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

Philippe J. Giabbanelli *[Cambridge]*

Andrew Tugwell, Lydia Drasic *[PHSA]*

Diane T. Finegood, Grace MacEwan *[SFU]*

Provincial Health Services Authority
Province-wide solutions. Better health.

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Soon at

Northern Illinois University

Outline

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

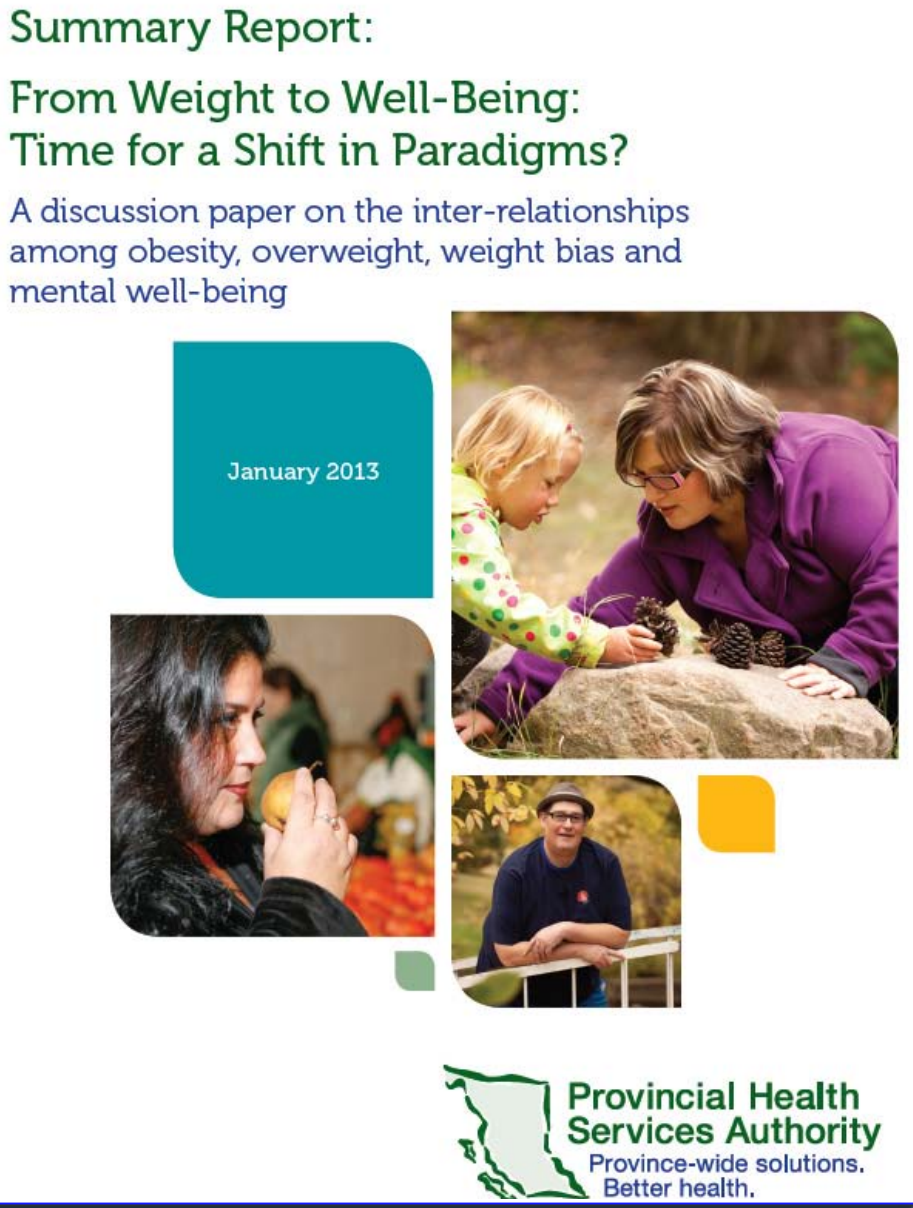
Next step

Testing and using the model to support decision-making

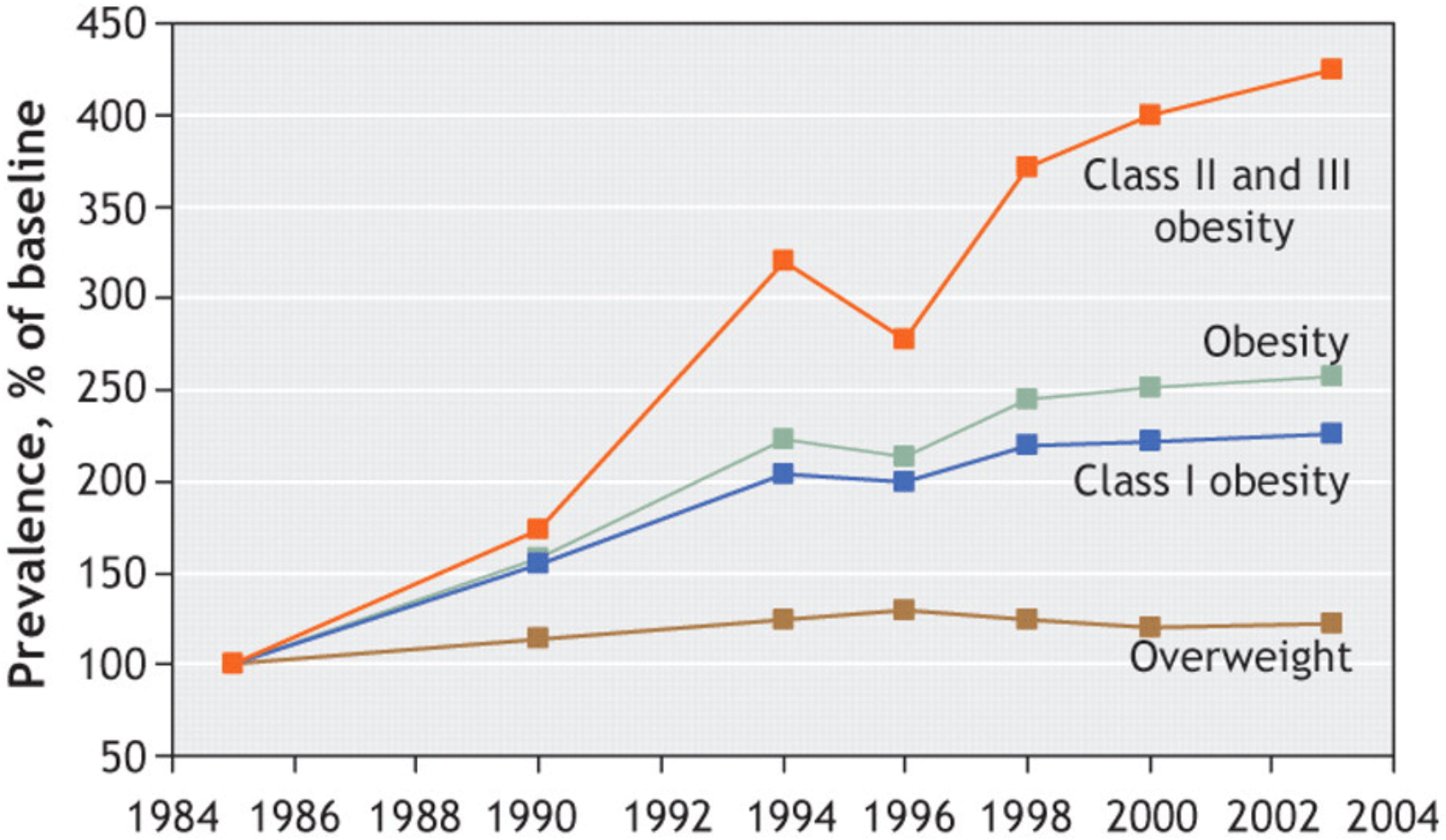
Policy context

- 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.



Policy context



Prevalence of class I, II and III obesity in Canada (Katzmarzyk & Mason, CMAJ 174(2))

Policy context

Report presented:

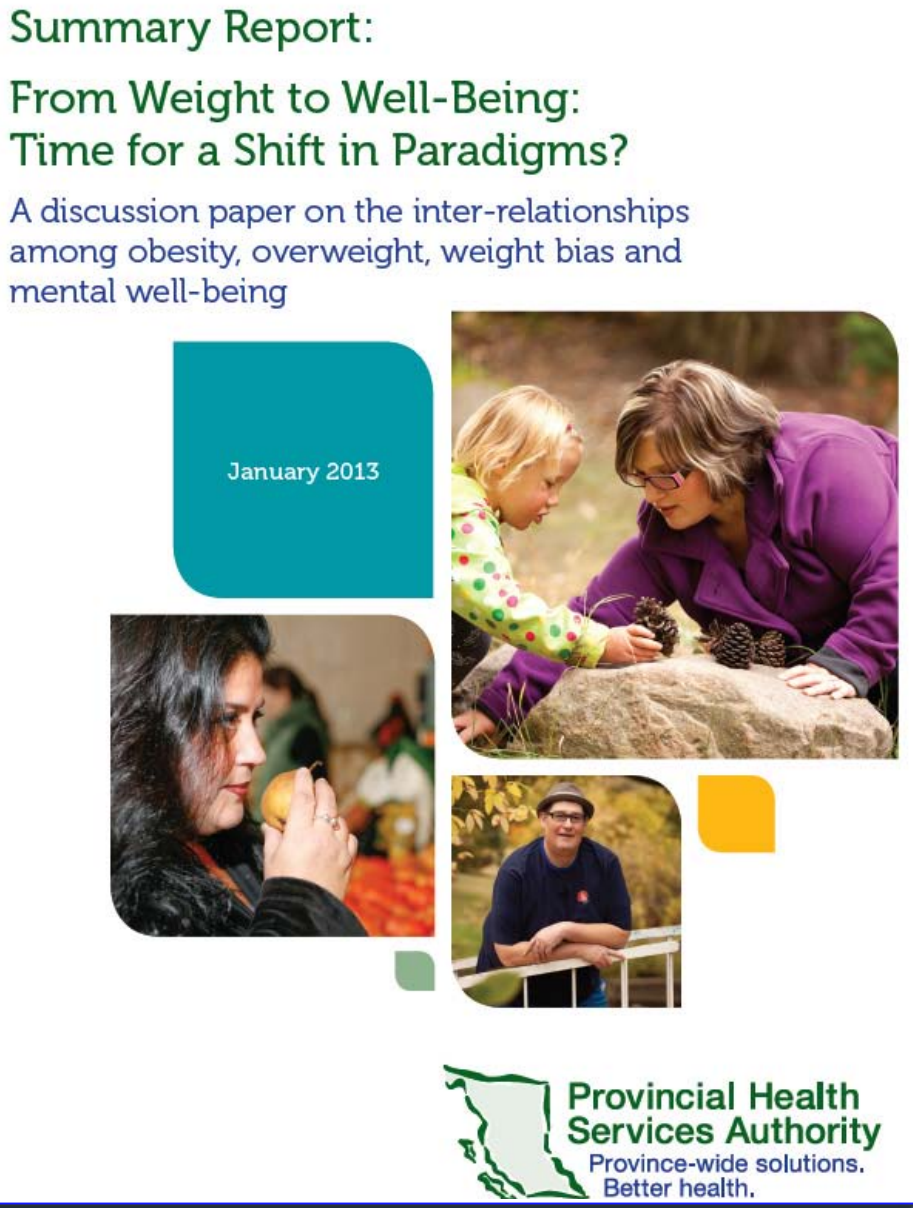
- Addressing obesity is complex and not totally understood
- Traditional approaches of the focus on weight to have not been successful
- Weight Bias and stigma cause harm
- Well-being focused approaches that promote healthy weights & mental well-being may be preferable

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.



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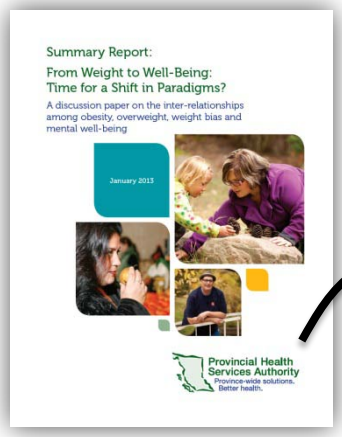
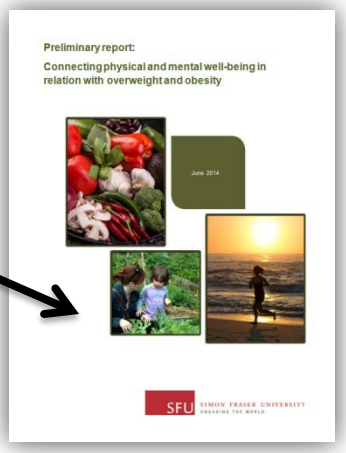




The team led by Dr. Giabbanelli had the following **objectives**:

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

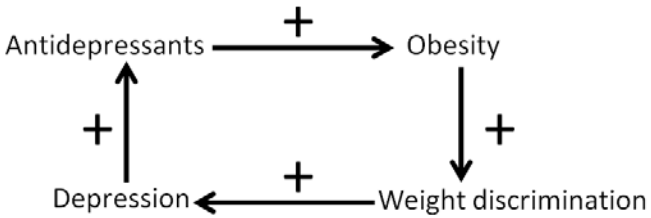
- Create an innovative tool that can be used to inform the policies and practices regarding healthy-weight interventions

- Collaborate closely with the direction of the Provincial Health Services Authority to ensure relevance with local approaches

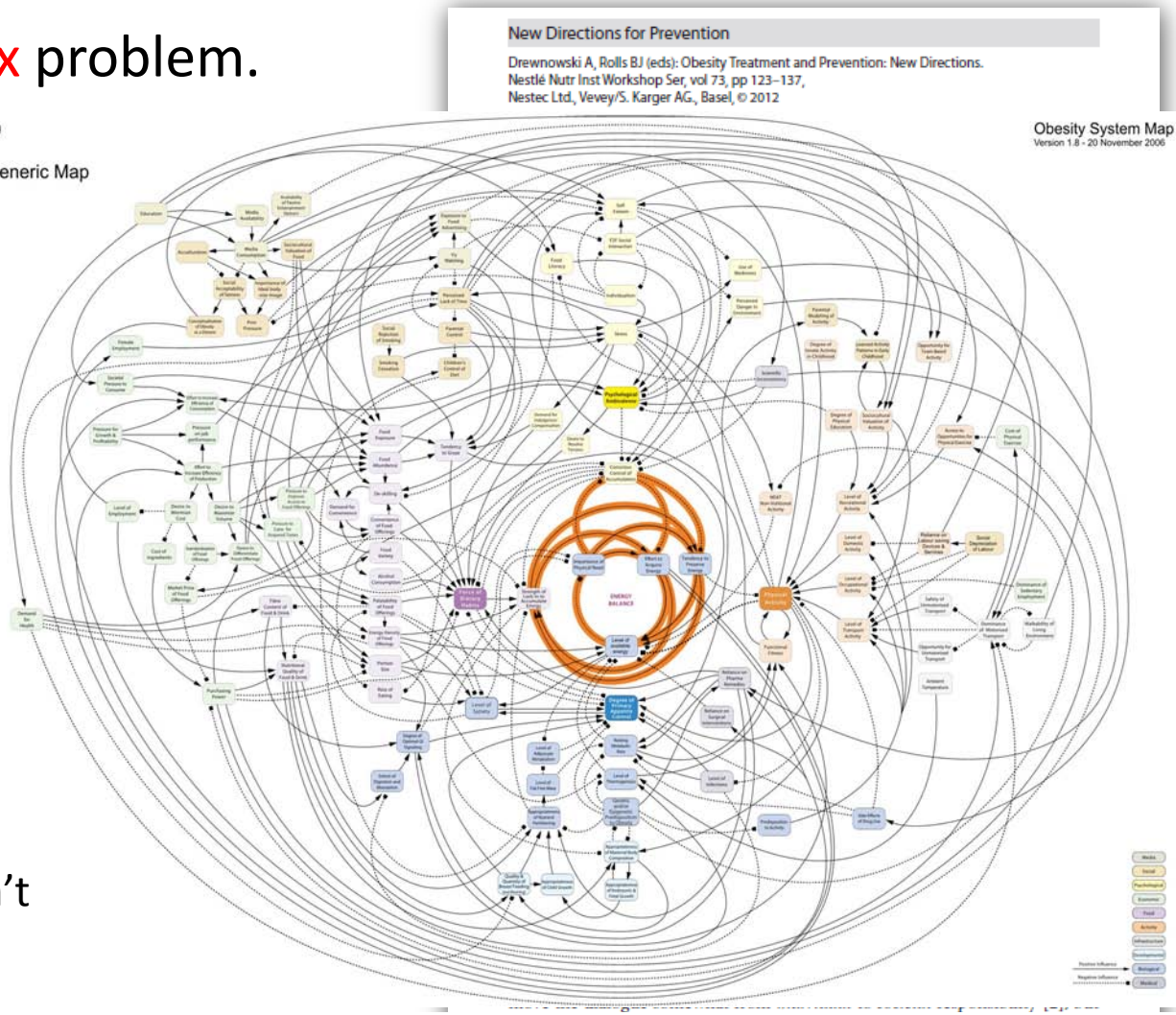
Methods - *motivation*

Obesity is a complex problem.

- loops



Many statistical models don't cope well with loops

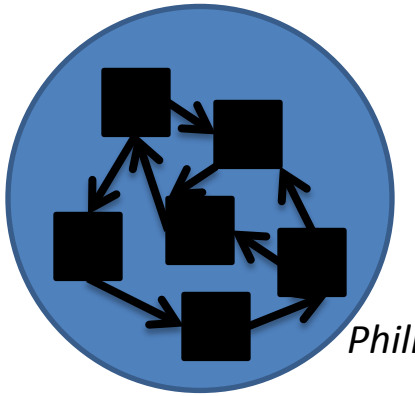


Methods - *motivation*

Obesity is a complex problem.

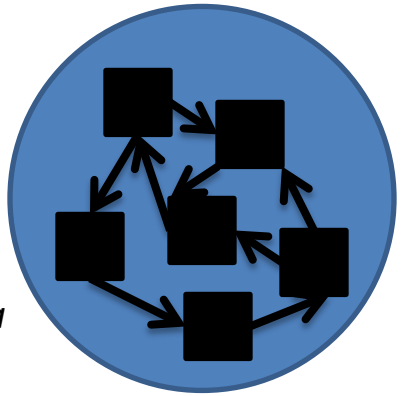
- loops
- heterogeneity

Models commonly used in epidemiology assume homogeneity.



Philippe

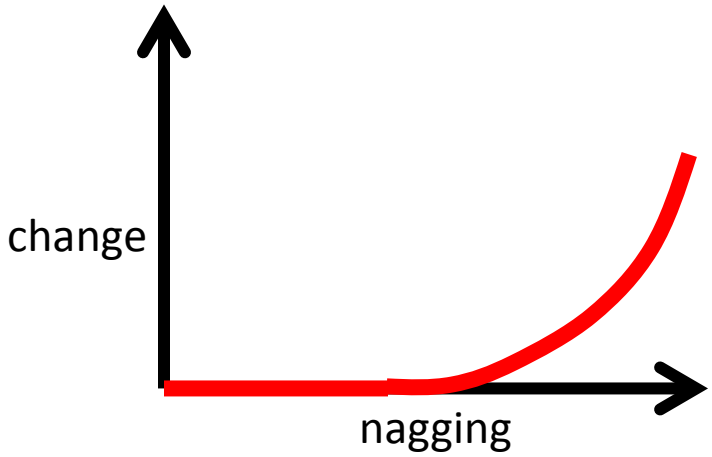
Lydia

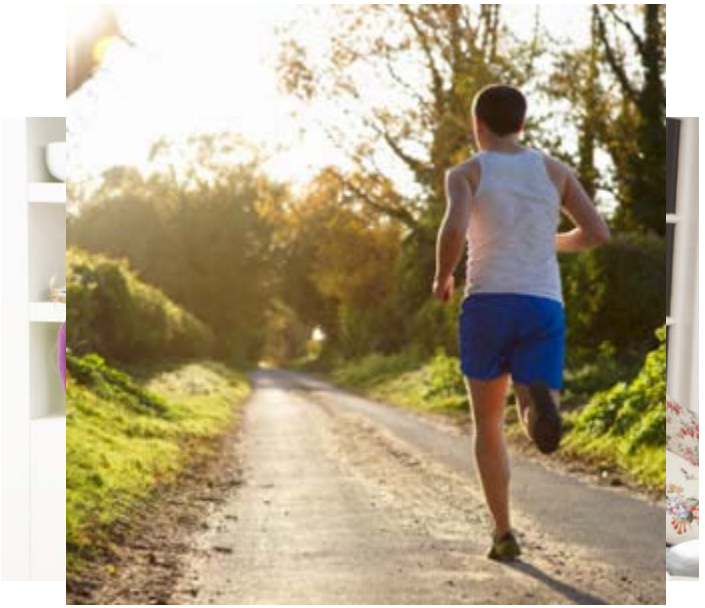


Methods - *motivation*

Obesity is a complex problem.

- loops
- heterogeneity
- nonlinearity





Methods - *motivation*

Obesity is a complex problem.

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

Methods - *motivation*

Obesity is a complex problem.

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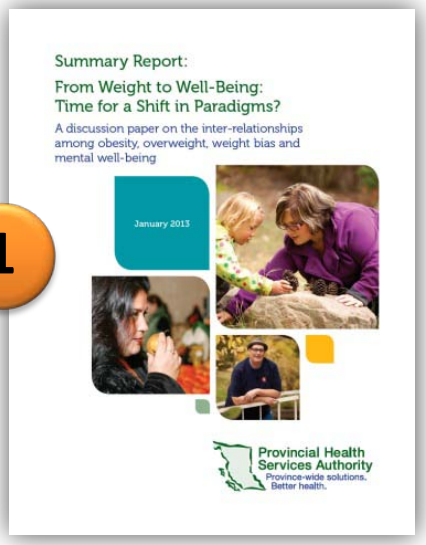
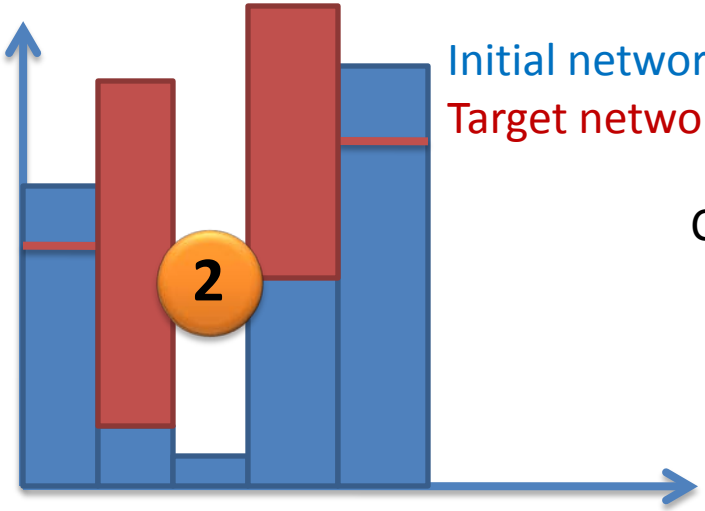
Our objectives were to create a model to particularly capture loops and uncertainty.

Methods - *Overview*



1

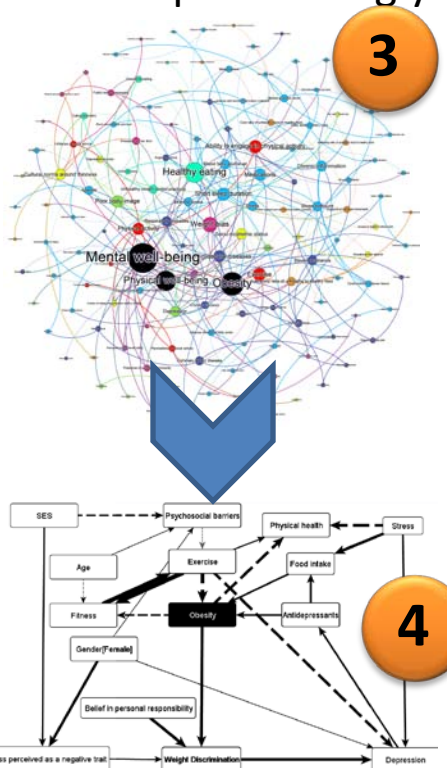
Structure the evidence of the previous report as a network



2

Analyze the network to identify strengths and gaps.

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

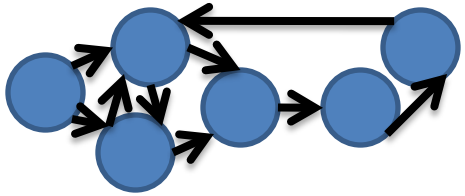


3

4

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

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.



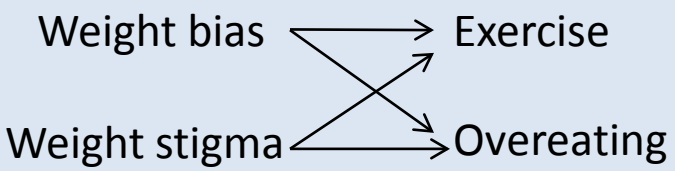
Methods – *Step 1*

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

- Manually coded every relationship mentioned in the report

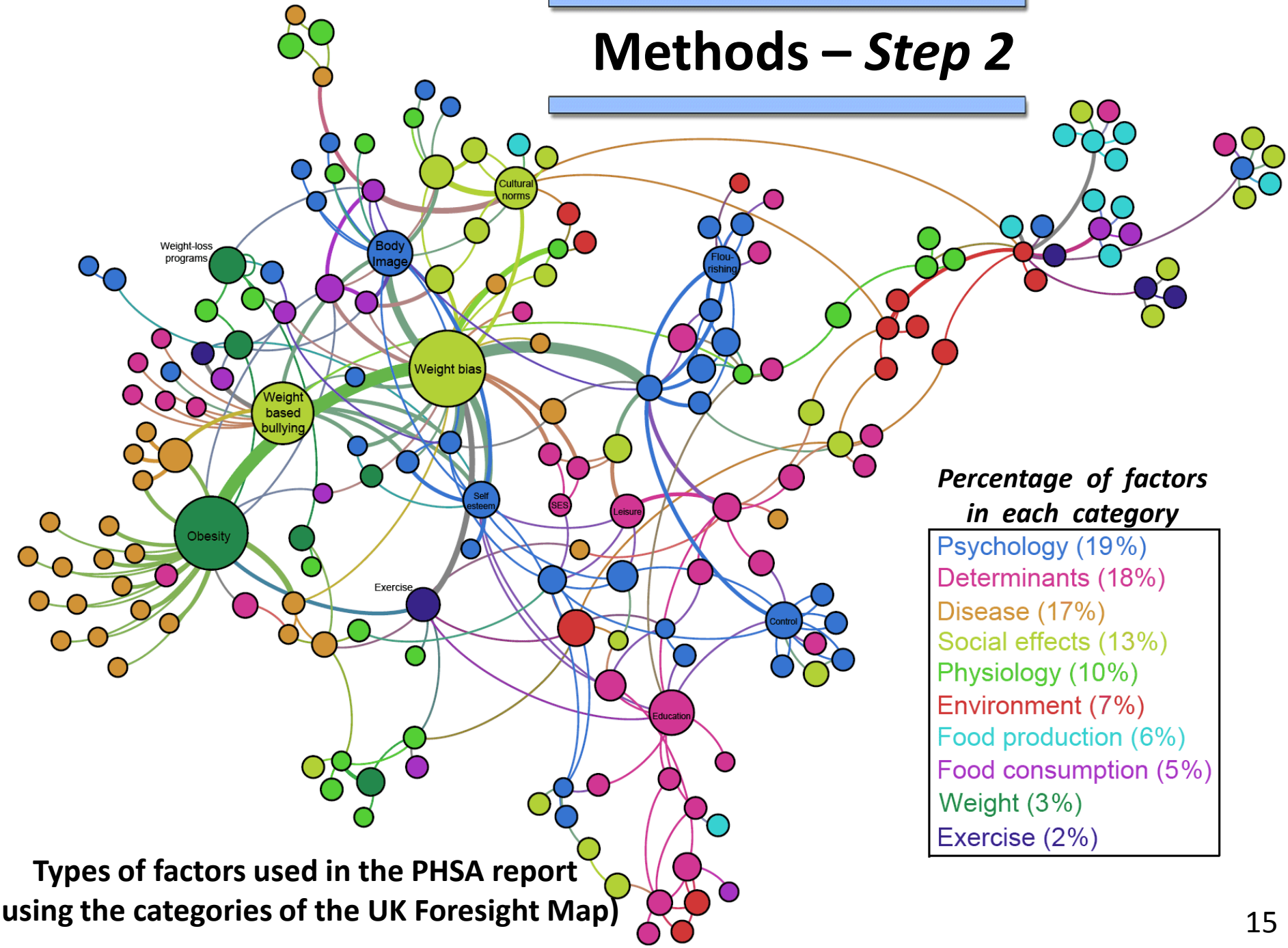
Example of 4 connections (right) derived from the PHSA report (left)

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



- Structured these relationships into an initial network

Methods – *Step 2*

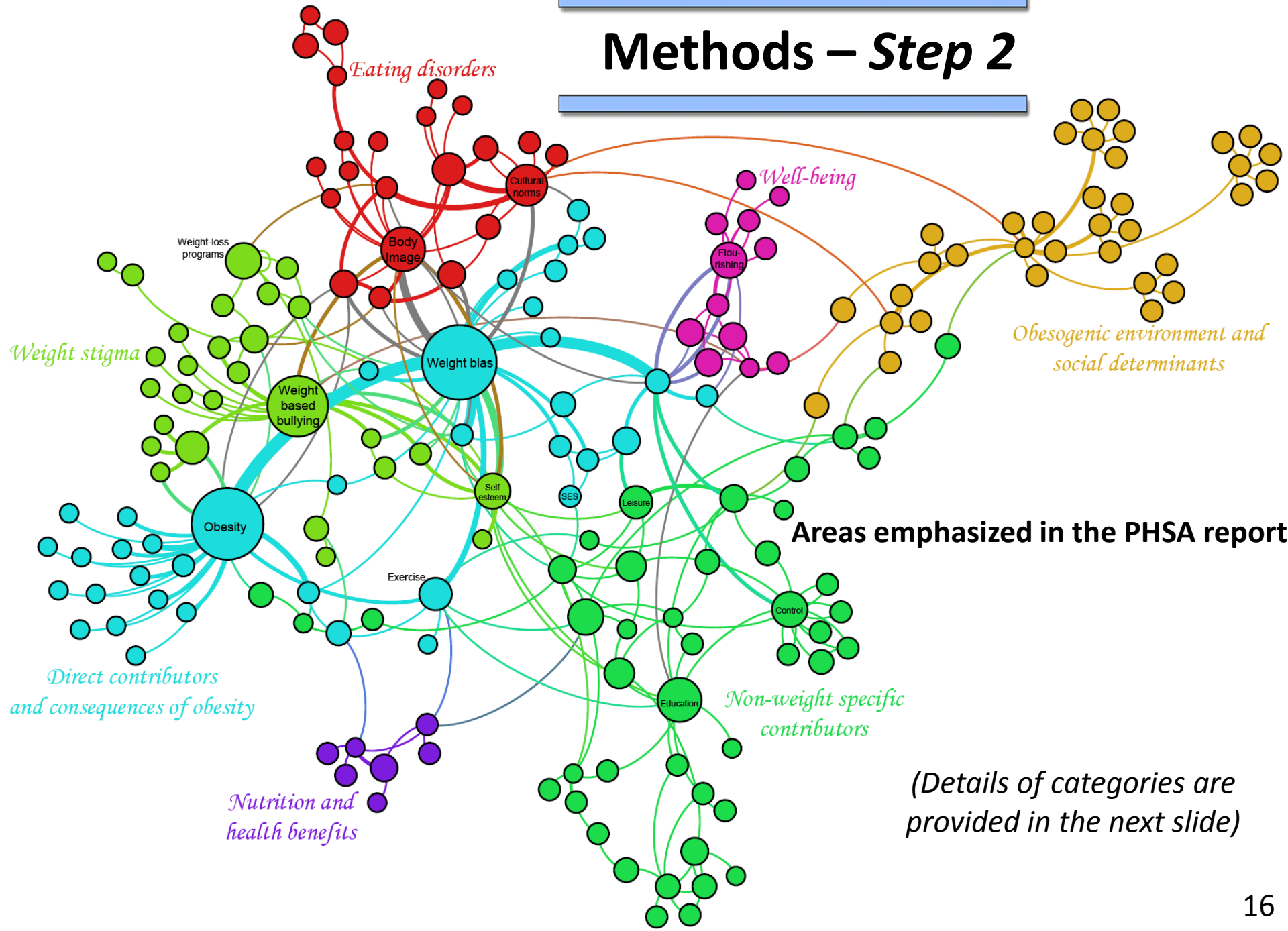


Percentage of factors in each category

- 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)

Methods – *Step 2*



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

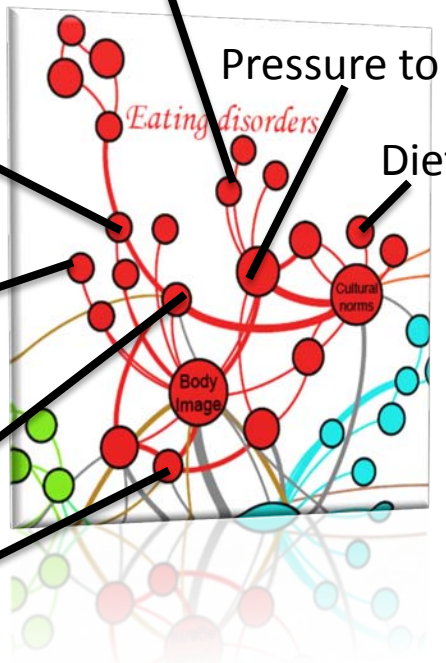
Eating disorders component

Reduced awareness of hunger

Pressure to be thin

Self-destructive behaviour

Diet industry

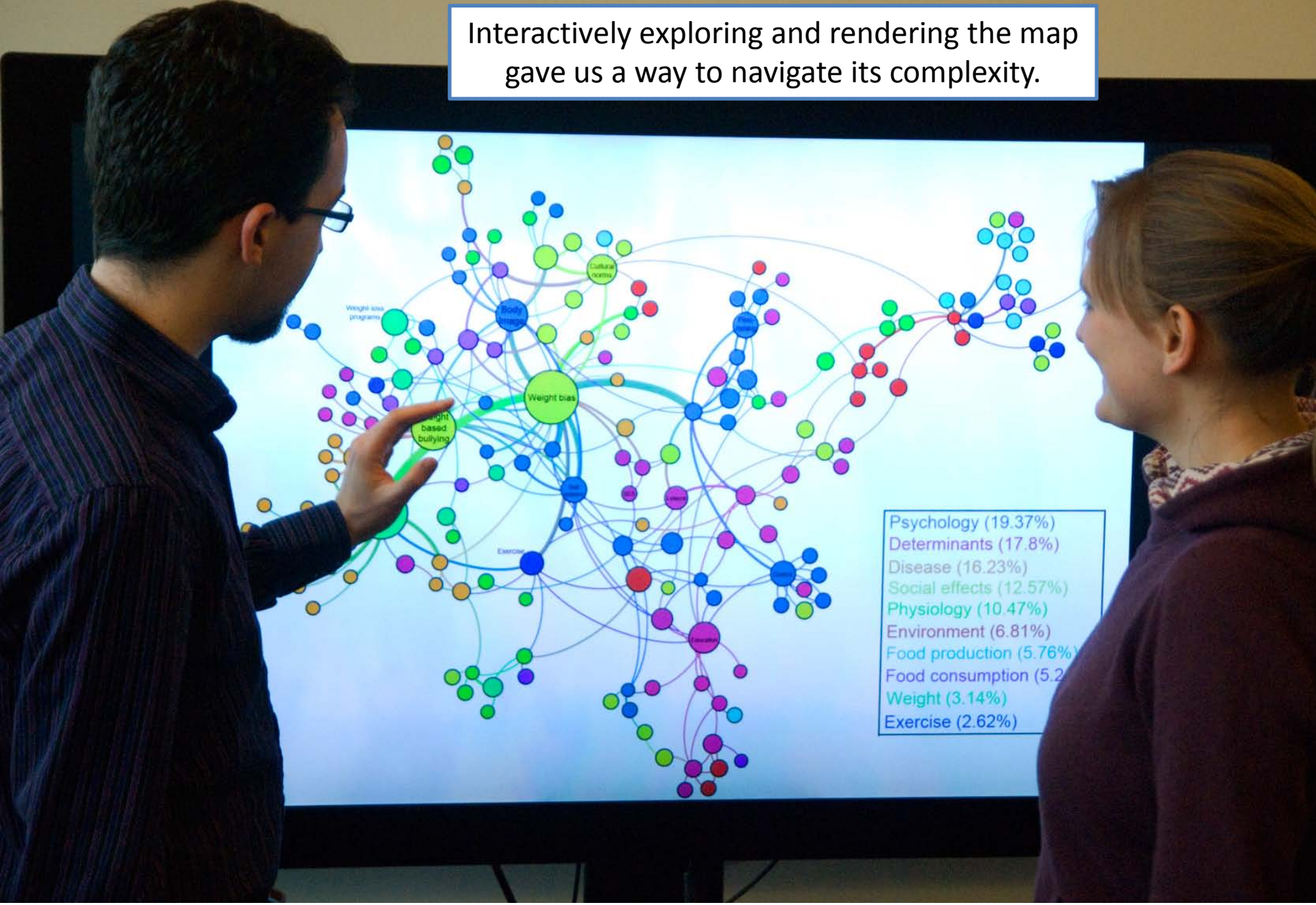


Social anxiety

Eating disorders

Disordered eating

Interactively exploring and rendering the map gave us a way to navigate its complexity.



Methods – *Step 2*

Based on the strengths of the previous report and its gaps, we identified 3 areas which needed further data collection.

Strengths of the previous report and areas to emphasize		
Strengths of the past report	**Areas emphasized in this project**	**Areas peripheral to this project**
• Psycho-social pathways (e.g., consequences of weight stigma) • Mental well-being • Resources impacted by obesity (e.g., job opportunities)	• Clinical pathways (e.g., consequences of co-morbidities, impact of nutrition) • Physical well-being • Resources enabling a high level of physical well-being (e.g., the built environment)	• Food production • Food consumption • Genetics

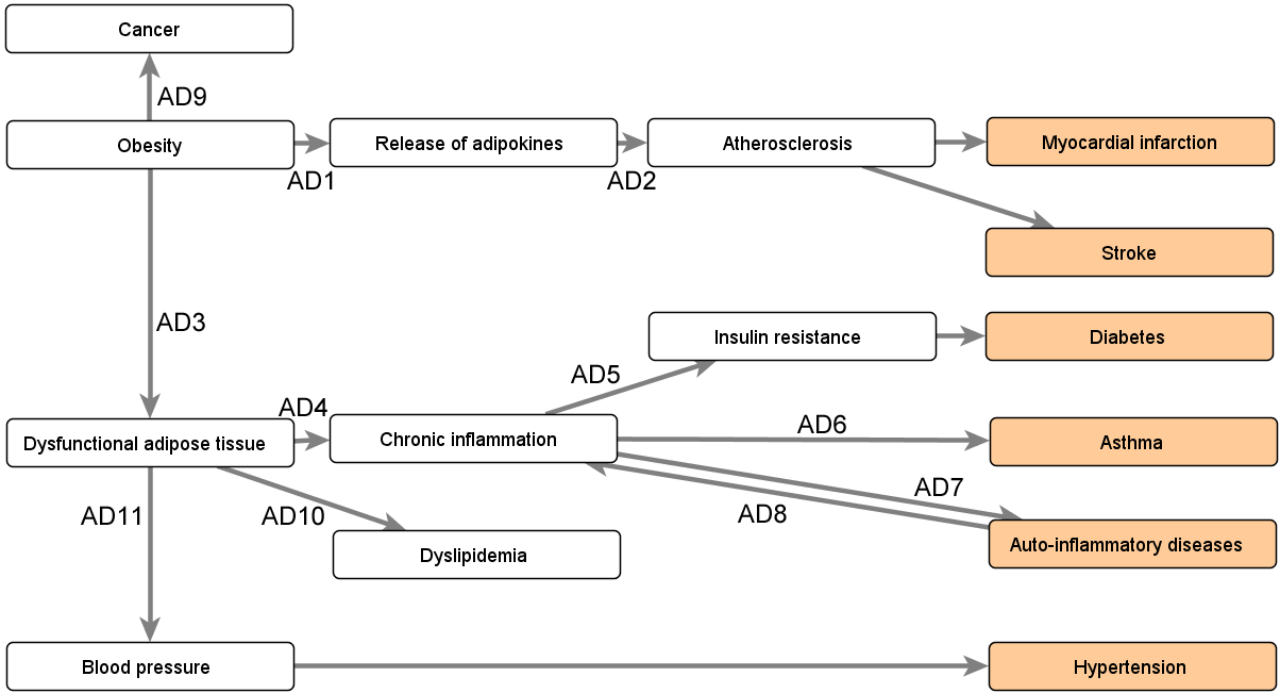
Methods – *Step 3*

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:

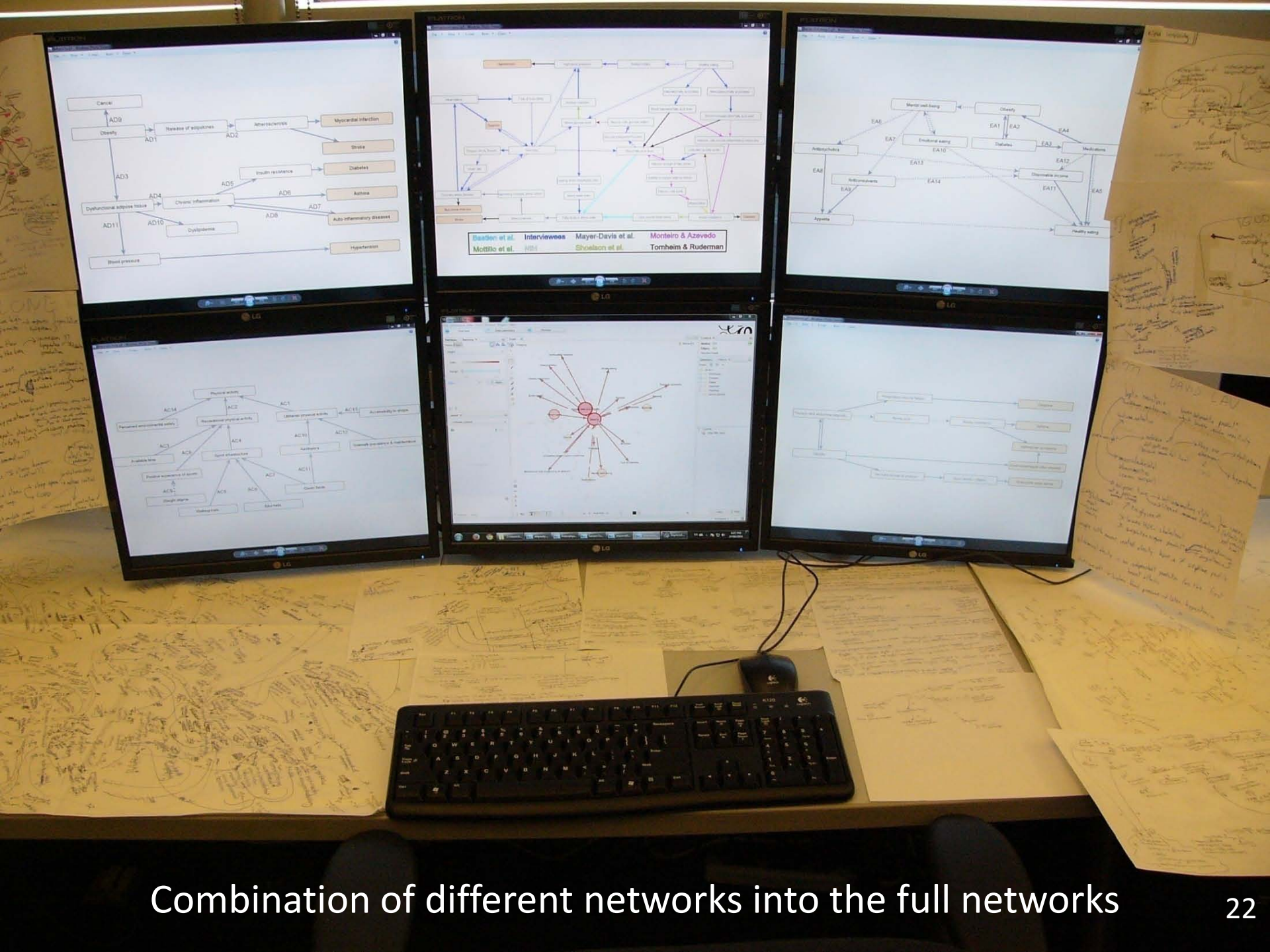
- We identified 19 experts for all priority areas, and attempted to reach saturation
- We performed interviews from a systems thinking perspective
- We transcribed and analyzed the interviews to extract more connections

Methods – *Step 3*

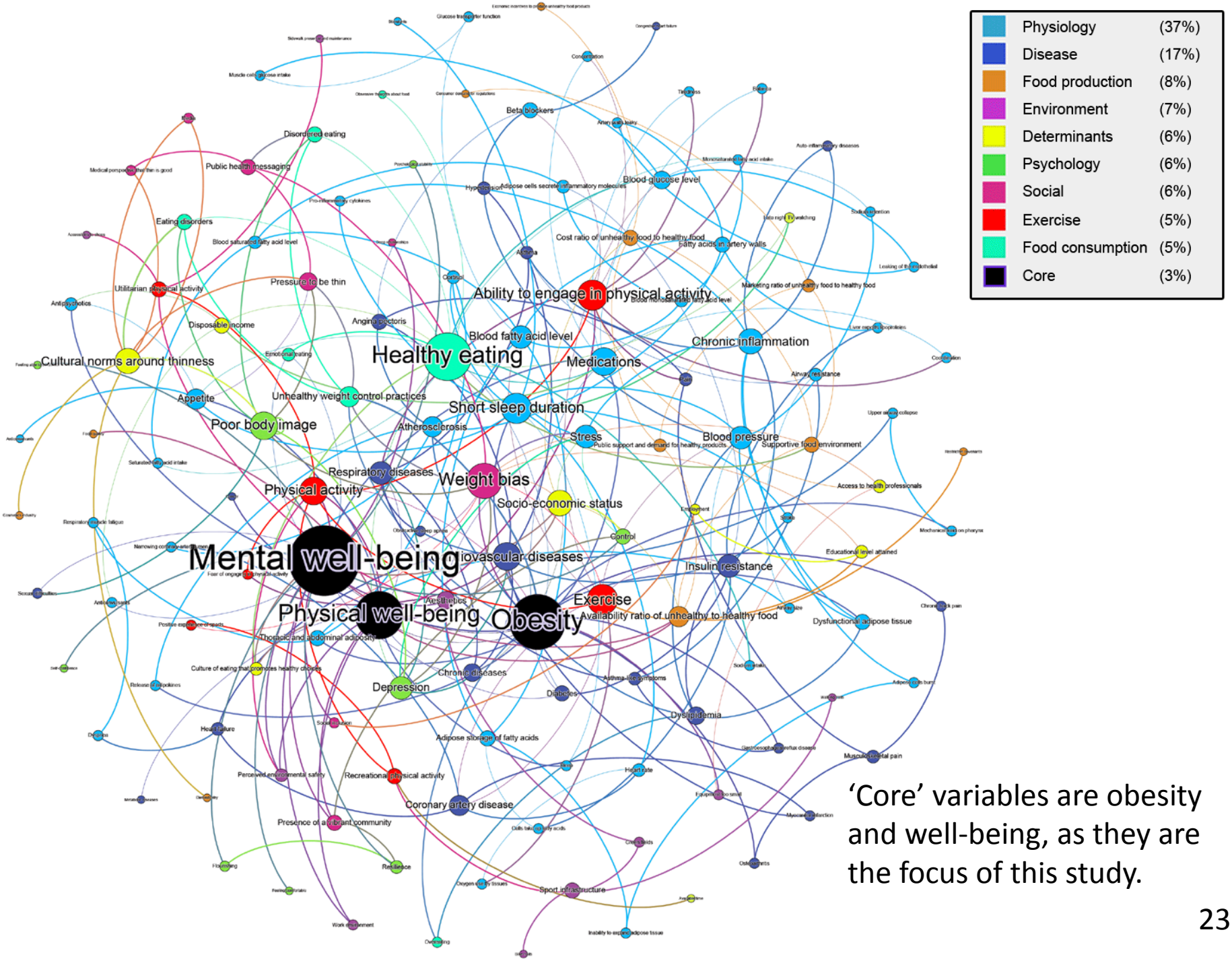
The connections found during the interviews were summarized into a series of sub-networks.



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.

Methods – *Step 4*

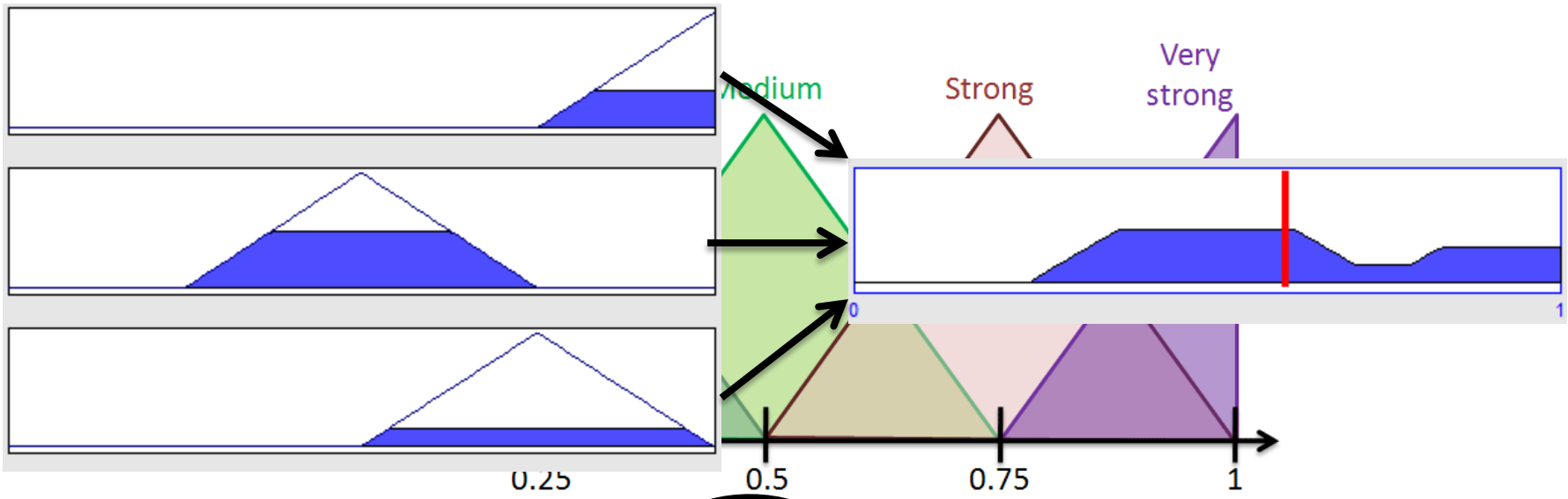
To get values (=strengths/weights) for each edge, we used fuzzy logic.

Decisions under approximate information and inaccurate data

Mathematical specification of uncertainty and vagueness

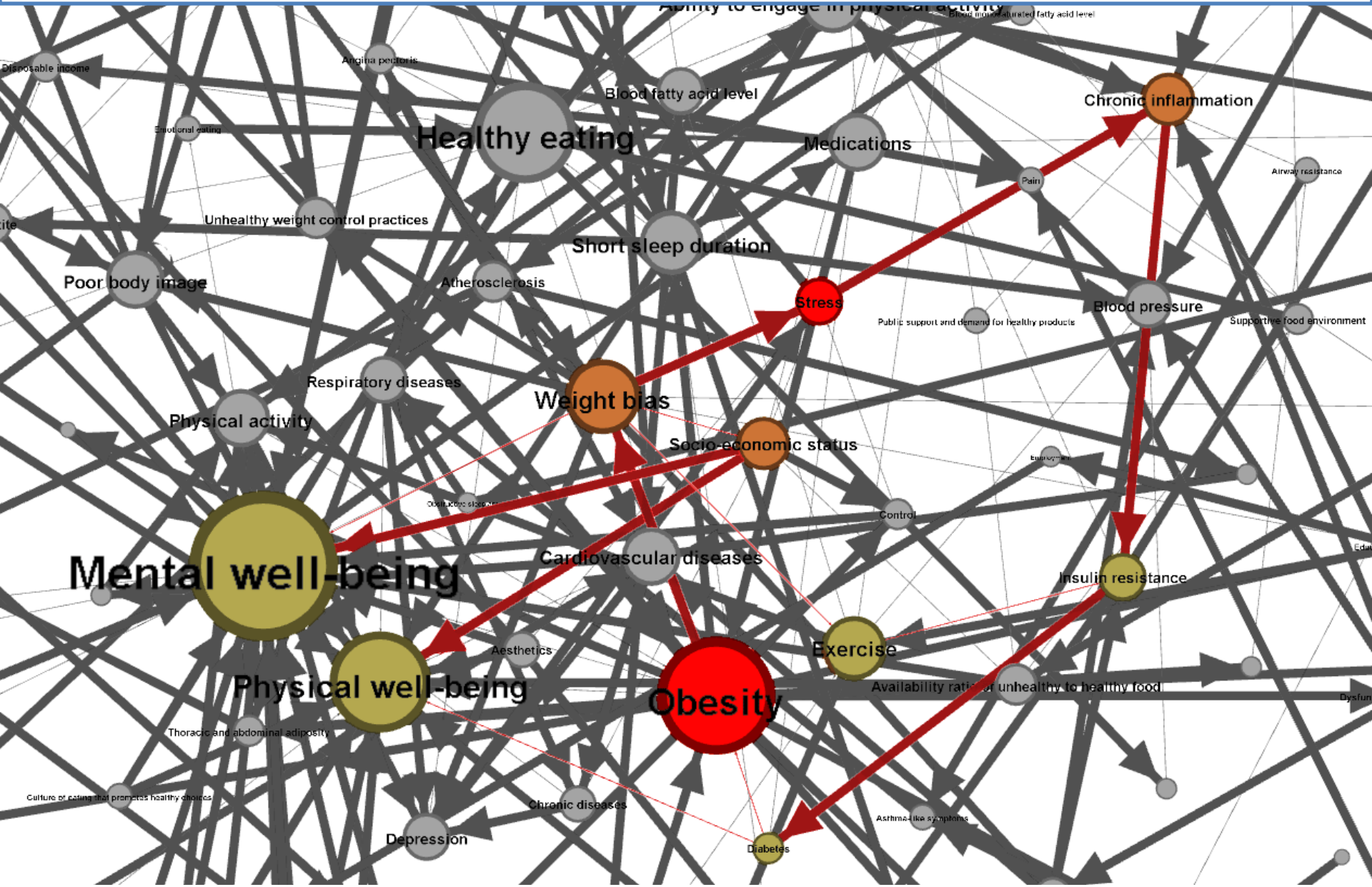
Methods – *Step 4*

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.

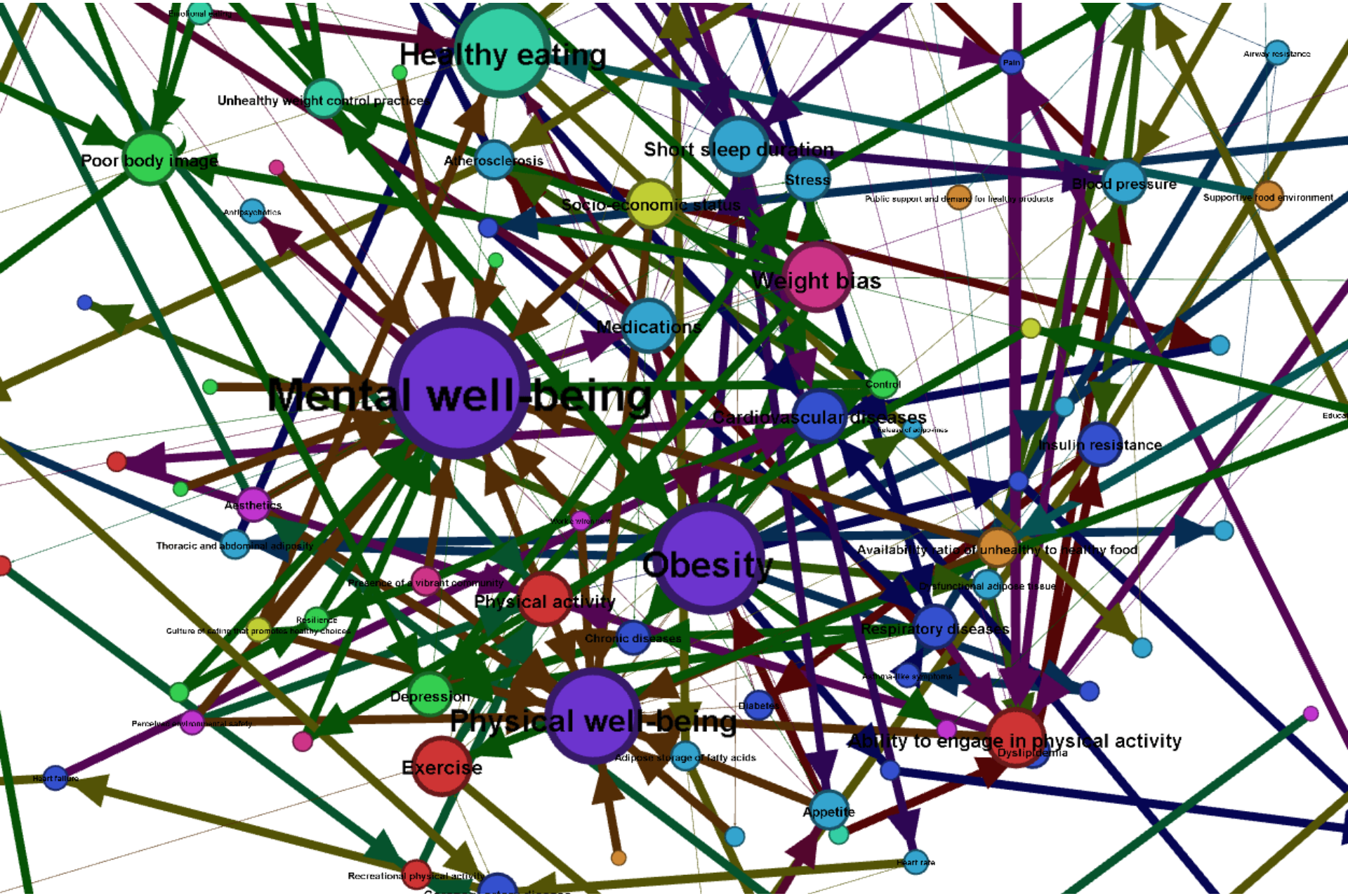


Our model – *Analysis*

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.

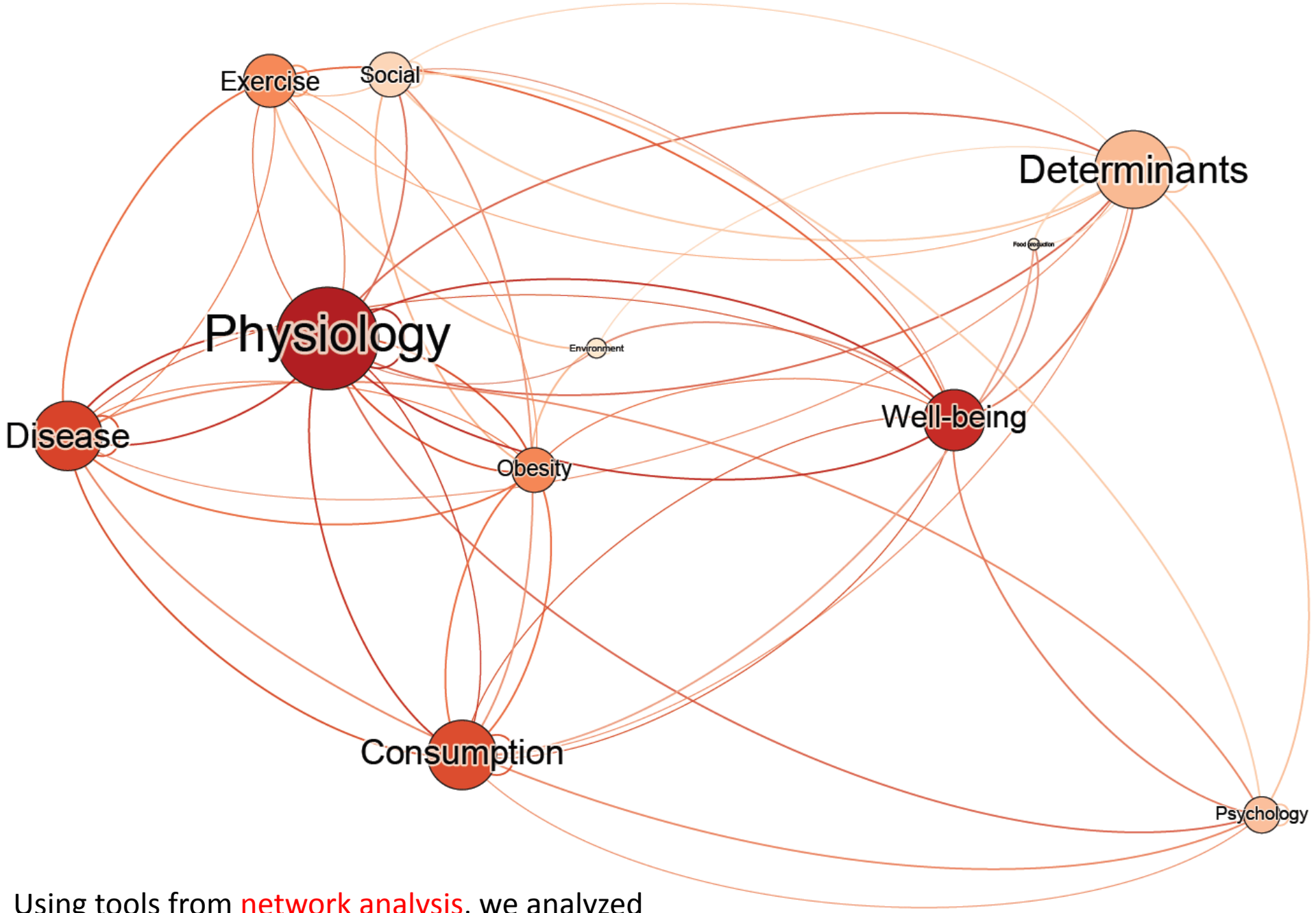
2. We can do text analytics to see what themes emerge when discussing obesity versus well-being.


Healthy eating
Unhealthy weight control practices
Poor body image
Atherosclerosis
Short sleep duration
Stress
Socio-economic status
Blood pressure
Public support and demand for healthy products
Supportive food environment
Weight bias
Medications
Mental well-being
Cardiovascular diseases
Insulin resistance
Aesthetics
Thoracic and abdominal adiposity
Obesity
Availability ratio of unhealthy to healthy food
Physical activity
Respiratory diseases
Chronic diseases
Depression
Physical well-being
Ability to engage in physical activity
Dyslipidemia
Exercise
Appetite
Heart rate
Recreational physical activity

Our model – *Analysis*

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

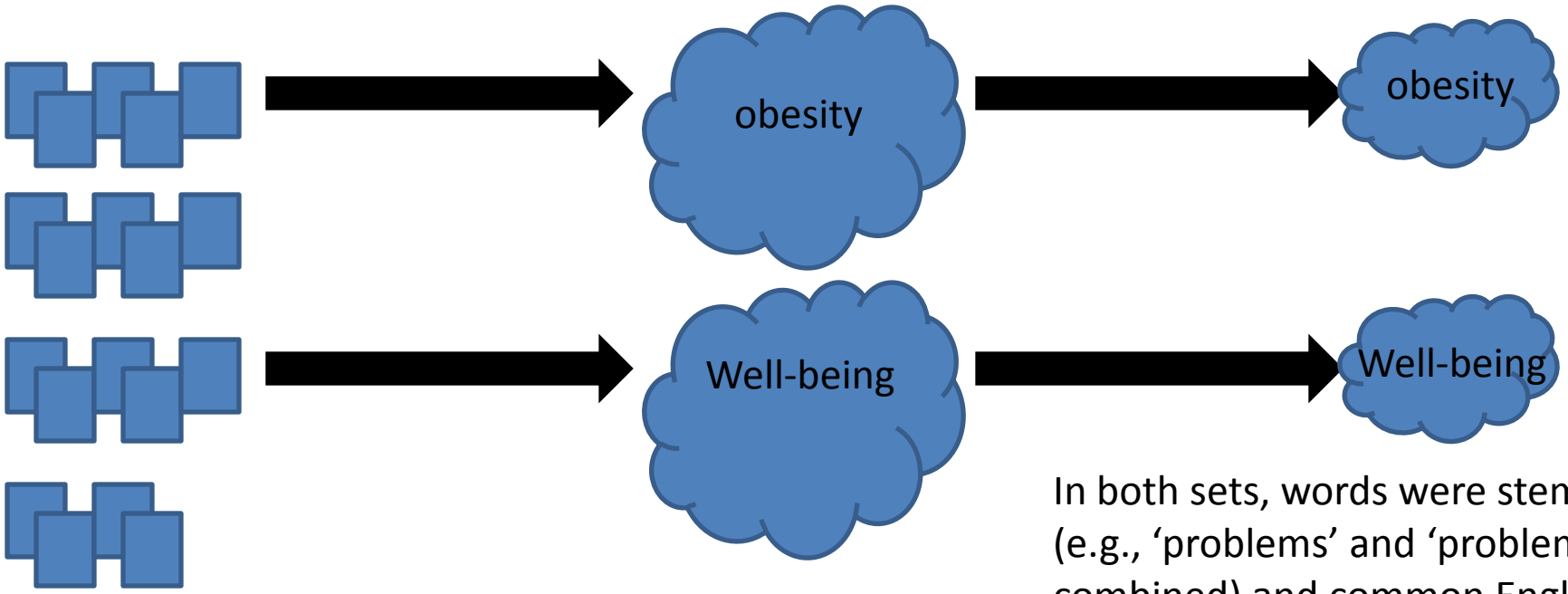
	Causes	Is a consequence of
Obesity	Short sleep duration	Medications
	Cancer	Overeating
	Dysfunctional adipose tissue	Physical activity
	Weight bias	Diabetes
Well-being	Antipsychotics	Perceived environmental safety
	Medications	Presence of a vibrant community
	N/A	Resilience
	N/A	Ability to engage in physical activity



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

Our model – *Analysis*

The analysis using natural language processing (NLP) involved steps the following.



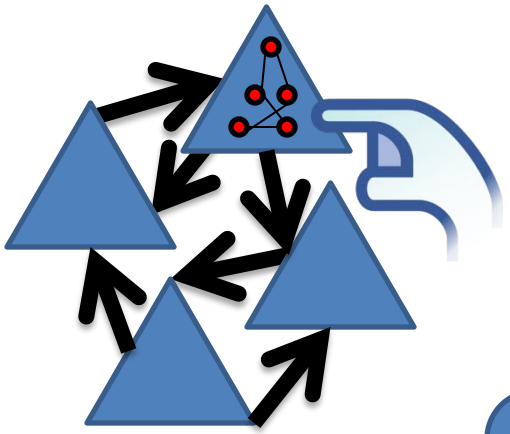
The interviews were divided into sets of answers. In one set, all answers had to include obesity; in the other set, they all had to include well-being.

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.

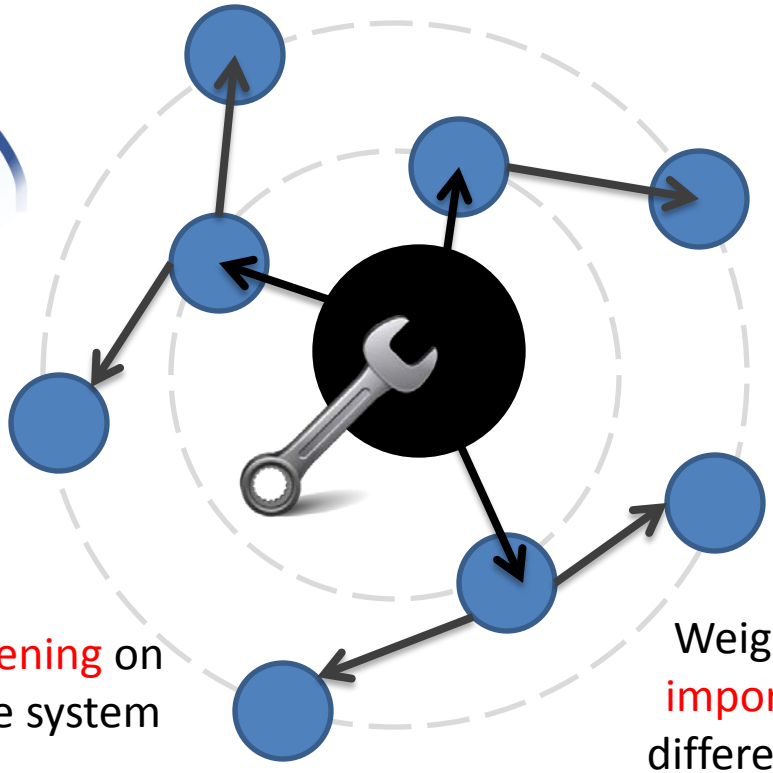
The themes were then compared and discussed with the direction of the provincial health services authority.

Our model – *Interactivity*

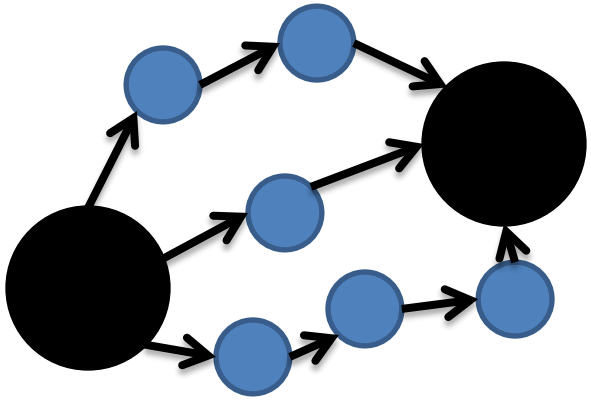
We focused on supporting four tasks as a starting point.



Interactive exploration

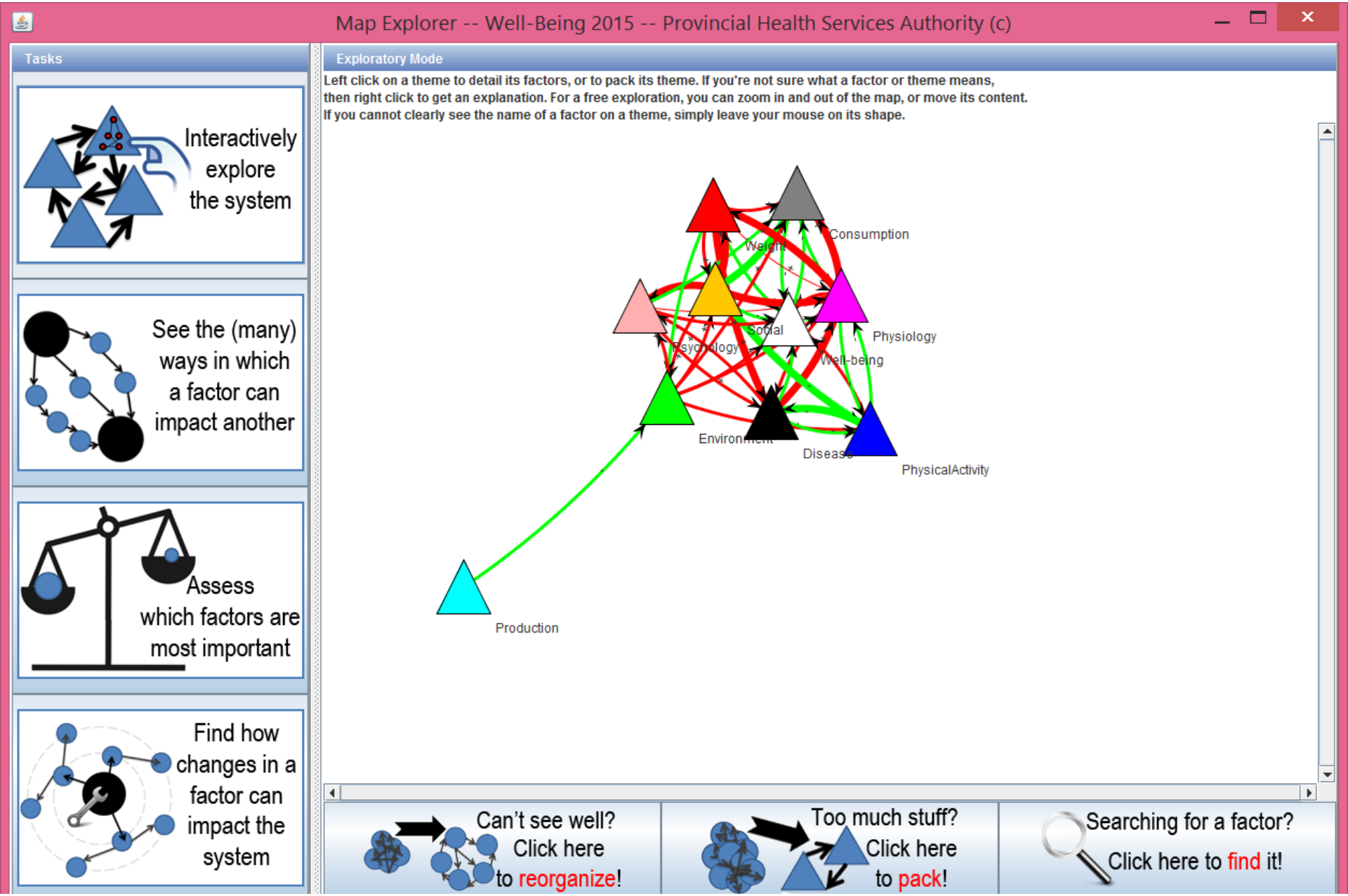


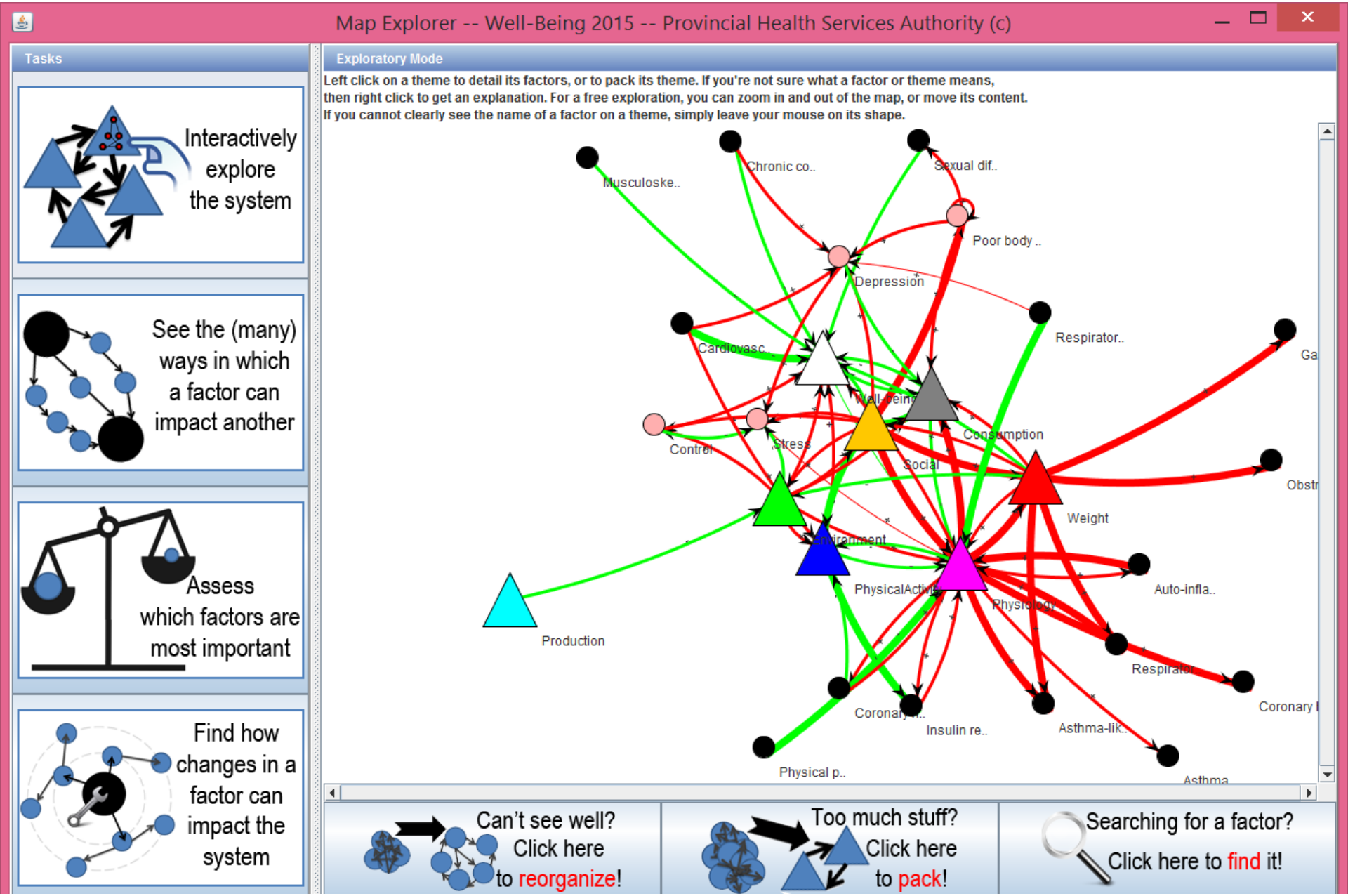
Consequences of intervening on one factor for the whole system



Finding the different ways in which one factor can impact another

Weighing the importance of different factors


Map Explorer -- Well-Being 2015 -- Provincial Health Services Authority (c)
Tasks
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
Exploratory Mode
Left click on a theme to detail its factors, or to pack its theme. If you're not sure what a factor or theme means,
then right click to get an explanation. For a free exploration, you can zoom in and out of the map, or move its content.
If you cannot clearly see the name of a factor on a theme, simply leave your mouse on its shape.
Consumption
Weight
Physiology
Social
Psychology
Well-being
Environment
Disease
PhysicalActivity
Production
Can't see well? Click here to reorganize!
Too much stuff? Click here to pack!
Searching for a factor? Click here to find it!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Musculoske..
Chronic co..
Sexual dif..
Poor body ..
Depression
Respirator..
Cardiovasc..
Control
Stress
Social
Consumption
Weight
Production
PhysicalActivity
Physiology
Auto-infla..
Respirator..
Coronary I
Insulin re..
Asthma-lik..
Physical p..
Asthma
Can't see well? Click here to reorganize!
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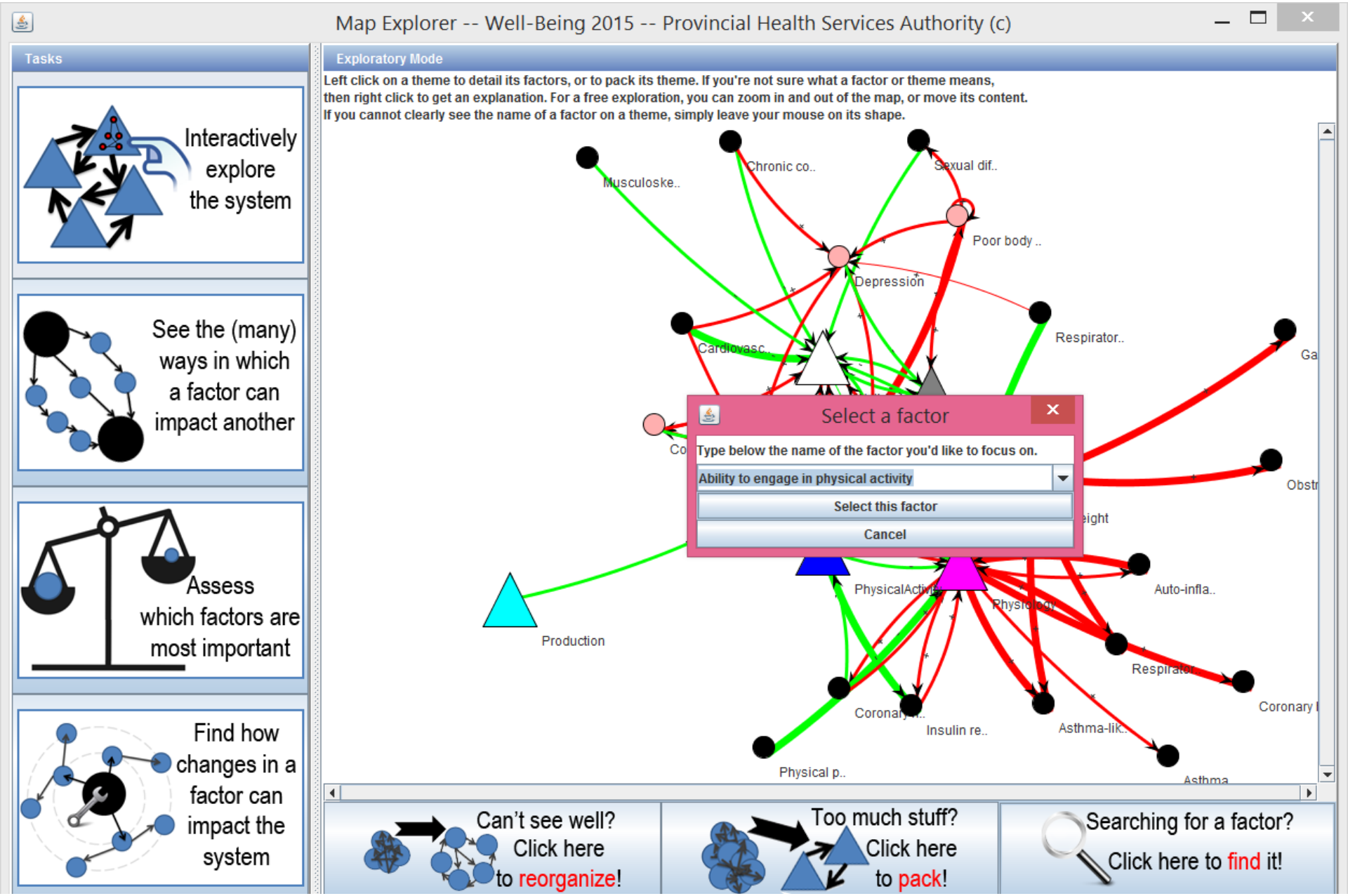
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If you cannot clearly see the name of a factor on a theme, simply leave your mouse on its shape.
Musculoske..
Chronic co..
Sexual dif..
Poor body ..
Depression
Cardiovasc..
Respirator..
Select a factor
Type below the name of the factor you'd like to focus on.
Ability to engage in physical activity
Select this factor
Cancel
Production
PhysicalActivity
Physiology
Auto-infla..
Respirator
Coronary
Insulin re..
Asthma-lik..
Physical p..
Asthma
Can't see well? Click here to reorganize!
Too much stuff? Click here to pack!
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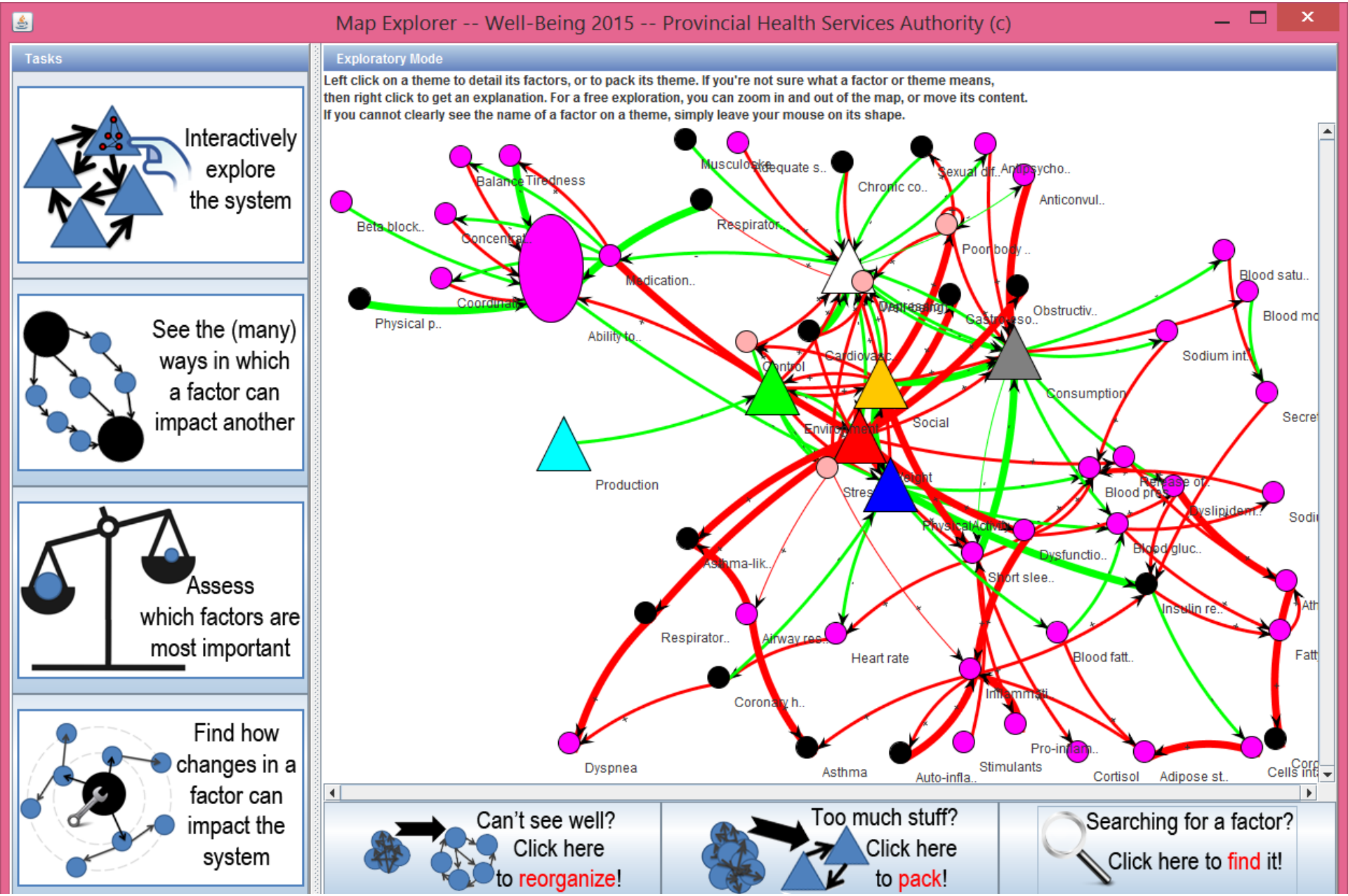
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Balance
Tiredness
Beta block..
Concentrat..
Coordinati..
Physical p..
Medication..
Ability to..
Respirator..
Musculoske..
Adequate s..
Chronic co..
Sexual dif..
Antipsycho..
Anticonvul..
Poor body ..
Depressing
Gastroeso..
Obstructiv..
Blood satu..
Blood mo
Sodium int..
Consumption
Secre
Social
Cardiovasc..
Control
Environment
Production
Stres
Weight
Release of..
Blood pres..
Dyslipidem..
Sodi
PhysicalActivity
Dysfunctio..
Blood gluc..
Short slee..
Asthma-lik..
Insulin re..
Ath
Respirator..
Airway res..
Heart rate
Blood fatt..
Fatt
Coronary h..
Inflammati..
Pro-inflam..
Dyspnea
Asthma
Auto-infla..
Stimulants
Cortisol
Adipose st..
Cells inf
Corp
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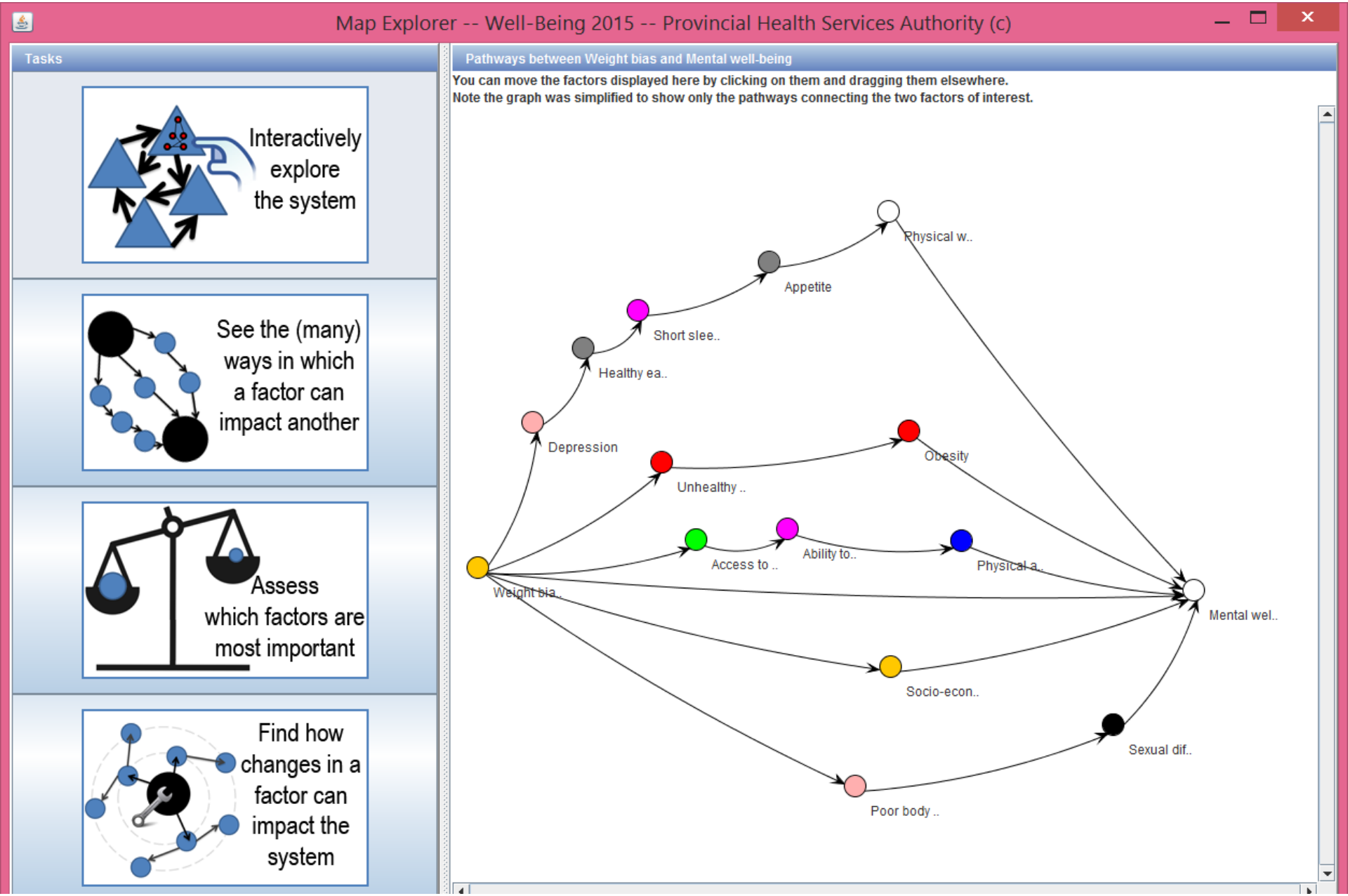
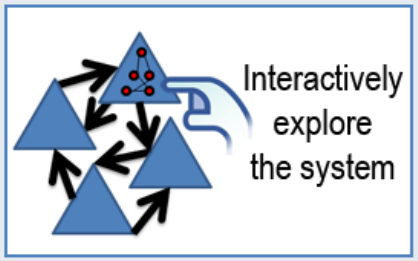
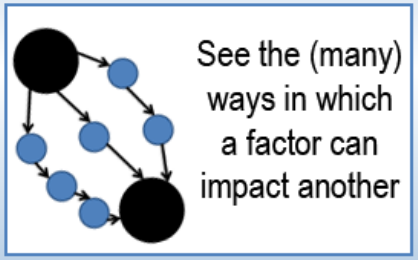
Too much stuff? Click here to pack!
Searching for a factor? Click here to find it!

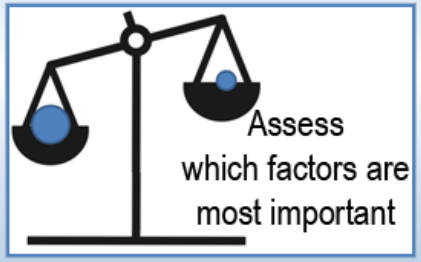

Map Explorer -- Well-Being 2015 -- Provincial Health Services Authority (c)
Tasks
Interactively explore the system
See the (many) ways in which a factor can impact another
Assess which factors are most important
Find how changes in a factor can impact the system
Pathways between Weight bias and Mental well-being
You can move the factors displayed here by clicking on them and dragging them elsewhere.
Note the graph was simplified to show only the pathways connecting the two factors of interest.
Physical w..
Appetite
Short slee..
Healthy ea..
Depression
Obesity
Unhealthy ..
Access to ..
Ability to..
Physical a..
Weight bia..
Mental wel..
Socio-econ..
Sexual dif..
Poor body ..

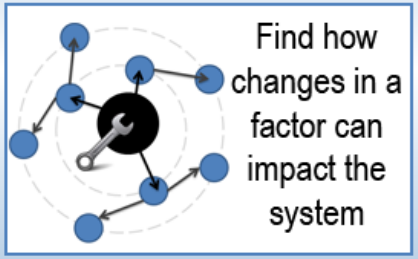
Map Explorer -- Well-Being 2015 -- Provincial Health Services Authority (c)

Tasks





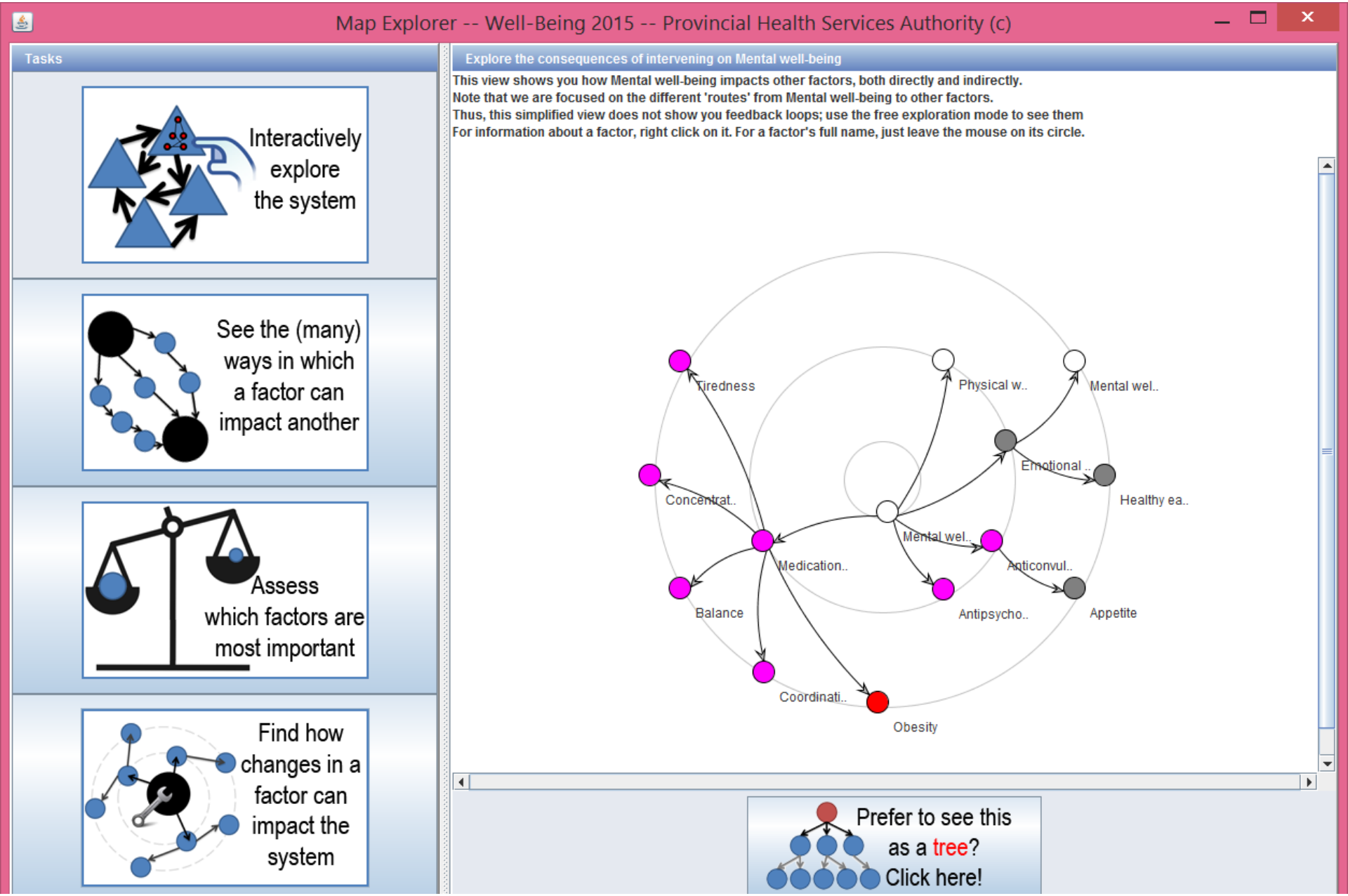




Importance of each factor

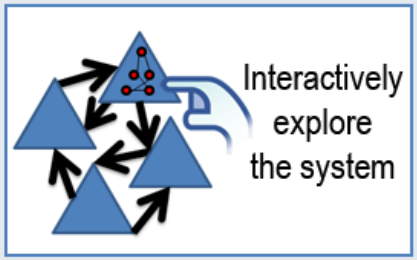
For each concept, you are given its degree and betweenness. The degree is the number of other concepts that it directly connects to. For example, if depression is impacted by stress and impacts mental well-being, it has a degree of 2. Betweenness is an indicator of how central a concept is. For example, if most paths between any 2 factors go through mental well-being, then mental well-being will have a high betweenness centrality. Note that a factor that connects to lots of others may not be very central: it may connect to many peripheral factors while being rarely involved in pathways. Betweenness may thus be the most valuable indicator when thinking of what comes into play for policies.

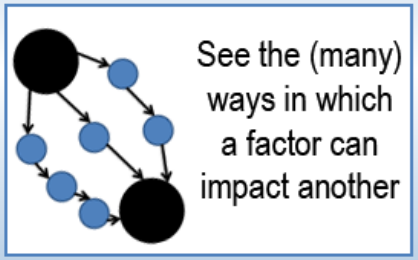
Factor	Degree	Betweenness
Supportive food environment	4	174
Quality of the sport infrastructure	1	0
Emotional eating	3	330
Unhealthy weight control practices	5	121
Culture of eating that promotes healthy c...	3	0
Mental well-being	19	1708
Auto-inflammatory diseases	2	0
Asthma	2	0
Tiredness	2	16
Sidewalk prevalence and maintenance	1	0
Unhealthy foods are more available than...	1	0
Blood glucose level	5	105
Fear of engaging in physical activity	2	1
Inflammation	8	189
Resilience	2	24
Consumer demand for regulations	2	0
Late night TV watching	2	0
Dyslipidemia	5	173
Cultural norms around thinness	6	19
Adequate sleep amount	1	0
Quality of the sport infrastructure	3	0
Cortisol	1	0
Marketing of unhealthy foods	2	0
Appetite	5	419
Balance	2	16
Insulin resistance	6	161
Obesity	12	1078
Physical pain	1	0
Poor body image	8	79
Medical perspective that thin is good	2	0

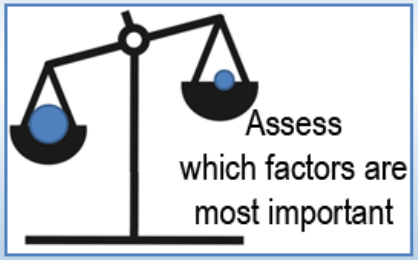

Map Explorer -- Well-Being 2015 -- Provincial Health Services Authority (c)
Tasks
Interactively explore the system
See the (many) ways in which a factor can impact another
Assess which factors are most important
Find how changes in a factor can impact the system
Explore the consequences of intervening on Mental well-being
This view shows you 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.
Tiredness
Physical w..
Mental wel..
Emotional ..
Healthy ea..
Concentrat..
Mental wel..
Medication..
Anticonvul..
Balance
Antipsycho..
Appetite
Coordinati..
Obesity
Prefer to see this as a tree? Click here!

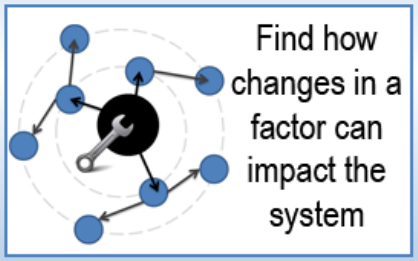
Map Explorer -- Well-Being 2015 -- Provincial Health Services Authority (c)

Tasks









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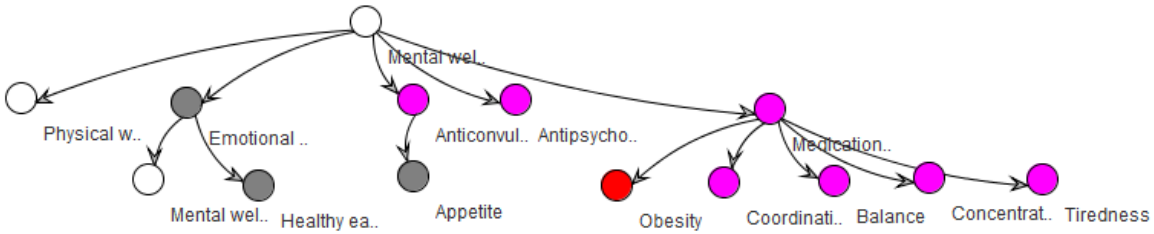

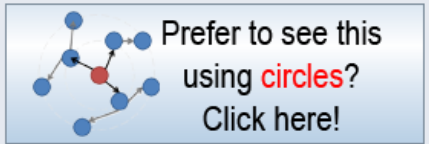

Next steps

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?**

The model is finished. We are currently testing custom-made software to use it.