A Complex Systems Approach to Perceptions of Obesity in Service Users, Health Care Practitioners and Policy Makers

by

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Abstract

Current research supports the complexity of obesity and the need for collaboration between sectors to create change, yet there is still a pervasive perception that individuals are to blame for their weight.

The Applied Research Collaborations for Health Research group, Dalhousie University, Halifax, Nova Scotia conducted key informant interviews to examine the beliefs of service users, health practitioners and policy makers regarding obesity. These data were used to conduct a secondary analysis using qualitative analysis methodology to explore perceptions of obesity within a complex systems framework.

Three major themes were common among participant groups. There was a desire for immediate results, a focus on individual blame and a resultant tension for change. Exploring these themes using a complex system lens demonstrated the importance of engaging contradictory groups to work together in a collaborative framework. Aligning paradigms across the treatment spectrum is crucial to working towards solutions that embrace complexity.

Keywords: obesity; complexity; systems thinking; paradigms; feedback; interpretive description; policy; treatment; patient care experience
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1. Introduction

1.1. The burden of obesity

Obesity is often characterized as an important public health issue facing Canadians, yet there is still no clear defined solution for reducing rates of obesity across the country or indeed elsewhere. According to measured height and weight data from 2007 to 2009, over one in four Canadian adults is obese (1,2). While the rate of increases in obesity has slowed down slightly in the last few years, the numbers are continuing to rise, particularly in the Maritime provinces (3). Numbers for overweight and obesity are about 10% higher in Nova Scotia compared to the national average (2). This is a problem because obesity is a significant risk factor for chronic diseases and poses a considerable strain on healthcare resources (4). In 2006, the estimated total costs associated with overweight and obesity in Canada were $6.0 billion (5). The influence of obesity on health is largely accepted in the research and healthcare communities, however the causes and solutions are controversial, and not yet fully understood (6).

1.2. Obesity is a complex problem

Research has predominantly focused on biomedical models of obesity in an attempt to isolate specific physiological causes at the level of the individual (7). According to the biomedical perspective, obesity is the result of a chronic energy imbalance driven by individual behaviour where energy intake exceeds energy expenditure over time (8). Obesity research has progressed from an individual focus to a socio-ecological view of obesity, in which individual choices
are influenced by external forces in the environment. The socio-ecological model takes economic, cultural, and political determinants into consideration and suggests that solutions to obesity should include shaping the environment to better support healthful decisions among individuals (4,9). The *International Obesity Task Force* (IOTF) presents these external forces in a causal web that illustrates their proximity to the individual; from the home, school, workplace setting to the more distal community, national and global setting (4,10). This diagram demonstrates that multiple causes contribute to obesity, however the ecologically nested model of causation still presents obesity in a linear model and thereby fails to account for certain characteristics of the obesity problem that are better understood through the application of complex systems thinking (4,11,12).

Complexity science refers to a relatively new field of study that investigates how relationships between parts of a system give rise to the collective behaviours of a system (13). It is an interdisciplinary field that has been employed in many different specialties, including agriculture, chemistry, biology, anthropology, business and others (14). Applying complexity science to obesity involves understanding obesity as a property emerging from a complex system made up of multiple elements, interconnections among these elements, feedbacks and discontinuous non-linear relationships (6). The following discussion will expand on the key characteristics of obesity that make it complex and the potential for complex systems thinking in the development of effective policies and interventions to combat the obesity problem.

One of the major challenges of addressing complex problems involves the heterogeneity among the systems’ actors and subsystems and the goals and motivations of these various parts (15). The Foresight group effectively frames obesity as a problem emerging from a complex system made up of over 100 variables and 300 interconnections clustered in seven sub-systems that influence energy balance (16). The subsystems include food consumption, food production, social psychology, individual psychology, physiology, individual
physical activity and the physical activity environment (16). The variables within these sub-systems can range from an individuals' genetic makeup, to the quality of food formulation to safety of transport (16). Furthermore, each of these sub-systems involves a diverse range of agents with differing goals, motivations, modes of decision making and types of connections to other actors (15). The causal loop diagram highlights the complex interplay between environmental, social and biological causes of obesity from the population level down to the individual level and reflects the diversity of factors that can affect food and physical activity environments (16).

The Foresight map illustrates the broad range of influences on individual behaviour and subsequent relationship to obesity. It also demonstrates the non-linearity that is present throughout these relationships (6,10,15). According to the energy balance equation a decrease in energy intake should lead to weight loss. However, variability among other factors such as fuel selection, energy expenditure, genetic and epigenetic mechanisms and biological bases for food preferences make the body weight response non-linear (10,17–19). The Foresight map successfully communicates this non-linearity and the difficulty with trying to shift the emergent property of obesity at the individual and population level. It shows that a simple solution targeting individual behaviour such as ‘eat less, move more’ will have little effect on the overall system because it addresses only a small fraction of the many interconnected variables involved (20).

An important attribute of complex systems and the obesity problem in particular is the presence of feedback loops. The Foresight map illustrates more than one hundred feedback loops where actions by one element of the system in turn affect the flows into or out of that same element (10,21). Feedback loops in a complex system can drive change (positive or reinforcing feedback) or lock in system behaviour and stifle change (negative or balancing feedback) (10,20). There are many reinforcing and balancing feedback loops that contribute to obesity. For example, the demand for convenience food increases the production
of convenience food and consequently reduces individual skills around food preparation (10). Non-linearity and feedback in complex systems suggests that small changes at either the micro or macro level can have large impacts on the system (15).

Other key characteristics that distinguish obesity as a complex problem include: self-organization and adaptability, interdependence between systems components, and unpredictability (10,22). The system map reveals that an individual's food choices can be influenced by such forces as the availability of food, the price of food, the biological responses to the reward value of food and the cultural meaning of food and these factors are continuously changing and evolving (23). Furthermore, systems typically have “fuzzy” boundaries, such that pushing on one part of the system can have unintended consequences in other areas or systems (24). For example, public health messaging intended for the entire population may increase the knowledge and adoption of recommendations among higher socio-economic groups but may unintentionally increase the knowledge gap and reinforce social disparities (25). Relationships are even more difficult to predict in complex systems due to confounding time delays between actions and outcomes (26). This is true regarding individual weight gain as well as population level weight loss. The length of time required to see significant results inevitably complicates prevention efforts (26).

1.3. The meaning of applying a complex systems lens

While the complexity of obesity can be overwhelming in its’ entirety, recognizing the diverse set of elements that contribute to the obesity problem is crucial for working towards solutions that can sway the complex system towards a healthier population (15). Complex systems approaches generally take into account both the influence of causal variables at multiple levels and the interrelationships among these variables (6). Applying a complex systems lens to
obesity may therefore prove to be a promising strategy for public health to alleviate some of the ambiguity in taking action as it embraces biomedical, socio-ecological and complex models to address obesity.

Research suggests that solutions to complex problems should take a more holistic approach that is integrative and multidisciplinary (10,14,27). Gortmaker et al. (19) explain that to address obesity, solutions should include diverse interventions that combine initiatives to influence energy balance, structural actions to inform and enable change and amplifiers to address social norms. While the call for action using complex systems strategies is increasing, there are multiple frameworks and methods to choose from and implementation of these methods may prove challenging. Bar-Yam proposes that even in very complex systems, people can solve complex problems when they work together effectively (13). Suggestions for creating solutions include recognizing that individuals matter, aiming to match the capacity of the individual to the complexity of the task, forming cooperative teams and creating competition (13). Wheatley and Frieze suggest that emergence is essential to creating change in a system (28). Emergence occurs as a result of connections and networks between like-minded thinkers (28). These networks grow into communities where new knowledge and ideas are quickly shared and potentially lead to greater system change (28).

As a leading systems thinker in the 1990’s, Donella Meadows proposed twelve leverage points to intervene in a system to change “the structure of systems to produce more of what we want and less of what is undesirable” (21). Awareness and manipulation of these points could facilitate action across the levels (21). Meadows listed the leverage points in order of their potential impact and their difficulty of implementation. The bottom levels focus on the individual ‘constants, numbers and parameters’ that are relatively easy to change yet have the least potential impact (21). The middle levels include the goals of the system and feedback loops and delays (21). At the highest level, the paradigm is a shared unstated assumption under which a system operates and is the most
difficult, yet also the most effective change to trigger (21). This framework is unique in that many complex systems approaches assist with thinking about the problem, whereas leverage points help researchers take action by targeting specific avenues for creating novel solutions tailored specifically to address the components of complex problems.

1. Power to transcend paradigms
2. Paradigm that the system arises out of
3. Goals of the system
4. Power to add, change, evolve, or self-organize system structure
5. Rules of the system
6. Structure of information flow
7. Gain around driving positive feedback loops
8. Strength of negative feedback loops
9. Length of delays
10. Structure of material stocks and flows
11. Size of buffers and other stabilizing stocks
12. Constants, parameters, numbers

**Figure 1 – Meadows Twelve Leverage Points to Intervene in a System(10)**

Meadows described her list of places to intervene as a work in progress and an invitation to think more broadly about systems change and solving complex problems (21). The power and potential of this framework inspired the Finegood lab to create a condensed version called the Intervention Level Framework (ILF) (29). The ILF was developed with the intention of applying it to obesity to provide insight into the various changes needed to effectively reverse the obesity epidemic (10). This framework was an integral part of the analysis technique for this work and is further discussed in the methods.
Despite the variety of approaches to complex systems frameworks, the importance of relationships and the sharing of information between individuals and networks remains a unifying theme (13,30). The various concept maps and frameworks currently available help to visualize why these relationships and interconnections are essential to working towards solutions to obesity. The various approaches produce not only universal rules about system function, but also provide methods for dissecting complex problems and the key system elements and relationships that may be glossed over with a simple or complicated perspective regarding the issue. These methods also emphasize the need to recognize that a problem is complex as a critical first step to working towards solutions.

1.4. Overview of obesity treatment and prevention

Despite the evolution in our understanding of obesity as a complex problem and the emergence of complex systems based strategies, current approaches to treatment and prevention tend to focus on obesity as a simple problem solvable by addressing individual behaviours (20). Interventions to address obesity have typically encouraged individuals to ‘eat less and move more’, thereby tipping the energy balance equation to promote weight loss (20,31).

1.4.1. Clinical treatment

In the clinical setting, the *Canadian Clinical Practice Guidelines on the Management and Prevention of Obesity* provide guidance to clinicians on treatment options for obese patients (32). Clinical treatments include behavioural, cognitive, surgical and pharmaceutical therapies. Pharmacotherapies have produced modest weight loss in patients, however more research is needed due to long-term health consequences and safety concerns (33). Bariatric surgery can be highly effective for weight-loss, but access for patients can be limited due
to long wait lists, high costs and variable follow-up care (34). Additionally, the invasive nature of surgery can result in a range of adverse events and mortality related to the procedures (34,35). Pharmaceuticals and bariatric surgery are also infrequently recommended by physicians as a weight loss approach (36). This may be partially attributable to the controversial discourse around the causes of obesity and the belief that individual willpower and the energy balance equation are the root causes of obesity (37). Given the limitations of pharmaceutical and surgical approaches, behavioural or lifestyle interventions remain the foundation of obesity treatment (32).

Behavioural treatment of obesity involves helping individuals learn healthy behaviours that will help guide their eating or physical activity habits. Although an individuals’ experience with behaviour modification is inherently complex due to the wide range of variables affecting behaviour, addressing obesity at the level of the individual has shown some success (38). The American Clinical Guidelines for the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults reviewed 22 randomized controlled trials using behaviour therapy in obesity treatment and concluded that behaviour therapy can produce 10% weight reduction over 4 to 12 months (39). While no specific behaviour therapy has been found to be superior, studies suggest that longer treatment time increases weight loss maintenance (39,40). Core features of behaviour modification for obesity based on recommendations from the World Health Organization include but are not limited to: self-monitoring, social skills, goal setting, changes in eating habits, relapse prevention, changing the environment and positive reinforcement (41–43). This extensive range of variables implies that treatment should be comprehensive in order to address the complexity of obesity.

Although lifestyle interventions can be successful at reducing obesity, adherence to programs is poor and patients rarely maintain long-term weight-loss (32). Furthermore, those who benefit are generally from the advantaged demographic and are well situated socially and financially (44). Health
practitioners may be poorly equipped to treat obesity because they lack training in weight loss strategies and obesity management (45). Effective care is further inhibited by a lack of appropriately sized equipment, lack of access to interdisciplinary care teams, large volumes of patients and limited time with patients due to tight patient-care schedules (45). Therefore health practitioners attempting to address obesity with their patients may be inhibited by a mismatch between their capacity to deal with obesity and the complexity of obesity management.

1.4.2. **Policy implementation**

Within Canada, many government policies aimed at preventing obesity rely on the individual as the source of action (46). Alvaro et al. (20) describe Canadian government policies as being ‘stuck’ at promoting individual lifestyle change. These policies tend to ignore the underlying socio-economic and political forces that have shaped the obesity epidemic (44,47). Meanwhile, a growing number of policy documents are acknowledging the link between the social determinants of health and the need to change the environment to improve health (48). Many of these documents call for action from government policies to tackle the socio-economic conditions underlying health conditions (49). For example, ActNowBC was designed in British Columbia to create healthy communities by enhancing individuals’ ability to make healthy decisions by engaging schools, employers and local government. Even with the best intentions of adopting a more ecological approach to prevention of disease, the initiative poses much of the emphasis on encouraging individual behaviour change and fails to account for complex factors that contribute to obesity, such as key economic issues in food production and access (20).

There are many competing diagnoses of what matters in the development and implementation of policy designed to address obesity. Health policy can influence institutions, organizations, services, funding arrangements and actions
by the public, private and voluntary organizations (50). The evidence base regarding the effectiveness of policy based obesity prevention is very small (50). Policy cacophony can occur when the noise around the discussion drowns out the symphony of effort (31). This policy cacophony is further inhibited by a fear of interventions being interpreted as restricting personal choices in food and lifestyle (31). Obesity is an issue that has developed over decades and current solutions are unlikely to produce the desired outcomes overnight. The increasing evidence of environmental and social influences has stimulated a call to action among researchers to examine broad systemic changes to address and prevent obesity (8,19,31,51).

1.5. Policy resistance to complex system strategies

While the literature is supportive of broad systemic change to address obesity, these strategies and frameworks remain underutilized by individuals across the treatment spectrum. For policy makers, implementing complex system based strategies is likely a challenging task as the research is limited and there is no definitive answer on how best to proceed (10). Adding to the challenge is the general belief throughout society that solutions to obesity should focus on factors within personal control, such as overeating or lack of exercise (52). Individuals tend to invoke metaphors to better understand complex problems and may do so through a variety of sources, including media depictions, framing by politicians and personal experiences (37). Obesity metaphors, such as likening obesity to sinful behaviours, can be powerful predictors of support for public policies to curb obesity (37). Policy makers may accept obesity as complex and wish to support innovative policies to address it, but they are inhibited by societal perceptions that focus on blaming the individual (7). Even obese individuals themselves have a strong sense of personal responsibility for their weight (7).
The clinical setting and health care practitioners have the potential to significantly influence individuals dealing with overweight or obesity by supporting attempts at behaviour change. They are also in a position to be effective agents of change when it comes to shifting the “eat less, move more” paradigm among the general public. However, practitioners addressing obesity as a simple problem have produced discouraging results. Clinicians have reported obesity treatment as being “doomed to failure”, frustrating and ineffective (36,45,53,54). The stigma associated with obesity can also complicate health care interactions and negatively impact patient experiences and the quality of care received (55). Many health practitioners have described obese patients as lazy, lacking in self-discipline, unintelligent, dishonest and non-compliant with treatment (56,57). We know that a patient’s experience with weight bias can have a negative impact on weight loss and can actually increase binge-eating and unhealthy weight control behaviours (58) (59). As a result, health practitioners attempting to help patients with behaviour change may actually be perpetuating weight bias and individual blame, which can discourage efforts with health behaviour change among individuals.

1.6. Project rationale

Policy makers, health professionals and individuals living with obesity should all be included in the discussion concerning the management of obesity. Systems theorists emphasize the importance of examining the political, social and cultural aspects of a system when working towards systems change (60). Individuals from the various perspectives can act as important agents of change when attempting to solve a complex problem. When normative beliefs among these agents of change are not consistent with systems based efforts, they can be a source of resistance or delay to implementation of systems change (60). The diversity of perspectives across the treatment spectrum with respect to the causes and solutions to obesity show a significant lack of cooperation between
these three groups, thereby producing a possible source of resistance to implementing innovative solutions to obesity. Understanding these perspectives has the potential to provide new insight into shifting our paradigms regarding the causes of obesity. It is clear that accepting obesity as a complex problem is an important step in working towards solutions that will address the multiple interconnections between sectors and elements that contribute to obesity.

This project aimed to explore the perceptions, beliefs and experiences of service users, health care practitioners and policy makers with regard to the causes and treatment of obesity. This work demonstrates how applying a solutions oriented framework is useful for designing effective solutions to obesity using the principles of complex systems. This approach sheds light upon collaborative approaches to innovative solutions to obesity from all three perspectives.
2. Methods

The Chronic Disease Systems Modeling Lab (CDSM) formed a collaboration with the Applied Research Collaborations for Health (ARCH) research group in Halifax, Nova Scotia to perform a secondary data analysis using transcript data. The ARCH research team collected the data with the original research aim to examine the divergent experiences of targeted groups of individuals regarding obesity using semi-structured interviews. While the CDSM objective is in alignment with the original research intent, a secondary analysis of the interview data allowed for the application of a novel analytical approach that embraces a complexity lens with the intent to provide insight into system-oriented solutions.

2.1. Participant interviews

A research team led by Dr. Sara Kirk in Halifax, Nova Scotia conducted semi-structured key informant interviews to examine the experiences of overweight individuals, and the perceptions of health care providers and policy makers in the assessment and management of obesity. The Dalhousie University Health Sciences Research Ethics Board and the District Health Authorities granted ethics approval for their work.

Participants were recruited through the distribution of emails and posters through professional associations, personal networks of the research team (specifically for policy makers), hospitals in each of the local nine District Health Authorities and community organizations such as Taking Off Pounds Sensibly (TOPS) and Weight Watchers. All participants were given a study information
package prior to the interview and provided informed consent. A trained research coordinator and research assistant conducted the interviews in person. Participants were asked to provide insight through individual interviews about the personal, social, institutional and political aspects of obesity.

The aim of the service user interviews was to examine the personal perceptions, beliefs and experiences of overweight and obese individuals toward their own weight and how it is perceived by others, in particular their health care providers. The original research aim for the health care practitioner interviews was to investigate the personal perceptions, beliefs and experiences of health professionals in relation to obesity and their perceptions of interactions with overweight and obese individuals. Finally, the policy maker interviews focused on perceptions of the social, institutional and political structures within existing health care settings that might help or hinder obesity management within the province, such as treatment policies and referral practices. The researchers used 3 to 4 open-ended topic guides specific for each group to help steer the interviews, such as:

- Please tell me about your overall thoughts and feelings regarding obesity and being overweight.
- Can you tell me about your overall experience discussing your weight with a health care professional (physician, nurse, dietician etc.)?

Participants were encouraged to speak freely about their experiences. Subsequent questions and prompts were guided by the stories of the subjects. For example:

- Can you talk about your experience in delivering care to overweight and obese patients?

Probes:

- What kind of support do you have?
- What kind of support do you need but don't have?
Interviews lasted between 30 to 90 minutes and were recorded and transcribed verbatim. All transcripts were confidential and names or personal identifiers were changed to code numbers.

2.2. Participant groups

Service users included 20 overweight or obese individuals who had been treated by at least one health care professional in Nova Scotia for weight management. The participants ranged in age from 27 to 73 years old and included 4 males and 16 females. Nine of the subjects reported co-morbid conditions while eleven did not. Living environment type was almost evenly split, with 9 subjects coming from an urban setting and 11 coming from a rural setting.

Health care practitioners were included if they were presently practicing in Nova Scotia and encountered overweight or obese clients for the purpose of weight management. Nearly all of the health care practitioners were female (only one male participant), and they ranged in age from 26 to 58 years old. Professional groups represented in the health care practitioners included 8 dieticians, 4 nurses and 4 family physicians. They averaged 125 total patient visits per month, however this ranged from 0 to 300 total patients per month. The health care practitioner with 0 patient visits had an administrative role and based responses largely on previous experience with patients, and was thereby coded as a health professional. There was only one health care practitioner who reported being from an urban setting and the participants averaged a time of nine years in their current position.

The policy makers interviewed included one male and three females with an age range from 42 to 60 years old. Participants were recruited on the inclusion criteria that they worked as a policy maker at the organizational level or government policy level, such as the Nova Scotia Department of Health. Half of the subjects came from urban environments and half from rural environments.
### 2.3. Secondary data analysis

The ARCH research group granted access to transcribed data without the use of personal identifiers for the purpose of a secondary data analysis using a complex systems framework. All procedures for this work were approved by the SFU research ethics board. Data were imported into NVivo 9 qualitative data analysis software (QSR International). The software provides a framework to visualize the coding structure and organize the binned data from each transcript.

This project involved several steps during the methodological process (Figure 2). An appropriate qualitative analysis methodology (interpretive description) was required throughout the analysis. A comprehensive literature search about obesity care and policy issues was completed to form the basis of the analytic framework and to help inform the predetermined codes used during the qualitative analysis (Appendix A). Codes were also generated from the data itself using inductive reasoning. Data were reviewed and coded for themes from complex systems frameworks in addition to themes from the obesity literature related to issues with policy makers, health practitioners and patients seeking treatment. Themes were sorted using the Intervention Level Framework (ILF) to help contextualize and interpret the meaning of the results within the lens of complex systems thinking.
Figure 2 – Outline of Qualitative Analysis Using Interpretive Description
3. Qualitative Analysis

3.1. Data analysis using interpretive description

Interpretive description was used as a qualitative methodology because of its' specific intention to generate knowledge relevant for the clinical context of applied health disciplines (61). It emerged out of frustration from nurse researchers who have struggled to use qualitative methods developed in other fields for the purpose of clinical health research (62). Qualitative nurse researchers have generally sought credibility through phenomenology (developed in philosophy), grounded theory (developed in sociology) or ethnography (developed in anthropology) (62). However the objectives and aims of these disciplines can be divergent from nursing’s domain of inquiry. Interpretive description combines the most fitting elements from the social sciences and integrates them into a method that would be ideally suited to the study of practice-based questions such as, “What is the experience of cancer patients during their entire disease continuum, from diagnosis to treatment and recovery or end of life planning?” (62). Since its inception, nurses and others in applied sciences have found interpretive description to provide a logical structure and rationale for the design decisions made in qualitative inquiries (63,64). As such, this method was well suited for our research because of the specific purpose to embrace complexity using open-ended analysis techniques in a logical and systematic manner.

When developing an analytic framework for the use of interpretive description, the researcher must have a strong understanding of previous knowledge in the field so as to supply new information that is applicable to current practices (62). This framework acts as an initial starting point and can be
adjusted as needed during the analysis (65). Analysis using interpretive
description is inductive and uses a coding scheme that is less intense which
stems from a preliminary review of the data. The mechanics of interpretation
depend less on coding, sorting and organizing than they do on the process of
intellectual inquiry (65). The analysis therefore involves synthesizing, theorizing
and re-contextualizing the data to promote continuous re-evaluation of the data
and inclusion of new insights (62,66). Previous studies have reported their results
as a supplement to previous research in a way that tells a story as opposed to
other qualitative methodologies that discourage the presentation of findings in the
context of existing knowledge (62).

The use of interpretive description as a qualitative methodology during this
process did impose the risk of certain limitations. The extensive literature review
conducted before the analysis may have introduced bias into the study, however
two researchers reviewed the data and both confirmed coding patterns and
interpretation. There was also a risk of personal or professional bias during the
analysis process. Removing all bias is unlikely but the use of a research journal
was used to record field notes, alterations in coding approaches or lines of
thought throughout the analysis. Additionally, direct quotations and major themes
were presented in an attempt to provide an objective view of the data.

3.2. Theme development

Transcripts were coded for themes identifying how different respondents
understood the causes, effects and interventions that would address obesity.
Although the use of pre-determined codes (Appendix A) was used to initially
begin the coding process, all data received multiple passes for coding based
upon pre-determined codes and themes generated inductively from the data.
Interpretive description served as the conceptual framework for analysis.
3.3. Categorizing of themes within the Intervention Level Framework (ILF)

The themes were sorted using a framework that embraces the concepts of complex systems. The twelve leverage points put forward by Meadows were considered as a potentially useful tool for sorting the data because each level categorizes actions and their expected influence on the system (21). However, previous research discovered that twelve leverage points could produce significant overlap in coding (29). Malhi et al. (29) were inspired by Meadows places to intervene and sought to operationalize the leverage points into a practical framework that could potentially guide change in complex systems. A team adapted the twelve points into the five level ILF in order to create a generalizable framework and to maintain all of the original concepts from Meadows (67).

The five levels of the ILF reflect the broader groups of Meadows’ twelve leverage points (Table 1). The top level paradigm represents the deepest held, often unspoken, beliefs about the way the system works (21,29). Actions and ideas at this level propose to either shift or reinforce the current paradigm and can be very effective yet difficult to implement (29). Level two goals represent the aims and priorities of the system (29). System goals are significant drivers of the actions at the lower levels, including the physical stocks and flows, feedback loops and self-organizing behaviour (21). Level three refers to the system structure and contains all of the elements that make up the system as a whole, including the subsystems, actors, and interconnections between these elements (29). Actions at this level will change the system structure by changing the relationships within the system or by introducing novel structural elements (29). Level four is characterized by feedback and delays. As previously discussed, feedback loops occur when actions by one element of the system affect the flows into or out of that same element (29). Wheatley explains that understanding the critical role played by feedback in systems could help us develop measurement
processes that support the behaviours and capacities that we require (68). Therefore adding new feedback loops or changing feedback delays has the potential to restructure the system (29). At the very bottom of the ILF are the structural elements that include the subsystems, actors and the physical elements of the system (29). Actions at the structural elements are generally the least effective change to implement, as a result many structural element actions would be required to create system-wide change (29).

**Table 1 – Intervention Level Framework**

<table>
<thead>
<tr>
<th>System Level</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Paradigm</td>
<td>System’s deepest held beliefs. System goals, rules and structure arise out of the paradigm.</td>
</tr>
<tr>
<td>2. Goals</td>
<td>The aims and priorities of the system.</td>
</tr>
<tr>
<td>3. System Structure</td>
<td>All of the elements that make up the system as a whole including the subsystems, actors and interconnections between these elements.</td>
</tr>
<tr>
<td>4. Feedback and Delays</td>
<td>Loops that cause an action by one element of the system to in turn affect the flows into or out of that same element.</td>
</tr>
<tr>
<td>5. Structural Elements</td>
<td>Subsystems, actors, and the physical elements of the system.</td>
</tr>
</tbody>
</table>

The five level ILF was initially used to sort action statements from three sets of data: the McGill 2007 Health Challenge Think Tank survey, the Public Health Advocacy Institute’s 2008 Policy Recommendations from their 5th Conference on Public Health, Law and Obesity and the Coalitions Linking Action and Science for Preventions’s action statements from an expert group survey (67). Members of the research team first sorted the statements independently, then came together to compare and discuss results, create rules for sorting and re-sort the statements to test for inter-coder reliability (67). This process demonstrated the ILF to have high inter-rater reliability and it has since been used to compare actions recommended to make food systems healthy, green, fair and affordable (29). The ILF was used to sort ideas presented in the data set
and also identified gaps in strategic planning. The ILF was also found useful when applied to a subset of recommendations to prevent and address childhood obesity (69). In this case, the ILF helped researchers move away from a detailed dissection of the system parts and move towards understanding the problem as a whole through a complex systems lens (69).

Although the use of the Intervention Level Framework is still in its infancy, recent work suggests it will be useful for sorting the distribution of efforts in obesity interventions (10). The Intervention Level Framework was therefore used to sort themes resulting from the coding of the transcripts into the five levels in order to examine the distribution of beliefs among participants.
4. Results and Discussion

There were a number of themes that emerged during our analysis. Three key themes were identified as significant for being present among all three groups. The commonality of beliefs throughout these themes are important to discuss given the diversity of perspectives previously described between service users, health practitioners and policy makers when it comes to beliefs about obesity. The identification of these three key themes and their interpretation using complex systems approaches are the focus of the following results and discussion.

4.1. The desire for immediate or unrealistic results

All three participant groups expressed a strong desire to see immediate results or feedback with regard to weight control and behaviour change. This result was striking because many of the same individuals claimed that they recognized the key to real change required small lasting changes made over time. The fact that all three groups strive for quick results and big changes is interesting, as it reveals normalcy in the desire to get immediate rewards or feedback. Although overweight individuals are usually accused of seeking “quick fixes” with disdain, as though they lack the motivation to accomplish more difficult goals, it is important to see in these data that the professional groups and those in positions of power and decision making follow the same tendency. Though unrealistic expectations can be a unifying challenge, the ILF may be used as a powerful tool to help design more realistic outcomes and goals with regard to feedback for each participant group.
4.1.1. **Unrealistic expectations and feedback in service users**

Individuals often reported a strong desire to be thin and associated this desire with happiness in general. The drive to reach a certain body ideal or specific weight loss number was very strong.

I just always felt like no matter what I do I’m never going to be worth much to her unless I’m skinny. (Service User 2)

And I will not live out the rest of my life without doing everything I can to try to experience that... I could drop dead a month later but if I reach that point of truly being happy then I’m good. (Service User 12)

Measuring body weight represents feedback in the system because it allows individuals to track behaviour changes by measuring the outcome through the number on the scale. Feedback delays, such as those associated with self-weighing, can have a significant influence over behaviour and may lead to oscillations in a system (70). The optimal frequency of self-weighing is poorly understood, although anything from daily to weekly self-weighing appears to be a good predictor for moderate weight loss, less weight regain, or the avoidance of initial weight gain in adults (71). However, there is concern that frequent self-weighing may encourage negative body image or increase the potential for other psychological consequences in vulnerable patients (72). For individuals, it is important for them to understand the variability of feedback delays regarding weight loss.

Using complex systems thinking and specifically the ILF to understand feedback and delays with regard to weight loss also highlights potential solutions to improving the feedback cycle. Individuals regularly discussed success in direct alignment with reaching a smaller body size rather than taking measurable actions to change behaviours. This illustrates the fact that individuals would benefit from changing goals to focus on health benefits associated with behaviour change rather than end result appearances. This theory is supported by current research that claims that before engaging in an activity, thinking about the
outcome goal will increase the likelihood of forming intentions, however during the activity thinking about the process and experience of the activity has greater benefit for continued pursuit of the activity (73). This is especially true since no two individuals will end up with the same changes in body shape and size simply because they are following the same health regimen. Self-monitoring of diet, physical activity and body weight have all been positively associated with weight loss, however measuring a behaviour such as steps taken per day will provide immediate feedback and allow for immediate adjustments, whereas measuring body weight will have a longer delay before meaningful changes can be seen (74).

4.1.2. Unrealistic expectations and feedback in health practitioners

Health practitioners had a similar perspective when describing obese patients and their success stories or failures. They consistently discussed the importance of small, measurable goals when it came to advising patients on weight loss. However, when asked about success stories they could recall few examples, and these were generally characterized by very drastic weight loss and extreme lifestyle changes.

...and he wanted to lose weight but he was kind of struggling...I think maybe he had lost 5 pounds in the first year...And him and his girlfriend together really decided...we are going to make this change...And they both lost a lot of weight ...They were very successful... I really only have that one shining example of that couple who did really exceptionally well, out of 2 years of seeing people. (Health Practitioner 3)

And you just keep reinforcing the positive message... I had one guy who went from 260 to 200, I think. And at 200, he's still obese... I say, look, if you can get it down a little more, go ahead. (Health Practitioner 8)

Well, I usually find out...if they have kind of a goal in mind. Also their doctor will sometimes tell them how much they want to lose. A lot of times the patient will feel that that is totally unrealistic. You know, to lose 100 pounds in 6 months because you need surgery... (Health Practitioner 6)
In this case, a patient who has successfully changed certain behaviours but lost little to no weight may be treated by health practitioners as resistant to treatment when in reality they are on the path to success. When health practitioners use extreme weight loss as their definition of success, the feedback they receive from a patient’s weight status may reinforce perceptions that patients with minimal weight loss are lazy and unmotivated. These perceptions can have negative consequences for the patient and health practitioner relationship. In reality, the definition of successful weight loss in the literature varies but is usually described as a number between 5 to 10% of initial body weight lost and maintained between 6 months to 2 years (75–78). Shifting weight loss goals to this scientific definition of successful weight loss and maintenance will likely create more success stories in the discourse around obesity while altering the measurements clinicians monitor and impacting the feedback and reward system in building patient relationships.

The benefit of the ILF in this case is that it allows us to see how feedback can influence paradigms. For health practitioners, shifting their definition of successful weight loss to the scientific definition could help them see the positive benefits of health behaviour change and may stimulate a paradigm shift to a more positive perception of their patients’ efforts to improve health. Health practitioners emphasized the importance of lifestyle changes to reach weight loss goals, but they may see more positive results by encouraging patients to focus on goals relating to process as opposed to outcome. Once health practitioners realize goals can be centred around healthy behaviours for all individuals, rewards and examples of success may be treated very differently.

The following health practitioner understood that every individual will have a different definition of success:

The success stories are people who don’t gain it all back and then some. Some people will gain it back but they still are lighter than when they started, and they maintain that. That is pretty successful. (Health Practitioner 9)
The ILF encourages greater understanding of the need to support feedback, which is better accomplished with monitoring behaviours than weight. Additionally, a patient would potentially be viewed as very successful if significant changes in physical activity, diet and sedentary habits are shown. The patient would also likely feel less disappointment and frustration with marginal weight loss and be encouraged to continue with a healthier lifestyle.

4.1.3. Unrealistic expectations and feedback in policy makers

Our results confirmed that decision makers may wish to implement more comprehensive or preventative policies for the whole population, but they remain more likely to engage in actions with shorter term impact or results that are easier to measure. Targeting childhood obesity was often discussed as a primary target for policy makers because there was a perception that these types of interventions were more supported socially. Additionally, addressing childhood obesity is likely an easier target for receiving feedback on policy implementation, as children from all demographics are accessible in the school setting.

Government said we need a childhood obesity strategy... you want to use the word obesity because politically it is important to use the word obesity, to be seen to be doing something about obesity. (Policy Maker 2)

Keeping in favour with socially acceptable policy decisions is an important consideration for policy makers when dealing with funding restrictions, the need to show measurable results and a constantly changing political climate. Although policy makers recognized that creating effective change could involve considerable delays, they felt pressured to produce immediate feedback to appease the public.

If we take a population health approach, we should really look at healthy public policy. And I think we don't have to look very far...when you look at how we were able to move the smoking rate down in a matter of half a dozen years. Usually for
population health changes, it takes a generation.

(Policy Maker 1)

Targeting one area alone for the purpose of showing a ‘strategy’ may have unintended consequences and may not achieve the desired outcome. For example, when addressing childhood obesity, decreasing access to sugar sweetened beverages (SSB) in schools has shown a decrease in youth consumption of SSB (79). While widely supported, the effects of these types of nutrition policies on youth BMI have been inconclusive, possibly because of behaviour that compensates for the decreases in SSB consumption, such as increased intake of other unhealthy foods or increased consumption of SSB outside of school (80). The ILF helps illustrate that one action alone may not lead to the desired outcome and unintended consequences may occur as a result. It also shows that policy makers should be cautious of making quick fix promises or offering ‘light’ solutions (31). The ILF helps to identify the possible delays from certain actions and the implications these have for targeted system goals. Furthermore, it helps us understand that reversing obesity trends will require multiple strategies from the various system parts.

Once we understand how complex systems function, it is more acceptable to see that all interventions or changes in a complex system will have an impact after a certain amount of delay. The desire for unrealistic results is not only related to misguided expectations, but also to a lack of understanding that feedbacks and delays require more patience and long term vision than all individuals across the treatment spectrum may anticipate. For behaviour change to be successful, the feedback loops must occur within an appropriate time frame in order for the information to still be relevant (81). Therefore, the length of time of the delays and the quality of the feedback can impact the continuation or discontinuation of a behaviour change or intervention. The ILF is useful because it proactively identifies delays and provides leverage points to mitigate the negative impact of unintended or unexpected delays.
4.2. A focus on individual blame and individual behaviour change

Our results confirmed that all three groups focus on individual behaviour change as the major agent of change when attempting to reverse obesity. The focus on individual behaviour change and the limited success in these attempts has created an environment that promotes individual blame. An analysis of these beliefs using the ILF helps us see that all three groups would benefit from a paradigm shift around individual blame of obesity and emphasizes the need to create interventions that address all system parts to support lifestyle changes.

4.2.1. Individual blame and the need for a paradigm shift in service users

Obese individuals experience a significant amount of blame from society and from their own internal dialogue with regards to the causes and solutions to obesity. While individuals would reflect on the barriers to behaviour change and discuss a lack of support, they would ultimately place the blame for their obesity on their own personal choices and lack of motivation.

But I always felt, you know if I really wanted to do something I could. (Service User 2)

I can go to all the dieticians and doctors and psychologists that I want to but it’s ultimately, I think, up to me. (Service User 9)

Obese individuals also expressed a negative perception of other individuals who appear overweight or obese:

I respect people that are not [overweight] more so than people that are...I think maybe it’s been drilled into our brains for so long that... it’s something that people could have controlled but they didn’t... people believe that it’s just you do it or you don’t and you’ve chosen not to. (Service User 3)

Using complex systems and the ILF to understand these paradigms reveals that a natural reaction when faced with a complex problem is to assign
blame, retreat and have a belief that the problem is beyond hope (13). The ILF also reveals that the paradigm is the hardest and potentially most effective change to stimulate in the system. This may help to explain why societal perceptions of obesity tend to focus on the need to change individual behaviours, such as overeating and lack of exercise (52). Blame towards obese individuals can cause weight bias and a tendency to place judgment on obese individuals. We know from the literature that an individuals’ personal body image and experience with weight stigma can have a negative impact on weight loss and can actually increase binge-eating and unhealthy weight control behaviours (82). Experiences with weight bias reinforced the service user paradigm that their obesity is a result of personal failures. Shifting individual paradigms and societal paradigms to understanding obesity as a complex problem is a potentially important change to help support individuals with lifestyle behaviour change.

As researchers, when we understand that the lower levels of the ILF all contribute to creating a paradigm shift, we can develop solutions that target goals, system structure, feedback and structural elements. For example, improving interventions for those who seek treatment may be better served by targeting system structure through family support and involvement. The influence of social networks has been explored among various behaviours and properties, including eating patterns and the spread of obesity (83,84). In chronic disease management, partners and close family make the highest contributions to behaviour and this supports the idea that individual behaviours are connected to those with whom we are socially connected (85). Pachucki and Christakis (83) suggest that “you are what people in your social network eat” therefore addressing eating patterns where humans work, live and socialize with others may in turn, improve individual food choices. Addressing the networks and relationships within the system offers an opportunity to move away from an exclusive individual focus and explore the contributions and resources available to individuals in need of support (86). Changing this requires more than just encouraging individuals’ to simply “try harder”. Researchers can thereby use the
ILF framework to design interventions that address all parts of the system, including social networks that can reinforce individual habits and behaviours.

4.2.2. Individual blame and the need for a paradigm shift in health practitioners

Health practitioners appeared to have sympathy for the barriers individuals face when attempting behaviour change. One health practitioner in particular discussed obesity as complicated:

You know where I really think we are going to get the most bang for our buck...it's the whole society thing, it's the active transportation, it's putting down the infrastructure, and of course the whole prevention thing. You know, that you can do it. And they are trying to make some headway with the healthy eating strategies in schools and all that sort of stuff. (Health Practitioner 14)

This same individual then ultimately discussed individual blame as a treatment strategy:

I'm not going to sort of do that, "It's not your fault. It's a medical condition." Because that is what happens. The minute you say it's a medical condition, then people start thinking, "Oh, yes, it's not my fault."

(Health Practitioner 14)

There were also revealing statements about how health practitioners view their patients and their experiences trying to motivate patients to change:

They think they are eating healthy because they eat vegetables once a day. (Health Practitioner 1)

And a lot of people bring up the barriers first. Like I can't walk because there's coyotes. I mean if you want to walk, you can walk. But it's like I don't want to walk on the side of the road because I'm scared of the traffic. And now there's coyotes. (Health Practitioner 5)

There is a huge education process that needs to be started so that the people know that they are the problem. Because they don't know that they are the problem. They want what they
want when they want it...Now, I might be sounding a little bit negative here but truly that is the way it is. 
(Health Practitioner 13)

While health practitioners may not consider their views to be weight biased or blaming towards individuals, service users expressed a significant awareness about the underlying tones of their health practitioners’ perceptions.

And he said anyway, it’s run by a nutritionist and anything a nutritionist could tell you, if you really wanted to learn about it you could find it on the internet, so why would I refer you to a program. 
(Service User 2)

When health practitioners reveal their deepest held beliefs around obesity and their tendency to blame individuals and exhibit weight bias, it illustrates the need for a paradigm shift in the clinical setting. Weight bias among health practitioners has been well documented in the literature; however simply reporting on these instances may not carry the power to affect change. Realizing that weight bias may be a natural part of the blaming process when faced with complex problems may help alleviate some of the emotional challenges that allow for a paradigm shift. For example, getting health practitioners to recognize the complexity of obesity and the recognition that they too are a product of their own complex system may help them view the issue in a different light and be more responsive to change. When the capacity of an individual is mismatched with the complexity of the task, the individual is more likely to fail (13,87). Therefore, clinicians may avoid discussing obesity or may address it in an inappropriate manner if they feel overwhelmed by the complexity of the health care setting, such as the need to keep clinical visits short, a large patient load and minimal resources or treatment options. Shifting health care practitioner paradigms to a more compassionate and systems based perspective may increase their capacity to deal with the complexity of the issue and thereby improve health care practitioner and patient interactions.
Addressing system structure in the health care setting can have benefits for the clinicians, staff and patients. In the clinical setting, the isolation obese patients feel and lack of respect they regularly deal with makes it difficult for them to trust and buy in to treatment care and settings. Using complex systems thinking helps health care providers realize that even if they are not ready to address weight bias out of sensitivity, the issue may gain traction with even the most busy of care teams once they understand that a true sense of collaboration and trust is necessary to keep the patient care system intact and help drive positive change in the right direction. For example, treating health literacy among patients as an organizational value infused into all aspects of planning and operations of a primary care setting was found to improve collaboration and knowledge sharing between staff members and increased patient engagement (88). The model increased the capacity of individual professionals within the health care organization and also created an environment that encouraged collaboration, communication and feedback with the goal of improving patient outcomes (88).

This is one reason that the treatment for childhood obesity may carry such powerful unintended consequences. Health care practitioners view childhood obesity with concern and feel that intervention is important (89). There has also been increased attention to childhood obesity and the importance of integrating primary care, public health and community-based efforts (90). When overweight children join treatment programs, clinical care centres are more likely to engage in best practices and family based care. As a result, obesity treatment in children benefits from an automatic systems approach that overweight adults are generally deprived of entirely. Family based care encourages teams and group support in critical ways that impact the entire system.
4.2.3. Individual blame and policy resistance

Policy makers had a very strong understanding regarding the complexity of obesity:

There's this web of all the things that impact obesity. And so all these environmental things, policy things, behavioural things, marketing things, private sector things...It's this huge map of all the things that ultimately impact...you need to really be working in all these different areas...So yes, I mean this is huge. I mean it's not as simple as healthy eating and physical activity.  
(Policy Maker 4)

Obviously we live in a...society with an emphasis on unhealthy public policy in relation to food and physical exercise. And it's also hooked up with other lifestyle and stressors and addictions...But I think it is pretty complex. If it was simple obviously it wouldn't be an epidemic.  
(Policy Maker 1)

Policy makers also recognized that societal views tend to focus on blaming the individual and that this societal paradigm influenced policy development and the types of interventions to be applied.

And I think it is overly simplified. Victims are blamed and are thought to be lazy. You know, just stop eating and start exercising. Well, if it was as simple as that then we wouldn't have 50% of people overweight or whatever it is in NS.  
(Policy Maker 1)

You know, you have sort of a social sense that people who are fat brought it on themselves. So you know, if somebody has lung cancer, they should have stopped smoking. If somebody is fat, they should have stopped eating. And that whole pervasive blame thing is part of it too. It's hard to get past all of that.  
(Policy Maker 3)

I mean political will comes from community will...If the communities aren't engaged in saying this is an issue for us, politically there is no way they are going to do it. But if the community is saying you know what, yes, we are really concerned about obesity in our children. We are really concerned on how it is going to impact the healthcare system...The next time I go to the ballot box, this is going to be really important...So when communities get mobilized and voice...That is what gives you political will...  
(Policy Maker 2)
I think the Minister's position on childhood obesity is naturally expandable to adult obesity. I do. And I think that is the next logical step for government to take. But it is harder to take with adults because the whole system and the whole sense in our culture is that somehow these people did it to themselves. (Policy Maker 3)

Current research supports the need for collaborative action from multiple levels to have an impact on the system as a whole and policy makers appear to support these types of interventions (7). Yet the perception of obesity as an individual failure persists among many different groups of people, including among those most closely involved in treating and preventing obesity. Negative depictions of obese and overweight people in the media and political discourse have the power to perpetuate weight bias and shape public policy (91). This creates a policy resistance for policy makers attempting to implement more comprehensive interventions. These results support the need for anti-stigma messages to be implemented into obesity prevention campaigns. Puhl and Heuer suggest shifting the focus away from personal blame by promoting social justice and the rights of individuals to have adequate resources to resist the obesogenic environment (91). Public health messaging that shifts societal paradigms towards a complex systems view of obesity is an important step in working towards solutions that harness the rules of complex systems to create real and sustainable change. This can help every member of the system view the solution as a way to help overweight people live full lives while truly enjoying their food and activities like every other member of society.

All three groups recognized that the majority of the focus for obesity treatments and interventions target individuals and their decision making around food and physical activity. A focus on individual failures around behaviour change has led to an acceptance of blame and judgment towards individuals dealing with obesity. The ILF helps us recognize that solutions to obesity should expand to all system parts. Primary care is an important component of the system, but so are public health agencies, schools and places of work. Public health messaging has
the opportunity to create more favourable public responses to obesity by encouraging compassion and increasing public understanding of obesity as a complex problem. Increasing public understanding of obesity as a complex problem is an integral paradigm shift that is needed to increase public support of complex system based strategies to address obesity.

4.3. Challenge of obesity care a mismatch for current design of health care system

All three groups agreed that the current health care system is not currently set up to help individuals that are obese. While this paradigm was consistent throughout the interviews, each group seemed to arrive at this idea through very different contexts.

4.3.1. Tension for change in system structure for service users

For service users, these views developed from multiple experiences of weight bias and stigmatization while seeking treatment from various sectors of the health care system. It has been well established that obese people are subject to prejudice and bias from their healthcare practitioners (57,92–94). These negative attitudes can have serious implications for clinical treatment of obese patients and the effectiveness of public health interventions (91). Our interviews confirmed this previous research with an overwhelming description of weight bias and stigmatization experienced by service users while seeking treatment from health professionals.

They were very sort of rigid... it was also about if you don't keep a diary, I won't see you again...I felt like I was being judged. And this is the last person that I want to judge me...They assume I’m big so I must be stuffing my face all the time. And I thought this is horrible that she would judge me and just treat me like a little kid...So I didn't go back. (Service User 10)
I kind of had this old school doctor back in NB who was basically, "Well, join a gym," or whatever. And that was it. You know, there wasn't really a consultation. He didn't even weigh me or take my height or anything. So it felt like there was a bit of a lack of interest.  

(Service User 11)

Service users consistently described a lack of confidence in the health care system and generally felt that in order to receive help for their obesity they would need to reach out to private sector services. The weight loss industry is flooded with misinformation and products that have little evidence of success, yet individuals repeatedly turn to commercial diets or internet sources in their attempts to lose weight (95,96). Researchers may benefit by therefore using the ILF to generate and prioritize actions for government and community organizations seeking innovative strategies to help individuals dealing with obesity. For example, addressing the system structure could involve creating an online service for obese individuals outside of traditional primary care that would provide local resource connections for activities and professionals in the field, evidence based information and recommendations and an online forum to encourage a supportive network that resonates with an individuals' health and social experiences. This in turn may play a role in shifting the paradigm of individuals around the efficacy of the health care system and provide them with a stronger network to address their own individual challenges when it comes to behaviour change and weight management.

4.3.2. Tension for change in system structure for health practitioners

Health practitioners expressed significant frustration at being unable to help patients with weight management. This frustration often led to a sense of inevitable failure and retreat from addressing weight with patients. This was a clear exhibit of common responses to complex problems. When our capacity to deal with the issue is mismatched by the complexity of the issue, the natural reaction is to feel despair, retreat or assign blame (97). For health practitioners, a
lack of resources, limited treatment options and low success rates created a sense of helplessness. Previous research has seen that healthcare professionals attitudes towards obesity can lead to less time spent with obese patients and discrimination when discussing treatment options and access to treatment (55). In the context of our interviews it appears retreat of healthcare practitioners from the issue of obesity emerged from these feelings of helplessness. The resulting sentiment was a strong emphasis on the need for innovation in the health care system and more support and treatment options for health care practitioners dealing with obesity on a daily basis.

I guess because statistically the chance of success is so terrible, I am really deemphasizing it. (Health Practitioner 14)

As far as physicians are concerned, we are too stretched. We really don't have the time to deliver specific obesity management care. Not effectively. (Health Practitioner 8)

I haven't given up on helping people get to more of a better body weight but you don't waste a lot of your emotion on it anymore...Because sometimes you think, well, why am I going to tell this person when you don't have anything to offer them? (Health Practitioner 9)

I don't think I'm qualified to manage these obesity patients. Absolutely not. (Health Practitioner 12)

These results suggest that an important target for improving obesity care involves empowering health practitioners to confidently navigate the complexity of obesity treatment. Using the ILF provides a guideline for potential strategies to improve the experiences of health practitioners. We have previously discussed the prospective benefits of modifying goals to focus on health behaviours as opposed to specific weight loss targets. Similarly, shifting expectations around the time delays required to accomplish weight loss may improve feedback health practitioners receive when dealing with patients. Addressing the system structure may further improve health practitioners’ abilities when it comes to addressing obesity in the clinical setting. This could involve collaboration between specialists, nurse practitioners, dietitians and general practitioners or could also
involve reaching out to community organizations. This may be particularly important for health professionals in rural settings where professional networks are limited. Collaborative and cohesive health professional networks can improve the quality and safety of care and facilitate the coordination of care (98).

4.3.3. **Tension for change in system structure for policy makers**

Policy makers viewed obesity as a larger scale issue and recognized that current health care methods from prevention to clinical practice were not effective at reducing the rates of obesity. While policy makers understood the complexity of obesity and described solutions that addressed the socio-ecological conditions that contribute to obesity, they described a lack of support for these types of interventions.

I see resource barriers. I see stigma barriers. I see even the whole change, defining it as a problem, as a barrier. I think we need a bit of a social marketing campaign. (Policy Maker 1)

It's more than just...educating people to be more active and to eat better. It's far more. It's changing the socio-economic environments, the physical and cultural environments that facilitate or not people being able to make choices. (Policy Maker 2)

But I think management of obesity has to be within the context outside of health because unless you talk about income, unless you talk about education, unless you talk about jobs and transportation, until you talk about the family dynamics. All of those things factor into obesity. It's not always just a medical issue. (Policy Maker 3)

And it is not a medical solution. I think medicine can contribute to the solution because there is a need in lots of ways for the medical establishment to intervene differently. But they have failed abysmally in that so I wouldn't want them to own it. I think doctors have their place absolutely, and I work very well with them...But obesity and the ability to deal with it is a societal issue, not a doctor issue. (Policy Maker 3)

We are going to have to ask those questions when these morbidly obese people show up on our doorstep too late to save with advanced coronary artery disease...So I think it is a time bomb. I think it is going to be a huge issue for us 10 to 20 years
from now. The system won't have enough money. We are already in lots of trouble financially. We don't have the equipment. We don't have the programs. We don't specialize in bariatric care. We don't specialize in bariatric senior care in the long-term care facilities. (Policy Maker 3)

Policy makers also exhibited some of the common responses to complex problems, such as retreat, despair and believing the problem is beyond hope (13). Moving policy makers beyond the common responses to complex problems requires matching their capacity to the complexity of the task at hand. The ILF can help researchers prioritize potential solutions that will move policy makers away from a sense of despair and trigger them to take action at multiple levels. The paradigm around the current failures of the health care system requires actions at the lower levels that will inspire a belief that obesity is a complex problem but that the health care system is an integral part of the solution. This could include creating new goals for policy makers that involve improving patient outcomes by addressing patient engagement and health literacy. There is a growing body of evidence that shows patients have better health outcomes and care experiences when they are more engaged or activated in their health care (99–102). Addressing patient activation as an organizational value infused into all aspects of planning not only provides a new measurement to receive feedback on the functioning and success of the health organization, but also provides an opportunity to address system structure. This could include clinical information systems to track and plan patient care, health practitioner teams to support patient self-management and connections to community resources. Using the ILF to develop innovative solutions for policy makers to take action will aid in matching their capacity with the complexity of the health care system.

4.3.4. System readiness for innovation

For all three groups there appeared to be a significant tension for change and a readiness to accept innovation in the healthcare system. Greenhalgh explains that when individuals in a system or organization perceive the situation
as intolerable, a potential innovation is more likely to be assimilated successfully (103). Recognizing the paradigms around the effectiveness of the health care system and the underlying beliefs of each group is an important step in working towards solutions and moving past the common responses to complex problems. Creating a paradigm shift may be the most difficult level to change, however working towards a new paradigm is considered the most effective method for inspiring system change. The tension for change currently present in the health care system has the potential to trigger innovations that could lead to lasting change in the system. The ILF provides a potential framework for researchers to develop solutions and innovations that will mobilize individuals across the system spectrum. The novel focus of the ILF on solutions provides a unique opportunity for researchers to impact the obesity system at what seems to be the current tipping point. By focusing on solutions we can get past the common responses to complex problems and work towards a paradigm shift.

4.4. The power of the ILF

The ILF was originally presented in the methodology in a list of predetermined codes developed before the analysis process (Appendix A). Initial attempts to code the raw data using the levels of the ILF produced very few results among study participants. This may be reflective of the tendency for individuals among the three participant groups to have limited understanding of complex systems thinking. This result is not surprising since previous work exploring perceptions of obesity have identified individuals across the treatment spectrum as focusing primarily on the biomedical perspective or socio-ecological perspective (7). The predominant codes from the analysis inspired theme development and the use of the ILF became more focused as a sorting tool to organize and interpret these themes.
Throughout the results and discussion, the ILF proved useful for interpreting the themes emergent among the three participant groups. Using the framework to understand the beliefs of service users, health practitioners and policy makers helped illustrate the vast interconnections among these three groups and how these interconnections contributed to their paradigms. Policy makers expressed the belief that obesity is a complex problem, but they were very aware that societal paradigms focus on individual blame. Policy makers thereby felt restricted to developing interventions that address individual behaviour because societal goals, system structure and the expectations regarding feedback were aligned with a paradigm that focuses on the individual. Understanding the themes in relation to the levels of the ILF helped us understand the problem of obesity as a whole and the need to create actions that are aligned with the desired paradigm.

The ILF can further help individuals across the treatment spectrum develop potential solutions to obesity by using the levels to prioritize strategies that will lead to the ultimate goal of a paradigm shift. Simply targeting one level in the framework will not have a significant impact, but targeting many levels may have greater influence on system change. It also emphasizes the need for feedback in a system, an area that is generally ignored when developing treatment or interventions to deal with a complex problem such as obesity. For example, health practitioners had a desire to see immediate and extreme results when monitoring patient weight status. This level four feedback in the system perpetuated health practitioner paradigms around individual blame and the belief that patients are generally doomed to failure when attempting to lose weight. The ILF made us think about shifting this paradigm by addressing the level two goals. By focusing on process over outcome goals when treating patients, health practitioners may change the feedback in the system and create more success stories in their clinical practice. This may additionally help shift their paradigm away from blaming the individual and move towards a more compassionate approach to patient care.
The ILF further encourages researchers to promote interventions that engage groups that may appear to disagree and mistrust each other, such as health practitioners and individuals dealing with obesity, to work together in a collaborative framework. Although complex problems involve multiple subsystems, actors and interconnections; systems thinking reasons that even in very complex systems individuals matter (13). An individual dealing with obesity on a personal level, a health practitioner treating numerous obese patients and a policy maker struggling to implement population health strategies, are all integral actors in the system and are important to developing solutions to obesity. Matching an individuals’ capacity to the complexity of their environment or specific task is an important target for improving system function and the ILF helps propose methods to achieve this (13). Coherent actions among and between subsystems can help achieve system-wide change that is aligned with goals and paradigms.

4.5. Commonality of themes

Previous research has framed perceptions of obesity among service users, health practitioners and policy makers as divergent and considerably different in how they each view obesity (7). Our results showed that each participant group is a product of their own complex system and understanding their beliefs using a complex systems lens identified some commonalities between groups we would typically expect to be uncooperative. The discovery of common themes between these three groups is therefore a result in itself since previous work has typically cast these groups as very distinct from each other. For example, although health practitioners perceived service users as lazy, unmotivated and doomed to failure, both service users and health practitioners expressed a desire for service users to achieve and maintain extreme weight loss. Similarly, policy makers were cognizant of the need to produce significant results when attempting to promote population weight loss. For all three groups,
there was a strong desire to produce immediate or unrealistic results regarding the weight loss of individuals dealing with obesity, however the context out of which this theme emerged was from each groups’ own complex system. Finding common ground between these three groups may help alleviate some of the tension present around discussions of obesity. Recognizing that individuals matter and that each individual is influenced by their own complex system may increase cooperation between these groups and help us all work together to develop solutions to the complex problem of obesity.

4.6. Limitations and future work

There were a number of limitations to the applicability of this research. The location was limited to Nova Scotia so participant thoughts expressed during the interviews may have been based on environmental factors limited to that geographic location and may limit the transferability of our findings. The number of participants was also small among all three groups, particularly in the policy makers. Sample size is a challenging number to define when planning a research study as qualitative research does not abide by concrete rules or power calculations to determine the appropriate sample size (104). However, reaching “saturation”, the point whereby additional interviews are not expected to yield new or valuable information, suggests that the sample size is adequate (104). According to Sandelowski (105), an acceptable sample size in qualitative research is one that permits “the deep, case-oriented analysis that is a hallmark of qualitative inquiry, and that results in a new and richly textured understanding of experience”. In this study, the use of two researchers and the process of constant comparison helped determine “saturation”. Furthermore, there was remarkable consistency in themes between groups and with findings from other studies and this suggests that these findings are robust and transferable to other locations and populations.
The applicability of the ILF itself may be called into question due to its infancy in the literature as an analysis tool with transcript interview data. Previous work found the ILF useful for understanding the importance of coherent actions among policy recommendations (29). Our results suggest the ILF may be useful for analyzing data for more in-depth qualitative examination and future studies using the ILF in this manner will help improve its’ credibility as an analytical tool. Future studies exploring the applicability of the ILF may wish to use the ILF to help stakeholders understand how to inspire meaningful change in a complex system. This could include comparing stakeholders’ beliefs regarding obesity to the actual actions and targets from recommendations. The ILF could thereby be used as a tool to identify gaps in the attention paid to certain parts of the system and help develop interventions to address these gaps.
5. Conclusion

Complex problems such as obesity are inherently non-intuitive to solve and present strategies to reduce obesity have had limited success. Exploring perspectives of obesity among individuals across the treatment spectrum helped us understand the problem as a whole and recognize the interconnections among these beliefs and the conditions that contribute to them. Our results support the notion that public opinion typically frames obesity as an individual problem solvable by an increase in willpower among obese individuals. Shifting paradigms away from individual blame to a greater focus on obesity as a complex problem may help mobilize individuals from all levels to request more comprehensive obesity strategies. Public support for wider policy implementation is a critical step in working towards system-based interventions and this can in turn trigger system-wide change.

This work used a novel complex systems framework to critically think about efficient solutions to a seemingly intractable complex problem. The ILF proved to be useful as a qualitative data analysis tool because it helped identify and prioritize potential solutions for future policy development and interventions. Solutions to obesity require efforts from multiple sectors and encouraging service users to focus on health behaviours as opposed to weight, providing health practitioners with greater supports and resources for clinical treatment and empowering policy makers to create public health messaging that encourages compassion and wellness for all are just a few of the potential solutions to obesity. Implementing the ILF for future analysis of other data in this field may further help to lend unique and helpful insight to obesity policy, care and behaviour change. Using a complex systems based framework helped us move
away from the common responses to common problems and instead begin to think about potential solutions that would account for the complexity of obesity.
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Appendices
Appendix A.

Pre-determined and Data Generated Codes

0. Un-codeable
1. Paradigm
2. Goals
3. System structure
4. Feedback and delays
5. Structural elements

A. Obesity is a complex problem
B. Characteristics of complex systems
   a. Heterogeneity
   b. Dynamic
   c. Interdependence
   d. Time delays
   e. Adaptation and self-organization
C. Linear relationship or Reductionist approach
D. Common responses to complex problems
E. Emergence
   a. Local social innovations
   b. Networks
   c. Communities of practice
   d. System of influence at a larger scale
F. Mismatch between complexity and capacity
G. System readiness for innovation
H. Tension for change
I. Barriers to systems thinking
   a. Implementation of systems approaches are challenging
   b. Oppressed policy makers
   c. Policy driven by unconscious bias
   d. Policy resistance

J. Solutions to Complex problems
   a. Expand cross-category funding
   b. Support dynamic and diverse networks
   c. Inspire integrative learning
   d. Explore systems paradigms and perspectives
   e. Individuals matter
   f. Match capacity to complexity
   g. Set functional goals and directions for improvement
   h. Distribute decision action and authority
   i. Form cooperative teams
   j. Create competition
   k. Assess effectiveness
   l. Foster critical connections
   m. Evidence based policy
   n. Policy changes aimed at transforming ways of living

K. Causes of obesity
   a. Health inequities
   b. Biomedical perspective
   c. Obesogenic environment
   d. Individuals ability to make healthy decisions
   e. Obesity is related to mental health
   f. Eating disorder or food addiction
L. Individual behaviour change
   a. Loss of motivation
   b. Loss of self-respect
   c. Blame absolving
   d. Individual failure or blame

M. Perspectives of obesity
   a. Ambivalence towards obesity
   b. Frustration from health care providers
   c. Feeling ill-equipped to deal with obesity
   d. Resigned to failure
   e. HP not seen as resource for help

N. Weight stigmatization
   a. Negative stereotypes associated with obesity
   b. The endorsement of stereotypes
   c. Prejudice

O. Solutions to Obesity
   a. Deprivation
   b. Eat less move more
   c. Small individual behaviour changes
   d. Yo-yo dieting
   e. Weight loss surgery
   f. Obsessing about food
   g. Therapy as treatment

P. Novel Themes

Q. Favourite Quotes