A participatory approach to modeling how social, behavioral, and medical factors connect to well-being and obesity

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Policy context

Why undertake a modelling project on obesity and well-being in British Columbia?

Methods

How did we combine participatory modeling and data analytics?

Our model

An interactive software to navigate the complex system of obesity & well-being

Next step

Testing and using the model to support decision-making
• In January 2013, the Provincial Health Services Authority (PHSA) of British Columbia published *From weight to well-being*.

• This discussion paper provided a review of the evidence regarding the relationships between overweight, obesity and mental well-being.
Prevalence of class I, II and III obesity in Canada (Katzmarzyk & Mason, CMAJ 174(2))
Policy context

Report presented:
• Addressing obesity is complex and not totally understood
• Traditional approaches of the focus on weight to have not been successful
• Weight Bias and stigma cause harm
• Well-being focused approaches that promote healthy weights & mental well-being may be preferable
Policy context

• How does the evidence on physical effects of obesity fit with this paradigm? What can we learn by applying complexity concepts?

• To answer these questions, the PHSA opened a call in November 2013.

• The insights obtained by applying complexity concepts will be discussed today.

Summary Report:
From Weight to Well-Being: Time for a Shift in Paradigms?
A discussion paper on the inter-relationships among obesity, overweight, weight bias and mental well-being

January 2013
The team led by Dr. Giabbanelli had the following **objectives:**

- Synthesize the available **evidence regarding obesity** and well-being from a systems perspective

- Create an innovative **tool that can be used to inform the policies and practices regarding healthy-weight interventions**

- Collaborate closely with the direction of the Provincial Health Services Authority to ensure relevance with local approaches
Obesity is a **complex** problem.

- loops

Many statistical models don’t cope well with loops.
Obesity is a complex problem.

- loops
- heterogeneity

Models commonly used in epidemiology assume homogeneity.
Methods - *motivation*

Obesity is a complex problem.

- loops
- heterogeneity
- nonlinearity

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Methods - motivation

Obesity is a complex problem.
• loops
• heterogeneity
• nonlinearity
• uncertainty
• randomness
• dynamic

Fear has a very high impact on exercise.
I think it’s more medium.
Obesity is a complex problem.

- loops
- heterogeneity
- nonlinearity
- uncertainty
- randomness
- dynamic

Our objectives were to create a model to particularly capture loops and uncertainty.
Methods - Overview

1. Structure the evidence of the previous report as a network.

Obesity creates musculoskeletal issues and results from an imbalance in energy intake and expenditure, which itself is the result of thermogenesis, metabolism and physical activity. Energy intake comes from the diet, which is influenced by one’s socio-economic position as well as the availability and affordability of foods. In addition, hunger and appetite are impacted by a variety of physiological mechanisms (e.g., ghrelin, leptin) as well as eating disorders.

2. Analyze the network to identify strengths and gaps.

3. Conduct 1-on-1 interviews and adapt the map accordingly.

4. Deploy questionnaires based on fuzzy-logic to turn the conceptual map into a fuzzy cognitive map.

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To analyze the connections highlighted in the PHSA report, we:

- Manually **coded every relationship** mentioned in the report

  - **Example of 4 connections** (right) derived from the PHSA report (left)

    "**bias and stigma have significant negative consequences, including overeating and avoidance of exercise**"

    Weight bias $\rightarrow$ Exercise

    Weight stigma $\rightarrow$ Overeating

- **Structured these relationships** into an initial network
Methods – *Step 2*

**Percentage of factors in each category**

- Psychology (19%)
- Determinants (18%)
- Disease (17%)
- Social effects (13%)
- Physiology (10%)
- Environment (7%)
- Food production (6%)
- Food consumption (5%)
- Weight (3%)
- Exercise (2%)

**Types of factors used in the PHSA report (using the categories of the UK Foresight Map)**

[Diagram showing various factors and their connections, such as Obesity, Body image, Weight bias, Self-esteem, etc.]
Areas emphasized in the PHSA report

Details of categories are provided in the next slide
Methods – Step 2

Well-being component
- Emotional well-being
- Sense of belonging
- Social well-being
- Satisfaction of needs
- Ability to realize aspirations
- Can cope with the environment

Eating disorders component
- Reduced awareness of hunger
- Self-destructive behaviour
- Social anxiety
- Eating disorders
- Disordered eating
- Pressure to be thin
- Diet industry

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Interactively exploring and rendering the map gave us a way to navigate its complexity.
Based on the strengths of the previous report and its gaps, we identified 3 areas which needed further data collection.

<table>
<thead>
<tr>
<th>Strengths of the past report</th>
<th>Areas emphasized in this project</th>
<th>Areas peripheral to this project</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Psycho-social pathways (e.g., consequences of weight stigma)</td>
<td>• Clinical pathways (e.g., consequences of co-morbidities, impact of nutrition)</td>
<td>• Food production</td>
</tr>
<tr>
<td>• Mental well-being</td>
<td>• Physical well-being</td>
<td>• Food consumption</td>
</tr>
<tr>
<td>• Resources impacted by obesity (e.g., job opportunities)</td>
<td>• Resources enabling a high level of physical well-being (e.g., the built environment)</td>
<td>• Genetics</td>
</tr>
</tbody>
</table>
The previous step showed that we had to better capture the clinical pathways, physical aspects and resources at work in obesity and well-being. This was achieved through semi-structured interviews:

- We identified 19 experts for all priority areas, and attempted to reach saturation
- We performed interviews from a systems thinking perspective
- We transcribed and analyzed the interviews to extract more connections
The connections found during the interviews were summarized into a series of sub-networks.

These sub-networks were combined into one network.
Combination of different networks into the full networks
‘Core’ variables are obesity and well-being, as they are the focus of this study.
To get values (=strengths/weights) for each edge, we used fuzzy logic.

Decisions under approximate information and inaccurate data

Mathematical specification of uncertainty and vagueness
Example: imagine that you ask 6 experts to evaluate the impact of obesity on dysfunctional adipose tissue.
Our model
Let’s see how the map can help us understand multiple pathways between factors.
Let’s compare an approach centered on well-being to a (more classical) approach centered on obesity. There are 2 ways:

1. We can do network analysis to see what components are connected to obesity versus well-being.

2. We can do text analytics to see what themes emerge when discussing obesity versus well-being.
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Our model – *Analysis*

Example of factors causing (left) or resulting from (right) either obesity or well-being

<table>
<thead>
<tr>
<th>Causes</th>
<th>Is a consequence of</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Obesity</strong></td>
<td></td>
</tr>
<tr>
<td>Short sleep duration</td>
<td>Medications</td>
</tr>
<tr>
<td>Cancer</td>
<td>Overeating</td>
</tr>
<tr>
<td>Dysfunctional adipose tissue</td>
<td>Physical activity</td>
</tr>
<tr>
<td>Weight bias</td>
<td>Diabetes</td>
</tr>
<tr>
<td><strong>Well-being</strong></td>
<td></td>
</tr>
<tr>
<td>Antipsychotics</td>
<td>Perceived environmental safety</td>
</tr>
<tr>
<td>Medications</td>
<td>Presence of a vibrant community</td>
</tr>
<tr>
<td>N/A</td>
<td>Resilience</td>
</tr>
<tr>
<td>N/A</td>
<td>Ability to engage in physical activity</td>
</tr>
</tbody>
</table>
Using tools from network analysis, we analyzed the full conceptual map as well as reduced version to compare the roles of obesity and well-being.
The analysis using natural language processing (NLP) involved steps the following. The interviews were divided into sets of answers. In one set, all answers had to include obesity; in the other set, they all had to include well-being. In both sets, words were stemmed (e.g., ‘problems’ and ‘problem’ are combined) and common English words (e.g., ‘and’, ‘or’, ‘that’) were removed. Then, the frequency of words in the 2 sets was compared.
The themes were then compared and discussed with the direction of the provincial health services authority.
Our model – *Interactivity*

We focused on supporting four tasks as a starting point.

- **Interactive exploration**
- **Consequences of intervening on one factor for the whole system**
- **Finding the different ways in which one factor can impact another**
- **Weighing the importance of different factors**
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Interactively explore the system

See the (many) ways in which a factor can impact another

Assess which factors are most important

Find how changes in a factor can impact the system

This view shows how Mental well-being impacts other factors, both directly and indirectly. Note that we are focused on the different ‘routes’ from Mental well-being to other factors. Thus, this simplified view does not show you feedback loops; use the free exploration mode to see them.

For information about a factor, right click on it. For a factor’s full name, just leave the mouse on its circle.

Prefer to see this as a tree? Click here!

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A participatory approach to modelling well-being & obesity
The model is finished. We are currently testing custom-made software to use it.

Next steps

1. How can the model better support decision-making?
2. What questions would be asked?
3. How do practitioners and policymakers envision interacting with the model?

Testing the model with a health authority

Broadening the testing and use of the model and providing a users guide

Developing the model