

Review

Monitoring the price and affordability of foods and diets globally

A. Lee^{1*}, C. N. Mhurchu^{2*}, G. Sacks^{3*}, B. Swinburn^{2,3*}, W. Snowdon^{3,4*}, S. Vandevijvere^{2*}, C. Hawkes⁵, M. L'Abbé^{6*}, M. Rayner^{7*}, D. Sanders^{8*}, S. Barquera⁹, S. Friel¹⁰, B. Kelly¹¹, S. Kumanyika¹², T. Lobstein^{13,14}, J. Ma¹⁵, J. Macmullan¹⁶, S. Mohan¹⁷, C. Monteiro¹⁸, B. Neal¹⁹ and C. Walker²⁰ for INFORMAS[†]

¹School of Public Health and Social Work and School of Exercise and Nutrition Sciences, Queensland University of Technology, Brisbane, Australia; ²School of Population Health, University of Auckland, Auckland, New Zealand; ³WHO Collaborating Centre for Obesity Prevention, Deakin University, Melbourne, Victoria, Australia; ⁴Pacific Research Centre for the Prevention of Obesity and Non-communicable Diseases (C-POND), Suva, Fiji; ⁵World Cancer Research Fund International, London, UK; ⁶Department of Nutritional Sciences, University of Toronto, Toronto, Canada; ⁷British Heart Foundation Health Promotion Research Group, University of Oxford, Oxford, UK; ⁸School of Public Health, University of the Western Cape, Cape Town, South Africa; ⁹National Institute of Public Health, Mexico City, Mexico; ¹⁰National Centre for Epidemiology and Public Health, Australian National University, Canberra, Australia; ¹¹School of Health and Society, University of Wollongong, Wollongong, New South Wales, Australia; ¹²Perelman School of Medicine, University of Pennsylvania, Philadelphia, PA, USA; ¹³International Association for the Study of Obesity, London, UK; ¹⁴Public Health Advocacy Institute of Western Australia, Curtin University, Perth, Australia; ¹⁵Chinese Center for Disease Control and Prevention (CCDC), Beijing, China; ¹⁶Consumers International, London, UK; ¹⁷Public Health Foundation of India, New Delhi, India; ¹⁸School of Public Health, University of São Paulo, São Paulo, Brazil; ¹⁹The George Institute for Global Health, University of Sydney, Sydney, Australia; ²⁰Global Alliance for Improved Nutrition (GAIN), Geneva, Switzerland

Address for correspondence: Professor A Lee, School of Public Health and Social Work and School of Exercise and Nutrition Sciences, Faculty of Health, Queensland University of Technology, Victoria Park, Road Kelvin Grove, Brisbane, Queensland 4059, Australia.
E-mail: amanda.lee@qut.edu.au

Summary

Food prices and food affordability are important determinants of food choices, obesity and non-communicable diseases. As governments around the world consider policies to promote the consumption of healthier foods, data on the relative price and affordability of foods, with a particular focus on the difference between 'less healthy' and 'healthy' foods and diets, are urgently needed. This paper briefly reviews past and current approaches to monitoring food prices, and identifies key issues affecting the development of practical tools and methods for food price data collection, analysis and reporting. A step-wise monitoring framework, including measurement indicators, is proposed. 'Minimal' data collection will assess the differential price of 'healthy' and 'less healthy' foods; 'expanded' monitoring will assess the differential price of 'healthy' and 'less healthy' diets; and the 'optimal' approach will also monitor food affordability, by taking into account household income. The monitoring of the price and affordability of 'healthy' and 'less healthy' foods and diets globally will provide robust data and benchmarks to inform economic and fiscal policy responses. Given the range of methodological, cultural and logistical challenges in this area, it is imperative that all aspects of the proposed monitoring framework are tested rigorously before implementation.

Keywords: Food prices, food affordability, non-communicable disease, food policy.

obesity reviews (2013) **14** (Suppl. 1), 82–95

*Members of the writing group for this manuscript, listed in order of their contribution to the writing of the manuscript.

[†]INFORMAS is the International Network for Food and Obesity/non-communicable diseases Research, Monitoring and Action Support. All authors who are not members of the writing group are listed in alphabetical order, and contributed to discussion of the key concepts and issues raised in this manuscript as part of the first formal meeting of INFORMAS from 19 to 23 November 2012.

Background

Food prices influence food choices

Food prices and food affordability (defined here, in broad terms, as the cost of the diet of a household relative to the household's income) are important determinants of food choices (1,2) and, accordingly, dietary patterns, nutrition and health (3–6). In addition, the price and affordability of food affects food security at all levels (7–9).

While food price has been reported by some groups as a more important determinant of food choice than taste, promotions, convenience or environmental concerns (10–12), there is still much to learn about the impact of food prices on dietary choices (13). Generally, consumers purchase fewer foods when their prices rise and the converse when prices fall (8,14–20). However, estimates of food price elasticity values (a measure of the percentage change in the amount purchased relative to percentage change in price) vary greatly (13). Particularly in high-income countries (21), consumers may be more sensitive to price changes between close food substitutes, such as wholemeal bread and white bread, or diet soft drinks and sugar-sweetened soft drinks, than between foods that are not close substitutes (13). While recent randomized controlled trials indicate that targeted price discounts can increase purchases of 'healthier' food (22,23), experimental studies do not show how price changes affect the total diet or how sustainable any effects may be.

Prices of 'healthy' and 'less healthy' foods and diets

Differentials in the price of 'healthy' and 'less healthy' foods and diets can contribute to obesity, non-communicable diseases (NCDs) and their inequalities (24). However, despite several studies that have investigated this (25–29), it is not clear whether 'healthy' foods and diets are generally more expensive than 'less healthy' foods and diets on the basis of price per calorie (30–32). Under times of economic stress, it has been postulated (33,34) that socio-economically disadvantaged groups tend to choose cheaper foods that are energy-dense. When food choices are made within the context of sustained budgetary constraints and/or rising food prices (35), it has been postulated that they maximize energy value for money (dollars per megajoule [\$/MJ]), resulting in habitual energy-dense, nutrient-poor dietary patterns that contribute to obesity and diet-related NCDs (24,27,34,36–42). However, the unit of measure is critical; many 'healthy' foods such as fruit and vegetables, despite having low energy-to-price ratios, can provide nutrients at a reasonable cost when compared with 'less healthy' foods (43,44). Similarly, the

lack of standard definitions of 'healthy' and especially 'unhealthy' diets is problematic.

In low- and middle-income countries, food accounts for a large and increasingly volatile share of the budget of poor and urban families (29,45), and small changes in food prices can impact considerably on household expenditure and diet. In these countries, middle-class households may spend between 35% and 65% of their gross income on food (46). Among the poorest groups, up to 80% of income can be spent on food (29). For example, in one South African study, food accounted for between 38% and 71% of total household expenditure (47). In the face of rising food prices in these countries, there is evidence that the most vulnerable individuals initially ration consumption to prioritize energy-dense but nutritionally poor foods (48–53). This results in a decline in dietary quality followed by reduced dietary quantity as resources are depleted (51), causing micronutrient deficiencies (54) and 'hidden hunger' (55), and contributing to the cycle of malnutrition (56), lower incomes and high rates of NCDs in later life (53,54,56). Better understanding of the differential between the cost of 'healthy' and 'less healthy' foods and diets in low- and middle-income countries would help provide insights into the determinants of food price and affordability in the development of obesity and NCDs in these countries.

In high-income countries, greater total spending on food tends to be associated with more nutritious dietary patterns (38,41,57). However, if populations were to follow dietary guidelines/recommendations, this may lead to higher food costs (58). Those households with the lowest incomes are more vulnerable to increasing food prices, as they spend less per person on food, but a greater proportion of their total expenditure on food. For example, in Australia, a 'healthy' diet costs between 28% and 40% of the disposable income of a welfare-dependent family compared with 20% for families on the average income (59–61) and in Los Angeles, United States, a 'healthy' food basket costs 35–40% of low-income consumers' budgets (62). Thus, it is important for measures of food prices to relate to income or purchasing power to be meaningful (29).

Government efforts to influence food prices

A range of complex factors influence food prices, including political, economic, socio-cultural and environmental factors at the local, national and international levels (4,63). Food prices may be manipulated by governments through a variety of complex policy approaches. Three common pricing strategies at a state or national level are as follows: taxes on specific foods, e.g. soft drinks; exemption of selected goods from a goods and services or value added tax; and subsidies such as agricultural and transport subsidies, or voucher systems targeted to high-risk groups

(16,64). Recently, Denmark introduced a 'fat tax' (now revoked) (65); Hungary has a 'junk food tax'; and France, four Pacific countries and 40 states in the United States tax sugar-sweetened beverages specifically (21,66,67). In Australia, Canada, France and the United Kingdom, differential application of taxes on food occurs, although health benefits are not necessarily the primary driver (68). The health outcomes of these taxation policies have not been evaluated.

Food subsidy programmes have been operating for many years in the United States and the United Kingdom, but until recently have not tended to focus on promoting healthier eating (69–71). The Special Supplementary Nutrition Program for Women, Infants and Children has demonstrated increases in targeted nutrients and foods and some improvement in perinatal outcomes (72). Poland (73) and South Korea (74) have similar programmes in place. Other food subsidy systems are more local. For example, vulnerable women, children and the elderly are provided with coupons to purchase fresh fruit and vegetables at outdoor farmers' markets in Massachusetts, United States, resulting in increased purchases of fruit and vegetables in around 30% of participants (75).

The need for monitoring of food prices

Many leading international bodies are advocating for economic and fiscal policies to promote the consumption of healthier foods, improve the nutritional quality of diets and raise revenue to fund population health programmes (16,76–79). In order to strengthen the case for these policies, and evaluate their impacts, it is clear that monitoring systems are needed to understand the relative price and affordability of foods, with a particular focus on the difference between 'less healthy' and 'healthy' foods, meals and diets.

The International Network on Food and Obesity/non-communicable disease Research, Monitoring and Action Support (INFORMAS) is a global network of public-interest organizations and researchers that aims to monitor, benchmark, and support public and private sector actions to create healthy food environments and reduce obesity, NCDs and their related inequalities (80). This paper introduces the food prices module of INFORMAS, which seeks to answer the research question, 'What is the relative price and affordability of "less healthy" compared with "healthy" foods, meals and diets?'. This paper reviews previous methods and tools used to assess food prices and affordability, and outlines a step-wise framework to monitor the price and affordability of 'healthy' and 'less healthy' foods, meals and diets between countries and over time.

In this paper, a 'healthy' diet is defined as one that provides recommended amounts of foods, nutrients and

other food components, within estimated energy requirements, to promote normal growth and development in children, reduce risk of obesity and NCDs, and promote optimum well-being, consistent with national dietary guidelines/recommendations (81). For the purposes of this paper, a 'less healthy' diet is defined as the current average diet of each country's population (63), assessed, where available, by national intake surveys. The definition of 'less healthy' foods and beverages are those high in energy density, containing saturated fat, *trans* fat, added sugar, added salt and/or alcohol (81).

Overview of previous and ongoing food price monitoring activities

Global commodity food prices

Internationally, commodity price indices tend to be applied in economic rather than health contexts (7,82–86). Different staple foods are collated in a range of global commodity price indices for different purposes, including the Food Price Index compiled by the Food and Agriculture Organization (87), the food and beverage components of the International Monetary Fund Primary Commodity Price Index (76), and the food and beverage components of the World Bank Commodity Index (84,88).

International food price data can be contextualized to take into account country-specific factors, such as local political and weather conditions, as illustrated by the Global Information and Early Warning System on Food and Agriculture, the Food Price Data and Analysis Tool (87), and the World Food Programme's Vulnerability Analysis and Mapping Food and Commodity Prices Data Store (89,90). These approaches can provide useful insights into regional food pricing pressures. However, achieving reliable, comprehensive food security monitoring systems is an ongoing challenge (89–91).

Commodity food prices fluctuate widely depending on factors such as international oil prices, weather conditions, crop and production yields, global and domestic demand, state of surplus stocks, market speculation and other financial issues (9,53,87). Specific stressors include climate change, the global and European economic downturns (9,51), population growth, demographic changes and demand for biofuels (53,83,84,92). Food commodity prices spiked in 2008 and 2010–2011; most projections suggest they will remain higher this decade than that leading up to the previous peaks (53,92).

International prices do not translate directly into local prices due to a number of factors, including regional import/export drivers and local policies affecting taxes and subsidies (92). As they are based on highly selected, aggregated staple items, commodity prices cannot readily be

used to provide quantitative assessment of the cost differentials between 'healthy' and 'less healthy' foods.

National/regional food price databases

Few countries regularly monitor the retail prices of foods and publish results in accessible formats. The U.S. Department of Agriculture's (USDA) Centre for Nutrition Policy and Promotion national food price database provides the cost per one gram edible portion of most foods and beverages reported in dietary recalls collected in the 2001–2002 National Health And Nutrition Examination Survey survey based on the average retail prices of foods and ingredients across the country at that time (93).

The European Commission is developing economic monitoring tools for selected products throughout the European food supply chain, including indicators such as the harmonized index of consumer prices, producer price index, purchasing power parity (PPP) and the agriculture commodity prices index (94,95). Current limitations include that different products tend to be monitored in different countries and available data sets are incomplete (94,95).

The New Zealand Food Price Index reports monthly on the rate of price change of 176 commonly purchased foods across six regions collected as part of that country's Consumer Price Index (CPI) programme (96). Similarly, the National Agricultural Marketing Council of South Africa monitors quarterly detailed price changes of selected foods (97).

Apart from that of the USDA, no currently available national/regional data set can be used to compare differentials in prices between 'healthy' and 'less healthy' foods as the food groupings are too highly aggregated.

Consumer Price Index

Many countries regularly survey household expenditure on selected consumer goods and services to inform the CPI as a measure of inflation. Prices are collected for a sample of goods and services, including foods, from a number of locations for a number of times per year. Data are weighed either upon proportional expenditure for a sample of households or upon estimates of the proportion of consumption expenditure in the national accounts. Some countries, such as New Zealand and South Africa, also report specifically on the food component of the CPI (96,97). Detailed CPI data are published on the statistical websites of some countries, but only compiled data tend to be published for most countries (98) and specific regions (e.g. the Economic Commission for Latin America (99)).

Various methods and 'representative' baskets are used to estimate CPI, and a number of sources of bias exist (100). Some attempts have been made to classify foods priced to

calculate CPI into 'healthy' and 'unhealthy' categories (101,102). Challenges reported include bias in food sampling, varying quality of seasonal foods, aggregation of products and lack of comparability across countries. However, where CPI (foods) is based on actual household purchases, this index may be a useful proxy for the changing price of basket of standard 'less healthy' foods over time (101,103).

Price of selected food baskets

A range of food baskets have been costed for different purposes worldwide:

- The World Bank uses the price of a 1200-kcal basket of reference foods to set the food poverty line (104).
- The (semi-humorous) Big Mac Index is published by *The Economist* as an informal way of measuring the PPP between different currencies and has given rise to the term 'burgernomics' (105). The costed unit is a single 'Big Mac' burger as sold locally by the McDonalds fast food chain. Purchasing power comparators are calculated on the basis of both the unit price and the amount of time that an average worker in a given country must work to earn this amount (106).
- Various countries and regions have attempted to measure PPP on a larger selected number of standard goods including foods. For example, in Europe, data are collected on selected food products for 37 countries (107), and help inform estimates of Gross Domestic Product per capita (108). Various issues with data quality have been identified (95).

Price of 'healthy' diets, meals and foods

Various approaches have been used to measure the cost of a 'healthy' diet or list of 'healthy' foods. Rarely have studies assessed the price of 'healthy' meals.

Price of 'healthy' diets

In a few countries, notably Australia, Canada, New Zealand and the United Kingdom, baskets of 'healthy' food reflecting the total diet have been developed and used as tools for monitoring prices and availability at the national (109,110), state/provincial (103,111–113) and community (61,114,115) levels. Several local studies have investigated the costs of 'healthy' food baskets on a more *ad hoc* or one-off basis (116–119).

Few of the above-mentioned studies have been written up in peer-reviewed journals; most are published in web-based data sets or within the grey literature (110,118,120–122). Generally, methods are not well described, and the rationale for and composition of 'healthy' food basket monitoring tools vary greatly. Types of 'healthy' diet

baskets range from those modelled on national dietary guidelines (60,109,123,124) to those modified to be 'more realistic' (60,61,103,111,113–115,125–127). The latter frequently includes foods not commonly considered 'healthy' such as sugar, biscuits and ice cream. Some models use only fruit and vegetables as a proxy for 'healthy' foods (73). Several 'healthy' diet baskets are based on habitual intake determined by nutrition or household budget surveys. Given that current dietary intakes tend to be inconsistent with dietary recommendations (63), such baskets represent standard 'less healthy' rather than 'healthy' diets (103,128). Some studies have based assessment of dietary quality on stratification of diet scores from various surveys (25,29,129) but these are not specific enough for answering the research questions of this module of INFORMAS.

There is also great variability in how foods are selected to develop monitoring tools; e.g., in the degree to which cultural preferences are accommodated. Some 'healthy' diet baskets are developed for specific age/gender groups (109), others for hypothetical reference families/households (61,103,111,115). Monitoring tools vary according to whether branded, generic or cheapest available products are included; the size of the items is specified; and in the proportion of fresh/canned/ refrigerated/frozen or juiced products included. Survey protocols also vary greatly. For example, prices may be collected either manually or electronically, in-store, from catalogues or on-line. The size and type of retail outlets surveyed, the number of outlets included, recording of standard or special promotional prices, frequency of data collection and attempts to control for seasonality also vary greatly. The high number of 'healthy' food items missing in retail stores can be problematic in some areas (111,118,130). In addition to time trends, serial results have been reported by regional location (131,132), remoteness (103,111), and income and demographics (128,133).

Food basket costing studies commonly assume that most foods purchased are consumed; that all foods are consumed equitably by family members according to nutritional need; and that waste is minimal. Few consider issues such as home production of food.

Price of selected 'healthy' foods

Most studies investigating the costs of 'healthy' foods do not attempt to encompass total diet and apply highly selected shopping lists/baskets of healthier food choices (62,132,134–139). Compared with 'healthy' diet baskets, there is even greater variability in development and composition of 'healthy' food lists/baskets. Some studies apply nutrient profiling (140), others use key foods consumed by those meeting nutritional recommendations in dietary surveys (141) or informed by national dietary guidelines (137), but most appear to be quite subjective (138). For

example, one study of 'healthy' foods costed sausages, chocolate and butter (135), which were not included in other 'healthy' food lists.

Differential between the price of 'healthy' and 'less healthy' foods and diets

The price of 'less healthy' diets has rarely been compared with that of 'healthy' diets; a major challenge is the lack of standard definition of a 'less healthy' (or 'unhealthy') diet.

Most commonly, studies reporting price differences between 'healthy' and 'unhealthy' foods have costed selected lists of 'standard' and 'healthier' items (141). The most common method to categorize foods is nutrient profiling (32,62,140,142). Within food categories, corresponding healthy/unhealthy items may not be identified readily for all foods, e.g. for fruit or eggs, or conversely for commercial-baked goods and sugar/sweets. Therefore, common lists of 'healthy' and 'unhealthy' foods do not necessarily correspond to each other in terms of culinary use or energy or key nutrients provided (32,138). Studies have varied greatly in the number of foods included, from very comprehensive lists (32,140) to highly selected items, such as fruit and vegetables and salty snacks (131).

Most recent studies use price per energy unit as the basis for comparison, reporting results in terms of food categories or energy-adjusted nutrients, rather than total diet (26,34,140). Other units reported include per edible volume (131), per edible gram, per energy (calorie) and/or per average portion (32). Carlson and Frazao (32) recently analysed the costs of 'healthy' foods by food category, and compared these with 'less healthy' foods using three price unit metrics. When the price was expressed per unit of energy, foods high in nutrients and low in energy density, such as fruits and vegetables, were relatively expensive compared with energy-dense nutrient-poor foods, especially those high in saturated fat and added sugar. However, when measured on the basis of edible weight or average portion size, grains, vegetables, fruit and dairy foods were less expensive than most protein foods (meat, poultry, fish, eggs, peanut butter), and were also less expensive than most energy-dense nutrient-poor foods. The authors concluded that it was less costly to meet U.S. dietary recommendations for grain products, dairy foods and fruit than for vegetables and protein foods (32).

Most, but not all, monitoring studies report rising disparities between the price of 'healthy' and 'unhealthy' foods (101–103,137,140,143,144). In one study, the price of 378 foods and beverages was monitored in Seattle, United States, from 2004 to 2008. Nutrient-dense items increased in price by 29.2% compared to a 16.1% increase for the least nutrient-dense items (140). As another example, in a UK study, the cost of a 'healthy' shopping basket increased by 49% from 1988 to 2003, while the cost

of an 'unhealthy' basket increased by 33% over the same time (145). However, lack of specificity and consistency between studies makes interpretation and comparison of results difficult (13,32,146).

Associated costs in preparation of food

In addition to the price of foods, a number of other inputs add to the cost of producing a household meal. These include time and energy such as transport, shopping, storage, preparation and cooking, including electricity, gas or other fuels (147). Other costs are associated with relevant 'health hardware' such as stoves, cooking pots, utensils, plates and bowls, washing equipment and facilities for food storage (148). Such costs have rarely been considered in studies of food prices (149), but could impact on the price differential for 'healthy' and 'less healthy' meals and diets. There are many methodological challenges involved in collecting such data, particularly without conducting very expensive household surveys.

Affordability and household income data

The need to measure household income as a denominator of affordability of foods introduces another challenge into food price monitoring and surveillance programmes (29). Very few food price studies have estimated affordability at household level (62,133,150,151).

A range of estimates of disposable income at the household level is collated for different countries, including median household income (152), disposable household income (153), household budget survey data (154), and

household expenditure and income data for transitional economies (155). Caution must be exercised when using such economic data sets to draw inter-country comparisons due to variations in methodology (156).

Food affordability has a strong social gradient, and in high-income countries, measures such as welfare payments have also been used to benchmark the proportional cost of a healthy diet (59–62).

Proposed step-wise approach to monitor prices and affordability of foods and diets

Overview of monitoring framework

A step-wise framework (including 'minimal', 'expanded' and 'optimal' approaches) for monitoring the price and affordability of foods, meals and diets at country level is proposed (Table 1). The step-wise approach is designed to take into account differences in the available capacity, infrastructure and resources of countries to conduct monitoring activities.

For simplicity, at this stage, it is proposed to collect retail price data for foods, meals and diets, but not to collect non-food costs associated with food/meal preparation, nor estimate costs of home food production.

Contextual analysis

The first step as part of the proposed monitoring approach will be for each country to conduct a contextual analysis to gain an understanding of the circumstances affecting food prices in that country. This would include the country's

Table 1 Proposed step-wise framework to monitor price and affordability of 'healthy' and 'less healthy' foods, meals and diets

	'Minimal' approach	'Expanded' approach	'Optimal' approach
Indicator	Differential between the price of selected 'healthy' foods and 'less healthy' foods	Differential between the price of 'healthy' diets and meals, and 'less healthy' diets and meals	Affordability of 'healthy' and 'less healthy' diets and meals
Data sources	Retail prices of foods Nutrient profiling system to differentiate nutritional quality of comparable foods	Relevant country dietary guidelines and national dietary intake data (where available) Relevant country food composition tables, dietary modelling and/or food selection guides (where available)	As 'expanded' approach together with median household income data
Analysis	Comparison of the cost (and tax component) of 'healthy' and 'less healthy' equivalent foods	Diets: Comparison of the cost of a 'healthy' diet for a reference (healthy weight) family over 2 weeks versus cost of the 'current' diet for a reference (current weight) family over 2 weeks Meals: cost of a reference 'healthy' meal vs. the cost of a similar but less healthy meal (of equivalent weight)	As for 'expanded' but expressed as costs in relation to median household income
Stratification	No stratification	Stratification by region	Stratification by region and by household socioeconomic status
Representativeness	Country-wide	Country-wide/regional	Country-wide/regional Socioeconomic groups

population characteristics, available food and nutrition intake data, risk profile, NCD risk factors, relevant national and local government policy issues, key private sector actions and pricing policies, household income measures, consumer group/non-government organization activities in the area, and an assessment of the likelihood of change in the policy environment. Where available, CPI (foods) and/or contextualized commodity prices could inform the contextual analysis.

For the policy analysis, information about food taxation and subsidization will be critical, including details about the taxes on specific foods or drinks, any foods exempted from taxation, and agricultural, transport, direct or any other form of subsidies that affect food prices. Ideally, the structure of food pricing would be described in each country, including issues such as purchase price stability.

The assessment of the types and quality of available data, resources and capacity will assist identification and prioritization of the most appropriate monitoring approach (i.e. 'minimal', 'expanded' and/or 'optimal') for each country.

Data collection methods and tools

It is proposed that INFORMAS team members will lead the development and testing of protocols and standardized food price monitoring tools for subsequent tailoring within

each country. The proposed components of the data collection approach are illustrated in Fig. 1.

The '*minimal*' monitoring approach will be used to collect data to assess the differential between the cost of 'healthy' and 'less healthy' (i.e. regular/standard) foods. Examples of the types of foods that will be included as healthy or less healthy are shown in Table 2. Standardized lists of common 'healthy' and 'less healthy' foods and beverages within the same food category will be drawn from the literature, contextualized for each country and confirmed by expert consensus within the country. Standardized unit sizes will be identified and included on 'shopping lists' ready for pricing.

The current retail price of foods in the 'shopping list' will then be collected, either in-store or on-line during a stand-alone survey. Where available, the tax component of each food price will also be collected to aid interpretation of results. Ideally, this data collection activity will be incorporated as an extension of monitoring conducted as part of the INFORMAS food composition (157) and/or food labelling (158) modules. Either way, detailed data collection and analysis protocols will need to be developed and tested for these purposes.

As an alternative method of data collection, food price information may be purchased from commercial data bases (such as Kantar World Panel 2012 (159)). Where detailed food price data are collected for determination of the CPI,

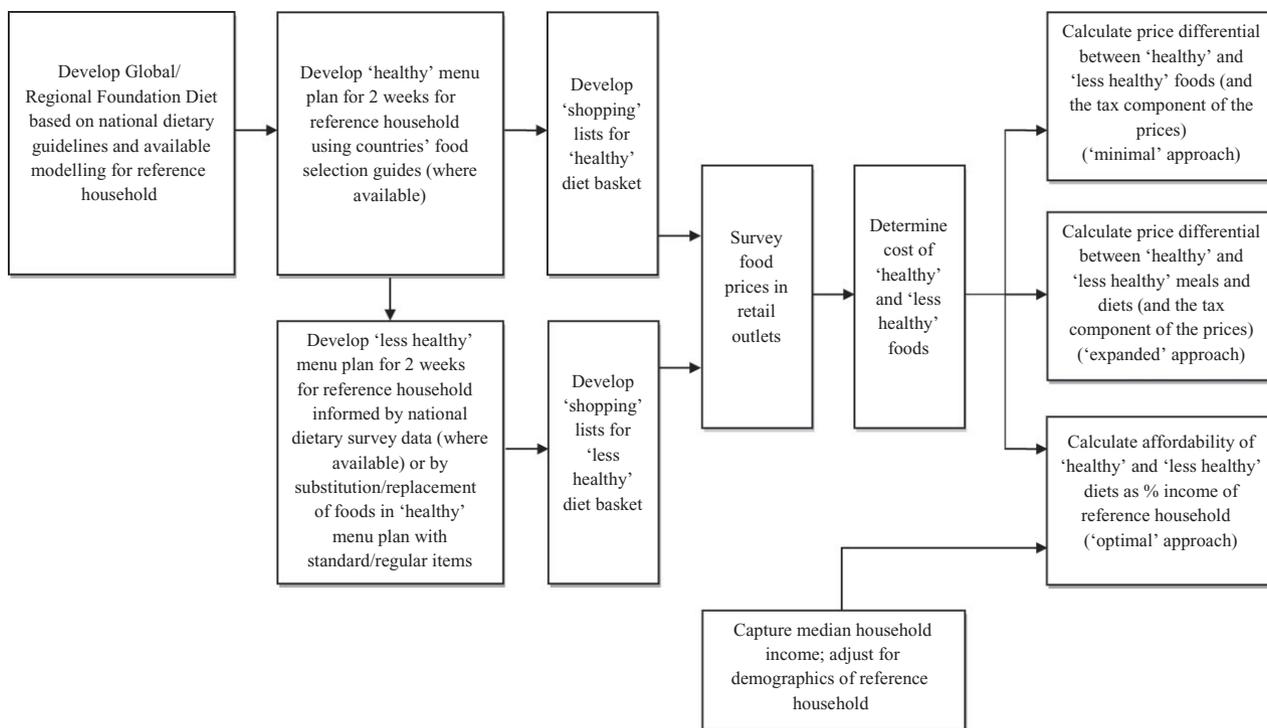


Figure 1 Overview of proposed data collection and analysis approach for monitoring food prices and affordability.

Table 2 Examples of 'healthy' and 'less healthy' foods

Food group	'Healthy' food	'Less healthy' food
Meat and alternatives	Lean mince beef	Standard mince beef
	Trimmed red meat (specific type)	Standard red meat (specific type, e.g. lamb flap)
	Pulses/legumes	Standard mince beef
	Lean, low salt sausages	Standard sausages
	Fresh meat	Tinned 'Spam'
	Fresh tofu	Fried tofu
Milk and alternatives	Reduced fat milk	Full cream milk
	Reduced fat yoghurt, plain	Full cream yoghurt, plain
	Reduced fat cheddar	Cheddar – standard
Grain (Cereal) foods	Wholegrain bread	White bread
	Whole grain cereal- no added sugar (specific type)	Sweetened breakfast cereal (specific type)
	Brown rice	White rice
	Wholegrain pasta	Pasta
Fruit and vegetables	Fruit (apple)	Pack potato crisps
	Boiled/baked potatoes (where potatoes are grouped as a vegetable)	Hot fried potato chips
	Fresh fruit	Fruit juice drink
Oil/spread allowance	Polyunsaturated spread	Butter
	Unsaturated oil	Palm oil
'Discretionary' foods, high in energy-density, saturated fat, salt and added sugar compared with healthier option from other groups	Artificially-sweetened soft drink	Sugar-sweetened soft drink
	Frozen yoghurt (plain, no sugar)	Ice cream
	Plain dry biscuits (wholegrain)	Corn chips
	Nuts (unsalted)	Potato crisps
	Fruit (e.g. banana)	Sweet biscuits
	Dried fruit (e.g. sultanas)	Confectionary

it is theoretically possible to access disaggregated data to compare changes in the cost of the component 'healthy' foods with regular/standard foods (as a proxy for 'less healthy' foods). Accordingly, this could also be an alternate source of data for this step.

The 'expanded' monitoring approach will be used to collect data to assess the differential between the cost of 'healthy' and 'less healthy' (i.e. regular/standard) meals and diets. As the starting point for this approach, it is proposed that Global/Regional Foundation Diets for a reference household are developed. This will be based on, where available, each country's dietary guidelines and any underpinning dietary modelling or food selection guide (e.g. those developed in Australia (81)). It is proposed that this will initially be developed by INFORMAS team members as part of INFORMAS pilot initiatives.

The Foundation Diets will then need to be translated into standardized 'healthy' diets to construct 'healthy' menu plans for 2 weeks for the reference household. 'Less healthy' menu plans for 2 weeks for the reference household will be informed by national dietary survey data (where available) or by substitution/replacement of foods in 'healthy' menu plans with standard/regular items. The menu plans will be transcribed into 'shopping lists' ready for pricing, as per the 'minimal' approach.

The 'optimal' monitoring approach will be used to collect data to assess the affordability of 'healthy' and 'less healthy' diets and meals at the household level. It will consist of the 'expanded' monitoring tool as well as tools to collect/collate household income data. The measure of income that appears to hold most promise as a denominator is median household income. However, as affordability of a 'healthy' diet is likely to be more challenging for lower socioeconomic groups, a range of other income measures, including welfare payments, should also be investigated.

Data analysis

Standardized methods of data analysis will be developed and tested by the INFORMAS team. Data will be analysed within each country and reported centrally. Monitoring will assess how the price differential of 'healthy' and 'less healthy' foods and diets and/or the affordability of 'healthy' and 'less healthy' diets differs between countries and over time.

In addition, it will be important for countries to monitor the food price regulatory and policy environment, as described under contextual analysis, over time. The collection of case studies would be valuable to provide contextual examples.

Discussion

There is an urgent need for global monitoring of the price and affordability of 'healthy' and 'less healthy' foods, meals and diets (13,28,103,160–163), and for the improvement of systems to monitor changes in the vulnerability of populations to rising food prices (29,85,89–91,164,165).

A major challenge lies in developing cost-effective, simple monitoring tools relevant at the family/household level that complement available data sets, and do not require expensive and intensive household surveys. Useful price indicators need to be robust; policy relevant; pertinent to nutrition, obesity, NCDs and their inequalities; sensitive to system pressures, such as climate change and economic drivers; and changes in the price differentials need to be comparable between countries and within countries over time. Robust indicators could trigger preventative policy action and would be useful in establishing baselines, and for monitoring and evaluating structural, economic interventions at the country/regional and household levels.

Given the methodological complexities in assessing and monitoring food prices and affordability globally, a step-wise monitoring approach is proposed, with transition from 'minimal' through to 'optimal' indicators, depending on the capacity and resources available within each country. Several countries would have the capacity to monitor all three levels of food price indicators, providing the opportunity for the performance of the indicators to be compared.

Major challenges in the development of monitoring tools are the lack of consistent definitions of 'healthy' and 'less healthy' foods, and composition of 'unhealthy' diet baskets (146,166–168). In this INFORMAS module, the latter challenge may be circumvented by focusing on the indicator most relevant to food price and affordability policy: the cost differential between 'healthy' and 'less healthy' diets, where 'less healthy' diets are based on current intake.

In developing tools to measure the differential price of foods, as opposed to diets, specific problems include the lack of rationale to compare foods across different product categories; difficulties in comparing foods with different weight, volume and energy densities; and lack of an 'anchor' determining the numbers of foods included in pricing lists. The use of 'diet' as a metric effectively applies daily energy intake as an anchor for the types and amounts of foods to be included in these monitoring tools. Analysing the cost of diets also avoids the question of which unit to use (energy, weight or portion) when comparing the price of 'healthy' and 'less healthy' foods.

As people chose to produce, purchase, prepare and consume foods rather than macro- or micronutrients (169,170), it is imperative that solution-orientated research investigating the price determinants of dietary intake focus on foods and dietary patterns rather than nutrients. In this

regard, the proposed development of food-based Global/Regional Foundation Diets will be an ambitious attempt to develop 'healthy' diet metrics that are standardized to some extent, but can be tailored to reflect locally available foods throughout the world.

Given the range of methodological challenges in assessing the price and affordability of 'healthy' and 'less healthy' foods and diets in different countries, and that logistics affecting implementation are likely to vary both between countries and within countries, it is imperative that all aspects of the proposed monitoring framework are developed and tested rigorously. The degree of variability of proposed indicators is largely unknown and targets cannot be set currently.

Conclusion

Robust indicators for monitoring the price and affordability of 'healthy' and 'less healthy' foods and diets are required to help inform national and international economic and fiscal policy responses to improve population diets and reduce obesity, NCDs and their related inequalities. INFORMAS provides a timely framework to embed a feasible food price and affordability monitoring programme within a broader research, monitoring and action support system. Such work is imperative to help address the global burden of obesity and NCDs.

Acknowledgements

Sarah Appleton, Wilma Waterlander and Amanda Wood contributed to discussions around the key concepts. The Rockefeller Foundation kindly supported the work of INFORMAS by hosting the first formal meeting of INFORMAS at the Rockefeller Foundation Bellagio Centre, Italy, from 19 to 23 November 2012. The following organizations provided funding support for the travel of participants to Italy for this meeting and the preparation of background research papers: The Rockefeller Foundation, International Obesity Taskforce, University of Auckland, Deakin University, The George Institute, University of Sydney, Queensland University of Technology, University of Oxford, University of Pennsylvania Perelman School of Medicine, World Cancer Research Fund International, University of Toronto and The Australian National University. The authors would like to thank Francesco Branca and Godfrey Xuereb from the World Health Organization, and Janice Albert from the Food and Agriculture Organization for their participation in the first formal meeting of INFORMAS, and for their input into this paper. The Faculty of Health at Deakin University kindly supported the costs for open access availability of this paper, and the Australian National Health and Medical Research Council Centre for Research Excellence in Obesity Policy and Food

Systems (APP1041020) supported the coordination and finalizing of INFORMAS manuscripts.

Conflicts of interest

Bruce Neal is the Chair of the Australian Division of World Action on Salt and Health (2007–present), was a Member of the Pepsico Global Scientific Advisory Board (2010–2012), was the Independent Adjudicator for the Australian Responsible Marketing to Children's Initiative (2009–2010) and holds funding from the Australian Food and Grocery Council as part of a National Health and Medical Research Council of Australia Partnership project (2010–2014). The other authors declare that they have no competing interests.

References

- Glanz K, Basil M, Maibach E, Goldberg J, Snyder D. Why Americans eat what they do: taste, nutrition, cost, convenience, and weight control concerns as influences on food consumption. *J Am Diet Assoc* 1998; **98**: 1118–1126.
- Turrell G, Hewitt B, Patterson C, Oldenburg B, Gould T. Socio-economic differences in food purchasing behaviour and suggested implications for diet-related health promotion. *J Hum Nutr Diet* 2002; **15**: 355–364.
- Darmon N, Drewnowski A. Does social class predict diet quality? *Am J Clin Nutr* 2008; **87**: 1107–1117.
- James WP, Nelson M, Ralph A, Leather S. Socioeconomic determinants of health. The contribution of nutrition to inequalities in health. *BMJ* 1997; **314**: 1545–1549.
- Martikainen P, Brunner E, Marmot M. Socioeconomic differences in dietary patterns among middle-aged men and women. *Soc Sci Med* 2003; **56**: 1397–1410.
- Beydoun MA, Wang Y. How do socio-economic status, perceived economic barriers and nutritional benefits affect quality of dietary intake among US adults? *Eur J Clin Nutr* 2008; **62**: 303–313.
- Evans A. *The Feeding of the Nine Billion: Global Food Security*. Chatham House: London, 2009.
- Andreyeva T, Long MW, Brownell KD. The impact of food prices on consumption: a systematic review of research on the price elasticity of demand for food. *Am J Public Health* 2010; **100**: 216–222.
- Committee on World Food Security. Price volatility and food security. High level panel of experts. Report 1. Rome. July 2011. Report No.
- Power EM. Determinants of healthy eating among low-income Canadians. *Can J Public Health* 2005; **96**(Suppl. 3): s37–s48.
- Ni Mhurchu C, Eyles H, Dixon R, Matoe L, Teeval T, Meagher-Lundberg P. Economic incentives to promote healthier food purchases: exploring acceptability and key factors for success. *Health Promot Int* 2012; **27**: 331–341.
- Steenhuis IH, Waterlander WE, de Mul A. Consumer food choices: the role of price and pricing strategies. *Public Health Nutr* 2011; **14**: 2220–2226.
- Hawkes C. Food taxes: what type of evidence is available to inform policy development? *Br Natl Found Nutr Bull* 2012; **37**: 51–56.
- Wall J, Ni Mhurchu C, Blakely T, Rodgers A, Wilton J. Effectiveness of monetary incentives in modifying dietary behavior: a review of randomized, controlled trials. *Nutr Rev* 2006; **64**: 518–531.
- Cash SB, Sunding DL, Zilberman D. Fat taxes and thin subsidies: prices, diets and health outcomes. *Acta Agric Scand C* 2005; **2**: 167–174.
- Sassi F, Cecchini M, Lauer J, Chisholm D. *Improving Life-styles, Tackling Obesity: The Health and Economic Impact of Prevention Strategies*. OECD Publishing: Paris, 2009. [WWW document]. URL <http://dx.doi.org/10.1787/220087432153> (accessed 30 June 2013).
- Jensen JD, Smed S. Cost-effective design of economic instruments in nutrition policy. *Int J Behav Nutr Phys Act* 2007; **4**: 10.
- Waterlander WE, Steenhuis IHM, de Boer MR, Schuit AJ, Seidel JC. The effects of a 25% discount on fruits and vegetables: results of a randomized trial in a three-dimensional web-based supermarket. *Int J Behav Nutr Phys Act* 2012; **9**: 9–11.
- Epstein LH, Jankowiak N, Nederkoorn C, Raynor HA, French SA, Finkelstein E. Experimental research on the relation between food price changes and food-purchasing patterns: a targeted review. *Am J Clin Nutr* 2012; **95**: 789–809.
- Eyles H, Ni Mhurchu C, Nghiem N, Blakely T. Association between food pricing strategies, population diets and non-communicable disease: a systematic review of simulation studies. *PLoS Med* 2012; **9**: e1001353.
- Brownell KD, Farley T, Willett WC *et al*. The public health and economic benefits of taxing sugar-sweetened beverages. *N Engl J Med* 2009; **361**: 1599–1605.
- Ni Mhurchu C, Blakely T, Jiang Y, Eyles H, Rogers A. Effects of price discounts and tailored nutrition education on supermarket purchases: a randomised controlled trial. *Am J Clin Nutr* 2010; **91**: 736–747.
- Waterlander WE, de Boer MR, Schuit AJ, Seidell JC, Steenhuis IH. Price discounts significantly enhance fruit and vegetable purchases when combined with nutrition education: a randomized controlled supermarket trial. *Am J Clin Nutr* 2013; **97**: 886–895.
- Drewnowski A, Darmon N. The economics of obesity: dietary energy density and energy cost. *Am J Clin Nutr* 2005; **82**(Suppl. 1): 265S–73S.
- Cade J, Upmeier H, Calvert C, Greenwood D. Costs of a healthy diet: analysis from the UK Women's Cohort Study. *Public Health Nutr* 1999; **2**: 505–512.
- Drewnowski A. Obesity and the food environment: dietary energy density and diet costs. *Am J Prev Med* 2004; **27**(Suppl. 1): 154–162.
- Andrieu E, Darmon N, Drewnowski A. Low-cost diets: more energy, fewer nutrients. *Eur J Clin Nutr* 2006; **60**: 434–436.
- Waterlander WE, de Haas WE, van Amstel I *et al*. Energy density, energy costs and income – how are they related? *Public Health Nutr* 2010; **13**: 1599–1608.
- Brinkman H-J, de Pee S, Sanogo I, Subran L, Bloem MW. High food prices and the global financial crisis have reduced access to nutritious food and worsened nutritional status and health. *J Nutr* 2010; **140**: 153S–61S.
- Lipsky LM. Are energy-dense foods really cheaper? Reexamining the relation between food price and energy density. *Am J Clin Nutr* 2009; **90**: 1397–1401.
- Burns C, Sacks G, Rayner M, Bilenkji G, Swinburn B. Correctly calculating the cost of food. *Nutr Rev* 2010; **68**: 182–185.

32. Carlson A, Frazao E. Are healthy foods really more expensive? Depends on how you measure the price. *Economic Information Bulletin*, May 2012. Report No. 96.
33. Darmon N, Briand A, Drewnowski A. Energy-dense diets are associated with lower diet costs: a community study of French adults. *Public Health Nutr* 2004; 7: 21–27.
34. Drewnowski A, Specter SE. Poverty and obesity: the role of energy density and energy costs. *Am J Clin Nutr* 2004; 79: 6–16.
35. Webb P. Medium- to long-run implications of high food prices for global nutrition. *J Nutr* 2010; 140: 143–147.
36. Swinburn BA, Caterson I, Seidell JC, James WP. Diet, nutrition and the prevention of excess weight gain and obesity. *Public Health Nutr* 2004; 7(1A): 123–146.
37. Swinburn B, Sacks G, Ravussin E. Increased food energy supply is more than sufficient to explain the US epidemic of obesity. *Am J Clin Nutr* 2009; 90: 1453–1456.
38. Schroder H, Marrugat J, Covas MI. High monetary costs of dietary patterns associated with lower body mass index: a population-based study. *Int J Obes* 2006; 30: 1574–1579.
39. Maillot M, Darmon N, Darmon M, Lafay L, Drewnowski A. Nutrient-dense food groups have high energy costs: and econometric approach to nutrient profiling. *J Nutr* 2007; 137: 1815.
40. Powell LM, Bao Y. Food prices, access to food outlets and child weight. *Econ Hum Biol* 2009; 7: 64–72.
41. Rehm CD, Monsivais P, Drewnowski A. The quality and monetary value of diets consumed by adults in the United States. *Am J Clin Nutr* 2011; 94: 1333–1339.
42. Vernarelli JA, Mitchell DA, Hartman TJ, Rolls BJ. Dietary energy density is associated with body weight status and vegetable intake in U.S. Children. *J Nutr* 2011; 141: 2204–2210.
43. Darmon N, Darmon M, Maillot M, Drewnowski A. A nutrient density standard for vegetables and fruits: nutrients per calorie and nutrients per unit cost. *J Am Diet Assoc* 2005; 105: 1881–1887.
44. Drewnowski A. The nutrient rich foods index helps to identify healthy, affordable foods. *Am J Clin Nutr* 2010; 91: 1095S–101S.
45. Sanogo I. Global food price crisis and household hunger: a review of recent food security assessments findings. 2009. [WWW document]. URL <http://www.odihpn.org/report.asp?id=2988> (accessed 12 June 2012).
46. Banerjee AV, Duflo E. What is middle class about the middle classes around the world? *J Econ Perspect* 2008; 22: 3–28.
47. Jacobs FT. The status of household food security targets in South Africa. *Agrekon* 2009; 48: 410–433.
48. Torlesse H, Kiess L, Bloem MW. Association of household rice expenditure with child nutritional status indicates a role for macroeconomic food policy in combating malnutrition. *J Nutr* 2003; 1320–1325.
49. Koumou G, Subran L, eds. Impact of high food prices on risk to food insecurity in Haiti. World Food Programme: Rome, 2008.
50. Darnton-Hill I, Cogill B. Maternal and young child nutrition adversity affected by external shocks such as increasing global food prices. *J Nutr* 2010; 140: 162–169.
51. Bloem MW, Semba RD, Kraemer K. Castel Gandolfo workshop: an introduction to the impact of climate change, the economic crisis, and the increase in the food prices on malnutrition. *J Nutr* 2010; 140: 132S–5S.
52. Jensen RT, Miller NH. *The Impact of the World Food Price Crisis on Nutrition in China*. Centre for International Development at Harvard University: Boston, MA, 2008.
53. The World Bank. Food Prices, Nutrition and the Millennium Development Goals, Global Monitoring Report. Washington: 2012.
54. Victora CG, Adair L, Fall C *et al.* Maternal and child undernutrition: consequences for adult health and human capital. *Lancet* 2008; 371: 340–357.
55. Klotz C, de Pee S, Thorne-Lyman A, Kraemer K, Bloem MW. Nutrition in the perfect storm: why micronutrient malnutrition will be a widespread health consequence of high food prices. *Sight Life Mag* 2008; 2: 6–13.
56. Food and Agriculture Organization (FAO) of the United Nations. The state of food insecurity in the world. Food and Agriculture Organization (FAO): Rome, 2008.
57. Bernstein AM, Bloom DE, Rosner BA, Franz M, Willet WC. Relation of food cost to healthfulness of diet among US women. *Am J Clin Nutr* 2010; 92: 1197–1203.
58. Monsivais P, Aggarwal A, Drewnowski A. Following federal guidelines to increase nutrient consumption may lead to higher food costs for consumers. 2011. [WWW document]. URL <http://content.healthaffairs.org/content/30/8/1471.full> (accessed 20 June 2012).
59. Kettings C, Sinclair AJ, Voevodin M. A healthy diet consistent with Australian health recommendations is too expensive for welfare dependent families. *Aust N Z J Public Health* 2009; 33: 566–572.
60. Williams P. Monitoring the affordability of healthy eating: a case study of 10 years of the Illawarra Healthy Food Basket. *Nutrients* 2010; 2: 1132–1140.
61. Wong KC, Coveney J, Ward P *et al.* Availability, affordability and quality of a healthy food basket in Adelaide, South Australia. *Nutr Diet* 2011; 68: 8–14.
62. Jetter K, Cassady D. The availability and cost of healthier food alternatives. *Am J Prev Med* 2006; 30: 38–44.
63. Beaglehole R, Bonita R, Horton R *et al.* Priority actions for the non-communicable disease crisis. *Lancet* 2011; 377: 1438–1447.
64. Powell LM, Chaloupka FJ. Food prices and obesity: evidence and policy implications for taxes and subsidies. *Milbank Q* 2009; 87: 229–257.
65. Stafford N. Denmark cancels ‘fat tax’ and shelves ‘sugar tax’ because of threat of job losses. *BMJ* 2012; 345: e7889.
66. Thow AM, Quesada C, Juventin L, Kun R, Khan AN, Swinburn B. Taxing soft drinks in the Pacific: implementation lessons for improving health. *Health Promot Int* 2011; 26: 55–64.
67. Villanueva T. European nations launch tax attack on unhealthy foods. *Can Med Assoc J* 2011; 183: 109–403.
68. Mytton OT, Clarke D, Rayner M. Taxing unhealthy food and drinks to improve health. *BMJ* 2012; 344: e2931.
69. Dinour LM, Bergen D, Yeh M-C. The food insecurity – obesity paradox: a review of the literature and the role that food stamps may play. *J Am Diet Assoc* 2007; 107: 1952–1961.
70. United States Department of Agriculture. A short history of SNAP. United States Department of Agriculture; 2012. [WWW document]. URL <http://www.fns.usda.gov/snap/rules/Legislation/about.htm> (accessed 15 October 2012).
71. National Health Services. Healthy Start, United Kingdom. 2012. [WWW document]. URL <http://www.healthystart.nhs.uk/> (accessed 12 October 2012).
72. Black AP, Brimbelcombe J, Eyles H, Morris P, Vally H, O’Dea K. Food subsidy programs and the health and nutritional status of disadvantaged families in high income countries: a systematic review. *BMC Public Health* 2012; 12: 1099.
73. Capacci S, Mazzocchi M, Shankar B, eds. The regional price of junk foods relative to healthy foods in the UK: indirect estimation of a time series, 1997–2009. 86th Annual Conference of the Agricultural Economics Society, University of Warwick, UK, 16–18 April 2012.

74. Kim CI, Lee Y, Kim BH, Lee HS, Jang YA. Development of supplemental nutrition care programs for women, infants and children in Korea: NutriPlus (+). *Nutr Res Pract* 2009; 3: 171–179.
75. Webber D, Balsam A, Oehlke B. The Massachusetts Farmers' Market coupon program for low income elders. *Am J Health Promot* 1995; 9: 251–253.
76. International Monetary Fund. Data and statistics. 2012 [WWW document]. URL <http://www.imf.org/external/data.htm>; <http://www.indexmundi.com/commodities/?commodity=food-price-index&months=300> (accessed 22 August 2012).
77. World Health Organization. 2008–2013 action plan for the global strategy for the prevention and control of non-communicable diseases. World Health Organization: Geneva, 2008. [WWW document]. URL http://whqlibdoc.who.int/publications/2009/9789241597418_eng.pdf (accessed 12 October 2012).
78. Cecchini M, Sassi F, Lauer JA, Lee YY, Guarjardo-Barron V, Chisholm D. Tackling of unhealthy diets, physical inactivity, and obesity: health effects and cost-effectiveness. *Lancet* 2012; 376: 1775–1784.
79. Institute of Medicine. *Local Government Actions to Prevent Childhood Obesity*. National Academies Press: Washington, DC, 2009.
80. Swinburn B, Sacks G, Vandevijvere S *et al*. International Network for Food and Obesity/non-communicable diseases Research, Monitoring and Action Support (INFORMAS): overview and key principles. *Obes Rev* 2013; 14 (Suppl. 1): 1–12.
81. National Health and Medical Research Council. A modelling system to inform the revision of the Australian Guide to Healthy Eating. National Health and Medical Research Council: Canberra, 2011. [WWW document]. URL http://www.eatforhealth.gov.au/sites/default/files/files/the_guidelines/n55c_dietary_guidelines_food_modelling.pdf (accessed 23 March 2013).
82. Food and Agriculture Organization (FAO). Trade reforms and food security – conceptualising the linkages: Food and Agriculture Organization (FAO); 2002. [WWW document]. URL <http://www.fao.org/docrep/005/y4671e/y4671e06.htm> (accessed 20 June 2012).
83. Organisation for Economic Co-operation and Development and Food and Agricultural Organization (OECD/FAO), ed. *Agricultural Outlook, 2008–2017*; 2008; Organisation for Economic Co-operation and Development and Food and Agricultural Organization (OECD/FAO): Paris.
84. The World Bank. Prospects: Commodity markets. 2012. [WWW document]. URL <http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTDECPROSPECTS/0,contentMDK:21574907~menuPK:7859231~pagePK:64165401~piPK:64165026~theSitePK:476883,00.html> (accessed 20 August 2012).
85. Food and Agriculture Organization (FAO)/Food Insecurity and Vulnerability Information and Mapping Systems (FIVIMS). FAO/FIVIMS framework: linkages between the overall development context, the food economy, households and individual measures of well-being. Food and Agriculture Organisation (FAO)/Food Insecurity and Vulnerability Information and Mapping Systems (FIVIMS), 2008.
86. Food and Agriculture Organization (FAO)/Food Insecurity and Vulnerability Information and Mapping Systems (FIVIMS). Food and Agriculture Organization of the United Nations (FAO) Making FIVIMS work for you: tools and tips; Rome: Food and Agriculture Organization (FAO)/Food Insecurity and Vulnerability Information and Mapping Systems (FIVIMS); 2002. 1–29.
87. Food and Agriculture Organization (FAO). FAO Food Price Index: Food and Agriculture Organization (FAO); 2012. [WWW document]. URL <http://www.fao.org/worldfoodsituation/wfs-home/foodpricesindex/en/>; <http://www.fao.org/giews/pricetool2/> (accessed 22 October 2012).
88. The World Bank. The World Bank Food Price Watch – August 2012. 2012. [WWW document]. URL <http://siteresources.worldbank.org/EXTPOVERTY/Resources/336991-1311966520397/Food-Price-Watch-August-2012.htm> (accessed 12 October 2012).
89. World Food Program. The market monitor – trends and impacts of staple food prices in vulnerable countries, issue 15. 2012. [WWW document]. URL <http://www.wfp.org/content/market-monitor> (accessed 20 June 2012).
90. World Food Program. VAM Food and Commodity Prices Data Store. 2012. [WWW document]. URL <http://foodprices.vam.wfp.org/> (accessed 12 June 2012).
91. Committee on World Food Security. Food Security and Nutrition Actions Mapping in support of the Committee on World Food Security (CFS). 2011. [WWW document]. URL http://www.fao.org/fileadmin/templates/cfs/Doc1011/Mapping/CFS_Food_Security_and_Nutrition_Actions_Mapping_Review_Final.pdf (accessed 24 June 2012).
92. United Nations World Food Programme, ed. *World Hunger Series: hunger and markets Earthscan*, United Nations World Food Programme; 2009; London.
93. Carlson A, Lino M, Juan WY *et al*. Development of the CNPP prices database: US Department of Agriculture, Centre for Nutrition Policy and Promotion and Economic Research Services; 2008. [WWW document]. URL <http://www.cnpp.usda.gov/Publicaitons/FoodPland/MiscPubs/PricesDatabaseReport> (accessed 20 June 2012).
94. European Commission. A European food prices monitoring tool, a first design. European Commission, Eurostat: Luxembourg, 2009.
95. European Commission. Consumer prices research. An experimental analysis into the measurement of indicative price levels for consumer products, third pilot. European Commission, Eurostat: Luxembourg, 2011.
96. Statistics New Zealand. Food Price Index Information Releases. 2012. [WWW document]. URL http://www.stats.govt.nz/browse_for_stats/economic_indicators/prices_indexes/food-price-index-info-releases.aspx (accessed 2 October 2012).
97. The National Agricultural Marketing Council (NAMCSA) of South Africa. Food Price Monitoring. 2012. [WWW document]. URL <http://www.namc.co.za/dnn/PublishedReports/FoodPriceMonitoring.aspx> (accessed 19 September 2012).
98. Food and Agriculture Organization (FAO) STAT. Consumer Price Index and Consumer Price Index (Food): Food and Agriculture Organization (FAO); 2012. [WWW document]. URL <http://faostat.fao.org/site/683/default.aspx#ancor> (accessed 15 October 2012).
99. The Economic Commission for Latin America. Consumer Price Index and Consumer Price Indices food and drink. 2012. [WWW document]. URL <http://www.websie.eclac.cl/sisgen/ConsultaIntegrada.asp?idAplicacion=6&cidTema=357&idioma=i> (accessed 15 October 2012).
100. Hausman J, Leibtag E. CPI bias from supercentres: does the BLS know that walmart exists? Diewert WE, Greenless JS, Hulthen CR (eds). *Price Index Concepts and Measurement*. University of Chicago Press: Chicago, IL, 2009, pp. 203–231.
101. Kuchler F, Stewart H. Price trends are similar for fruit, vegetables and snack food: Economic Research Service US Department of Agriculture. 2012. [WWW document]. URL <http://www.ers.usda.gov/publications/err55.pdf> (accessed 20 June 2012).

102. Burns C, Sacks G, Gold L. Longitudinal study of consumer price index (CPI) trends in core and non-core foods in Australia. *Aust N Z Public Health* 2008; **32**: 450–453.
103. Harrison M, Lee AJ, Findlay M, Nicholls R, Leonard D, Martin C. The increasing cost of healthy food. *Aust N Z J Public Health* 2010; **34**: 179–186.
104. The World Bank. Poverty lines. 2012. [WWW document]. URL http://siteresources.worldbank.org/PGLP/Resources/povertymanual_ch3.pdf (accessed 20 June 2012).
105. Ashenfelter OC. Comparing real wages, NBER working paper 18006 [Working Paper]. National Bureau of Economic Research: Cambridge, MA, 2012. [WWW document]. URL http://www.nber.org/papers/w18006.pdf?new_window=1 (accessed 19 June 2012).
106. Clements KW, Lan Y, Seah SP. The Big Mac Index two decades on: an evaluation of burgeronomics. *Int J Finance Econ* 2012; **17**: 31–60.
107. European Commission. Purchasing power parities (PPPs). European Commission, Eurostat: Luxembourg, 2012. [WWW document]. URL http://epp.eurostat.ec.europa.eu/portal/page/portal/purchasing_power_parities/introduction (accessed 19 June 2012).
108. European Commission. Purchasing power parities (PPPs) publications, news releases. European Commission, Eurostat: Luxembourg, 2012. [WWW document]. URL http://epp.eurostat.ec.europa.eu/portal/page/portal/purchasing_power_parities/publications/news_releases (accessed 19 June 2012).
109. Health Canada. National nutritious food basket. 2012. [WWW document]. URL <http://www.hc-sc.gc.ca/fn-an/surveill/basket-panier/index-eng.php> (accessed 25 June 2012).
110. University of Otago. Food Cost Survey 2012. 2012. [WWW document]. URL <http://nutrition.otago.ac.nz/consultancy/foodcostsurvey> (accessed 20 October 2012).
111. Lee A, Darcy A, Leonard D *et al.* Food availability, cost disparity and improvement in relation to accessibility and remoteness in Queensland. *Aust N Z J Public Health* 2002; **26**: 266–272.
112. Ward PR, Coveney J, Verity F, Carter P, Schilling M. Cost and affordability of healthy food in rural South Australia. 2012. [WWW document]. URL http://www.rrh.org.au/publishedarticles/article_print_1938.pdf (accessed 20 October 2012).
113. Williams P. Can Nova Scotians afford to eat healthy? Report on 2010 participatory food costing. 2010. [WWW document]. URL http://www.feednovascotia.ca/images/2010Food_Costing_Report.pdf (accessed 20 October 2012).
114. Williams P, James Y, Kwan J. The Illawarra Healthy Food Price Index. 2. Pricing methods and index trends from 2000–2003. *Nutr Diet* 2004; **61**: 208–214.
115. Williams P, Hull A, Kontos M. Trends in the affordability of the Illawarra Healthy Food Basket 2000–2007. *Nutr Diet* 2009; **66**: 27–32.
116. Palermo CE, Walker CZ, Hill P, McDonald J. The cost of healthy food in rural Victoria. *Remote Rural Health* 2008; **8**: 1074.
117. Renzaho AMN. Is a healthy diet affordable and accessible in the city of Yarra, Victoria-Australia? An analysis of cost disparity and nutritional choices. *Ecol Food Nutr* 2008; **47**: 44–63.
118. Bowyer S, Caraher M, Eilbert K, Carr-Hill R. Shopping for food: lessons from a London borough. *Br Food J* 2009; **111**: 452–474.
119. Socha T, Chambers L, Zahaf M, Abraham R, Fiddler T. Food availability, food store management, and food pricing in a northern community first nation community. *Int J Hum Soc Sci* 2011; **1**: 49–61.
120. Northern Territory Department of Health and Community Services. Market Basket Surveys. 2011. [WWW document]. URL <http://digitalibrary.health.nt.gov.au/dspace/simple-search?query=%22market+Basket%22> (accessed 20 October 2012).
121. Owusu-Sekyere BN. Baseline monitoring system report for Butha-buthe district (a draft unedited work). 2008. [WWW document]. URL http://thembosdev.com/butha-buthe_baseline_selection_2008.pdf (accessed 20 October 2012).
122. Landrigan T, Pollard C. Food access and cost survey. Western Australia. 2010. [WWW document]. URL <http://www.public.health.wa.gov.au/cproot/4115/2/Food%20Access%20and%20Costs%20Survey%202010.pdf> (accessed 20 October 2012).
123. Darmon N, Ferguson EL, Briend A. A cost constraint alone has adverse effects on food selection and nutrient density: an analysis of human diets by linear programming. *J Nutr* 2002; **92**: 1761–1767.
124. Darmon N, Ferguson EL, Briend A. Impact of a cost constraint on nutritionally adequate food choices for French women: an analysis by linear programming. *J Nutr Educ Behav* 2006; **38**: 82–90.
125. Nelson M, Peplow K. Construction of a modest-but-adequate food budget for households with two adults and one pre-school child: a preliminary investigation. *J Hum Nutr Diet* 1990; **3**: 121–140.
126. Barratt J. The cost and availability of healthy food choices in southern Derbyshire. *J Hum Nutr Diet* 1997; **10**: 63–69.
127. Cohen B. Community food security assessment toolkit. 2002. [WWW document]. URL <http://www.fpcanecounty.org/wp-content/uploads/2012/07/usdafoodassessToolkit.pdf> (accessed 20 October 2012).
128. Friel S, Walsh O, McCarthy D. The financial cost of healthy eating in Ireland. 2004, Combat Poverty Agency Working Paper 04/01, October 2004.
129. Wiesmann D, Bassett L, Benson T, Hoddinott J. Validation of the World Food Programme's Consumption Score and alternative indicators of household food security. 2009, International Food Policy Research Institute (IFPRI).
130. Dawson J, Marshall D, Taylor M, Cummins S, Sparks L, Anderson A. Accessing healthy food: availability and price of a healthy food basket in Scotland. *J Mark Manag* 2008; **24**: 9–10, 893–913.
131. Stewart H, Dong D. Variation in retail costs for fresh vegetables and salty snacks across communities in the United States. *Food Policy* 2011; **36**: 128–135.
132. Todd JE, Leibtag E, Penberthy C. Geographic differences in the relative price of healthy foods. U.S. Department of Agriculture, Economic Research Service: Washington, DC, 2011. [WWW document]. URL <http://www.ers.usda.gov/Publications/EIB78/EIB78.pdf> (accessed 20 October 2012).
133. Friel S, Walsh O, McCarthy D. The irony of a rich country: issues of financial access to and availability of healthy food in the Republic of Ireland. *J Epidemiol Community Health* 2006; **60**: 1013–1019.
134. Sooman A, Macintyre S, Anderson A. Scotland's health – a more difficult challenge for some? The price and availability of healthy foods in socially contrasting localities in the West of Scotland Health Bull (Edinb). *Health Bull (Edinb)* 1993; **51**: 276–284.
135. Cummins S, Macintyre S. A systematic study of an urban foodscape: the price and availability of food in Greater Glasgow. *Urban Stud* 2002; **39**: 2115–2130.
136. Ling N. A comparison of prices for 'healthy' and 'less healthy' food baskets in contrasting neighbourhoods. 2005. [WWW document]. URL <http://www.nutrition.otago.ac.nz/>

- _data/assets/file/0017/1727/DTP_NLing.pdf (accessed 20 October 2012).
137. Ni Mhurchu C, Ogra S. The price of healthy eating: cost and nutrient value of selected regular and healthier supermarket foods in New Zealand. *N Z Med J* 2007; **120**: 1248.
 138. Anderson AS, Dewar J, Marshall D *et al*. The development of a healthy eating indicator shopping basket tool (HEISB) for use in food access studies-identification of key food items. *Public Health Nutr* 2007; **10**: 1440–1447.
 139. Temple NJ, Steyn NP, Fourie J, De Villiers A. Price and availability of healthy food: a study in rural South Africa. *Nutrition* 2011; **27**: 55–58.
 140. Monsivais P, McLain J, Drewnowski A. The rising disparity in the price of healthful foods: 2004–2008. *Food Policy* 2010; **35**: 514–520.
 141. Mooney C. Cost and availability of healthy food choices in a London health district. *J Hum Nutr Diet* 1990; **3**: 111–120.
 142. Ricciuto L, Lin K, Tarasuk V. A comparison of the fat composition and prices of margarines between 2002 and 2006, when Canadian labelling regulations came into effect. *Public Health Nutr* 2009; **12**: 1270–1275.
 143. Christian T, Rashad I. Trends in US food prices, 1950–2007. *Econ Hum Biol* 2009; **7**: 113–120.
 144. Monsivais P, Drewnowski A. The rising cost of low-energy-density foods. *J Am Diet Assoc* 2007; **107**: 2071–2076.
 145. NCH (formerly National Children's Home). Going hungry: the struggle to eat healthily on a low income. NCH: London, 2004.
 146. Hawkes C. Defining 'healthy' and 'unhealthy' foods: an international review. Office of Nutrition Policy and Promotion, Health Canada:Canada, 2009. [WWW document]. URL http://www.aboutmen.ca/application/www.aboutmen.ca/asset/upload/tiny_mce/page/link/Defining-Healthy-and-Unhealthy-full-report.pdf (accessed 21 October 2012).
 147. Davis GC, You W. Not enough money or not enough time to satisfy the Thrifty Food Plan? A cost difference approach for estimation a money-time threshold. *Food Policy* 2011; **36**: 101–107.
 148. Torzillo PJ, Pholeros P, Rainow S *et al*. The state of health hardware in Aboriginal communities in rural and remote Australia. *Aust N Z J Public Health* 2008; **32**: 7–11.
 149. Engler-Stringer R. Food, cooking skills and health: a literature review. *Can J Diet Pract Res* 2010; **71**: 141–145.
 150. Caraher M, Dowler E. Food projects in London: lessons for policy and practice – a hidden sector and the need for 'more unhealthy puddings ... sometimes'. *Health Educ J* 2007; **66**: 188–205.
 151. Cassady D, Jetter KM, Culp J. Is price a barrier to eating more fruits and vegetables for low-income families? *J Am Diet Assoc* 2007; **107**: 1909–1915.
 152. Organization for Economic Co-operation and Development. Society at a Glance 2011 – OECD Social Indicators. Median Household Income: Organization for Economic Co-operation and Development; 2011. [WWW document]. URL <http://www.oecd.org/els/socialpoliciesanddata/societyataglance2011-oecd-social-indicators.htm> (accessed 20 October 2012).
 153. Luxembourg Income Study. Disposable household income. 2012. [WWW document]. URL <http://www.lisdatacenter.org/wp-content/uploads/data-key-inequality-dhi.pdf> (accessed 20 October 2012).
 154. European Commission. Household budget surveys, 2005: European Commission; 2005. [WWW document]. URL http://www.epp.eurostat.ec.europa.eu/cache/ITY_Public/3-19062008-AP/EN/3-19062008-AP-EN.PDF (accessed 21 October 2012).
 155. The World Bank. Household expenditure and income data for transitional economies (HEIDE). 2012. [WWW document]. URL <http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/0,contentMDK:20346891~pagePK:64214825~piPK:64214943~theSitePK:469382,00.html> (accessed 12 October 2012).
 156. Atkinson AB, Brandolini A. Promise and pitfalls in the use of 'secondary' data-sets: income inequality in OECD countries as a case study. *J Econ Lit* 2001; **39**: 771–799.
 157. Neal B, Sacks G, Swinburn B *et al*. Monitoring the levels of important nutrients in the food supply. *Obes Rev* 2013; **14** (Suppl. 1): 49–58.
 158. Rayner M, Wood AT, Lawrence M *et al*. Monitoring the health-related labelling of foods and non-alcoholic beverages in retail settings. *Obes Rev* 2013; **14** (Suppl. 1): 70–81.
 159. Kantar World Panel. 2013. [WWW document]. URL <http://www.kantarworldpanel.com/> (accessed 30 June 2013).
 160. Seal J. Monitoring the price and availability of healthy food-time for a national approach? *Nutr Diet* 2004; **61**: 197–198.
 161. Glanz K, Sallis JF, Saelens BE, Frank LD. Nutrition Environment Measures Survey in Stores (NEMS-S): development and evaluation. *Am J Prev Med* 2007; **32**: 282–289.
 162. White M. Food access and obesity. *Obes Rev* 2007; **8**: 99–107.
 163. Swinburn B. Obesity: why governments must act. *World Nutr* 2012; **3**: 307–325.
 164. Department of Health (DoH). The food and health action plan. Food and health problems: analysis for comment. London: 2003.
 165. Scottish Executive. Eating for health: meeting the challenge. Scottish Executive: Edinburgh, 2004.
 166. Drewnowski A, Fulgoni V. Nutrient Profiling of foods: creating a nutrient-rich food index. *Nutr Rev* 2008; **66**: 23–39.
 167. Lobstein T, Davies S. Defining and labelling 'healthy' and 'unhealthy' food. *Public Health Nutr* 2009; **12**: 331–340.
 168. Garsetti M, de Vries J, Smith M, Amosse A, Rolf-Pedersen N. Nutrient profiling schemes: overview and comparative analysis. *Eur J Nutr* 2007; **46**(Suppl. 1): 15–28.
 169. Jacobs DR Jr, Tapsell LC. Food, not nutrients, is the fundamental unit in nutrition. *Nutr Rev* 2007; **65**: 439–450.
 170. Mozaffarian D, Ludwig DS. Dietary guidelines in the 21st century – a time for food. *JAMA* 2010; **304**: 681–682.