

Food Futures: A detailed study protocol for combining a food systems approach and public health nutrition

A Paper with the FAO Project ‘Meeting Urban Food Needs’

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Abstract

Global nutrition is in a state of crisis; 842 million people worldwide are undernourished, while simultaneously the number of overweight and obese individuals increased to 2.1 billion in 2013. Furthermore, the widespread of non-communicable disease is one of the biggest societal problems globally. Our highly commercialized food system promotes overconsumption of foods that are harmful for both public health and the environment and there is growing support for a closer look into this system to find sustainable solutions. This paper outlines a study protocol on innovative research combining systems approaches and public health nutrition. The aim of this research is twofold: 1) Develop a food systems approach for public health nutrition; 2) Examine the operation of the food system to inform the design of sustainable public health nutrition interventions.

This programme of research is divided into three phases: A) Availability and affordability of food; B) Determinants of (healthy) food availability and affordability; and C) Food system intervention development. The proposed research is unique in that it combines established systems methods with public health by using New Zealand (NZ) case studies with a global perspective. Phase A forms the fundament of this research combining a series of smaller projects examining food availability, affordability and healthiness in NZ, within an international context. Phase B will use Global Value Chain Analysis (GVCA) to examine potatoes and potato products and identify different attributes of value, including both health and monetary values, as products move through the chain. Industrial processing mostly increases the monetary value of products, but simultaneously diminishes the nutritional value (e.g., whole potatoes versus potato crisps). The GVCA will give a detailed overview of how potatoes move along the food chain, how this relates to health and monetary value, who the key players are and how decisions are made. Finally, Phase C aims to combine Group Model Building methods with a Delphi Study design to explore power dimensions and identify sustainable food system public health interventions. The ultimate goal of this research is to reveal how public health can be integrated in the food system instead of having to work against it.

1. Background & Rationale

Meeting the demand for food, energy, fuel and water as world population increases and in the face of climate change is a major challenge for future food systems. While being highly developed, our current food system delivers extremely costly food in terms of consequences to public health (e.g., global rising rates of obesity and non-communicable disease (NCD)), capacity of the earth (biodiversity, ecosystem degradation and greenhouse gas emissions) and the unfair demand on developing countries (Lang, Barling and Carahar, 2009; McMichael *et al.*, 2007; O'Kane, 2012; Swinburn *et al.*, 2011). In addition, it is unacceptable that surplus food production and widespread hunger currently co-exist at global level (Pinstrup-Andersen, 2002), especially when about one-third of the global food supply gets wasted (FAO, 2013a).

This research aims to take a detailed look into the operation of the food system and identify potential levers for change with a focus on population health nutrition outcomes. Global nutrition is in a state of crisis; 842 million people worldwide suffer from under-nutrition (FAO, 2013b), while simultaneously the number of overweight and obese individuals increased to 2.1 billion in 2013 (Ng *et al.*, 2014). Furthermore, the widespread burden of diet-related NCDs such as diabetes is becoming one of the world's largest societal problems (Amuna and Zotor, 2008; Lim *et al.*, 2012; Ministry of Health and University of Auckland, 2003; UN General Assembly, 2011; WHO, 2012) and forms a barrier to achieving development goals including poverty reduction and economic stability (Beaglehole *et al.*, 2011). In New Zealand (NZ) about 40% of mortality is attributable to the effects of poor diets (Amuna and Zotor, 2008; Lim, *et al.*, 2012; Ministry of Health, 2013) and even modest improvements in diet could have a major impact on health if they are adopted by much of the population (Scarborough *et al.*, 2010; Stefanogiannis *et al.*, 2005).

Research to date has identified interventions that could be effective in improving population health via improved dietary intake, however most strategies lack population reach (nutrition education) (Rekhy and McConchie, 2014; Swinburn, Egger and Raza, 1999; Swinburn *et al.*, 2011) or cannot be sustained in the current market-driven food economy (for example health-related food taxes). One of the main problems is that previous research has been largely one-dimensional without considering how public health interventions must operate within the rest of the food system and global economy. For example, a growing body of evidence shows that soft drink taxes could be an effective way to address obesity (Thow, Downs and Jan, 2014; Waterlander, Ni Mhurchu and Steenhuis, 2014). However, published studies to date have not taken into consideration how these policies would operate within the commercial market place where manufacturers can adopt strategies to circumvent the tax with a view to minimising impact on product sales. A retrospective example of such circumvention comes from the 1980s where United States farm policies made sugar more expensive expecting that this would result in higher soft drink prices and subsequent decreased consumption. However, the Coca-Cola Company substituted high-fructose corn syrup for sugar, saving them around \$25 million per year making Coca Cola both cheaper and more profitable (Hawkes *et al.*, 2012). Currently, with net profit margins are around ¼ of the retail price, soft drink production is one of the most profitable industries in the world (Stuckler *et al.*, 2012). Another example is the Danish saturated fat tax (introduced in 2011 to discourage saturated fat consumption) which was abolished within one year of its introduction. While it was too early to know the effects on population health, competing economic and political interests made the government decide to put it on hold (Stafford, 2012; Vallgarda, Holm and Jensen, 2014) even though recent studies have indicated some positive effects on sales of targeted products (Jensen and Smed, 2013). Similar examples can be found in the field of tobacco

prevention research where the tobacco industry has found to circumvent health policies by absorbing tax increases on some of their brands to keep the prices low (Gilmore *et al.*, 2013).

It needs to be acknowledged that public health cannot operate in isolation and has to be able to achieve its goals within the existing systems. A key problem associated with the current food system is that food has become highly commercialized and prices do not incorporate externalities such as effects on public health or the environment (Caraher and Coveney, 2004; Pinstруп-Andersen, 2002). The system produces an oversupply of dietary energy and certain crops (e.g., sugar, corn) (Schafer Elinder, Lock and Blenkus, 2006) and provides us with more products in ultra-processed form containing excessive salt, sweeteners, refined grains and oils (Nugent, 2011; Swinburn, 2008; Tillotson, 2004). Furthermore, the international food system has become highly complex where no single player has a complete overview of the whole system. There is a clear need to look closely at the operation of the food system to find sustainable solutions addressing population health, economic welfare and environmental sustainability¹ (Swinburn *et al.*, 2011). We should be looking at questions such as ‘*What makes our current food environment so unhealthy?*’ And ‘*Why do we overproduce and oversell unhealthy food?*’ (Hawkes and Ruel, 2011) New inter-sector studies combining a systems approach and public health are needed to identify the best interventions and answer questions on how to achieve a healthy sustainable food environment (Acres, 2010; Burlingame and Dernini, 2011; McCorrison, 2013).

1.1 Aims

The aim of this research is twofold: 1) Develop a food systems approach for public health nutrition research; 2) Examine the operation of the food system to inform the design of sustainable public health nutrition interventions.

1.2 Outline of the research

This paper outlines a detailed study protocol and some first results on a programme of food systems research from a public health perspective (called Food Futures). This research is unique in that it combines systems research with public health by using the NZ food system as a case study. NZ is particularly well suited for such a case-study because it is an island nation with an isolated geographic location making its food system relatively coherent compared to that of other countries. Nevertheless, NZ is still highly developed with a similar economic and social structure to other countries in the Organisation for Economic Cooperation and Development (OECD) (Statistics New Zealand, 2005). Finally, NZ is part of the global food system meaning the methods of this case study will be able to be further expanded for use on a global scale.

¹ The importance of wider systems was already famously stated by Rose in 1985 quoting that to understand the reasons for sick populations, we must not just look at the individual but at the society

2. Methods

This programme of research is divided into three separate phases:

- A: Analysis of the availability and affordability of (healthy) food;
- B: Determinants of (healthy) food availability and affordability;
- C: Food system intervention development.

Figure 1 shows the systematic logic model for the full programme of Food Futures research.

2.1 Part A: Analysis of the availability and affordability of food

Part A forms the fundament of this research and comprises of a series of smaller projects examining food availability, affordability and healthiness in NZ, within an international context. Evidence from the United States suggests that there is a large gap between dietary recommendations and the food that is available in the food supply where, for example, the total amount of fruit available per capita is not sufficient for everyone in the population to meet dietary guidelines, while the availability of sugar per capita exceeds dietary recommendations (McNamara *et al.*, 1999; Miller *et al.*, 2015). A recent paper by Stuckler and colleagues (2012) on the role of global producers on increased consumption of unhealthy commodities concluded, amongst other things, that more data is needed on market concentration of transnational corporations; percentage of retail space owned by a limited number of firms; and the capacity to produce and distribute low-cost healthy alternatives domestically (Stuckler *et al.*, 2012). The aim of Phase A is to gain insight into these issues by examining food availability in NZ supermarkets and link this to public health.

The research in Part A will focus predominantly on supermarkets (as opposed to for example fast food restaurants) as they play a central role within the food system. Supermarket' share of retail sales is growing globally, including in both developed and developing countries (USDA, 2005). Supermarkets also play a significant role in the availability of food (e.g., the products they stock, prices and marketing), thereby influencing the food environment (Story *et al.*, 2008). Finally, the importance of supermarkets is highlighted by their dominant position compared to the other actors in the chain. This dominance is seen globally, but particularly in NZ where two retail organisations, Foodstuffs and Progressive Enterprises Ltd., form a duopoly in the retail sector and control over 90% of the grocery market (Bava, Jaeger and Dawson, 2009). This lack of competition is expected to negatively impact (healthy) food availability and is important to examine in this research context (Australian Competition and Consumer Commission, 2007; USDA Foreign Agricultural Service, 2009; Wardle and Baranovic, 2009). This will be studied in more detail in Phase B of this research.

Part A will take a detailed look into the availability, affordability and origin of foods in NZ supermarkets and link this to public health. This will be achieved by combining a series of smaller projects and by building on work that is already been carried out by the research team including Dr Helen Eyles' Nutritrack and Nutrisales work (Chand, Eyles, and Ni Mhurchu, 2012; Eyles and Ni Mhurchu, 2014), Prof Boyd Swinburn's INFORMAS work (Swinburn *et al.*, 2013) and by using existing data such as from the Food and Agriculture Organization of the United Nations (FAO) food balance sheets (FAO, 2014). NutriTrack is a database developed by the University of Auckland to monitor the packaged food supply and identify opportunities for healthier reformulation of ultra-processed foods. Information is collected directly from all packaged products in four large NZ supermarkets. The database includes

brand and package information, and all nutrients present on the mandatory Nutrition Information Panel (NIP) including: energy (kJ), protein (g), carbohydrate (g), sugar (g) total fat (g), saturated fat (g) and sodium (mg). With relatively small additions from other data sources Nutritrack will form an excellent starting point to assess food NZ availability. A key strength is that Nutritrack contains information on specific brands and manufacturers, enabling analysis by market concentration and product origin. A limitation is that Nutritrack only contains information on packaged foods, missing data on for example fresh produce and meat. Therefore, two projects in this phase (A1 and A2) aim to collect additional data on non-packaged foods. Projects included in Part A are:

- A1. What food is available in NZ supermarkets, how does this relate to level of industrial processing, healthiness and food group?
- A2. How frequently are foods discounted and how does this relate to healthiness and level of industrial processing and food group?
- A3. What is the availability of *packaged* food products for sale in NZ supermarkets by levels of industrial processing, healthiness, price and the variety of brands?
- A4. How diverse is the NZ packaged food supply? What are the most commonly used ingredients in packaged foods and how do these relate to level of processing?
- A5. To what extent does NZ food availability align with dietary guidelines and how has this changed over time (using FAO Food Balance Sheets)?

2.1.1. First results on food availability, healthiness and processing

We have now completed parts of this research. Results showed that the majority (84% in 2011 and 83% in 2013) of packaged foods available in NZ supermarkets were ultra-processed. Also we found that ultra-processed foods were significantly unhealthier (had a significantly higher nutrient profiling score) compared to less processed foods (**Figure 2**). Furthermore, we observed many variations of virtually the same product and a high dominance of a small number of large food manufacturers. For example, 311 breakfast cereal products were available, of which 92 (29.6%) were produced by two food manufacturers, Ozone Organics and Kellogg's. Likewise, we observed 703 varieties of chocolates and sweets (6.3% of all ultra-processed food); 255 of these (26.3%) were produced by two food manufacturers, Mondelèz/ Kraft and Nestlé. The ten largest food manufacturers produced 35% of all packaged foods available.

2.2 Part B: Determinants of (healthy) food availability and affordability – development and analysis

Part B aims to examine what determines the availability and price of food and how this relates to health by building an overview of the operation of the food system including its different actors, activities and relations between them. Such an overview is essential because understanding the structure, strengths, and weaknesses of the food system is required to find realistic alternatives (Hendrickson and Heffernan, 2002). Interestingly, while food is fundamental for human survival, good understanding of our food system is limited internationally. In NZ, food production is the major contributor to the economy and there is a highly developed agricultural system (Campbell *et al.*, 2009); however, there is no policy at central government that outlines a long-term food strategy (Acres, 2010). The system focuses entirely on short-term economic profits without considering long-term consequences for public health. This is worrisome, not only for public health, but also in terms of food security. Different countries, including the

United Kingdom, Australia and Canada intend to move from agro-production oriented food policies towards a comprehensive national food strategy and a recent scientific report to the Dutch government concluded that the Netherlands needs to take a whole food systems approach to ensure a sustainable, secure and healthy food production for the population (WRR, 2014).

To achieve an overview of the NZ food system including public health outcomes, we will first focus on one commonly consumed commodity in fresh and packaged form in NZ (potatoes) and using this commodity to develop an innovative systems approach methodology by combining global value chain analysis and public health methods.

2.2.1 Global Value Chain Analysis

Value chain analysis (VCA) is defined as ‘analysis of where, how, and why value is added and created along the (food) chain. Its objective is to understand why the value chain is structured as it is and how it could be leveraged for change (Hawkes and Ruel, 2011)’. VCA was originally developed in the 1980s as an instrument to help businesses to be more efficient and generate more profits and has been rarely used for public health nutrition outcomes (Hawkes and Ruel, 2011). However, the food supply chain has been identified as a major opportunity to improve population nutrition (Ni Mhurchu and Lawes, 2005) and value chains have specific features that are important for food availability, affordability and quality (Hawkes and Ruel, 2011). For example, while food processing is a way to increase the monetary value of products (Stuckler *et al.*, 2012), it is generally negatively associated with nutritional values and, from a health perspective, consumption of this category should be discouraged (Monteiro *et al.*, 2010). Nevertheless, sales of ultra-processed foods are increasing rapidly where currently about three quarters of total global food sales are ultra-processed foods (United States Department of Agriculture (USDA), 2005) and these foods form the majority component of unhealthy diets (Monteiro, 2009; Slimani *et al.*, 2009).

VCA basically consists of two steps; 1) constructing the value chain including all different actors and activities; 2) analysing the chain and identify levers for change. However, chains can become increasingly complex by adding elements of power dimensions, international perspectives and influences of policies. To achieve this full perspective, we will use **global value-chain analysis (GVCA)** which is a specific form of VCA that draws on world systems theory (Hopkins and Wallerstein 1986) and concerns the food industry sector on a global scale (Gereffi and Christian, 2010). This global perspective is important because the food system operates internationally. For example, NZ Food and Beverage exports contribute over 10% to expenditure on Gross Domestic Product (GDP) and represent half of all NZ merchandise exports by value (New Zealand Trade and Enterprise, 2013). Each stage of the food production system connects NZ to other countries and these connections are driven by the practices of lead firms (e.g., Coca-Cola, Fonterra). The prevalence of NCDs can be linked to the behaviour of these lead firms in global food production systems (Gereffi and Christian, 2010). To date, GVCA has been used merely to analyse agro-food chains where it focuses on quantifying facets of costs, prices, profits, and returns in the chain (Hawkes and Ruel, 2011). However, similar to VCA, GVCA has the ability to be used to identify what influences the availability, affordability and quality of food. Also, GVCA has the specific advantage of being able to analyse the differing amounts of power exerted by each actor in the chain and how the system operates on a global scale (Hawkes and Ruel, 2011). These methods will be used in this project where we will build on a report by Hawkes and Ruel that outlines how VCA methods can be used in nutrition and health (Hawkes and Ruel, 2011).

Specific GVCA Procedures

GVCA is a new method in public health nutrition research. Therefore, we will start with a case study using GVCA for a specific product category (potatoes see below) to build the method which can form the basis for future research in this area. We aim to expand the analysis to other food products once the method has been fully developed.

Potatoes we chosen because they are considered a staple food and important source of dietary energy and carbohydrate for many populations globally. Data from Statistics NZ show that potatoes are amongst the three most highly weighted fresh vegetables in the Food Price Index basket, accounting for over one-third of the expenditure weight of vegetables (Statistics New Zealand, 2014b). However, potatoes are often processed into healthier foods such as salty crisps and French fries.

We will conduct GVCA on whole potatoes and processed potato products following the four GVCA steps as outlined below:

- 1) Value chain analysis on specific food products: What are lead firms and suppliers for the selected food products? (Hawkes *et al.*, 2012)
 - a. Identification of actors and the relationship between them.
 - b. Documentation of activities and their location.
 - c. Examining attribution of value corresponding to activities and actors in the chain.

First, we will build the value chain, including health and monetary value, of products as they move along the chain. We will start by identifying the actors at the beginning of the chain (potato growers) and the final products at the end of the chain (the potato products available for sale in NZ supermarkets (Hawkes *et al.*, 2012; Hawkes and Ruel, 2011). To identify all food products containing potatoes in NZ we will use the NZ Nutritrack dataset and collect data in NZ supermarkets. This process is underway and we recorded 952 food products with potatoes in the ingredient list (~7% of total). Next, products will be categorized according to their level of processing (based on taxonomy by Monteiro *et al.* (Monteiro *et al.*, 2010)) and nutrient values and health value using the Food Standards Australia New Zealand (FSANZ) Nutrient Profiling Scoring Criterion (NPSC) (FSANZ, 2013). We will then analyse the healthiness of potato products in relation to their level of processing. Based on this analysis, we will select some specific products (for example potato chips) to be included in the VCA that are most relevant for public health based on their nutrient values and market shares. For these products we will conduct a detailed VCA by identifying all actors and activities involved in bringing the product from the farm to the supermarket. For example, we will aim to analyse what the incentives are to produce healthier potato products instead of healthier potato products and how this related to profit margins. Furthermore, these products will form the basis for the next three steps in the VCA as outlined below. We will start this process by using online sources (including Potatoes NZ, our Nutritrack database and Statistics NZ) to build the value chain as detailed as possible. Next, we will conduct interviews with actors in the chain (farmers, retailers, food processing, etc.) to complement this information and to examine each actor's perspective on power dimensions in the chain. Ultimately, we hope to provide an indication of the real cost of food by recording the health and monetary margins during each step in the food chain.

- 2) Determining the geography of the chain:
 - a. How do the NZ lead firms operate within the world market, what sources do they have access to? Which foods are imported to NZ?

In this step, we aim to expand the value chain by taking a global perspective and looking more closely into the effects of food trade and large international corporations. The key questions in this step include how NZ lead firms operate within the world market, what sources they have access to and the role of import/export markets.

Imports and exports are very relevant to food availability and pricing. For example, data from Statistics NZ show that the average domestic price of products that are exclusively imported to NZ (such as bananas and grapes) closely aligns with the import price. However, other fresh fruit and vegetables have average domestic prices that align with the export price (Statistics New Zealand, 2014a). Also, this analysis is crucial with regard to ultra-processed foods; about 75% of global food sales include ultra-processed foods, however only 6% of ultra-processed food sales are traded (USDA, 2005). Food suppliers generally build a local plant so that they can be more responsive to local market and consumer needs. Also, trade tariffs are much higher on fully processed goods as opposed to primary products. Countries are trying to capture value-added locally and implement trade regulations that encourage imports of less-processed commodities (United States Department of Agriculture (USDA, 2005). On the other hand, NZ is investing significant amounts of money to increase export value of processed foods and use this to stimulate the national economy. It is important to record and understand these processes accurately if we aim to successfully limit production of ultra-processed foods from a health perspective.

- 3) Analysis of governance structures and ties between firms: How does the NZ food supply chain operate and who controls the diffusion of technology, standards and brands?
- 4) Analysis of the institutions that influence the activities of the chain: What is the role of governmental institutions and regulations within the chain (e.g., agricultural subsidies)?

Each public health programme must comply with relevant legislation and standards (Ministry of Health, 2006). Therefore, in step 3 and 4 we will analyse the role of institutions and governance structures and how these influence food availability and affordability and how this relates to public health. For example, many countries have restrictions on the import of fresh potatoes due to phytosanitary reasons. Also, agricultural policies can have important effects. At a national level, NZ government support to agricultural producers is the lowest among OECD economies (Rae, Nixon and Lattimore, 2004). Nevertheless, it is likely that the NZ food system is affected by international subsidizing schemes, such as the European Common Agricultural Policy (CAP), via food imports (FAO, 2014). Furthermore, the central NZ government is involved in the food system by putting large efforts into growing a stronger export economy in the agri-food sector. NZ also has free trade agreements with numerous countries, including Australia and China, and is negotiating the Trans Pacific Partnership Agreement (TPPA) with the United States. These free trade agreements are thought to have important impacts on public health as well (Public Health Association Australia, 2014).

2.3 Part C: Food system intervention development

The GVCA procedures outlined above will provide insight into the actors in the chain, their activities, location and where (monetary or nutritional) value is added along the chain. However,

this process does not provide full insight into power relations and how decisions are made, particularly because the food system is highly complex and power dimensions are tricky to measure. For example, a common problem when thinking about public health interventions is that the actors in the system have different priorities and are reacting to different feedback i.e. economic profits as opposed to effects on population health; this requires in-depth analysis to know how the system really works and how public health can play an effective role within this system. Also, while the GVCA will provide a detailed overview of the operation of the food chain, it does not yet provide sustainable public health interventions that can work in this system. Therefore, the final project aims to combine Group Model Building methods with a Delphi Study design to explore power dimensions and identify sustainable food system public health interventions.

2.3.1 Group Model Building

A common approach to uncovering complex systems is *community-based systems dynamics*. This method is participatory and involves communities in the process of understanding systems from the endogenous or feedback perspective of system dynamics (Hovmand, 2014a). A specific method within system dynamics is *Group Model Building* which uses the benefits of involving stakeholders in the process of developing a model with the expectation that this will lead to a better understanding of the model, shared insights, consensus and motivation for implementing the results (Hovmand, 2014b). We will use Group Model Building (GMB) to complement the GVCA and to examine who holds power in the system. The outcomes of the GBM will also serve as the first round of a Delphi Study that will aim to find effective public health interventions within the system (see below). For example, a commonly perceived problem is the high availability, low cost and profitability of ultra-processed food. Often, public health people try to develop interventions to make people eat less of these foods. Instead, in this project, we will ask industry/ retail ‘what are the incentives for you to produce ultra-processed foods?’ Public health interventions cannot work in isolation and for interventions to be successful they have to be able to operate within the rest of the system. To achieve this, it is crucial to understand the drivers and incentives of the key players in the system which we aim to achieve by involving these players in the conversation. A second strategy (if key players are not willing to share information) is to use ‘whistle-blowers’ such as people who have held key positions in the food system in the past and now have the ability to share information on their food future vision without being constrained by conflicting interests.

The design of GMB can vary along four dimensions: 1) the method for defining the initial problem; 2) structuring of the group process; 3) the type of model; and 4) the starting point. In this project, the initial problem will be defined by the programme team based on the outcomes of Part A (the food that is available) and B (the global value chain analysis). GMB has the potential to develop full computer simulation models that can be used to predict the effects of certain changes on complex systems (for example the effect of changing agricultural subsidies on food production). However, before this can be done, it is important to first identify how the system operates. Due to the complexity of the food system and the large number of different players and interests involved, this project will initially aim to build an informal causal map. Participants will be provided with some initial model structure illustrating the players in the NZ food system (Hovmand, 2014b). The GMB workshop will be designed with input from NZ expert(s) and will be developed using the ScriptsMap framework which helps linking together tasks and deliverables (Ackermann *et al.*, 2011).

Moreover, the format will be built on previous similar activities and publications such as a recent Institute of Medicine (IOM) report on using Agent-Based-Modelling, System Dynamics and Life Cycle Assessment to identify the inducements and barriers to fruit and vegetable consumption throughout the food system (IOM and National Research Council of the National Academies, 2015). For the GBM we aim to mainly include representatives from the food industry and government sector; public health experts will not be included until the Delphi study phase.

2.3.2 Delphi Study

The final step of this research programme will be the identification of levers for change in the food system that could benefit public health nutrition (or other elements of a sustainable food system) in both developed and developing countries. Here the challenge is to identify opportunities that can operate and sustain within the food system instead of having to fight against it (which is often the case with traditional public health interventions). The definite methods for this phase will be determined based on the outcomes of the preceding research, but it is envisioned that we will use a Delphi design or similar methodology. The Delphi method is an established way of finding solutions for complex problems (Waterlander *et al.*, 2010) by eliciting information and judgments from key stakeholders in the field to facilitate problem-solving and decision-making (Rayens, 2000). Here there is an opportunity to build on the outcomes of the Group Model Building research which also involves stakeholder consultation. Here we also aim to incorporate the GENERATE Change model (Wegener, Hanning and Raine, 2012) which can be used to guide multi-sectoral collaboration and policy and environmental change. This model highlights the importance of including all stakeholders which will be a specific aim of this Delphi Study. Delphi Studies consist of multiple rounds where experts from different sectors will be consulted systematically. The aim is to achieve consensus on particular intervention strategies. This will be achieved by starting with an interactive group session followed by quantitative survey rounds (via internet) where experts will receive statistical feedback on each other's responses. For example, a previous Delphi Study by our team included experts from academia, industry, retail, agriculture, policymakers, consumers and non-governmental organizations and aimed to identify feasible and effective food pricing strategies. This study resulted in a list of promising fiscal food policies with fair consensus levels among all experts. We aim to achieve similar outputs with the Delphi Study in the proposed research by defining a list of feasible food system interventions that are seen as promising by a wide group of experts and could substantially improve public health outcomes in both the short and long term.

3. Discussion

There is growing recognition that we need to move towards a more sustainable food system, especially in relation to projected population growth and growing concerns about climate change (Auestad and Fulgoni, 2015). According to the definition by the FAO, sustainable diets are “those diets with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations (FAO, 2012).” There is a clear need for high-level trans-disciplinary science that brings together agriculture, food systems, nutrition, public health, environment, economics, culture and trade to inform guidance on vital elements of healthy, sustainable diets (Auestad and Fulgoni, 2015; Rivera-Ferre *et al.*, 2013). The programme of research outlined in this protocol paper will contribute to this emerging science base by examining public health from a food system perspective and vice

versa (examining the food system from a public health perspective). This will be accomplished by providing a detailed overview of the availability and affordability of food in NZ (Part A), unique insights into how the global food system influences this availability (Part B) and identifying levers for change (Part C).

The second aim of the proposed research is to develop a new food systems method for public health nutrition research that can guide future intervention development and form the basis for new interdisciplinary research. We aim to achieve this goal by combining sound methodologies from systems science and public health. Also, we choose to focus on specific case studies to make the research comprehensible and feasible. However, we envision that the methods developed as part of this work will form the basis for future research in this area where it can be applied to other public health nutrition research (for example other food products, in relation to specific diseases, different countries) as well as other domains of a sustainable food system not specifically focussed on here e.g. economic, social and specific environmental outcomes. To assess whether we have been successful in developing this method we will include an evaluation component. This evaluation will contain specific elements including, but not limited to: ability to obtain/access required information; experienced barriers in conducting the research; and time and cost of conducting the research. This will be achieved by conducting a process evaluation where costs, barriers and facilitators of each step in the research process will be recorded. Also, we formed a steering group with experts from within and outside NZ to monitor the progress of the research and identify opportunities for improving the methods. Furthermore, we aim to provide an impression of the comprehensiveness of our analyses by reporting on any parts of the food supply chain or methods we have identified as missing. For example, by focusing on potato products in supermarkets we miss the potato processing industry for fast food giants as McDonalds and Burger King. While it is not feasible to do a complete VCA of this sector as part of this project, we do aim to provide some figures on the proportion of potatoes processed for each industry (retail; fast food; restaurants; etc.). This will enable us to provide an estimation of how much of the food system we have captured with our proposed methods. Finally, we aim to present this work at international inter-disciplinary conferences such as the First Mediterranean Conference on Food Supply and Distribution Systems in Urban Environments to obtain feedback from different disciplines and integrate this in the protocol. Altogether, we view this programme of research both as a way to find new answers and to develop new research methods for public health nutrition. Questions that we hope to answer as part of this process include:

- How can we best integrate a public health perspective in food systems research?
- How feasible is it to develop sustainable food system interventions that benefit public health nutrition?
- What are the best research methods to study the food system from a public health perspective?
- How feasible is it to collect information on power dimensions in the food system? In particular with regard to commercially sensitive information?
- What is the best way to get buy-in from food industry in this type of research?
- How can a public health focus best be aligned with other dimensions of a sustainable food system?

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FIGURES

Figure 1 Systematic logic model for the Food Futures research programme

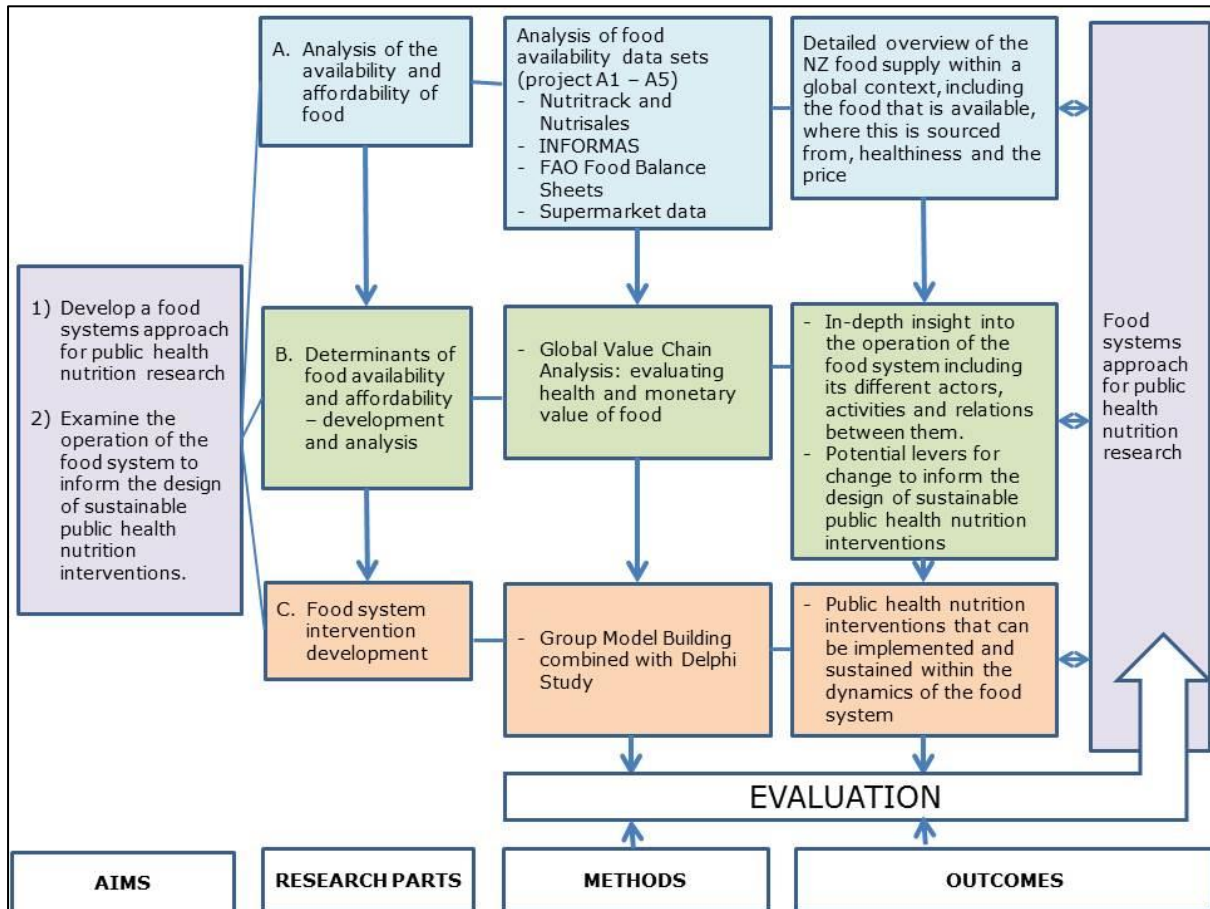
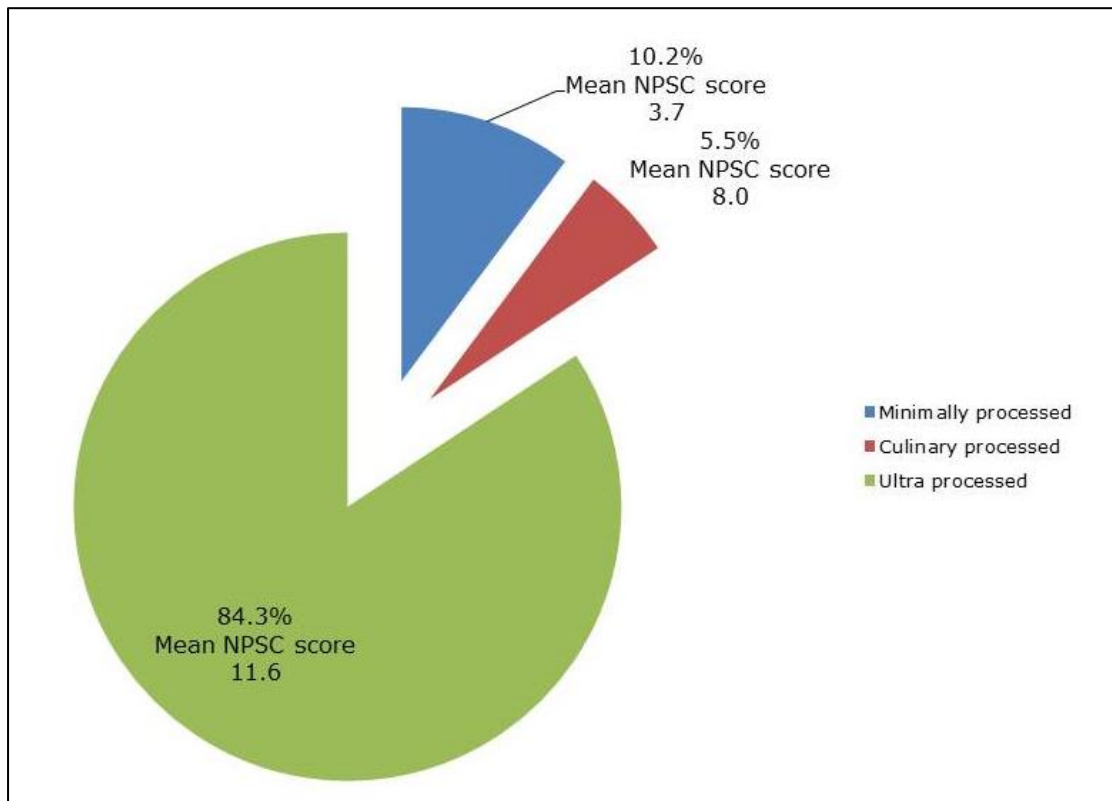


Figure 2

Percentage of packaged foods in NZ that are minimally, culinary or ultra-processed and their Nutrition Profiling Score (NPSC)^a



^a A higher nutrient profiling score means that foods are unhealthier