Obesity is widely recognized as a complex problem emerging from a system composed of many diverse, interacting variables. Several factors make the obesity system difficult to shift, including but not limited to the presence of feedback loops and delays; an abundance of nonlinear, overlapping interdependencies; and the heterogeneity of individuals and organizations. Policymakers and planners have responded to the obesity epidemic by producing a large number of frameworks, strategies, and action plans. Although past efforts have been criticized for emphasizing individual lifestyle change as the solution, recent efforts have embraced socioecological models of intervention, emphasizing the obesogenic environment and its impact on individual weight gain. The many options available to policymakers have the potential to result in what Lang and Rayner termed a “policy cacophony” of noise drowning out effort.

Efforts to shift the systems that support the emergence of chronic disease and obesity are starting to benefit from a focused effort to apply systems science, as has been done with other pressing public health issues such as tobacco. Obesity, tied up with difficult ideological and political questions regarding responsibility and stigma, is a particularly wicked social problem for which reductionist science may be less helpful. Systems science can complement socioecological models of health promotion by examining not just the causes of obesity but also interactions across its contributing subsystems. The UK government’s Foresight program contributed to the perception of obesity as a complex problem with the development of an obesity system map highlighting the diversity of factors involved in subsystems such as food production and consumption, individual physical activity and the physical activity environment, social and individual psychology, and physiology. The heuristic value of the Foresight map in demonstrating the complexity of obesity and the interdependencies between the system’s variables is an example of a systems science tool that may help to advance the conversation about what actions need to be taken.

Although the Foresight map helps to focus dialogue on the complex nature of obesity, it does not immediately lead to discussion of solutions appropriate for this complex problem. We recently developed a systems science framework that may be a useful and accessible means of operationalizing systems thinking toward solutions. The intervention-level framework (ILF) was adapted from Donella Meadows’s list of 12 places to intervene in complex systems. Meadows, a pioneering environmental scientist, spent decades analyzing the complexities of economic growth and environmental sustainability, and she grew frustrated with the unintended consequences that resulted when simple solutions were applied to complex problems. We collapsed the original 12 points of intervention into 5 more mutually exclusive levels that retain all of the original ideas but allow for the sorting of content in a reproducible fashion. These levels account for system operation at the levels of paradigm, goals, system structure, feedback and delays, and structural elements. To date, the ILF has been used in framework analyses of content concerning actions to improve food systems, wherein it was useful in elucidating points of conflict and convergence to make them more healthy, green, fair, and affordable.

In this article, we explore the application of the ILF to the obesity system by analyzing recent strategies and reports aimed at influencing policy and planning. Our interest was in developing a deeper, more integrated understanding of how best to act in addressing the complex problem of obesity. Using a systems lens, we sought to advance our understanding of the various system levels and the specific interventions required to support large-scale change. We also sought to further the application of systems-based frameworks in the analysis of complex health problems in a manner accessible to public health practitioners and policymakers lacking expertise in systems science methodologies.

**METHODS**

We located obesity strategies and policy documents developed by and for North...
American governments through online searches and recommendations from experts. We also searched academic repositories for documents containing population-level recommendations for obesity prevention and control. Rather than producing an exhaustive analysis of obesity strategies, our aim was to explore the utility of the ILF by identifying a rich set of recommendations garnered for a variety of purposes from decision-makers working in different environmental contexts. Therefore, we selected 12 documents for analysis: 9 strategies or reports written by or for governments or health authorities in the United States and Canada,17-25 1 Cochrane review of interventions to prevent childhood obesity,26 and 2 reports produced by the Institute of Medicine (IOM).14,27 We prioritized documents aimed at the national level for the United States and Canada and provincial-level documents from Canada only. We also prioritized comprehensive strategies that presented novel frameworks or approaches to obesity (see, e.g., From Weight to Well-Being18 discussed in our subanalysis).

All documents were published between 2004 and 2013, and 7 focus on childhood obesity. We used 2 sets of codes to evaluate elements of complex systems design within the scope of each document. We based the first set of codes on variables listed in the Foresight Obesity Systems map, with new codes added to account for variables not described in the map but common to obesity strategies. The final taxonomy included 30 variables organized around 4 subsystems: social and individual psychology, food production and consumption, physiology and clinical care, and physical activity. Where appropriate, data could be assigned more than 1 code, so total percentages could be more than 100%. We coded recommendations falling outside these predetermined categories using thematic descriptions driven by the data. We generated the second set of codes using the 5-level ILF (Box 1). Two researchers coded the recommendations and discussed differences until consensus was reached. We included 703 items in the final analysis once we removed recommendations deemed uncodable (n = 45), usually because of unfamiliar name and reference sources.

We conducted our analysis in 3 stages. In the first stage, we assessed quantitative distributions by ILF and Foresight topic to gain a broad overview of the data. In the second stage, we conducted a deeper examination of the data by ILF level, adapting the early-stage methods of framework synthesis28 to summarize and identify the type of recommendations that make up the various levels of system function. In this stage, we continuously incorporated data into a matrix based on our a priori frameworks. We summarized homogeneous content on the basis of categories of intervention type that we identified inductively from the data, with the aim of capturing a broad picture of the types of interventions and content that made up each level of system function. For the third stage, we selected 3 documents from our data set and conducted an independent nonpro document comparison such that we could compare and contrast recommendations from all 3 documents according to ILF level (Table 1).

### Results

Figure 1 presents the relative distribution of recommendations coded by Foresight topic for data from all 12 documents and for each of the 3 documents selected for more in-depth analysis. Quantitative distribution of coding by topic category demonstrated that the majority of focus in the reports was on changing the key determinants of energy imbalance: improving diets (42%; n = 294) and increasing physical activity (31%; n = 221). In the food production and consumption category, mentions of changing individual behaviors through interventions such as disincentives and incentives in the food environment and health education were most frequent (n = 117), followed by measures related to improving food access in underserved communities.

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**Description of Intervention Level Framework**

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paradigm</td>
<td>System’s deepest held beliefs</td>
</tr>
<tr>
<td></td>
<td>Source of system’s goals, rules, and structures</td>
</tr>
<tr>
<td></td>
<td>Difficult to intervene at this level but can be very effective</td>
</tr>
<tr>
<td>Goals</td>
<td>Targets that conform to the system’s paradigm and need to be achieved for paradigm to shift</td>
</tr>
<tr>
<td></td>
<td>Actions at this level can change aim of the system</td>
</tr>
<tr>
<td>System structure</td>
<td>Interconnections between system elements and subsystems</td>
</tr>
<tr>
<td></td>
<td>Actions at this level will shift the system structure by changing system linkages or incorporating novel elements</td>
</tr>
<tr>
<td>Feedback and delays</td>
<td>Allows the system to regulate itself by providing information about the outcome of different actions back to the source of the actions</td>
</tr>
<tr>
<td></td>
<td>Actions at this level can create new feedback or increase gain around existing loops</td>
</tr>
<tr>
<td>Structural elements</td>
<td>Subsystems, actors, and physical elements of the system</td>
</tr>
<tr>
<td></td>
<td>Easiest level at which to intervene</td>
</tr>
<tr>
<td></td>
<td>Many actions at this level are usually required to create system-wide change</td>
</tr>
<tr>
<td>Content</td>
<td>WH</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-----</td>
</tr>
<tr>
<td>Paradigms (deepest held beliefs)</td>
<td>None stated</td>
</tr>
<tr>
<td>Goals (the targets)</td>
<td>Look for opportunities to base policies and practices on current scientific evidence. Achieve a childhood obesity rate of 5% by 2030.</td>
</tr>
</tbody>
</table>

Implications for Intervention and Policy Design
May be explicitly stated (PHSA, IOM) or inferred from stated goals or other system activities. Represent the desired system’s underlying beliefs regarding health and its orientation toward solutions (see IOM, e.g.). Warrants consideration because it has potential to guide day-to-day thinking, behaviors, and norms at lower levels of system activity. Outcome goals such as targets for obesity rates (WH) appeal to leadership but should be considered in light of system influence, potential unintended consequences, and subjectivity to system feedback and delays. Process goals that set targets for system behavior (IOM, PHSA) push thinking about shifting norms and culture to produce healthier outcomes. They may also emphasize relationships and information flow, which can in turn be supported by action at the structural level. Actions designed to support relationship goals will differ significantly from actions intended to primarily support population weight reduction.
| Structure (across the system) | Incorporate more fresh food in school meals by connecting local growers to schools. | Health care leaders should advocate for strategies that improve physical activity and nutrition resources for patients and communities. Cross-sectoral collaborations to develop private funding for healthy food retailing in undeserved areas. | Share promising practices on whole-of-government and intersectoral approaches. Include fields such as anthropology, sociology, nursing, community psychology, arts and culture, and urban design to enable framing obesity as a complex sociocultural issue rather than a biomedical one. | The relatively low number of activities coded as this level suggests opportunity for more engagement with cross-sectoral activity. Activities here emphasize information flow, knowledge transfer, and relationship building (IOM, PHSA). They can also relate to shifting material conditions across the system, such as influencing supply and demand (WH). Closely linked to system goals. Can include traditional evaluation of policy and feedback in clinical settings (WH) or may reflect process-oriented goals regarding mental health and wellness (PHSA). Planners may attempt to affect feedback loops within the system (such as the IOM increasing healthy food production) with lower level activities built in to encourage positive feedback (by increasing healthy food consumption, in the case of the IOM). Presents opportunities for innovation in evaluation design and use of indicators for monitoring, as in the case of the PHSA emphasis on health equity indicators. |
| Feedback and delays (loop dynamics) | Evaluate sales taxes on less healthy, energy-dense foods. Evaluate targeted subsidies on purchases of healthy food through nutrition assistance programs. Pediatricians calculate children’s BMI and provide information to parents about how to help their children achieve a healthy weight. | Develop policy options for promoting increased domestic production of healthy, underconsumed foods. Evaluate evidence on the relationship between agriculture policies and the US diet. | Create policies and reward systems that focus on life balance. Fund and encourage health impact assessment within all government policies. Collect, monitor, analyze, and share health equity and population health indicators. | Continued |
Recommendations also addressed marketing practices targeting children (n = 19), nutritional labeling on food products (n = 18), and improving the nutritional quality of processed foods (n = 15). Physical activity recommendations included strategies to increase population-level activity (including building social supports and conducting social marketing campaigns; n = 96), changes to improve the built environment (n = 44), and increasing access to opportunities for activity through the opening of facilities and parks (n = 33). Schools were also mentioned as a focal point for increasing physical activity through daily activity or improved physical education (n = 23).

Recommendations that mentioned aspects of social and individual psychology made up 15% (n = 107) of the data set. The majority of these addressed weight bias, bullying, and disordered eating. Physiology and clinical care recommendations made up 14% (n = 101) of the data set. These recommendations most commonly addressed breastfeeding and prenatal care for mothers (emphasizing healthy weights for mother and baby; n = 45) and health care services (n = 42). Of the recommendations, 21% (n = 149) mentioned whole system outcomes such as obesity rates or the measurement of physical activity or dietary activities as indicators of system function. The IOM report and White House strategy had a higher-than-average focus on food production and consumption, whereas the PHSA report's focus on this area was lower than the others. The PHSA report also had a disproportionate emphasis on individual and social psychology, reflecting the document's focus on well-being and mental health in relation to obesity.

Table 1 displays data from all 12 documents coded for ILF level compared with each of the 3 documents in our subanalysis. Recommendations coded at the level of structural elements were the most common (76%, n = 533). Examples of such recommendations include:

- **Improve food and physical activity environments, especially in early childhood settings.**
- **Improve food and physical activity environments.**
- **Conduct participatory research and policy development, engaging people with weight-related issues.**

Activities at this level are influenced by regional and local population needs, and the evidence and informants consulted. For example, targeting sugar-sweetened beverage reduction (IOM), for example, is not universal in obesity strategies.

Activities at this level involve interventions that address multiple levels of the ILF framework. For example, interventions to improve access to healthy food in underserved communities and access to physical activity and services for populations with physical activity for populations with childhood settings. The IOM report and White House strategy had a higher-than-average focus on food production and consumption, whereas the PHSA report's focus on this area was lower than the others. The PHSA report also had a disproportionate emphasis on individual and social psychology, reflecting the document's focus on well-being and mental health in relation to obesity.

Note. BMI = body mass index; ILF = intervention level framework; IOM = Institute of Medicine; PHSA = Provincial Health Services Authority; WH = White House. Contents may be paraphrased from original documents.

**TABLE 1—Continued**

<table>
<thead>
<tr>
<th>Structural elements (subsystem specific)</th>
<th>Activities at this level are influenced by</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Improve food and physical activity environments,</strong> especially in early childhood settings.</td>
<td><strong>Improve access to healthy food in underserved communities and access to physical activity and services for populations with overweight and obesity.</strong></td>
</tr>
<tr>
<td><strong>Improve access to healthy food in underserved communities and access to physical activity and services for populations with overweight and obesity.</strong></td>
<td><strong>Engage public in discussion about environmental and policy changes.</strong></td>
</tr>
<tr>
<td><strong>Conduct participatory research and policy development, engaging people with weight-related issues.</strong></td>
<td><strong>Support translation of scientific evidence and best practices into local practice.</strong></td>
</tr>
<tr>
<td><strong>Support translation of scientific evidence and best practices into local practice.</strong></td>
<td><strong>Act to reduce weight bias in the population and increase body size diversity acceptance.</strong></td>
</tr>
<tr>
<td><strong>Act to reduce weight bias in the population and increase body size diversity acceptance.</strong></td>
<td><strong>Encourage clinical treatment without a focus on weight and address stigmatizing practices by professionals.</strong></td>
</tr>
<tr>
<td><strong>Encourage clinical treatment without a focus on weight and address stigmatizing practices by professionals.</strong></td>
<td><strong>Use holistic approaches to improving diet and increasing physical activity.</strong></td>
</tr>
<tr>
<td><strong>Use holistic approaches to improving diet and increasing physical activity.</strong></td>
<td><strong>Engage public in discussion about environmental and policy changes.</strong></td>
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<tr>
<td><strong>Engage public in discussion about environmental and policy changes.</strong></td>
<td><strong>Support translation of scientific evidence and best practices into local practice.</strong></td>
</tr>
</tbody>
</table>

Activities at this level are influenced by regional and local population needs, and the evidence and informants consulted. For example, targeting sugar-sweetened beverage reduction (IOM), for example, is not universal in obesity strategies. Structural elements can be expanded in right of higher-level activities to identify how they might support or be supported by them.
We coded 12% (n = 84) of recommendations as goals, which identify either measurable targets, such as rates of obesity or other indicators of healthy lifestyles, or aims for improving some aspect of system function, such as the achievement of walkable communities or stronger social relationships with regard to health. We coded 4% (n = 30) of recommendations as system structure changes and 6% (n = 40) as feedback. Activities coded as system structure included efforts to build collaborations across subsystems, thereby forging connections between new parties and expanding the boundaries of subsystems. The most common types of recommendations coded as feedback were calls to evaluate programs or services or conduct surveillance of obesity rates or individual body mass index.

We coded only 2% (n = 11) of recommendations as paradigms. The relative lack of recommendations at the level of paradigm is partly attributable to our data extraction process, in that including only demarcated recommendations may have excluded some statements in the bodies of the documents that would otherwise be coded as such. From those paradigms that were coded within recommendations, we found that they represented 3 general foci for addressing obesity: (1) an equity lens emphasizing the social determinants of health; (2) a socioecological approach, wherein it is believed that individual choices can be influenced by changes to the external environment; and (3) the concept of flourishing, or moving beyond obesity as a focus and toward overall health and the active promotion of mental well-being.

Figure 2 also highlights differences in ILF distribution among the 3 documents selected for closer analysis. The White House strategy had a higher percentage of structural elements and a lower percentage of goals and system structure than the general average. Distribution of the IOM report contents was more in line with the collected average. The PHSA report appeared to be more goal and paradigm oriented than the other documents and the collected average. To examine how the recommendations in each document may contribute to the overarching complexity of design and approach of each strategy, we synthesized and summarized the contents in an ILF framework. A selected sample of this analysis is presented in Table 1.

DISCUSSION

Our analysis suggests that using the ILF to sort and examine recommendations by system level is useful in bringing to the surface how the complexity of obesity is addressed within policy documents. The White House strategy, for
example, made no mention of obesity’s complexity. Its recommendations were guided not by a paradigm but by the goal of “solving childhood obesity within a generation.” and its recommendations were skewed toward the lowest level of system function. The IOM report differed in that it was explicitly grounded in a systems perspective. The PHSA report also recognized the complexity of obesity as a multifaceted issue resulting from not generate unintended consequences. The stronger orientation of the latter 2 documents toward planning at the level of goals and system structure may reflect a greater orientation toward a whole-systems approach to obesity.

The majority of recommendations for all documents were coded at the level of system elements, the level of system function at which the majority of concrete work in dealing with complex problems takes place. Taken together in a coordinated effort, these activities have the potential to integrate systems science into planning. Paradigms are inherently tied up with social values and cultural meaning, which are hotly contested topics with regard to obesity. The metaphors that stem from paradigms are also powerful predictors of policy support and are closely tied to the framing of responsibility that occurs in public discourse regarding obesity.

The documents discussed here represent a continuum of approaches to obesity as a social issue (Table 1). These range from a socio-ecological model emphasizing activities at the level of structural elements (White House), to a systems-based approach more firmly grounded in shifting the higher system drivers of obesity at a social level (IOM), to a paradigm-shifting lens wherein the societal response to obesity is seen as potentially more problematic than the condition itself (PHSA). Planning interventions using the ILF may encourage policymakers to engage with the complexity of the current debate regarding the paradigms guiding obesity as a public health and social issue.

Thinking seriously about paradigms can also help planners address what Meadows referred to as common system traps, such as “seeking the wrong goals.” Activities at the goal-setting level have considerable power to shift system dynamics by legislating or mandating which variables will be monitored for reporting. The process of framing the goals dictates the type of data collection that interventions will be designed to support. Therefore, success and failure in achieving goals is highly interdependent with feedback mechanisms and delays.

Situating system activities within the ILF may help decision-makers with design, evaluation, and knowledge transfer planning in light of these interdependencies. For example, evidence has suggested that outcome goals (such as targets for obesity reduction rates) may fall into the system trap of being the wrong goals. Not only does this particular goal fail to account for the sensitivity of system behavior to natural feedback loops, but it can also produce unintended consequences. A recent survey of public health interventions aimed at influencing energy balance in individuals found that the models underpinning efforts were simple and did not account for the feedback mechanisms identified in biochemistry and physiology. As such, many interventions were deemed failures in spite of potential success in improving health outcomes overall. Setting unrealistic goals regarding weight loss targets can poise both individuals and populations for failure, whereas process goals such as those set forth in the IOM report (i.e., “Make physical activity an integral and routine part of everyday life”) prompt a deeper examination of environments and opportunities to leverage change within them.

A stronger understanding of the interrelationships between feedback and goals, informed by systems science, may assist policymakers in formulating goals that speak to system processes and the concrete actions needed to be taken to make strategic shifts. Feedback mechanisms that are currently built into strategies often emphasize evaluation of recommended interventions, such as taxes and subsidies aimed at improving dietary habits (White House strategy). The PHSA report ties feedback to advocacy for a health-in-all-policies approach and to broader indicators of health and well-being, such as equity. This approach aligns with the document’s goals and paradigms and reflects a larger paradigm shift taking place as a growing number of policy documents address the social determinants of health.

The IOM report presents an example of moving beyond thinking of feedback at the level of monitoring system function (i.e., the success or failure of interventions or intended outcomes) and toward building feedback into a subsystem itself by seeking to affect the supply-and-demand relationship of healthy food production. Serman noted that a failure to focus on feedback in policy design has critical consequences, prompting us to reconsider the role of feedback and delays in future planning. This approach may help drive the use of novel approaches in assessing best practice and evaluation design. For example, the field of developmental evaluation calls for the incorporation of principles from systems thinking for optimal alignment between evaluation practices and the tenants of complex science.

Activities aimed at the level of system structure have the potential to shift both the physical components of a system and the flow of
information among its players. The White House strategy recommendation that schools, a major consumer of food products, be connected directly to local growers links the food production and consumption subsystems and has the potential to shift the laws of supply and demand that govern the food system. Cross-sector collaboration across subsystems also has the potential to network like-minded social movements and synergistically increase their impact while potentially addressing the system trap of policy resistance, which Meadows suggested is partly attributable to the competing interests of system actors. The IOM reimagined and extended the role of players in the obesity system as health care professionals acting as community advocates. The PHSA similarly extended the boundaries of subsystem activity by seeking to broaden the research base informing obesity policy to steer it away from a biomedical paradigm. Theorists have argued that changes in the obesity system will ultimately be grounded in shifting social norms and cultures, improving the dissemination of knowledge and innovation throughout system networks through activities targeting the system structure level may contribute to this shift.

**Limitations**

As noted previously, our data set was not comprehensive. Additionally, our inclusion of demarcated recommendations had some limitations, particularly when it came to locating goals and paradigm statements. These limitations were potentially mitigated by efforts to consider these challenges while conducting the more in-depth portion of the analysis, which may result in the qualitative results being more affected by these approaches than the quantitative results.

**Conclusions**

Complex public health problems such as obesity indicate the need for systems science study designs for research and training in public health. We have developed the ILF as an analytic and heuristic tool that may be helpful in planning for interventions aimed at complex social and public health problems. This study demonstrates the value of a systems perspective and how use of a tool such as the ILF can provide a deeper insight into changes required at multiple levels of the system. The term “holistic approaches” usually makes reference to either the inclusion of multiple sectors or strategies that include actions that range from individual to population levels. By applying the ILF to solutions design, we can optimize strategies to include interventions that range from targeting specific groups of people and a specific behavior to affecting the deeply held beliefs that underlie the actions of actors throughout the system.

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**Contributors**

L. M. Johnston, C. L. Matteson, and D. T. Finegood conceptualized the study and analysis plan, interpreted findings, and revised article draft. L. M. Johnston managed and analyzed the data. L. M. Johnston and C. L. Matteson drafted the article.

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**Human Participant Protection**

Human participant protection was not required because no human participants were involved in this study.

**References**


