co-evolve in their environment in unpredictable, often nonlinear, and dynamic ways. These factors lead to the development of patterns of relationships at the system level that influence the performance of the system and the individuals in it.

**Table 1**  
**Working Definition of CAS Properties**

<i>CAS property</i>	<i>Working definition</i>
Agents	The people directly involved with or participating in the intervention. In our analysis, we distinguished agents internal to the intervention from people and factors that are part of the external context <sup>a</sup> within which the intervention occurs.
Relationship	Relationships can be between agents, as well as between agents and the broader context. <sup>a</sup> These relationships are often short-range (information is received from near neighbours), nonlinear (small inputs can have a small, a large, or no effect), and include amplifying and condensing feedback loops.
Self-organization	Structures and forms of behaviour develop spontaneously—without the need for linear interactions among agents.
Co-evolution	Systems change over time in relation to other (local) systems.
Emergence	Patterns of behaviour develop as the result of the relationships of the agents and the system to other systems. Such patterns can be unpredictable and dynamic.

*Note.* The definitions in Table 1 are based on Eoyang and Berkas, 1999; Plsek and Greenhalgh, 2001; and McDaniel et al., 2009. <sup>a</sup> By context we refer to factors present in the environment or immediate surroundings, or activities with which one engages, that are related (implicitly, explicitly, or potentially) to the outcomes or process of the evaluation. These can include (but are not limited to) social and personal relationships (e.g., marital status); economics (economic development of country, household income); sociopolitical situations (i.e., involvement in civic issues, political campaigning); impacts of technology; and the broader social context (e.g., social norms). Personal characteristics of agents, such as age and sex, can also be relevant to understanding the broader social context (e.g., the sex of participants can be shown to be related to the social phenomena of gender); in such case, they are considered to be external contextual factors.

Our purpose was to investigate whether a CAS perspective is reflected in the design of published evaluations of HP interventions conducted in Canada targeting alcohol and/or tobacco use and abuse. Health promotion is a very broad field that can address a number of public health issues. For the purposes of this (scoping) review, we

focused on HP interventions for smoking and alcohol use and abuse. Health issues and consequences related to smoking and alcohol have attracted a significant amount of attention and are considered key health issues to target in Canada and internationally (Collins & Lapsley, 2008; Powers, 2007). Smoking and alcohol use are complex, because in addition to the direct effect on human physiology, they impact on social systems at multiple layers, their root causes may be unknown, and there is no clear or “one size fits all” solution or approach for success. Our specific research questions are to (a) identify published evaluations of HP interventions for alcohol and/or tobacco use and/or abuse in the peer-reviewed and grey literature, and (b) assess whether a CAS perspective was applied in the evaluation design.

## METHODS

We conducted a scoping review, which is a relatively new type of research literature review that provides a comprehensive approach to summarize or map out the literature in an existing topic area (Arksey & O'Malley, 2005; Brien, Lorenzetti, Lewis, Kennedy, & Ghali, 2010). A scoping review uses a systematic approach to organize and describe information; however, in contrast to a systematic review, it is indiscriminate of study design and study quality, enabling the inclusion and review of various literature sources. The scoping method is ideal when the research purpose is to examine “the extent, range, and nature of research activity, ... [and] to identify research gaps in the existing literature” (Arksey & O'Malley, 2005, p. 21). The review was conducted in two phases, identifying HP evaluations and assessing the evaluations for a CAS perspective.

### Phase 1: Identifying HP Evaluations

#### *HP evaluation inclusion criteria*

We scoped peer-reviewed and grey HP literature that was (a) published between 1986 (the year of the Ottawa Charter on Health Promotion) and 2009; (b) an evaluation of a HP intervention for use and/or abuse of alcohol and/or tobacco; (c) an evaluation of the process and/or outcome of the program; (d) conducted, at least in part, in Canada; and (e) published in English. The checklist used in our screening process to identify eligible HP articles is presented in Appendix 1, which is based in part on the checklist for HP used by Thurston and colleagues (2003).

### *Search strategy*

Working with two experienced librarians, we developed and conducted a comprehensive search strategy. We searched seven databases (PubMed, EMBASE, Social Science Abstracts, CINAHL, PsycINFO, ERIC, and Global Health) for articles published in the peer-reviewed literature (PRL), and seven databases (Canadian Research Index, Current Controlled Trials metaRegister of Controlled Trials; Canadian Health Research Collection; ProQuest Dissertation Abstracts; EPPI Database of Health Promotion Research; U of Laval KUUC; U of York Technology Assessment [HTA] Database) for articles published in the grey literature (GL). In addition, we searched specific websites indicated by key stakeholders and cross-examined the reference lists to identify any additional relevant publications. The search terms we used were based on the key concepts related to our research question: complex adaptive systems, health promotion, evaluation, tobacco and/or alcohol use and/or abuse, and Canada. We selected Canada because it has been at the forefront of the health promotion movement (e.g., Ottawa Charter of 1986, a defining point in the development of the field). By focusing on interventions in a country that is a leader in health promotion, we could obtain meaningful and reflective information about the use of CAS in this literature. For a full complement of search terms used for the PRL and GL databases, see Appendix 2.

### *Screening process*

To determine inclusion or exclusion, we screened the retrieved articles in two stages: (a) a title and abstract review and (b) a full-article review. All articles were independently screened by at least two team members. If there was disagreement or uncertainty about inclusion or exclusion of an article at this stage, the article was retained and reviewed in the second stage. The second stage consisted of a full-article review. To ensure consistency and reliability, each article was initially reviewed by the whole team. Once interreviewer consistency was established, each article was reviewed by two team members. Any disagreement or uncertainty with regards to decisions to include or exclude an article between the paired reviewers was brought to the group and a decision was made by group consensus.

## Phase 2: Assessment of HP Evaluations for a CAS Perspective

During the screening process, we did not find any evaluations that explicitly used a CAS framework or perspective. However, many

implicitly applied at least some CAS properties. To systematically assess the use of a CAS perspective in each evaluation, we created a set of CAS indicator questions. These questions functioned as a practical checklist to systematically identify or “see” complexity in the HP evaluation designs. Each article that met the scoping review inclusion criteria following the full-text review was then reviewed again using the CAS indicator questions to assess if and how a CAS perspective was adopted in the evaluation.

### *Development of CAS indicator questions*

In consultation with researchers in the HP and CAS fields and based on the CAS literature, we developed an initial set of CAS indicator questions, which were used to identify properties of a CAS perspective in the context of HP evaluation studies. Preliminary versions of the CAS indicator questions were reviewed, revised, and refined by the team. Once CAS indicator questions were agreed upon by the team, we returned to the HP and CAS experts for feedback regarding the representation of CAS properties in the questions and the clarity and practical utility of the questions. This feedback resulted in minor revisions in wording. Table 2 presents the final version of the 9 questions, along with an explanation of how each question captures different properties of the CAS perspective.

The response options for each CAS indicator questions were *yes*, *no*, or *implied*. *Yes* indicated that the specified CAS property was clearly demonstrated and included in the evaluation design. *No* indicated that the specified property of CAS was not discussed explicitly or implicitly in the article. *Implied* reflected that a specified property of CAS was raised, recognized, discussed, or referred to in the article, but it was not explicitly used or applied in the evaluation.

### *Application of CAS indicator questions*

All published evaluations identified through the screening processed were reviewed and assessed using the CAS indicator questions. To ensure consistency of independent assessments, we began this process by reviewing each evaluation until consensus was reached regarding the wording, interpretation, and understanding of the CAS indicator questions. This enabled us to discuss the CAS indicator questions further and identify if there was a lack of clarity or differences in the interpretation of a question. Once consistency in the application of the questions was established, each evaluation was assigned to two team members who completed independent

assessments. Their independent findings were then compared and discussed for a final decision. We met on a monthly basis to discuss any discrepancies and uncertainties, and to make final decisions regarding the assessments.

**Table 2**  
**CAS Indicator Questions**

<i>Indicator questions</i>	<i>CAS component</i>	<i>How the question captures CAS</i>
1. Does the evaluation aim to gather information from diverse agents (agent = people, participants in the study – internal) or different types of stakeholders?	Agents	“Complexity” emerges from the interactions of and relationships between the different agents that exist in a system. To capture these interactions in a health promotion intervention, the evaluation design should gather information (a) from multiple individuals involved in the intervention, and (b) on the nature of the interactions between these individuals.
1b. Does the evaluation design assess the relationships between agents identified in #1?	Agents Emergence	the evaluation should gather outcomes and/or information from multiple (and relevant) agents and also assess the relationship between these agents.
2. Is learning and/or behaviour change of one or more agents (agents =study participants) measured?	Agents Adaptation	CAS are characterized by the presence of agents (study participants) who can learn and change/modify their behaviour. Behaviour change is an important measure for evaluating the effectiveness of health promotion programs. Knowledge acquisition and behaviour changes should be included as outcomes of the evaluation.
3a. Is the evaluation design flexible so that it can be modified to the characteristics/needs of the agents and/or setting where the intervention is implemented?	Emergence Co-evolution	CAS are distinguished by their dynamic nature and ability to evolve and adapt within their (changing) environment. This adaptability or flexibility includes an ability to adapt or change measurement tools or data collection procedures (e.g., variations in measurement tools for different groups). The evaluation design should be flexible or adapted to specific needs and characteristics of its agents.
3b. Does the evaluation design capture information about relationships of the agents in the study with the external context/ environment and agents not specified in #1?	Agents Emergence Co-evolution Nonlinearity	CAS are distinguished by recognition of the influence of context and agent behaviour on each other. Contextual factors refer to any variables, situated within the environment where agents function, that impact outcomes or processes. The evaluation design should aim to capture the interconnections between agents and their context and/or how the context and agents functioning within it impact each other.

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4. Is information gathered used to change or modify the evaluation design during the evaluation process?	Emergence Co-evolution	CAS are distinguished by their dynamic nature and ability to evolve and adapt within their (changing) setting. Emergence, co-evolution, and unpredictability of a system are important outcomes of system. The evaluation design needs to be flexible in order to be modifiable in response to the information gathered during data collection.
5. Is data collected at multiple time points (i.e., beyond the standard pre-post)?	Emergence Co-evolution Nonlinearity	In CAS, the focus is not only on change but also how that change occurs and patterns of change. Process-related outcomes and patterns of change. The evaluation should capture outcomes through the time dimension at multiple time points in order to see both the quality of the change and emergent or unpredictable outcomes.
6a. Are different types and/or sources of data collected to address the evaluation/study objectives?	Emergence Co-evolution Nonlinearity	At the core of the CAS is the importance of the interactions between agents and the contexts in a dynamic setting. Relationships and their context can be explored
6b. Does the analysis enable an understanding of the relationships between multiple (predictor) variables/themes?	Agents Emergence Co-evolution Nonlinearity	and analyzed using different sources and types of information and through the application of different analytic approaches or techniques. The evaluation design should include a collection of data from multiple data sources and apply analytic techniques that aim to assess relationships and the nature of those relationships.

RESULTS

Search Results

The PRL searches yielded 3,073 publications, of which 45 met the inclusion criteria. The GL searches yielded a total of 727 publications, of which 9 evaluations were included. Of the 45 evaluations published in the PRL, 4 were identified as formative, 34 were summative, and 7 presented results of both formative and summative evaluations. Of the 9 evaluations published in the GL, 4 were identified as formative, 1 was summative, and 4 presented results of both formative and summative evaluations. The 54 publications included in the scoping review are indicated with an asterisk (\*) in the reference section.

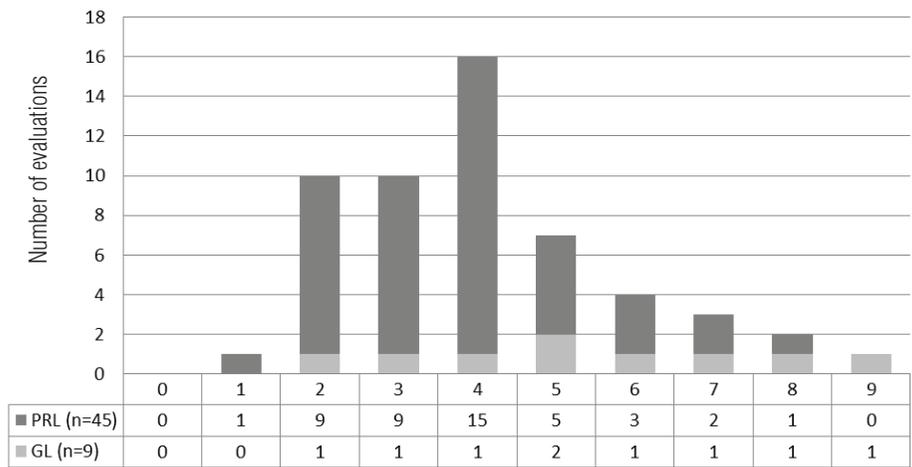
CAS Indicator Question Results

None of the reviewed evaluations explicitly used a CAS or complexity framework or design. However, our assessment using the CAS indicator questions indicated that all incorporated at least some of the CAS

properties (see Figure 1). Inclusion of CAS properties (implicitly) was variable across the evaluations, and some were more common than others (Figure 2).

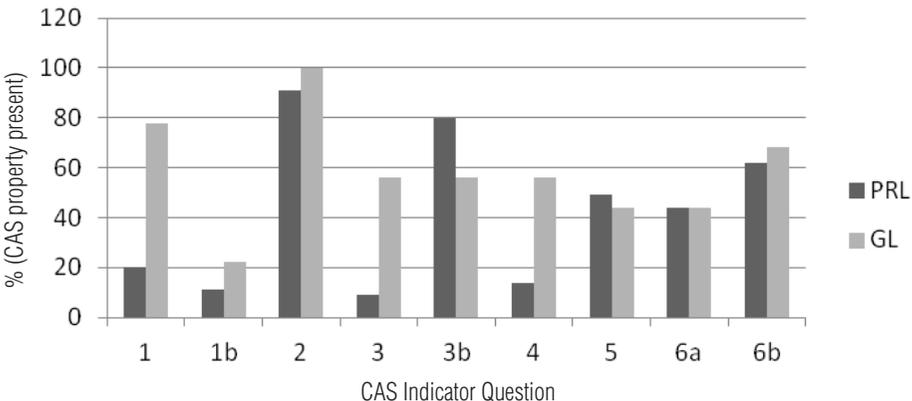
Of the 54 evaluations reviewed, only one included all of the 9 CAS indicator questions. Nine evaluations included between 6 and 8 (out of the 9) CAS indicators, and 45 included fewer than 5 CAS indica-

**Figure 1**  
**Identification of CAS Properties Using the Nine CAS Indicator Questions (#s 1–6b)**



Row 1: Number of CAS indicators identified. Rows 2 and 3: Number of CAS identified per evaluation type

**Figure 2**  
**Presence of CAS Properties in Scoped Evaluation (n = 54) Applying the CAS Indicator Questions**



tors. In the PRL, the greatest number of evaluations reflected 4 of 9 CAS indicators. The GL spanned the full range of indicators, from minimal (2 of 9) to complete (9 of 9).

Behaviour change and learning of one or more agents (the properties captured by Indicator Question 2) was the most common CAS property represented in both PRL and GL evaluations—in 91% and 100%, respectively. The relationships between agents (Question 1b) was the CAS property least commonly considered in the PRL (11%) and GL (22%) evaluations.

Differences between PRL and GL were also found in the extent to which certain properties of CAS were present. The GL was more likely than the PRL to address information from diverse agents or different types of stakeholders (78% vs. 22%), assess relationships between agents (22% vs. 11%), use a flexible research design (56% vs. 14%), and change or modify the design during the evaluation if necessary (56% vs. 9%). Evaluations in the PRL were more likely to incorporate information about relationships between agents and their external environment (80% vs. 56%). The PRL and the GL were quite similar with regards to measuring behaviour changes (91% vs. 100%), collecting data at multiple time points (49% vs. 44%), using different types and sources of data (both 44%), and enabling understanding of relationships between multiple predictive variables (62% vs. 68%). The detailed results for each CAS indicator questions are summarized in Table 3.

## DISCUSSION

Using a CAS perspective is theoretically appealing, given the complexity of HP interventions and the need for comprehensive evaluations of HP interventions. The question of how to capture this complexity in an evaluation of an HP intervention is challenging yet necessary in order to more fully understand how interventions work (or not) and why. Although there is a growing discussion on the application of complexity science in the field of health promotion, there is little information on whether and how this is being achieved. And yet this is important in learning how to apply such an approach to facilitate the ability of HP practitioners to incorporate such a perspective into their work. We identified an approach (Leykum et al., 2007) that used a scoring system to assess whether a CAS perspective was used in organizational interventions for type 2 diabetes; however, in that study the properties of CAS were not assessed individually in relation to the intervention. Therefore, we decided to undertake this

project to scope the literature and assess whether a CAS perspective was adopted, and, if so, how it is reflected in the evaluations. We developed and used a set of CAS indicator questions, to operationalize the abstract CAS properties into evaluation design language.

It is important to emphasize that our goal was not to rate the degree of complexity of the evaluations reviewed but rather to develop and apply a way to identify abstract CAS concepts in a language directly applicable to the design of HP intervention evaluations. The application of the CAS indicator questions may provide important insight into making such a determination. For example, it is clear that an evaluation where no CAS indicators were identified does not incorporate a CAS perspective. Evaluations where all CAS indicators were identified represent a design that fits within a CAS perspective, albeit often implicitly. The challenge lies in determining whether the evaluation captures the full complexity of the intervention when not all of the 9 CAS indicators are accounted for. We argue that evaluations that only consider multiple agents or only measure behaviour change are not complex designs, even though they incorporate components that are highly relevant to a complexity perspective.

**Table 3**  
**CAS Indicator Question—Detailed Results**

<i>CAS indicator questions</i>	<i>Detailed results</i>
1 and 1b: Identified the agents that were included in the evaluation and the types of relationships between the agents that were examined.	<p>15 of 54 evaluations considered different types of agents. Number of agent types ranged from 2 to 9.</p> <p>The most common number of agent types considered was 2 (in 9 of 15 evaluations).</p> <p>7 of 15 evaluations examined relationships between agents.</p> <p>Types of relationships analyzed included client-staff (most common), support-relationship ("buddy system"), peer influence, student-teacher, child/youth-parent, teamwork (e.g., staff to staff, group dynamics).</p> <p>Techniques used to assess relationships included closed-ended questions (in questionnaires), open-ended questions (in questionnaires or interviews), a combination of both, and field observation.</p>
2: Identified if learning, attitudes, and/or behaviour change, of at least one agent, is measured or considered as an outcome in the evaluation.	<p>50 of 54 evaluations measured behaviour change and/or learning.</p> <p>Types of behaviours measured (analyzed?) included smoking (e.g., amount, uptake, quitting); alcohol consumption (e.g., quantity, frequency, binge drinking); driving while under the influence of alcohol; social harm behaviour; substance use/abuse; and merchant behaviour (e.g., selling to minors, compliance with regulations).</p>

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*CAS indicator questions**Detailed results*


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	The most common behaviour change measured was smoking-related (e.g., uptake rates and quit rates).
	Learning or knowledge acquisition was measured in 3 evaluations (GL only)
3 and 3b: Identified the flexibility of the evaluation design, specifically whether it is able to adapt to specific needs and characteristics of its agents and/or context. This question also examined whether the evaluation design would be likely to capture the interconnections between agents and their context.	<p>9 of 54 evaluations described a design that was flexible or responsive to the specific characteristics of the agents and/or setting of the intervention.</p> <p>Design adaptations included providing surveys in different languages; including or excluding specific interview questions based on context-specific factors; and using iterative processes, where information gathered at each phase may be used to modify subsequent phases.</p> <p>41 of 54 evaluations examined the relationships between agents and their external environment.</p> <p>The external environments included geographic location, social and policy environments, and agents external to the intervention.</p>
4: Captured the flexibility of the evaluation design to be modified during the evaluation as the result of data collected during the evaluation.	<p>11 of 54 evaluations were modified in response to information collected during the evaluation.</p> <p>The types of modifications included regrouping participants, revising questionnaires, revising the analysis plan, excluding data, using different contact strategies, revising the research design methodology in general, revising program logic models, and weighting respondent groups for analysis.</p> <p>The most common type of modifications were regrouping of participants or changing the target group.</p>
5: Identified when data were collected (i.e., pre-post or at multiple time points) to assess whether, in addition to final outcomes, the evaluators considered how change occurred (i.e., patterns).	<p>26 of 54 evaluations measured outcomes and/or collected data at multiple time points (i.e., pre-, mid-, and/or post-intervention).</p> <p>24 of 54 evaluations measured outcomes at multiple time points pre- and/or post-intervention data collection.</p> <p>1 of 54 collected data pre-, mid-, and post-intervention (Gagne, 2007).</p> <p>The other situation where data was reported for multiple time points was for a historical trend analyses.</p>
6 and 6b: Identified whether different types and sources of data were collected in the evaluation. We also identified the type of analysis used and whether it enabled an understanding of the relationships between agents and/or variables.	<p>24 of 54 evaluations included collection of multiple data types.</p> <p>Data types included surveys, interviews, standardized outcome measures, databases, patient charts, document reviews, and observations.</p> <p>Surveys and interviews (individual or focus group) were the most common type of data collected (12 of 54), and were used in combination in 7 of the 54 evaluations.</p> <p>The most common data sources were the intervention participants, including students, children, parents, staff (e.g., teachers, clinic staff), vendors, and key informants.</p>
	<p>34 of 54 evaluations used an analytic approach that enabled an understanding of the relationships between agents and/or variables.</p> <p>These analytic approaches included multivariable regression and triangulation of data sources where each was examined for evidence to address the evaluation objective(s).</p>

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## Implications for Evaluation Design

The inclusion of CAS properties varied across the evaluations and some properties were more common than others (Figure 2); only 1 out of the 54 evaluations we reviewed incorporated a comprehensive set of CAS properties, based on our operationalization of these properties. Behaviour change and learning of one or more agents (the properties captured by Indicator Question 2) was the most common CAS property represented in the PRL and GL evaluations: 91% and 100%, respectively. This is not surprising, given that changes in behaviour or learning of new skills/behaviours are frequently desired outcomes of HP interventions, particularly those targeting smoking and alcohol use/abuse. In contrast, relationships between agents (Indicator Question 1b) were rarely assessed in the PRL (11%) and GL (22%) evaluations. This may reflect the tendency in standard evaluations to focus more on individual-level phenomena and key outcome variables (e.g., learning or behaviour change of the program participants) than on the relationships of the individuals involved in the intervention and how these impact outcomes. The interactions between agents are of central importance in the CAS perspective; evaluating these interactions may lead to a more nuanced understanding of the reasons behind the success (or failure) of interventions. As such, this may represent a key area in which evaluation approaches can be improved to better incorporate a CAS perspective. Lastly, the notion of context or setting was very important in our indicator questions. These concepts have been extensively addressed by Poland, Krupa, and McCall (2009). They identified that a context-sensitive approach sees as the objects of inquiry and intervention the physical, organizational, and social contexts in which people are found, and not just the people contained in or defined by that setting. As recognized by Patton (2011), we suggest that in future evaluations, context or setting should become a key component to be explicitly addressed in a separate question.

The differences between PRL and GL may be related to the fact that the PRL usually has strict word count limits and tends to focus on summative evaluations, which are generally based on assessing final outcomes. For example, the difference seen in Indicator Question 1 (regarding consideration of multiple agents) between PRL and GL may be because PRL articles, due to their strict word limits, are structured around the reporting of key outcome indicators; in the case of HP interventions, these are generally indicators of changes in knowledge, skills, or behaviours in program participants. Evaluations published in the GL, by contrast, are not restricted by word

count limits. They are more likely to include formative evaluations, including the assessment of program processes. The above differences suggest that an evaluator's ability to incorporate (or report on the incorporation of) a CAS perspective may also be impacted by restrictions imposed by the publishing source.

Our findings suggest that complexity concepts are incorporated, to varying degrees, into standard evaluation designs without using a formalized CAS evaluation framework. None of the evaluations we scoped explicitly applied a CAS perspective. This suggests an implicit recognition of the complex nature of HP interventions, and further supports the need for the development and application of evaluation designs that are explicitly framed within a CAS framework or approach.

### Methodological Issues

The evaluations reviewed often refer to systems or ecological approaches and to the complexity of the intervention; however, this was not always reflected in the evaluation methods that were used. For example, data analyses tended to be traditional and basic and did not use multilevel types of data analysis (e.g., hierarchical, nested, or mixed models), which could have better captured this complexity. The evaluations assessed used a wide range of methodological approaches. Although none stood out as the very best, overall we found that more sophisticated designs, in particular those that combined qualitative and quantitative evaluation methods, were more comprehensive in their assessment; furthermore, they were also better able to interpret why the interventions worked. Such designs appeared better able to capture complexity than single-method studies, due to the insights gained from using two different methodological perspectives. Multi-method or mixed methods designs often combine or integrate qualitative and quantitative approaches. In such designs, quantitative methods may be used to evaluate outcomes at a group level by means of counts and statistical analyses; qualitative methods are used to assess processes, such as the delivery of interventions. Qualitative methods also facilitate assessment of unexpected and/or difficult-to-measure outcomes of the intervention at an individual level, such as improving life skills and social skills, improving communication, and enhancing community activism. Furthermore, qualitative methods may further enrich an understanding of the relationships between agents and with the broader context. The combination of quantitative and qualitative methods also al-

lows identification of contextual factors that impact on individual behaviours (Johnson & Onwuegbuzie, 2004; Plano Clark & Creswell, 2011; Rogers, 2009).

### Drawbacks of Complexity

There are potential drawbacks to framing HP evaluations within a CAS perspective. For example, a key challenge is that such a perspective opens up the evaluation to emergence and adaptation, which are ongoing processes around which it may be challenging to set parameters without limiting or compromising results. The potential multitude of agents and their various interactions are other characteristics of a system that may be challenging to define and represent within an evaluation. This is particularly challenging within an evaluation culture that values and aims for certainty and predictive ability (requiring a high degree of control), and where the primary focus is on assessing predetermined goals.

### Challenges and Limitations

The development and use of the CAS indicator questions in our assessment of HP evaluations is, to our knowledge, the first attempt to develop a practical means of assessing the use of a CAS perspective. Although data interpretation was challenging, it was a highly useful exercise through which our team developed a greater understanding of CAS theory and a deeper sense of the challenges of translating and capturing abstract CAS concepts into evaluation methods and strategies. We recognize that there are limitations to the CAS indicator questions we developed. For example, the individual questions may not be specific enough to adequately capture some of the more abstract complexity concepts or phenomena, such as emergence and patterns.

A challenge of a different nature is that evaluations using a multi-strategy or multi-phase design often require multiple papers to fully report on the various components to capture the depth and breadth of the intervention. This is especially true for PRL, as indicated above. For such interventions, it was often difficult to find the various parts of the evaluation in the literature, as the links between the papers and/or reports were not made clear in the various publications. Explicit reference to the multiple reports or publications based on the same evaluation is needed for clear presentation of the comprehen-

sive evaluation (e.g., Health Canada, 2005; Prilleltensky, Nelson, & Valdes, 2000).

Much of the complexity literature at this time is theoretical in nature. As such, the challenge was to operationalize the properties of complexity, especially in a manner that reflects the practical realities faced by HP practitioners and program evaluators. Our aim was to ensure that the CAS indicator questions were useful in a “real world” context, and thus would allow us to move beyond the boundaries of the theoretical realm. We hope that the questions can serve as a starting point for further discussion on how to advance the practical application of CAS in applied fields such as health promotion and evaluation.

## CONCLUSION

The concepts underlying CAS, and complexity science more broadly, provide a different and innovative way of thinking about HP. The application of a CAS perspective in the evaluation of HP interventions may enable the design of studies that capture this complicated (multi- component) and complex (emergent) reality of HP (Rogers, 2009). Although theoretically meaningful, the question of how to apply CAS principles in an appropriate and practical manner is challenging. Our review can be seen as an innovative step forward in understanding complex interventions and identifying ways in which abstract CAS concepts can be applied in evaluation research. The CAS indicator questions presented and used in this scoping review made CAS more accessible at a practical level and raised awareness of its potential utility in HP research. We anticipate that they will facilitate the assessment and potential application of CAS in the evaluation of HP interventions, thereby supporting the implementation of more effective interventions.

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## Appendix 1

### Health Promotion Checklist

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#### HEALTH PROMOTION INTERVENTION CHECKLIST

- 1) Does this intervention aim to enable the target population to take control of their health?  
Yes\_\_\_\_ No\_\_\_\_ (If no, disregard the article)
- 2) Does this intervention utilize at least one of the following health promotion strategies?
  - a. Building a healthy public policy
  - b. Creating a supportive environment
  - c. Strengthening community action
  - d. Developing personal skills
  - e. Reorienting health services
 Yes\_\_\_\_ No\_\_\_\_ (If no, disregard the article)
- 3) Is this intervention directed to at least 1 of the 12 determinants of health?
  - a. Income and social status
  - b. Biology & genetic endowment
  - c. Social support networks
  - d. Personal health practices & coping skills
  - e. Education
  - f. Healthy child development
  - g. Employment & working conditions
  - h. Health services
  - i. Social environments
  - j. Gender
  - k. Physical environment
  - l. Culture
 Yes\_\_\_\_ No\_\_\_\_ (If no, disregard the article)
- 4) Does this intervention have an evaluation component?  
Yes\_\_\_\_ No\_\_\_\_

## Appendix 2 Search Terms

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### SCOPING REVIEW - KEY WORD SEARCH STRING

(health promot\* OR behaviour change OR behaviour change OR empower\* OR enabl\* OR (build\* AND capacity) OR health improv\* OR supportive environment OR community action OR personal skills OR public policy OR educat\* OR aware\* OR prevent\* OR harm reduc\*)

AND

(intervention OR program OR project OR evaluat\* OR evaluation study OR program evaluation OR assessment OR randomized controlled trial OR cohort study OR efficien\* OR effective\* OR impact OR benefit OR outcome OR success\* OR pretest OR pre-test OR posttest OR post-test OR monitor\* OR survey\* OR delphi OR longitudinal OR case stud\* OR RCT OR case control\* OR repeated measure\* OR quasi-experiment\* OR Time series OR non-equivalent group design\* OR within group design OR chart review\* OR observation OR qualitative OR naturalistic OR mixed method\* OR combined method\* OR questionnaire\* OR interview\* OR cross-sectional OR Social Network Analysis OR SNA OR secondary analysis OR existing data)

AND

(alcohol OR tobacco OR nicotine or cigarette or smok\*) OR (alcoholism OR smoking cessation))

AND

(Canada OR Alberta OR British Columbia OR Saskatchewan OR Manitoba OR Ontario OR Quebec OR Prince Edward Island OR New Brunswick OR Nova Scotia OR Newfoundland OR Nunavut OR Yukon OR Northwest Territories)

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