Implications of the Foresight Obesity System Map for Solutions to Childhood Obesity

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Shifting the paradigm

Our understanding of the causal factors that contribute to the obesity epidemic has evolved over time. Although some still describe the problem as "people eat too much and move too little," this articulation has not brought us closer to understanding what to do to reverse current trends. Various conceptual models have framed the problem of obesity in different ways. Bray suggested an epidemiological model which illustrates agents such as food, viruses, and toxins acting on a host to produce disease, and a homeostatic model where fat acts on the brain (controller) which in turn feeds back to act on the fat (controlled system) (1). He described the interpretation of these models as "genetic background loads the gun, but the environment pulls the trigger" and suggested they imply the need for a simple FLOURIDE (For Lowering Universal Obesity Rates Implement ideas that Don't demand Effort) solution.

The International Obesity Task Force expanded on the concept of environmental agents by introducing its "causal web" (2). In the causal web, environmental factors are illustrated as "black boxes" such as school food and activity, public transport and urbanization. These factors are organized in columns according to their proximity to the individual, i.e., factors associated with work/school/home, community/locality, national/regional, and international levels. Distal contextual factors such as globalization of markets, and media and culture are shown to act on more proximal factors which in turn act on energy expenditure and food intake. The connections are simple one way arrows and biological factors are not included. The causal web helps to illustrate the diversity of factors affecting individuals and suggests that we will need to implement many ideas that "don't demand effort" on the part of the individual. Although the causal web suggests the challenge of addressing obesity is complicated, it does not explicitly illustrate the problem as "complex". Absent from the causal web is consideration of the feedback loops which are a hallmark of complex adaptive systems.

More recently the Foresight Programme of the UK Government Office for Science published an obesity system map, developed through a multistakeholder process (3). This qualitative, conceptual model has 108 variables, some of which are measureable (e.g., the ambient temperature of the indoor environment), and other variables that are more difficult to quantify (e.g., desire to differentiate food offerings). The relationships between the variables are illustrated with >300 solid or dashed lines to indicate positive and negative influences. All the variables are interconnected, some with large numbers of inputs and others with large numbers of outputs. The connections give rise to feedback loops with as few as two variables (e.g., *a* affects *b* which in turn affects *a*) or involving as many as 16 variables. At the core of the map is "energy balance" (energy intake vs. energy expenditure). The core (also referred to as the engine) is surrounded by variables that directly or indirectly influence energy balance. These variables are clustered in seven themes ranging from *Food Production* to *Physiology*. Apart from the physiological cluster, most of the variables can be considered on an individual, family, group, or societal scale. For example, the "level of physical activity" can be considered for a particular individual or as an average for the whole population.

The Foresight obesity project articulated the ambitious goal of defining the obesity system as "the sum of all the relevant factors and their interdependencies that determine the condition of obesity for an individual or a group of people" (3). Although the notion that the process could give rise to a map of "all" relevant factors was perhaps over ambitious, the map effectively illustrates the complexity of obesity by highlighting the interdependencies among variables as diverse as the pressure on the food industry to cater for acquired tastes and conscious control of an individual's accumulation of energy. The map is dominated by its illustration of the connections and feedback loops between variables.

Although the map cannot be considered comprehensive, its construction engaged a broad range of stakeholders, including scientists, the private sector and government departments in a dialogue about how to tackle this wicked problem (4). The dialogue helped to forge multisector, multidisciplinary relationships that support future government decision making based on evidence (4). An enduring value of the map is its use as a heuristic. It illustrates the complex multifactoral nature of the systems that give rise to obesity and it can be used to stimulate an even broader discussion among relevant actors ranging from multiple government departments to school age children (5,6). In this way the map helps the development of a more sophisticated and integrated policy approach. The Foresight program on obesity gave rise to the work of organizations such as the English National Obesity Observatory (NOO) (http://www.

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noo.org.uk). The NOO's role is to map out, analyse, translate and explain the breadth and depth of the issues that need to be considered for a thorough understanding of obesity and its solutions. By communicating the systemic and messy nature of the problem, the system map can help to refocus the discussion away from ineffective single intervention approaches towards solutions more appropriate for complex problems.

Foresight revisited

Although the Foresight system map is a useful tool to convey the complexity of the challenge posed by obesity, the map is so complex that some have worried that its use would lead to despair and retreat from the problem. The density of information in the map makes it difficult to take in the details, so a series of derivative maps highlighting different information such as the strength of evidence or impact and the pathways relevant to different policy approaches was generated (7). Some of these derivative maps make it easier to focus on particular variables and pathways, such as the leverage points relevant to policy development for areas such as interventions at an early life stage, walkability, and taxes on food (7).

We reproduced the Foresight map in social network analysis software (8). Variables were coded according to their cluster assignment on the original Foresight map. Connections between clusters in the reduced map reflect the number of individual connections between the variables in each cluster of the full map. The width of the arrows is proportional to the number of underlying connections (**Figure 1**). For example, the thickest arrow goes from *Food Production* to *Food Consumption* and reflects that there are 22 direct influences from variables in the *Food Production* cluster on variables in the *Food Consumption* cluster in the original map. The thick border around *Physiology* reflects that there are 33 interconnections among the variables in this cluster, whereas the thin border around *Physical Activity Environment* reflects only eight interconnections among the variables in this cluster on the original Foresight map.

By reducing the complexity of the visual image of the map while summarizing underlying information like the number of internal or between cluster connections, some relationships become more apparent. For example, the reduced map illustrates that within this model there are many variables relevant to food production that have an impact on food consumption, but no variables in food consumption that act directly on food production. The reduced map also suggests that biological variables are highly interconnected and that relationships within the food domain are more complex than in the physical activity domain. Whether these observations reflect reality or are just a synthesis of the perceptions of the particular group of stakeholders involved, further exploration is warranted. Perception can be more important than actual relationships in driving behaviour (9), so we need to consider the implications of perceived as well as actual imbalances when using the map to stimulate discussion of policy and program options.

The Foresight map can thus be seen as a suite of tools, each with its own particular function. The full map provides an overview of the complexity and the intermeshed relationships, whereas a series of simpler maps allows us to focus in more clearly on particular areas. The map could be used as the basis for describing the complexity of the challenge posed by childhood obesity, but the elements would need to be reviewed and amended to address specific differences. The common characteristic of the map and its various and potential derivatives is that they treat obesity as a system problem, with failures at many points across the system leading to the outcome of obesity, and this directs us to system-wide solutions.

Complex systems solutions

Obesity, chronic disease, climate change, war, food safety, and food security are just a few of the many "wicked" problems we currently face. Wicked problems are complex problems, they are difficult to define and have no clearly described single or set of "true" solutions (10). Wicked problems are often perceived to be policy resistant (11). Common responses to wicked problems often include despair, retreat and an attempt to assign blame. But by acknowledging a problem as being wicked we

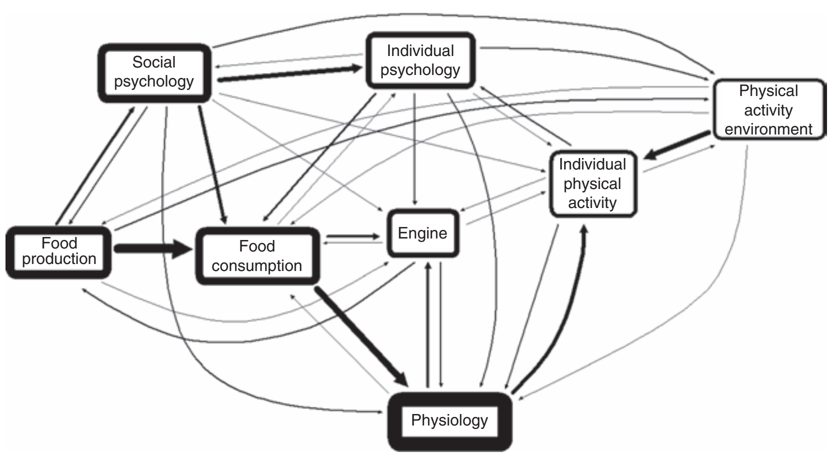

Figure 1 Reduced Foresight map. The number of individual connections between variables in each cluster is represented in the thickness of the connecting lines, whereas the number of connections within a cluster is shown as the cluster's border thickness.

can move beyond the tendency to seek simple solutions and begin to consider solutions appropriate for complex problems (**Table 1**)(12,13).

Individuals still matter

It may seem counterintuitive that individuals matter when problems are large, complex, and involve many environmental dimensions, but without considering individuals and their role in system function, there is little hope of creating successful change (12). Of particular importance is the need to match the complexity of people's tasks to their capacity to act, and the tasks of the individual actors in the obesity system vary considerably. Not only do we all make decisions about our own food and physical activity behavior within our own fairly unique set of contextual factors, there are many system actors who make decisions that affect other people's food and physical activity environments. Parents affect their child's food environment by deciding what food to purchase and bring into their home. Practitioners implement interventions based on the balancing of limited resources, the evidence they can access, the goals they have been given to work with, and the varied circumstances of the population they are trying to help. Decision makers in the private sector make decisions based on the balance of shareholder's interests, current trends in consumption, and the costs of raw materials and labor. In the complex obesity system, all of these individuals matter.

If our capacity as individuals to act exceeds the complexity of our tasks, we are likely to succeed at those tasks (12). If the complexity of a task or decision we face is too great, or if it rarely needs to be made, we are more likely to fail (14). Failure is also likely when there is little opportunity to gain experience or practice a complex task, or when we can't translate a task into terms we can easily understand. Thaler and Sunstein suggest that this is when we need system actors to consider their role as "choice architects" (people who have the responsibility for organizing the context in which people make decisions (14)). Choice architects can reduce the complexity of tasks by retaining elements of choice, by avoiding the mantra of demanding ever more choice, and by "nudging" people in the right direction.

Thaler and Sunstein point out that in our complex world, nudges and therefore choice architecture cannot be avoided (14). As the Foresight map demonstrates, the food and physical activity environments of most individuals are highly complex and involve many different influences, consciously or unconsciously created by many choice architects. Children have been encouraged to believe that "food is fun" and they make food decisions based on how much fun the food will be to eat, as well as peer pressure (they don't want food that would appear "too young for them") (15). They are not influenced by information on the package, or knowledge of the healthiness of the food (16). Clearly, as choice architects we need to find better ways to rebalance the nudges children are given. Children will generally have less capacity to deal with the complexity of their food and physical activity environments than adults do.

What should we do?

Strategies for changing complex environments include establishing multidisciplinary, multisector teams, giving them the ability to articulate appropriate, functional goals and providing tools to measure their effectiveness (**Table 1**). Together these strategies promote continuous improvement by establishing feedback loops between what we know and what we do. Current research and practice paradigms for addressing childhood obesity will need to change to meet the needs of such an integrated approach.

One way we have already found for dealing with the complexity of a challenge like obesity is to adopt a pattern of system-wide intervention. The traditional research approach has been to study the relationship between intervention and outcome while striving to reduce bias and error wherever possible. To do this on a system-wide basis requires a major research effort. Investment in large scale comprehensive chronic disease prevention projects with appropriate levels of research and evaluation seems to have lagged behind investment in other areas, although there is hope that through the building of coalitions of major funders that new opportunities will be forthcoming (17).

The systems approach to obesity leads quickly to the recognition that there is a need to understand system variables like capacity, complexity, connectivity, and social norms. Although we have not yet given much consideration to how to measure variables like capacity or complexity, the recent work of Christakis and Fowler demonstrates the importance of connectivity and social norms to the development of obesity and smoking cessation (18,19). Researchers have begun to employ complex systems methods such as microsimulation, system dynamics and agent-based modeling to help predict future trends and gain insight into the importance of behavioural interactions (20,21). Support for initiatives like the Collaborative Obesity Modeling network (obesitymodeling.net) and requests for applications for multilevel modeling to address childhood obesity are helping to expand this area of inquiry.

Another approach to dealing with complexity, rather than trying to control for it, is to establish cycles of continuous improvement, i.e., learn from what we do, at the levels in the system where contextual factors are "external" rather than "internal". Green has suggested that if we want more evidence-based practice, we need more practice-based evidence and that we may find it helpful to focus on recursive feedback through a systems approach (22). The School Health Action Planning and Evaluation System

Table 1 Solutions to complex problems

Consider that individuals matter
Match capacity to complexity
Set functional goals and directions for improvement
Distribute decision, action and authority
Form cooperative teams
Create competition and feedback loops
Assess effectiveness

(SHAPES) (http://www.shapes.uwaterloo.ca) is one example of a system that supports improvement based on school health profiles built using standard core items (23). SHAPES is being used for planning, evaluation, surveillance, and research in various schools and in regions across Canada. The Standard Evaluation Framework for weight management interventions introduced by the National Obesity Observatory offers guidance to those commissioning, running or evaluating weight management interventions (24). The CAPTURE Project (CAnadian Platform To increase Usage of Real world Evidence), recently funded by the Canadian Partnership Against Cancer, will also attempt to enhance the collection and use of "real world" evidence (http://www.thecaptureproject.ca). In addition to supporting continuous improvement at the level of organizations and communities, by introducing and enabling the use of common indicators and tools, these efforts will also enhance our ability to compare effectiveness of interventions across contextual factors.

What's next?

Development of the Foresight map was an important step forward. It has helped drive a greater understanding of the complexity of the challenge of addressing obesity and chronic disease prevention. Development of the system map has supported the discourse on policy interventions and derivative maps can be used to unpack the complexity into more manageable chunks relevant to program and policy interventions. Wicked problems such as obesity demand appropriate responses including recognition of the fact that contextual factors are important to the effectiveness of solutions. As such, we need integrated systems that support the work of a diverse set of actors in learning from what they do and adapting their actions to their current context. The existing research paradigm that seeks to identify a causal relationship between an intervention and an outcome is inadequate given the complex array of activities in different sectors, in different settings, and across the lifespan needed to address these challenges, especially when the "outcome" is so sensitive to the huge array of interactions and confounders. Nevertheless, it is of course important to maximize the available learning of what does and does not work to tackle the problem, and the increasing focus on learning from real world practice is an important feature of this. Now is an exciting time to be working in this field, as we need not only to research possible solutions to the problem, but also to learn new ways to conduct this essential research.

DISCLOSURE

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