ORIGINAL ARTICLE

# Comparing complex perspectives on obesity drivers: action-driven communities and evidence-oriented experts

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*Received 12 July 2018; revised 12 October 2018; accepted 15 October 2018*

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## Summary

### *Introduction*

The Foresight obesity map represents an expert-developed systems map describing the complex drivers of obesity. Recently, community-led causal loop diagrams have been developed to support community-based obesity prevention interventions. This paper presents a quantitative comparison between the Foresight obesity systems map and a community-developed map of the drivers of obesity.

### *Methods*

Variables from a community-developed map were coded against the thematic clusters defined in the Foresight map to allow comparison of their sizes and strength of adjoining causal relationships. Central variables were identified using techniques from network analysis. These properties were compared to understand the similarities and differences between the systems as defined by the two groups.

### *Results*

The community map focused on environmental influences, such as built physical activity environment (18% of variables) and social psychology (38%). The Foresight map's largest cluster was physiology (23%), a minimal focus in the community map (2%). Network analysis highlighted media and available time within both maps, but variables related to school and sporting club environments were unique to the community map.

### *Conclusion*

Community stakeholders focus on modifiable social and environmental drivers of obesity. Capturing local perspectives is critical when using systems maps to guide community-based obesity prevention.

**Keywords:** Community health, complexity, network analysis, obesity prevention, systems science.

## Introduction

Energy imbalance is an oversimplification of the complexity of the factors driving obesity, as obesity is influenced by myriad factors from individual behaviours to upstream determinants including food and physical activity environments, and policy settings and economic systems (1). A causal loop diagram or systems map (from systems science) represents an increasingly popular tool to visually encapsulate feedback, non-linearity and the dynamic nature of complex problems (2). Our understanding of the complex causes of obesity is maturing with the emergence of system science techniques (3). Systems science provides a range of analytical methods to improve our understanding of the properties of complex problems (4). . This maturation has led to calls for the use of systems science to acknowledge, rather than ignore, complexity in obesity and other public health issues (5).

The 'Foresight Obesity Systems Map' was the first high profile effort to create a causal loop diagram for the causes of obesity (6). The map was developed in 2007 by obesity researchers to understand the web of variables in the system of obesity drivers. The resulting systems map contained 108 variables connected by approximately 300 causal links. Each of the variables were categorized into one of seven thematic clusters including 'social psychology', 'physiology', 'individual psychology', 'physical activity', 'physical activity environment', 'engine', 'food production' and 'food consumption'. The Foresight map has faced the criticism that its visual complexity may 'deter' viewers rather than encourage them (7), however, represents a pivotal demonstration of the application of systems science to obesity prevention and shows the multiple interacting drivers of obesity (8). In an attempt to reduce visual complexity, Finegood *et al*. (7) collapsed the Foresight map into its constituent clusters (as defined in the Foresight report) producing a reduced map that represents the frequency of relationships both within and between the clusters. By providing a higher level abstraction, the diagram reduced the visual burden of the diagram, yet its utility is still untested.

The Foresight map was developed by experts across a range of fields and could be considered a representation of expert opinion of the obesity causal system. However, recent reviews of effective obesity prevention strategies point to community-based systems interventions (CBSIs) as best practice for obesity prevention (9). A number of CBSIs have resulted in significant reductions in body mass index *z*-score, by implementing prevention strategies targeting multiple parts of the system (10,11). Emerging CBSIs have used systems maps as a starting point to understand the causal system of obesity specific to their community (12), (13). An Australian community group model building (GMB) project created a systems map for community-level drivers of obesity and identified over 100 variables (12). GMB involves the development of systems maps representing opinions from multiple stakeholders (12). Like the Foresight development process, stakeholders created the map with an aim to describe the drivers of obesity, with the critical point of difference that stakeholders to the development of the Foresight map were expert researchers, while the stakeholders in the Australian project were members of the community under investigation. As with the Foresight map, the community diagram contained a high level of detail complexity, with a high number of variables and connections. The authors identified and highlighted four clusters: 'social influences', 'general physical activity', 'participation in sport' and 'fast food and junk food'. Systems maps are becoming increasingly popular to map the complexity of health issues at local levels (13), (14), (15).

The development of community models raises the question about the similarity with the Foresight map and hence the utility of the Foresight map at a community level. A key question is whether a community-led, bottom-up approach leads to different results when compared with the top-down, expert-led Foresight model. The size and visual complexity of the two maps raises the need for innovative techniques for comparison. Network analytic techniques have recently been applied to obesity systems maps to provide deeper understanding into the complex system (7,16). This paper uses analytical techniques from network analysis to address the question 'What are the similarities and differences between obesity causal loop diagrams developed at an expert and at a community level?'

## Methods

### Causal loop diagrams

The community-developed systems map analysed in this study was published previously by Allender *et al*. (12) and is one of the first published systems maps developed by local stakeholders describing obesity at a local level. The development took place in a community in Victoria, Australia, in 2014. A small participant group was recruited by local leaders in health promotion, based on relevance as stakeholders to the issue of childhood obesity in the community. These stakeholder networks have been identified as critical to the design and implementation of interventions in previous research (17,18). Participants included representatives from diverse sectors in the community such as local government, health services, community groups and schools. Participants were led through two 90-min GMB sessions and mapped the causal relationships of obesity in their community. At the conclusion of the sessions, participant had generated a systems map of obesity drivers in their community.

The Foresight diagram was accessed from the Foresight report (6), (19). The diagram was developed in 2007 by stakeholders from research institutions, government departments and the private sector. The map's focal point is 'energy balance' and expands to 108 variables aiming to describe 'all relevant factors and the interdependencies' that cause obesity at the individual and collective scale (6).

### Comparative analysis

Two methods were used to compare the diagrams. The first method involved replicating the approach by Finegood *et al*. (7), where the community-led map was visually reduced into inter-cluster and intra-cluster relationships based on the same thematic coding used on the Foresight map. This allowed for a shorthand visual comparison of the size and interconnection of clusters in the two causal loop diagrams. The second approach used network analysis techniques from McGlashan *et al*. (16) to elicit the central variables in the system. These techniques are detailed in the next discussion.

### Method 1

Variables in the community-developed systems map were coded under the thematic clusters used in the Foresight map: social psychology, physiology, individual psychology, physical activity, physical activity environment, engine, food production and food consumption. Four authors individually coded the full variable list from the community systems map to the appropriate domain in the Foresight map. Inconsistencies in variable coding were resolved through consensus between the four authors. Variables from the community map with a verbatim match to a variable from the Foresight map were coded directly to the corresponding domain. Variables that did not have directly matching text were assigned to the most appropriate category based on the descriptions provided in the Foresight report (6).

Following Finegood *et al*. (7), the community diagram was reduced to show the intra-cluster and inter-cluster relationships whereby the seven Foresight clusters were represented by nodes in the diagram, and the weight of adjoining edges was proportional to the frequency of connections between two clusters. Thickness of node borders indicates the number of intra-cluster relationships and allows comparison of number of causal links between thematic clusters within each diagram.

### Method 2

The two diagrams were represented as networks in order to apply network centrality measures (16). Variables with high in-degree and out-degree were elicited and compared. High in-degree variables are those factors that the participant group placed as an ‘effect’ in the highest number of causal relationships (i.e. arrows pointing towards them). Variables with a high out-degree have a large number of edges leading out and are a high influence or ‘cause’ of other variables in the system (i.e. arrows pointing away).

## Results

### Method 1

Physiology was the largest cluster in the Foresight diagram containing 23% of its variables (Figure 1). In contrast, only 2% of variables in the community diagram were from the physiology cluster. The social psychology cluster represented the community’s largest cluster, where 38% of the variables were attributed, compared with 16% of the Foresight map. Social psychology variables represent societal influences, including impact from peers, media or education. The Foresight map had a higher focus on variables related to individual-level diet and activity behaviours (i.e. food consumption = 14%, ‘individual physical activity’ = 10%) compared with the community (food consumption = 9%, individual physical activity = 5%). Similarly, the two diagrams attributed approximately 15% of variables to the food production cluster.

Figure 2 provides the comparison between the community map and Foresight using the approach first published by Finegood *et al*. (7). Both maps had a strong inter-cluster relationship from food production to food consumption and from physical activity environment to individual physical activity. One of the strongest connections in the community cluster diagram was from social psychology to individual physical activity, which was one of the weakest inter-cluster relationships in the Foresight diagram. The community map represents these relationships by linking variables in the systems map related to peer physical activity, and normalization of physical activity can impact an individual’s activity. Another strong relationship in the community diagram was the influence of social psychology variables over physical activity environment, e.g. the systems map had connections representing community members volunteering impacting the sporting club environment.

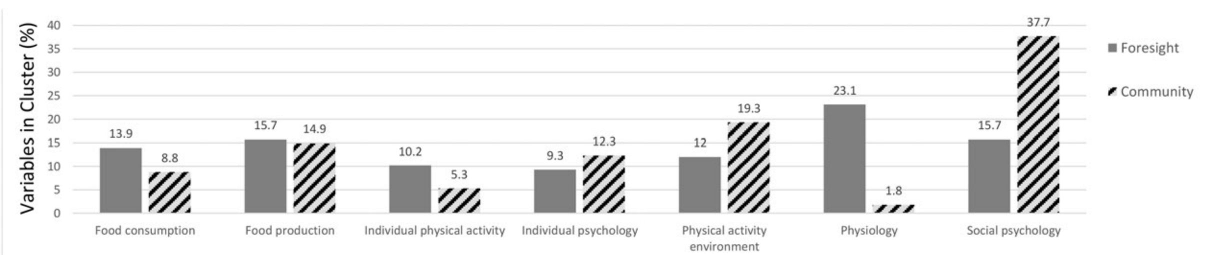


**Figure 1** Percentage of variables from the Foresight and community maps in each cluster.

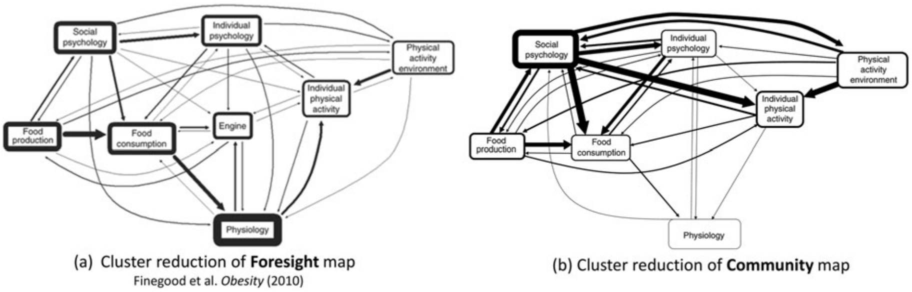


**Figure 2** Foresight and community systems maps collapsed into thematic cluster relationships (replicating approach from Finegood *et al*. (7)).

## Method 2

The community diagram had 114 variables compared with 108 in the Foresight map. Figure 3 shows the variables with the highest in-degree for (a) the Foresight map and (b) the community map. The high ranking in-degree variables, those that are affected by many others, were mostly dissimilar between the two systems maps. The Foresight map's high in-degree variables were focused on physiology: 'degree of primary appetite control by brain' and 'level of available energy' (Figure 3a). a). Contrastingly, the high in-degree variables in the community diagram were related to physical activity ('level of physical activity' and 'participation in sports'). Physical activity was influenced by many variables related to local infrastructure, school policy and cost of exercise. Both diagrams featured high in-degree variables related to food consumption habits: 'force of dietary habits' in the Foresight map, 'junk food consumption' and 'soft drink consumption' in the community map.

High out-degree variables, those that have the highest influence over many others in the system, tended to be somewhat aligned between the two maps (Figure 4). For example, the Foresight diagram's variable 'media consumption' had the third largest out-degree, and the community's highest out-degree variable was 'advertising/sponsorship of fast and processed food'. In the community diagram, the variable advertising/sponsorship of fast and processed food impacted variables related to social norms around eating, perceived value of fast food and consumption of sugar-sweetened beverages. In the Foresight map, the media consumption variable also impacted variables related to social norms around eating but also in relation to physical activity and body image.

The two maps also had variables related to available time (Foresight = 'available time', 'stress';

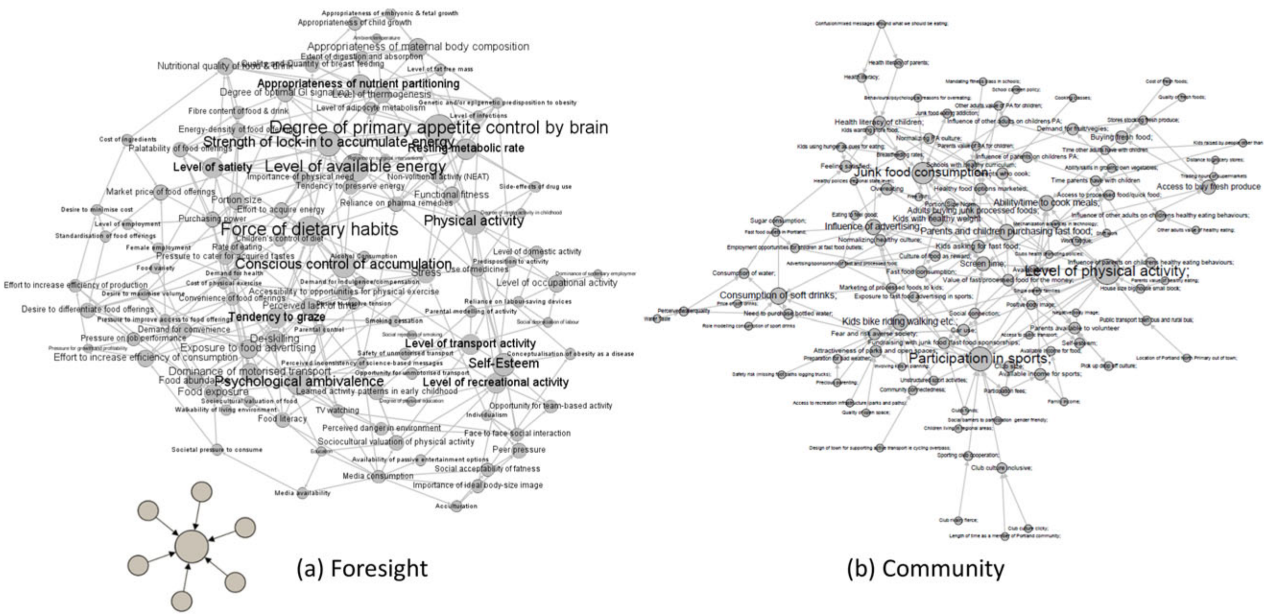


**Figure 3** Network representation of (a) Foresight and (b) community systems maps weighted by in-degree.

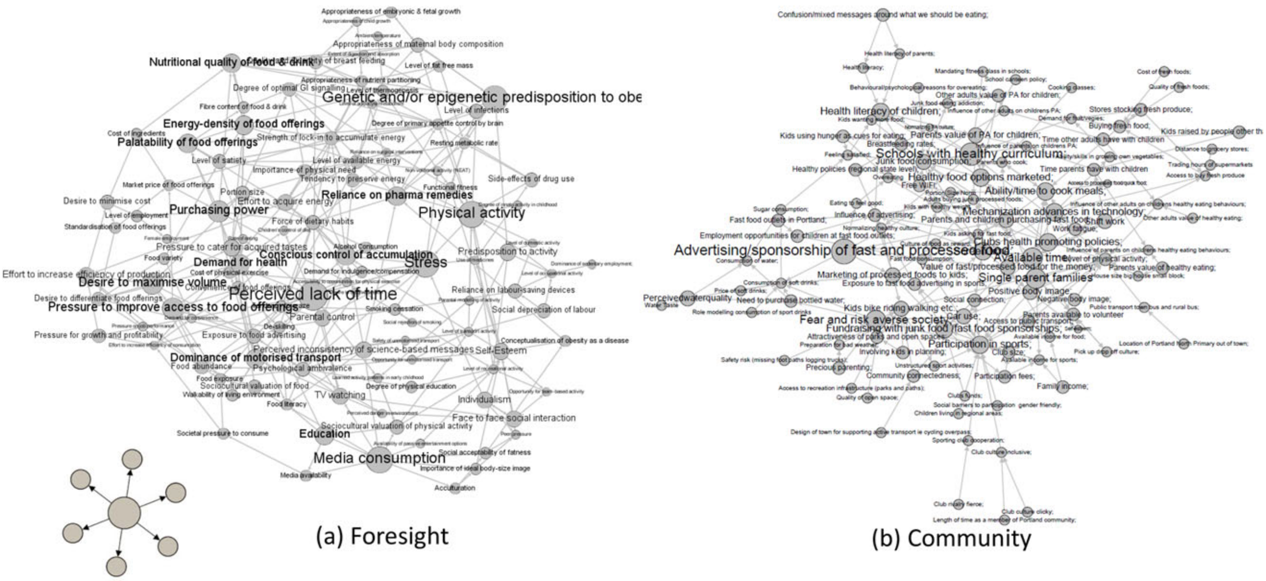


**Figure 4** Network representation of (a) Foresight and (b) community systems maps weighted by out-degree.

community = 'perceived lack of time') impacting a high number of other variables. A unique variable in the Foresight map with a high out-degree was 'genetic and/or epigenetic predisposition to obesity', which was dissimilar to any central variables in the community map, rather the importance of perceived safety, school environment, sporting clubs and health literacy were variables with a high out-degree.

## Discussion

This study aimed to explore the similarities and differences between obesity causal loop diagrams developed at an expert and community level. The results uncovered both similarities and differences between the Foresight map and a community-informed systems map of causes of obesity.

Several areas of clear agreement between variables in the maps were observed. In the first method, both maps represented a strong influence of social psychology on individual psychology and food production on food consumption. The second method found the commonality of variables related to marketing as central among both maps and was connected in similar ways to variables related to social norms. Given that both diagrams had marketing-related influences as key drivers, this can be interpreted that it has an impact at the community level and the broader population level. This is supported by literature defining marketing and advertising as one of the most commonly investigated factors driving the obesity epidemic (1). The influence of perceived lack of time was a central factor in both models, which is also known to be a barrier to healthy lifestyles such as through time to prepare healthy food (20) and inactive transport time (21). Furthermore, physical activity was a key variable in both maps. For example, in the community map, physical activity had a high in-degree and was influenced by local infrastructure, school policy and cost of exercise, suggesting that the community sees a need for environmental change in order to impact an individual's behaviour, rather than targeting short-term individual-level actions (3). Overall, the similarities suggest that some upstream drivers have a large impact on obesity levels but the maps were not fully concordant.

A number of differences between the two diagrams were observed. Healthy school environments was a central variable in the community map, but variables specific to the school environment were not included in the Foresight diagram. This is surprising because research has shown that changes in schools' environments to support healthy lifestyle have promise as effective interventions points in the prevention of childhood obesity (22), (23). This may be explained by the differences in group composition, and school settings may have been an under-represented focus area of the Foresight development team.

Further, the community focused less on individual behaviours (individual physical and food consumption) and more on the obesogenic environments shaping those behaviours (1). These findings align well with a recent a study that, through interviews with leaders from the food industry, government and non-government sectors, discovered a policy-level focus on individual responsibility, rather than considering the broader system and upstream drivers (24). The community stakeholders' view towards upstream drivers rather than individual choice supports existing literature stating that interventions should extend from traditional, individual choice strategies and rather acknowledge the broader system and its complexity (18).

The first comparison method found the community attributed majority of its variables to societal and environmental influence. Not only were these clusters important in and of themselves, but there was strong influence from variables in these clusters to many other parts of the system of obesity drivers (Figure 2). The Foresight diagram's largest cluster was physiology (23%), whereas the community had only 2% of variables in that cluster. Similarities were observed in another community-based causal loop diagram developed during the 'Healthy Kids, Healthy Communities' project (25). The Healthy Kids, Healthy Communities map included 227 unique variables, and, the authors reported that, the largest domains were 'social determinants of health' and 'healthy eating policy and environment'. Within these two clusters were variables related to schools, education, social factors and food production, but there were no clusters related to physiology or biology, thereby aligning with the current study.

There are several possible explanations for differences between the maps. Both models were developed through participants beginning with a seed question or problem statement, to guide the map development. Where the Foresight group sought to describe the drivers of obesity from an original focus on 'energy-in, energy-out' (6), the community was prompted solely to describe the drivers of obesity in their community (12). Another possible explanation could be the differences in group composition. The expert group comprised academic researchers, whereas community participants were representatives from schools, health services, sporting clubs and local government, a more diverse and less specialized group compared with the group informing the Foresight map. Therefore, it is possible that the Foresight map development group had an over-representation of basic scientists and an under-representation of clinical researchers and providers.

A final interpretation could be that the community had a focus on societal and environmental factors as the main contributors to obesity, because these elements seem more amenable to change in an effort to combat obesity within an obesogenic society (1). For example, factors related to the built environment are modifiable and a priority area in obesity prevention (26), compared with physiological factors. A Lancet report that sought to describe the causes of obesity defined obesity drivers as mostly environmental factors and explained physiological factors to be a result of external behaviours rather than a cause of obesity (1). These findings could highlight the importance of local stakeholders and lived experiences in designing systems maps and interventions, and given that interventions are promising at the community level, policy makers should seek to use tools like GMB to understand the unique barriers or drivers of obesity in each individual community (27), (28).

In this study, comparing all variables was not feasible given that over 100 variables were present in each map, and an alternative method was required to elicit key variables. A strength of the methods utilized was overcoming existing challenges of differing terminology when comparing systems maps from different developers. The clustering method simplified the diagram to show the size and relationships between the clusters. This then allowed comparison of two networks with an exact matching structure. A limitation of the technique was losing specific variable content; however, the centrality measures allowed comparison of key variables.

A limitation of the study was incorporating only one community, but this is mitigated by the involvement of 50 contributing participants, and, in addition, this type of research is in its infancy, and very few useable systems maps have been published. Future work will incorporate more communities, to highlight factors unique to each community, and allow sharable intervention plans where similarities are found. The techniques could also be used for other comparison purposes, such as how systems maps adapt and change over time and how communities differ from each other, or used in other complex problems in public health.

## Conclusion

This research found similarities and differences on the drivers of obesity between the Foresight map and one generated by a community in Victoria, Australia. The Foresight map may be useful in some settings but is unlikely to have much utility at the community level. When designing local-level interventions to reduce obesity prevalence, it is useful to seek the views of community members to create maps representing the drivers of obesity. Such maps are more closely aligned with community members' understanding of their own communities' situations and needs and may therefore result in more locally relevant and feasible intervention strategies.

## Funding

This study is supported by an NHMRC Partnership Project titled 'Whole of Systems Trial of Prevention Strategies for childhood obesity: WHO STOPS childhood obesity' (APP1114118). The work described herein has also received funding support from the Western Alliance. Some study researchers are within the NHMRC Centre for Research Excellence in Obesity Policy and Food Systems (APP1041020). Allender is supported by funding from an Australian National Health and Medical Research Council/Australian National Heart Foundation Career Development Fellowship. McGlashan is supported by the Australian Government Research Training Program Scholarship.

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