Measuring the cost and affordability of healthier and less healthy foods, meals and diets

Sally Dorothy Mackay

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ABSTRACT

Aim

Cost is a major determinant of food purchases. The central question for this PhD is whether healthy eating costs more than less healthy eating. Monitoring the cost of foods, meals and diets is important to provide evidence to inform policies. Each approach needs standardised methodologies to ensure fair comparisons over time, and between countries.

Method

Standardised methods were developed and piloted to measure the relative costs of healthier and less healthy foods, meals and diets using commonly consumed foods and locally collected prices. The use of different data sources and methodological approaches was explored to assess the impact on cost.

Results

The foods approach measured the price of foods over time using the WHO Europe nutrient profile model and the NOVA classification (degree of processing), and compared the cost of pairs of healthier and less healthy foods. The meals approach compared the cost of popular takeaway meals with healthier home-cooked meals, incorporating the cost of preparation or waiting time. The diet approach compared the cost of a healthy and a current diet.

Healthier and less healthy foods, and minimally processed, processed and ultra-processed foods all increased in price at a similar rate over ten years. The healthier items of a pair tended to cost the same as, or more than, the less healthy counterpart. Healthier home-made and home-assembled meals were less expensive than their takeaway counterparts. When time was included, home-assembled meals were the cheapest option and half the home-made meals were at least as expensive as the takeaway meals. The healthy and current diets were similar in price when only the current diet contained alcohol and takeaways, and the energy requirement of the diets was to maintain the recommended BMI for an active person (healthy diet) or maintain the current BMI at current activity levels. Altering aspects of diet, including or excluding takeaways, and generic labels, and altering the energy requirements had considerable impacts on cost.

Conclusion

This thesis developed novel methods to provide a simple, standardised approach to monitor the price of healthier and less healthy foods, meals and diets enabling comparisons over time, and between countries.

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PUBLICATIONS AND CONFERENCE PRESENTATIONS

Publications

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ABBREVIATIONS

ASAP	Healthy Diets 'ASAP' Australian Standardised Diet Affordability and Pricing method
BMI	Body mass index
CDC	Centers for Disease Control and Prevention, US
CPI	Consumer Price Index
FAO	Food and Agriculture Organization
FFQ	Food frequency questionnaire
FPI	Food Price Index
g	Grams
GST	Goods and Services Tax
HES	Household Economic Survey
HFAB	Queensland Healthy Food Access Basket
INFORMAS	International Network for Food and Obesity/non-communicable diseases Research Monitoring and Action Support
kcal	Kilocalorie
kg	Kilogram
kJ	Kilojoule
MET	Metabolic equivalent
MJ	Megajoule
NCDs	Non-communicable diseases
NHANES	United States National Health and Nutrition Examination Survey
NZ	New Zealand
NZANS	New Zealand Adult Nutrition Survey
NZCNS	New Zealand Child Nutrition Survey
NZDep2013	New Zealand Index of Deprivation 2013
OECD	Organisation for Economic Co-operation and Development
PAL	Physical Activity Level
TFP	Thrifty Food Plan
UK	United Kingdom
US	United States
WHO	World Health Organisation
USDA	United States Department of Agriculture

GLOSSARY

Affordability of diet	The cost of the diet as a percentage of household income.
Branded product	A label with a brand available across a range of stores.
Commonly consumed foods	Foods and beverages that are either consumed by more of the population than other foods.
Consumer Price Index	A measure of the cost of purchasing a fixed basket of consumer goods and services, including foods, of constant quality and similar characteristics[(1)].
Core foods	Foods that form the basis of a healthy diet[(2)].
Current diet	The foods and beverages that reflect the usual diet of the reference household for the current intake of foods, food groups, energy, macronutrients, fibre and sodium.
Degree of processing	A framework that classifies foods and diets according to 'the nature, purpose and extent of industrial food processing rather than in terms of nutrients and food types'[(3)].
Diet (optimal) approach	Measures the relative affordability of a healthy and the current diet over time.
Discretionary foods	Foods and drinks not necessary to provide the nutrients the body needs, but that may add variety, however many are high in saturated fats, sugars, salt and/or alcohol, and are energy dense. They can be included sometimes in small amounts by those who are physically active, but are not a necessary part of the diet[(2)].
Disposable household income	The income from wages and salary, welfare assistance, social insurance, self-employment, property, investment, available to a household after deduction of income tax and transfers[(4-6)].
Edible weight	The weight of a food that is edible, so does not include inedible skins, seeds, shells, bones, outer leaves etc.
Equivalised household income	Adjustment made to household income according to household size to account for economies of scale of larger households and indicate the economic resources available to each individual[(4)].
Food	The term 'food' is used to indicate foods and beverages.
Food-based dietary guidelines	Sets of advisory statements that give dietary advice for the population in order to promote overall nutritional well-being and to address all diet-related conditions[(7)].
Food Price Index	A measure of the cost of purchasing a fixed basket of food and beverages[(8)].
Foods (minimal) approach	Measures the change in price of healthier and less healthy foods over time.

FoodWorks	Dietary assessment computer program.
Generic label	A label unique to a supermarket chain. Also known as a home brand or private label.
Healthy diet	The foods and beverages consumed by the reference household that meet energy requirements, selected nutrient reference values and recommended consumption of key food groups.
Home-assembled meal	A meal that utilises pre-prepared items and ingredients that need to be assembled and heated or cooked at home.
Home-cooked meal	A meal prepared, assembled and cooked at home using no or few pre-prepared items.
Household economic survey	A national survey of the goods and services purchased and brought into the household. The survey may include household income.
Income support	Direct assistance from the state for living expenses.
Linear optimisation	A dietary modelling approach to developing diets where the outcome is optimised using a linear mathematical model based on a set of constraints related to nutrients and the amount of a food or food group consumed(9).
Meals	A main dish with a serving from two food groups or more with a meat, poultry, seafood, egg or alternative; grain or starchy vegetables; and non-starchy vegetable component.
Meals (expanded) approach	Measures the price differential between takeaway meals and their healthier home-cooked counterparts over time.
Meat and alternatives	Meat, poultry, seafood, eggs, legumes, nuts and seeds.
Minimally processed	Minimally processed foods have undergone minimal processing and have no added oils, fats, sugar, salt or other substances(10).
National food consumption survey	A national survey of food consumption of individuals or households. Also called a national nutrition survey.
Nutrient reference values	A system of reference values to identify the average requirements for nutrients needed by individuals or groups(11).
NZDep2013	NZDep2013 combines nine variables from the 2013 census which reflect eight dimensions of deprivation. This provides a deprivation score for each meshblock(12).
Pairs' component	Part of the minimal approach where the price of two complementary items is compared, where one item is healthier than the other.
Price metric	The calculation used to assess the price of a food or overall diet. Price per 100 grams Price per serving (grams) Price per kJ

Processed	Products manufactured by industry from natural or minimally processed foods with the addition of salt, sugar, oil etc[10].
Protocol	Standardised data collection and analysis guidelines for INFORMAS modules.
Reference household	The INFORMAS reference household has 2 adults (45-year woman, 45-year man) and 2 children (14-year boy, 7-year girl).
Takeaway meal/Fast food meal	Meals without wait service, obtained quickly, purchased in self-serve or carry-out venues.
Shopping list	The foods for which prices need to be collected for each approach.
Ultra-processed	Industrial formulations made from substances extracted from foods, food constituents or synthesised from food substrates[10].
Yield factor	A factor applied to a food to allow for weight changes during cooking due to changes in the water or fat content of the food.

1 INTRODUCTION

The rapid increase in obesity and diet-related non-communicable diseases (NCDs) is mainly driven by unhealthy diets which are now the major preventable risk factor contributing to the burden of disease globally[(13,14)]. The increasingly obesogenic food environment contributes to unhealthy diets[(15)]. The World Health Organization (WHO) adopted a global action plan for the prevention and control of NCDs from 2013-2020[(16)]. Recommended policy actions to increase the availability and affordability of healthier foods include developing guidelines, recommendations or policy measures that engage relevant sectors such as the food industry, food-service and retailers as well as consumers.

The focus of the WHO NCD monitoring framework is health outcomes, risk factors (including obesity) and national system responses[(17)]. Only two of the 25 indicators are related to food environments. Consequently, there is a need to complement the WHO monitoring framework with a comprehensive system for monitoring and benchmarking key aspects of food environments and policies that impact on the healthiness of population diets.

INFORMAS (The International Network for Food and Obesity/NCDs Research, Monitoring and Action Support) is a global network of researchers and public interest organisations initiated in 2013[(18)] i. INFORMAS aims to monitor, benchmark and compare the characteristics of food environments and policies globally, including food prices[(19)], that impact on the healthiness of diets. It provides a mechanism to hold governments and the private sector accountable if actions are not taken or are insufficient[(20)]. Society establishes the cultural norms for foods and dietary habits, which can influence the value placed on diets and certain foods. Dietary patterns are influenced by the interaction between individual factors (e.g., food preferences and habits) and food environments[(18)].

Price is one of the most important considerations when purchasing household food[(21,22)]. The relative price of food is important, especially for those on lower incomes. Therefore, food prices are important determinants of health and household food security[(23)] to ensure people have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences[(24)]. There is a call for economic and fiscal policies to promote the consumption of healthier food[(25)], improve the nutritional quality of diets and raise revenue from taxes to fund population health programmes[(16)].

INFORMAS monitoring activities aim to stimulate policy change and actions to improve food environments[(18)]. Monitoring the relative difference in price and affordability of healthier and less healthy foods and diets could be a powerful mechanism to provide data to influence social and fiscal policy. Affordability of food can be improved through increased income, or by changing the cost of healthy food[(26-35)]. Monitoring is particularly important to understand the impact of fiscal policies to promote the consumption of healthier foods[(16)]. The influence of taxes, subsidies and tariffs can be examined, including unexpected shifts in price or consumption of other foods[(31,36-38)].

NOURISHING[(39)] is a framework for reporting, categorising and monitoring policy actions around the world. A need was identified to improve the availability, affordability and acceptability of healthy diets and vice versa for less healthy diets. One policy area under NOURISHING is to 'use economic tools to address food affordability and purchase interventions'.

Costing healthy foods and diets is a tool used in many countries for a range of purposes, though the comparison to the cost of less healthy foods and diets is an under-developed monitoring tool. In some countries the cost of a healthy food basket is routinely used to monitor food security and observe changes in affordability for different income and household groups(27,31,40-43). For example, the Ontario Ministry of Health mandated that food affordability should be monitored using the Nutritious Food Basket Protocol(44). In addition, the availability and quality of healthy foods in different locations or geographic regions can be monitored(42,44,45).

The variation in methods used to define and select healthier foods or diets and their less healthy counterparts, and calculate the relative price differential, has resulted in varying outcomes(46). Some researchers use linear optimisation (dietary modelling based on a set of constraints for nutrients and foods) to define diets that meet nutrition recommendations for minimum cost(47) while others restrict food selection to key food groups such as fruit and vegetables(48-50), or fast food(49,51). Many attempt to define diets based on objective nutritional criteria, some diets include less healthy or treat foods(41,52) while others exclude these foods(28,53). Others define diets based on data about normal food purchasing patterns, combined with recommendations about healthy eating, to make the diets realistic(54,55). There is no standard approach for pricing diets and using current diets as a comparator with a healthy diet(19), a standardised methodology would allow comparisons over time and between locations.

The initial focus of INFORMAS was the development of foundation papers for each module to guide development of protocols(18). The INFORMAS food prices foundation paper offers a framework to examine the price differential of healthier and less healthy foods, meals and diets and the affordability of diets(19) to answer 'What is the relative price and affordability of 'less healthy' compared with 'healthier' foods, meals and diets?'. The foundation paper (19) states that 'food prices and food affordability are important determinants of food choices, obesity and non-communicable diseases' and 'affects food security at all levels'. Robust data and benchmarks on the relative price and affordability of foods, with a particular focus on the difference between current and healthy foods and diets, will inform economic and fiscal policy responses of government to the promotion of healthier foods(19).

Currently, the cost of a healthy diet compared with the cost of a current, less healthy diet is not routinely monitored. More commonly, only the cost of a healthy diet is priced and monitored over time(19). The results from studies looking at the cost differential between 'healthy' and 'less healthy' diets are mixed. A systematic review concluded that healthy diets cost more than less healthy diets, though this depends on whether the cost of the total diet or cost per 2000kcal is compared(56). Varying methodology leads to varying results(46), so a standardised methodology will allow valid comparisons over time and between locations.

Three differing price metrics can be used when measuring the cost of foods, leading to variation in the interpretation of results(57). Few studies(58) that compare the cost of popular takeaway meals with their healthier home-made equivalents also accounted for the cost of waiting or preparation time. There is a perception that takeaway meals are a quick cheap alternative to meals prepared at home[59-61].

This thesis focuses on the development of the INFORMAS food prices protocol, using standardised methods and tools to measure and compare costs of healthier and less healthy foods, meals and diets, and affordability of diets internationally[18]. Monitoring tools need to be cost-effective, simple, and relevant at the household level, and complement or make use of available data sets[19]. Useful price indicators need to be robust, policy relevant, and sensitive to economic and other changes. Although standardised, the framework for measuring the relative price and affordability of foods, meals and diets needs to be flexible to reflect locally available foods in different countries. Ways to translate the data collected into feasible actions for policy makers need to be considered.

The INFORMAS approach for monitoring is step-wise so a country can choose the level of monitoring appropriate for resources[18]. The foods (minimal) approach is suitable for data collection in all participating countries, requiring minimal resources. The meals (expanded) approach requires more resources and capacity. The diet (optimal) approach is the most comprehensive. For the food prices module, the minimal approach will measure the cost of healthier foods compared with less healthy foods. The expanded approach will compare the cost of takeaways and healthier home-cooked meals. The optimal approach will measure and compare the cost of a healthy diet with the current, less healthy diet and also consider affordability, by taking into account household income.

This thesis describes the development of a protocol for use by different countries involved in INFORMAS. This methodology is tested and implemented in New Zealand (NZ), a high-income economy[62], where dietary risks are the top risk factor driving death and disability[63]. In NZ, overweight and obesity affects nearly two-thirds of adults and a third of children[64]. New Zealand has GST (Goods and Services Tax) added to all goods and services, including food[65]. Supermarkets are the major retail outlet for food purchases.

Chapter 2 provides an overview of the relevant background literature. The following four chapters on selecting common foods, and the foods (minimal), meals (expanded) and diet (optimal) approaches explain how the methodology to assess the cost of foods, meals and diets was developed and how this was tested and implemented in New Zealand. Within each of these chapters, the results comparing the cost of healthier and less healthy foods, meals and diets, including a range of scenarios for varying prices and the diet contents, are described and compared to existing studies of food and diet costs. In the final chapters, the strengths and limitations of each approach are discussed, recommendations for changes to finalise the INFORMAS protocol are made, and implications for policy outlined. The term ‘food’ is used to indicate foods and beverages.

1.1 Aim of thesis

This thesis aims to develop, test and implement methodology to answer the question:

> 'Do healthier foods, meals and diets cost more than their less healthy counterparts?'

1.1.1 Research questions

1. How can the cost of healthier and less healthy foods be compared and measured over time, and between countries?
2. How can the cost of popular takeaway meals and their healthier home-cooked counterparts be compared and measured over time, and between countries?
3. How can the cost of healthy and less healthy diets be compared and measured over time, and between countries?

1.1.2 Research methods

1. Develop a protocol with standardised methods to assess the cost of healthier and less healthy foods, meals and diets; to collect and analyse prices; and to assess affordability of diets.
2. Implement the methods in New Zealand (NZ food prices, meals costs and diet costs studies).
3. Explore the use of different data sources and methodological approaches to compare the cost of foods and diets.
4. Refine methods and the protocol for use internationally by INFORMAS.

2 LITERATURE REVIEW

2.1 Introduction

Food prices are one aspect of the wider food environment that influence dietary patterns. The influence of food prices on household purchasing and therefore food affordability is outlined. In this chapter, the methods and tools required to determine the cost of foods, meals and diets are identified from existing studies, research gaps identified and the methodological strengths and limitations discussed in order to develop and test methodology for the INFORMAS protocol.

A descriptive literature review was undertaken to provide a comprehensive but general overview of the topic, identify current methods, and highlight gaps in the research to assist in refining the research questions. A systematic review and meta-analysis of prices of healthier versus less healthy foods/diet patterns was published in 2013(56), just prior to the beginning of this research. Therefore, it was not considered necessary to conduct another systematic review of the results of food cost studies.

The studies and reports published up to May 2017 were obtained from two electronic databases: Scopus and MedLine. Some of the documents were reported in the grey literature. Searches were restricted to English language documents published since 1994. The reference lists of the foundation paper published on monitoring food prices by the INFORMAS team(19), the 2013 systematic review and meta-analysis(56) and relevant papers were used to identify further papers. Searching manually identified other known documents.

For references relating to the cost of food, diet and affordability, a combination of the following search terms was used: ‘food cost’ OR ‘diet cost’ OR ‘healthy food basket’ OR ‘healthy diet’ OR ‘minimum income’ OR ‘minimum income standards’ OR ‘food budget standards’ OR ‘food affordability’ AND ‘humans’. The studies had to measure price. Studies could be cross-sectional or time series. Surveys using the same methodology to assess cost and/or affordability as another survey, but set in a different location, were not included as the focus is on identifying the range of methods. Studies that analysed the cost of foods rather than diets needed to classify foods by healthiness, rather than monitor all foods over time. Studies were included that only analysed the affordability of fruit and vegetables, as these provide useful methodology information.

The literature review discusses the following:

- A brief overview of food environments with a focus on how food prices influence purchasing and affordability.
- Data sources on food expenditure and consumption to identify commonly consumed foods for all approaches.
- Measurement of the cost of foods and classification of healthier and less healthy foods.
- The influence of cost and time on meal preparation and defining a healthy meal.

- Studies of the cost of healthy and current diets and the information required; food-based dietary guidelines and nutrient reference values to develop a healthy diet, and food and nutrient intakes from HES or food consumption surveys to define the current diet.
- A measure of household income to assess affordability of diets.
- Collection of food prices for all approaches.

2.2 Food environments

To reduce the risk of NCDs, food consumption patterns need to move populations towards diets that meet national dietary guidelines[18,20]. The increased availability of aggressively marketed, affordable energy-dense processed food has moved populations towards dietary patterns that are a risk factor for obesity and NCDs, as these diets are high in sugar, salt, trans fats and saturated fats and lacking in fruit, vegetables and fibre[15,66,67].

The food environment, along with individual factors, determines dietary patterns. The food industry influences food prices directly through their own prices and indirectly through influencing fiscal policy[15,68]. Government can influence prices through regulations and fiscal policies such as taxes and subsidies and influence purchasing patterns through health promotion initiatives. Society influences food consumed through traditional cuisines, cultural, religious values and practices[18]. Changes in technology, the nature of jobs, transportation and sedentary lifestyles contribute to obesogenic environments[15,69,70]. Barriers to action include: lobbying from the food industry (manufacturers, distributors and retailers of prepared processed foods) and the quick-service restaurant industry, governments being unwilling or having limited ability to implement policies, lack of pressure from civil society for political action and too little empirical assessment of the effects of programmes and policies[71]. Structural interventions are more powerful determinants of dietary behaviour than those that rely on individual responsibility[72].

2.2.1 Global changes in dietary patterns and food prices

At an international level, global trade, increased direct foreign investments in the food sector and marketing of less healthy foods are associated with shifts in dietary patterns linked with NCDs[67]. Countries undergoing rapid economic development also undergo transition in nutrition. There is a rapid increase in the production and consumption of food from multinational fast food chains and ultra-processed food and drink products[73,74]. Rapid urbanisation, socio-economic and cultural changes, and increased participation by women in the workforce has led to increased demand for convenience foods[75-77].

Trade agreements can influence the placement of tariff and non-tariff barriers, subsidies and other incentives to encourage production and consumption of healthier foods, tax policies, food labelling and advertising[78]. Countries adopting market deregulation policies experience a faster increase in less healthy food consumption and body mass index (BMI)[67].

Factors contributing to changes in food prices include energy costs, global demand for food and animal feed, policy reforms, price of raw commodities, labour costs, production costs, transportation, food processing and distribution. Environmental stresses, weather conditions, crop and production yields, changes in agricultural use and markets, market speculation and demand for biofuels also influence food prices[36,78,79].

Food prices are monitored globally at the commodity level. The FAO food price index monitors the price of a basket of food commodities monthly. Trends are reported for the overall basket and five commodities (dairy, sugar, vegetable oils, cereals, meat)[80]. Changes in the price of commodities are reported monthly by the World Bank[81] and the International Monetary Fund[82]. The World Bank uses the price of a 1200kcal basket of reference foods to set the food poverty line. The World Food Program Market Monitor[83] bulletin provides information on price changes for staple food items, their impact on the cost of the basic food basket and the contribution of each food item to household total energy intake. Many countries have a consumer price index (CPI) to monitor the cost of foods (among other items) over time.

2.2.2 Affordability of diets

The affordability of a diet can be measured in relation to household income. It is the relative cost of food compared to household disposable income that is important, especially among those on lower incomes. Food is only one aspect of household expenditure and can be more flexible compared to fixed and non-negotiable costs like rent, electricity, heating, health and transport costs[35,84,85]. In high-income countries, people spend approximately ten percent of their income on food compared to over half of household income in low-income countries[86].

The minimum cost of a healthy diet has been estimated in a number of countries: Thrifty Food Plan (US)[87]), National Nutritious Food Basket (Canada)[88], and Estimated Family Food Costs (NZ)[89]. In the United Kingdom (UK), the concept of a minimum income for healthy living is considered with the minimum cost for a healthy diet estimated[90].

Some studies in high-income countries find greater total spending on food is associated with healthier diets[91-93], however the evidence is mainly from cross-sectional studies. Low-income households are more likely to have patterns of food and nutrient intakes that contribute to poor short and long-term health outcomes[94-97]. A systematic review[98] found diets selected by those of lower socioeconomic status are of lower quality and generally cost less per calorie. When financial resources are limited, or food prices rise, consumers on low incomes try to get the most food energy for the lowest cost, choosing energy-dense, nutrient-poor foods and cheaper staple foods[99-101]. Studies using energy density as a metric generally show that those who spend less money have a diet higher in energy density and lower in nutrient density[101].

Poor quality diets are consumed by people of all income levels. Higher income individuals spend more on food, but at any food purchasing level there are households that purchase healthy diets[93,102]. Observational studies find some population sub-groups consume high quality diets while spending less on food[103,104].

2.2.3 Influence of food price on food purchasing

Cost is one of the most important considerations for consumers when purchasing food[21,22] but they are also influenced by taste, health, convenience, mood, sensory appeal, familiarity and ethical concerns[105], as well as time, food storage, culture, cooking skills and transport[106]. In NZ, surveys report the biggest influence on purchasing decisions is price followed by freshness, quality, and healthiness, with taste less of an influence[107]. The most commonly reported perceived barrier to eating more fruit and vegetables is cost, with convenience a common barrier[108].

Access to healthy food is influenced by income, accessibility, availability, knowledge and skills[109]. Low-income households particularly can be constrained by access to stores, limited selection of items within stores, lack of transportation, lack of time and child care[110].

Perceptions are a powerful influence on behaviour[111,112] so food purchasing may be influenced by people's perception of availability and price[112-114]. There is a perception that healthy food costs more, with people's subjective perceptions of the cost of healthy food differing from reality[112,115].

There are calls for fiscal measures that increase the price of less healthy foods[25] or reduce the price of healthier food, to improve the nutritional quality of diets[16]. The external costs to society arising from obesity are not reflected in the costs of producing the product, or the price paid by the consumer[116]. A tax on less healthy foods could raise revenue to fund population health programmes[25].

Demand for food is relatively price 'inelastic' as food is a necessary commodity[117], but small price changes can have a useful population effect[118]. Changes in demand for a food can result from its own price changing, or as a result of a price change in a different food[117,119]. Elasticity depends on the ability to be able to substitute other foods[120]. Monitoring and evaluation are critical to identify the food purchasing changes resulting from a tax or subsidy on a product, whether the intended substitution effects occurred, and that the taxed food is not replaced by another less healthy food[121].

There is considerable evidence from modelling studies that price modification can influence consumer purchasing[122] but there is limited evidence of possible health outcomes[123]. Research on the overall nutritional quality of purchases is mixed because of substitution effects[124], although a systematic review[125] found consistent evidence that taxation and subsidy interventions influenced dietary behaviour, both to reduce consumption of foods high in fat, sodium and sugar, and increase consumption of healthier foods.

Few countries have adopted health-related fiscal measures as a policy tool[68]. Governments have implemented taxes on specific foods, for example a tax on soft drinks in Mexico, or have not taxed healthy foods, for example, no GST on basic healthy foods in Australia[126].

2.2.4 Effect of changes in food price on chronic disease risk factors

Price changes are likely to affect some income and population groups more than others with those on a lower income more sensitive to changes in food prices[117,119,127,128]. Positive effects on low-income consumers would need to offset the potential regressive effects[129]. In Mexico, the reduction was greatest among households of low socioeconomic status[130]. Possible associations between the cost of food with risk factors for chronic diseases and body weight have been investigated through linking data from cross-sectional and cohort studies with price data. The effect of price changes often vary between socio-demographic groups within studies.

Studies have linked an increase in prices of some healthy food groups with an increase in blood sugar[118] or blood cholesterol[131] over time. A relative decrease in blood sugar[118] or blood cholesterol[131] is associated with increased prices of some healthy foods and decreased prices of some processed foods.

The association of chronic risk factors or body weight with price indices of selected foods, such as a fast food index and a fruit and vegetable index, have been investigated in longitudinal ecological studies. Lower fruit and vegetable prices over time are associated with lower body weight outcomes among both low-income children and adults. Increased fast food prices over time are associated with lower weight outcomes only among adolescents[127]. An increased price of soda and/or pizza over twenty years is associated with a reduction in energy from these foods, lower BMI and lower insulin resistance in young adults[132]

2.3 Data sources on food expenditure and consumption

To undertake monitoring of food prices, information is required to identify common foods and current dietary patterns. Data sources can be classified according to the level the data is presented[133] as outlined in Table 1:

- National: Food balance sheets.
- Household: Household economic surveys, consumer price index.
- Individual: Food consumption surveys (dietary surveys, nutrition surveys).

Table 1: Data sources on food expenditure and consumption: Advantages and disadvantages

Data source	Usefulness for food prices research	Advantages	Disadvantages
Food balance sheets	Commodity level Not recommended	Comparable information on food availability between countries[134].	Not at household level[135] so not useful for identifying commonly consumed foods and current diets. Tends to overestimate consumption[135].
Household economic surveys	Household level Useful if data sufficiently disaggregated Useful at foods level as data not required to be linked to individual intake	Conducted by many countries regularly using similar methodology within a country, large representative household samples, provides useful demographic data[136] relatively affordable[137].	Does not provide individual consumption data. Can under or overestimate consumption. Data may not be collected on food consumed away from home, gifts, food grown at home, food wastage or sharing with guests. Seasonality may not be accounted for, or include all major food groups[136,138,139].
Food consumption surveys	Individual level Recommended	Provides nutrient intakes and food consumption at individual level.	Expensive, complex, time-consuming, difficult to administer, subject to measurement error and under-reporting of intake[137,139,140].

2.3.1.1 Food balance sheets

A food balance sheet provides information on trends in food supply for commodities in individual countries at producer level including imports minus exports[141]. Food balance sheets provide an indication of the commodities available at a country level rather than a household level[139,141] so are less useful for food pricing studies.

2.3.1.2 Household economic surveys

Household economic surveys (HES), also known as household budget surveys or household expenditure surveys, provide information on goods and services purchased by the household[139]. Some provide data on household income. The primary purpose of an HES is to provide information about national accounts (estimating gross domestic product), to calculate the Consumer Price Index (CPI) and to measure living standards and poverty[142,143]. HES are often used for secondary purposes, such as food prices, where the data may not be collected in the ideal way, or all the information required is not provided[143]. Access may only be available for the aggregated data, not the underlying survey data[144]. The specific information collected and the methodology used varies between countries[138].

The data is provided per household, rather than per individual, so the distribution of food within a household is not known[139]. The diet approach requires information on individual intake of foods to develop a current diet. An Adult Male Equivalent scale can be applied for other age and gender groups(145). To estimate nutrition intake from an HES requires additional analysis to determine edible portion, the quantities consumed and to match to an item in a food composition database(145).

The usefulness of HES to identify foods depends on the aggregation of the food items. Foods may be coded as a food group rather than a food item, for example, breakfast cereals rather than toasted muesli. HES have been used to identify commonly consumed foods in food pricing studies(146-148) when the data is sufficiently disaggregated.

2.3.1.3 Consumer Price Index

The CPI measures the cost of purchasing a fixed basket of consumer goods and services of constant quality and similar characteristics, including foods(149). The CPI provides information on changes to prices of consumer items and a measure of household inflation(150). The items are chosen from HES data weighted by the proportional expenditure of households, or from estimates of the proportion of consumption expenditure in the national accounts(150). Prices are collected for a sample of commonly purchased goods and services, including foods, from a number of locations at regular periods during a year(150).

Some countries have a Food Price Index (FPI), while others report on the food portion of the CPI. FAO has a database of food price indices from different countries with a summary of methodology. The reporting of some indices is not sufficiently disaggregated to identify items, or insufficient detail is provided to classify foods as healthier or less healthy(19). Prices are usually reported for the major food groups (e.g., breads and cereals), subgroups (e.g., flour, breakfast cereal, rice, pasta, bread), and/or food items (e.g., white bread, flatbread, bread roll). The data are most useful if reported by food item to enable the healthiness of the item to be classified.

2.3.1.4 Food consumption surveys

A recent food consumption survey is required to conduct the diet approach to identify the nutrient profile and food patterns of the current diet. Food consumption surveys measure the food that is prepared, cooked and consumed(133), providing information on the dietary choices of the population. Diets are assessed using 24-hour diet recalls, diet records or food frequency questionnaires(139,151).

Most countries have conducted national food consumption surveys though few countries undertake regular surveys, especially in developing countries(152). The Global Dietary Database is a compilation of information on dietary intakes of major foods and nutrients from 193 countries in 2017(153). The European Food Safety Authority Comprehensive Food Consumption Database provides information on food consumption in grams per food group for a number of European Union countries(154).

Surveys vary in methodology, type of dietary assessment (recall, record, food frequency questionnaire) and the type of data reported (nutrients, food groups, sources of nutrients). Most surveys report the nutrient intake of the population for the nutrients of interest for INFORMAS: energy, macronutrients, fibre, sugar, sodium.

Food consumption survey data is very useful to identify commonly consumed foods. The ease of extracting the necessary data, and the assumptions required to identify commonly consumed foods and dietary patterns, depends on the way dietary data is reporting and collected. In some situations, additional work may be required to analyse the micro-data to estimate the amount of foods and food groups consumed in order to construct the current diet.

Food Frequency Questionnaires (FFQ) could be used to identify commonly consumed foods and dietary patterns, particularly if conducted at an individual level rather than at the household level. A quantitative FFQ may report nutrient intakes. A number of studies have used FFQs to estimate usual intake[91,93,102,155-158]. Decisions are required on the type of food to represent a survey category, for example, type of breakfast cereal. Food frequency questionnaires are less useful unless nutrient intakes are reported.

If the food consumption survey is not recent, the current diet may contain foods that are no longer common. Any regional surveys, dietary habit surveys or surveys conducted for particular age groups could be used in conjunction with the national survey. Some nutrition surveys do not include children. Adult data could be used for children with the amounts scaled to meet the child's recommended energy intake, though food consumption patterns can differ between adults and children. Other surveys, such as a school-based survey, may report on dietary habits, for example the reported fruit and vegetable intake or the frequency of consumption of sweetened beverages.

2.3.1.5 Other sources of food consumption data

Sales data may be available from a market research company. Depending on the level of disaggregation, items could be identified at an individual level which would enable identification of commonly consumed foods. Other possible information sources are supermarket sales figures, suppliers, retail magazines or consumer association surveys. The knowledge of local communities, ethnic groups, dietitians, nutritionists, experts and researchers can be useful to review information, particularly if information is not recent.

2.3.1.6 Summary of data sources on food consumption and expenditure

The sources and nature of information on food consumption and expenditure may differ between countries, therefore the INFORMAS protocol needs to provide flexibility for the type of information required. This thesis will explore the feasibility of using both the Household Expenditure Survey and the Adult Nutrition Survey to identify commonly consumed foods in NZ, along with market research data on popular brands.

2.4 Measuring the cost of foods

2.4.1 Introduction

The data sources and tools used to assess the price differential between healthier and less healthy foods or food groups, and to monitor the relative change in prices over time are described. The methods used to select foods, classify foods by healthiness, and the different price metrics used, are identified from studies that compare the cost of healthier foods with less healthy foods for individual foods, food groups or pairs. Studies that monitor the relative cost of foods over time by degree of healthiness are described. This information is used to identify common and feasible aspects of methods to determine the methods used for the foods approach of the INFORMAS food prices module, which monitors the cost of healthier and less healthy foods over time. Differences in methods are noted and the effect of these on the interpretation of price results are considered.

2.4.2 Comparing the cost of pairs

The most common approach reported in the literature to compare the cost of healthier and less healthy foods is the pairs approach, where a food item is matched to a similar healthier counterpart, for example wholegrain and white bread. The studies of pairs in the literature (Table 2), are often part of a larger study of food availability or diet costs, so the details about pair selection are brief. A strength of this approach is the direct comparison made between the healthier and less healthy item. Each item of the pair acts as a comparator, by having the same main ingredients or components and the same end purpose within the same food group. It can be difficult to select pairs for some food groups, such as a less healthy item for fresh fruits, therefore the number of pairs may be small and not represent all food groups. The pairs approach is simple to implement.

Generally healthier options were defined as low in saturated fat, salt or sugar and higher in fibre, or meeting food-based dietary guidelines. Most studies compare the price of each item per 100g. Some of the studies that report prices for pairs use a Nutrition Environment Measurement Survey in Stores Tool, which also measures availability[159-162].

Table 2: Studies comparing the price of foods using pairs of healthier and less healthy foods

Author	Number of pairs	Selection of foods	Source of price data	Analysis	Result	Type of price
Gosadi et al 2016[163] Saudi Arabia	24	Healthier: lower salt, fat, sugar	3 supermarket chains in 1 city	Price per kg	Overall price difference between pairs not statistically significant	Specified brand * **
Lee-Kwan et al 2014[159] American Samoa	9	Healthier: met dietary guidelines	70 stores (grocery, convenience) Geographically representative	Compared prices of pairs	Healthier foods less available, cost more than less healthy item of pair	Not stated
Llobrera 2013[164] US	15 differing in healthiness 9 differing in convenience	Healthier: met dietary guidelines Food selected from basket weighted by expenditure share HES and NHANES	140 food stores Stratified random sampling then large store matched to small stores	Compared price of all foods with and without substitutions by health and convenience	Substituting for healthier items increased overall cost slightly Substituting for convenience items mixed results	Cheapest
Temple et al 2011[165] South Africa	6	Healthier: higher content of micronutrients and/or fibre, lower saturated fat, lower energy density Identified from dietary survey	21 supermarkets and small food stores in 14 rural towns	Compared price per 100g and per 100kJ	Healthier foods cost 10-60% more per 100g, 30-110% more per 100kJ	Not stated
Krukowski et al 2010[160] US	10	Healthier: recommended for healthy eating Less healthy: foods contributing most to energy & fat	42 stores used by study participants	Overall price of healthier items compared to less healthy counterparts	Overall healthier items of pairs cost more	Each item of pair same brand No discount **

Author	Number of pairs	Selection of foods	Source of price data	Analysis	Result	Type of price
Wang et al 2010[166] NZ	7	Healthier: met dietary guidelines	1230 food outlets Rural & urban	Price of healthier and less healthy foods overall Items priced per 100g	Healthier foods cost 29% more	No discount **
Andreyeva et al 2008[162] US	Not stated, part of larger price survey		All stores (75) in specified area of 4 low-income neighbourhoods	Compared prices of pairs	Some healthier items more expensive	Not stated
Giske et al 2007[115] Australia	14	Healthier: dietary guidelines	57 supermarkets Stratified random sample by deprivation	Compared price per item	For most pairs, healthier item cost more than regular item	Cheapest * Standard package size
Glanz et al 2007[161] US	9	Healthier: dietary guidelines Selected pairs from field work and expert consultation	80 stores (grocery, convenience) in neighbourhoods	Compared price of pairs	Healthier item cost more than less healthy item for 4 pairs Price difference between each item of 5 pairs not significantly different	Not stated
Liese et al 2007[167] US	4	Healthier: Low fat, high fibre	All stores in region	Compared price per serving or per weight	Healthier item of pair cost more (except milk)	Cheapest No discount
Mooney 1990[168] England	15	Healthier: met dietary guidelines	9 supermarkets, largest in study area	Compared price per 500g	Healthier item cost 13-21% more depending on neighbourhood	Cheapest * Standard package size

* Use of discount or standard price not stated

** Inclusion of generic products not stated

2.4.3 Comparing the cost of foods classified by healthiness

As the pairs approach only includes a small selection of foods, and often does not include all food groups, another approach is required to measure the cost of foods over time. Foods can be classified by healthiness at the food group level, by nutrient density or by energy density. The price is compared by degree of healthiness. Three studies compared the cost of a range of healthier items within a food group (for example, reduced fat dairy) to the cost of a range of less healthy counterparts (for example, regular fat dairy)(169-171) (Table 3). Another study compared the overall average price of healthier food with less healthy food(163).

Studies reported in the literature (Table 3) generally define healthier foods as lower in saturated fat, salt, and sugar and higher in fibre (wholegrain), of higher nutrient density, or meeting food-based dietary guidelines. There is growing interest in the classification of foods by degree of processing, including the incorporation into the recent Dietary Guidelines for the Brazilian Population(10). Several studies use this classification to investigate the proportion of the population's dietary energy according to the degree of processing(73,172), and the expenditure on foods of varying degrees of processing(173). One study compared the cost of all packaged foods by degree of processing(174).

Therefore, two classification systems are considered in the testing of the food approach.

1. Classified as healthier or less healthy according to a nutrient profiling model.
2. Classified by degree of processing: minimally processed, culinary ingredients, processed, ultra-processed.

Initially attempts were made to compare the cost of commonly consumed foods classified as healthier and less healthy using a comparator of equal energy, equal number of items or equal weight per serving size. However, it was problematic to compare the categories because adjusting the number or amount of foods in the category to be equal in energy, number of items or weight, required subjective manipulation of the amount or number of foods in the category.

One study(163) measured the average price of common healthier and less healthy foods but some of the comparisons between food groups did compare products consumed in a similar way or amount, for example diary items classified as healthier (milk, yoghurt) are less energy dense and used in a different way than items classified as less healthy (butter, cheese). The healthier foods are cheaper but when pairs of healthier and less healthy counterparts are compared there is no difference in price.

To overcome this problem, the price should be measured using the average price per item of a food group. The absolute price of different food groups should not be compared, as there is no robust comparator for the categories. Instead the relative change in price of healthier foods compared to less healthy foods should be compared over time.

Table 3: Studies comparing the price of healthier and less healthy food groups

Author	Foods	Selection of foods	Source of price data	Analysis	Result	Type of price
Gosadi et al 2016[163] Saudi Arabia	162 foods	Healthier: lower energy, salt, fat, carbohydrate, higher fibre compared to other foods in food group	3 supermarket chains in 1 city	Price per kilogram	Overall average cost of healthier food cheaper than less healthy food	Specified brand * **
Luiten et al 2015[174] NZ	All packaged food in supermarkets	Degree of processing	Data from 4 supermarkets	Price per 100g, per serving, per 100 kJ	Minimally processed foods cost more than ultra-processed foods per serving & per 100g. No significant difference per 100kJ	Branded & generic All items in database *
Todd et al 2011[170] US	Healthier and less healthy food groups	Healthier: met dietary guidelines	Quarterly Food-at-Home Price Database	Price per 100g	Some healthier food groups more expensive, others less expensive	Not applicable
Katz et al 2011[171] US	131 common foods 8 food groups	Nutritious versus less nutritious using nutrition criteria	Supermarket number & selection not stated	Price per 100g	Little difference in cost between healthier and less healthy items in food groups	Most popular (branded or generic
Ni Mhurchu & Ogra 2007[169] NZ	88 foods 9 food groups Regular and healthier alternatives No fruit, vegetables	Healthier: met dietary guidelines Common foods indicated from sales data	1 supermarket, sales data	Average weekly household price of healthier and regular items in food group	Healthier options cost more than regular item for meat and poultry, butter and margarine, cheese; cost less for canned fish. Small difference for soft drinks, canned fruit, milk, bread, breakfast cereal	Brand with highest sales (branded or generic) *

* Use of discount or standard price not stated

** Inclusion of generic products not stated

2.4.4 Price metric

The price metric used to assess the cost of healthier and less healthy foods can alter the resulting price differential[36,46,57]. Three price metrics are commonly used:

- food energy ($ per calorie or kilojoule),
- edible weight ($ per 100g or 100ml),
- average serving ($ per average portion).

The metrics were comprehensively compared using 4,439 food items from the US National Health and Nutrition Examination Survey (NHANES) and the Centre for Nutrition Policy and Promotion Price Database[46]. The price per serving is based on typical portion sizes consumed in NHANES, reflecting current eating habits rather than dietary guidelines. The rankings of food prices are statistically different between each metric with price per calorie differing the most from the other two metrics. The correlations between each price metric are: per calorie and per edible weight 0.44; per calorie and per serving 0.5; per edible weight and per serving 0.57.

Foods low in energy for a given weight, for example fruits and vegetables, appear to have a higher price when measured per kilojoule. However, when measured by edible weight or average portion size, fruit and vegetables are less expensive than most protein foods and less healthy foods (high in added saturated fat, sugar or salt). Less healthy foods tend to be high in energy so have a low price per kilojoule, but are more expensive when measured by edible weight or average serving size[46]. The serving size metric is affected by the average serving size, so foods consumed in large quantities are likely to cost more than foods consumed in smaller quantities that cost more per 100g.

There is criticism of price per kilojoule as a metric in relation to energy density as the marker of healthiness. Energy cost is present in both the numerator of the independent variable (energy density) and the denominator of the dependent variable (energy cost) meaning energy cost is inversely proportional to energy density creating a negative auto-correlation[175,176]. Two studies[175,176] demonstrated this finding by taking the energy content (kcal/g) and weights of foods and applying a random number for the price of each food. Foods with a higher energy density provide more energy per 100g, so are cheaper per 100g. However, eating 100g lettuce can hardly be compared to 100g of pizza.

Measuring foods by energy density does not take the whole diet into context or reflect nutritious differences, such as the micronutrient content[177]. A healthy diet requires foods from different food categories to provide the necessary nutrients, including foods of high and low energy density. Fruit and vegetables provide nutrients at a reasonable cost when compared to other foods because they are nutrient-rich in relation to their low energy content[178].

A systematic review[56] looked at the price difference between healthier and less healthy foods per serving and per 200kcal. The unit of comparison altered the result for some food groups. The price differences between healthier and less healthy foods within a food category are larger for most food categories when the price is calculated per calorie compared to per serving, except for grains and fats/oils. The price differential for meats/protein foods is smaller per serving than per 200kcal. There is no price differential for grains for either metric. Healthier soda/juice alternatives are usually diet options, so are expected to be more expensive per calorie. Metrics based largely on fat content have greater price differences per calorie than per serving. For dairy foods, the healthier options are $0.004 less expensive per serving but $0.21 more expensive per 200kcal. Whole milk contains nearly twice as much energy than low-fat milk but generally a consumer would purchase according to volume, not energy. Per serving, meats/proteins have the largest price difference between healthier and less healthy items ($0.29), snacks/sweets, and soda/juice a smaller price difference ($0.12 and $0.11) and grains and fats/oils the smallest difference ($0.03 and $0.02), with no difference for dairy food items.

A study using the UK CPI(57) found that healthier foods are more expensive than less healthy foods when priced per calorie and per serving but cheaper when priced per 100g. Fruit and vegetables are the least expensive per 100g, second least per serving, but the most expensive per calorie. Meat and alternatives are the most expensive group per 100g and per serving, but intermediate in price per calorie. Breads and grains are the second cheapest per 100g, and cheapest per calorie and per serving. Dairy foods and less healthy foods are an intermediate price for all measures.

The advantages and disadvantages and potential use of each price metric are outlined in Table 4 as discussed by the authors in the study comparing the cost of foods in the UK CPI(57).

Table 4: Advantages and disadvantages of the use of three price metrics(57)

Component	Advantages	Disadvantages	Use
Mass: Per 100g	Does not account for the way a food is consumed and how much it contributes to energy.	Allows consumer to determine whether two products serving the same purpose differ in price.	When similar foods are compared.
Portion size: Per serving	Allows a direct substitution of one food for another using the amount likely to be consumed where foods may have different quantities of energy and mass.	Foods consumed in large quantities are likely to be more expensive than foods consumed in smaller quantities (e.g., bread and butter). Requires serving size data. Serving size data may differ according to different sources.	Estimate the likely impact on the cost to the consumer.

Component	Advantages	Disadvantages	Use
Energy: Per kJ	Relates to the amount of sustenance the food can contribute. Consumers may purchase foods related to provision of sufficient energy.	May not be relevant to consumer behaviour as compares foods eaten in quantities with considerably differing energy density and nutrient density. Does not take the whole diet into context or reflect nutritious differences such as the micronutrient content. Energy cost is inversely proportional to energy density creating a negative autocorrelation.	Useful for food security.

A decision on the price metric to use is required for the final INFORMAS protocol. In order to investigate the feasibility and the appropriate use, the cost of the foods is analysed using each price metric for the NZ food prices study.

2.4.5 Using price indices to monitor the cost of foods

INFORMAS encourages the use of existing datasets where possible. The CPI can be used to monitor food prices over time, if individual foods and prices are provided. This also provides a list of commonly consumed foods.

The UK CPI was analysed to monitor the price of 94 foods from 2002 to 2012(79). Tea, coffee, and mineral water are excluded, as these do not provide energy. Items that involve a cost of service were excluded (for example, restaurant or takeaway meals). A mean value for the year was calculated per unit price using the median price for a given quarter. Nutrition composition data was matched to the CPI data expressed as edible portion. Each item was assigned to a food group (grains, fruit & vegetables, dairy, meat and alternatives, foods & drinks high in fat and/or sugar) and also classified as 'more healthy' or 'less healthy' using a common nutrient profiling tool. Over the decade the mean price of all foods in the sample increased by thirty-five percent. The price of healthier foods rose significantly faster than less healthy foods per 1000kcal. An interactive tool allows the user to choose the metric to explore changes in food prices in the UK according to food group or healthiness(179).

The price of a 'junk' food basket and a fruit and vegetables basket was monitored from 1997 to 2009 for over 250 food items from the UK food consumption and expenditure surveys(180). 'Junk' food items are energy-dense and high in fat, sugar and salt. The price for junk food relative to all foods fell fifteen percent. The average price of fruit and vegetables steadily increased by seven percent relative to all food.

A new initiative of the Australian Bureau of Statistics, in partnership with the Department of Health, reclassified foods in the CPI using the food groups of the Australian Dietary Guidelines(181). The CPI classifies foods related to purpose (e.g., snack) while the guidelines classify related to nutritional value (e.g., 'meats and alternatives'). Restaurant meals and takeaway foods were excluded from the main analysis and analysed separately. Weights were applied to different products based on the share of household expenditure. The rate of change between 2001 and 2014 for all food was 2.9%, which is similar for discretionary items (3.0%), fruit (3.0%) and oils and fats (2.9%). Vegetables had a higher rate of price change (3.8%), while grains and cereals (2.4%), milk and alternatives (2.5%) and meat and alternatives (2.2%) had lower rates.

2.4.6 Summary of measuring the cost of foods

Studies identified in the literature that compare the cost of healthier and less healthy foods or food groups use a range of methods to select foods, define the healthiness of foods and to compare costs. A common method is to compare the cost of the healthier and less healthy item of a pair of foods. Another method is to compare the cost of healthier and less healthy groups of foods. A range of definitions are used to classify foods by healthiness in studies comparing the cost of healthier and less healthy foods. These include nutrient profiling tools, food-based dietary guidelines, degree of processing or the foods are described in terms of one or more of the following: lower fat, lower saturated fat, lower sugar, lower sodium, higher fibre. The aspects of the foods approach that require further development of the methodology for the INFORMAS protocol are outlined in Table 5. The feasibility of the methodology will be tested in the NZ food costs study.

Table 5: Further research required for the development of the foods approach

Issue	*Description of issue*	*Research required to address issue*
Principles required to select pairs	Lack of description in literature on how pairs selected	Develop principles to select pairs
A simple standardised system to classify foods by healthiness is required	Range of systems used in literature	Explore systems that are feasible to use in a range of countries and based on diet-health relationships
Range of possible price metrics	Differing metrics give different results: price per calorie or kilojoule, price per 100g, or price per serving	Explore metrics and select one for INFORMAS protocol

The fundamental limitation of the foods (minimal) approach is a lack of a direct comparator. Therefore price changes should be monitored over time, rather than a cross-sectional comparison. The exception is the pairs approach, as the healthier and less healthy item of the pair can be directly compared. Other limitations identified in the literature are the lack of a process to select foods, varying price metrics providing conflicting results, variation in defining healthiness of food and not selecting commonly consumed foods based on actual frequency and amount of consumption. It is challenging to include all food groups, particularly for the pairs' component .For some food groups (fruits, vegetables, eggs and takeaways), there is often no less healthy or healthier alternative. Most of these limitations can be overcome by comparing the cost of diet which is anchored by energy and nutrient requirements, rather than foods. However, this requires recent food consumption data and additional resources which countries may not be able to undertake.

Complementary methods have been identified for the foods approach to compare the cost of healthier and less healthy foods over time. Each method answers a different research question and has advantages and disadvantages, so are complementary. The pairs method can answer, 'What is the price differential between direct food substitutes with clear nutritional differences?' and the food groups method can answer, 'What is the change in price differential over time between healthier and less healthy foods?'. This research develops and implements the pairs approach, explores systems to classify food by healthiness, explores the use of different price metrics and the feasibility of monitoring food prices over time using data from the NZ Food Price Index.

2.5 Influence of cost and time on meal preparation

The INFORMAS food prices foundation paper(19) recommends to measure the price differential between healthy and less healthy meals. The research to inform the development of methodology is sparse, therefore the descriptive literature review explored background information on meals, as well as studies on the cost of meals. A combination of the search terms 'food cost', 'time', 'time-inclusive', 'meal', and/or 'preparation' were searched using Scopus and MedLine. The search was restricted to English language documents published since 1994. Analysing the cost of meals is a new area of exploration so the literature search was kept quite wide. The initial search in SCOPUS of 'food cost' AND 'time' yielded 6792 results. A second search of 'time' AND 'food' AND 'cost' yielded 8070 results. Therefore, the search criteria were narrowed to 'time' AND 'food' OR 'meal' AND 'preparation' AND 'cost' with 432 results. Additional articles were identified from the reference lists of articles found during the search.

The variation in the way terms related to meals and eating away from home are used in the literature is discussed. The impact of consuming food away from home on dietary patterns and health is outlined. Trends in foods prepared at home or away from home are described. Factors influencing where a household prepares or obtains a meal are discussed along with the impact on cost of the time to prepare or purchase a meal.

2.5.1 Definitions

2.5.1.1 Meal

There is no consensus in the literature on what is a snack, meal or eating occasion(182). These can be defined by the views of study participants, time of day, or eating occasion. Meals can be described by the nutrient content (energy, nutrient composition), pattern (frequency, timing, spacing), format (food combinations) and context (for example, location).

There is no consensus in the literature on the components of a meal. A usual meal has been defined as having at least three components[183] (protein, starch, vegetables), or having servings from at least two food groups with a recommended total serving size of at least 225g[184]. The UK Food Standards Agency guidelines[185] suggest that daily energy consumption should be split over four eating occasions, with lunch and the evening meal providing 30% of daily energy intake. Food-based dietary guidelines do not usually provide a recommendation for the energy contribution of a meal.

2.5.1.2 Eating away from home

The definitions of 'food away from home' and 'food at home' are used in different ways in the literature[186]. Food away from home can refer to food either prepared or consumed outside the home. For example, a lunch prepared at home but consumed at work would be classified differently depending on the definition. Foods prepared outside the home may be sourced from restaurants, cafés, takeaway or fast food outlets, workplaces, schools or friends or relatives' houses, depending on the definition.

2.5.2 Fast foods

In the literature the term 'fast foods' may refer to foods obtained quickly, such as burgers, fries, pizza and fried chicken[187], purchased in self-serve or carry-out eating venues without wait service[188] and foods purchased in quick-service restaurants. The World Cancer Research Fund and American Institute for Cancer Research considers fast food as readily available, energy-dense meals, snacks, foods and drinks served in transnational restaurants and the fast foods that are created to imitate these[189]. Differences in the definitions and in the methods used to ascertain takeaway and fast food consumption make it difficult to compare findings across studies.

2.5.3 Food prepared at home

Foods 'prepared in the home' may be prepared from raw ingredients, commercially prepared food items or a mix. The term 'home-cooked' refers to meals that do not include food purchased from a restaurant as either take out or delivery[183]. Meals lie along a continuum of preparation, assembling and cooking, from raw ingredients used to prepare dishes from 'scratch', to single ingredient processed items, to packaged, canned and frozen meals[190,191].

2.5.3.1 Convenience and ready-meals

'Convenience items' are ingredients purchased as ready-to-eat or requiring minimal preparation[183,191]. Ready-meals are complete meals that require no further ingredients and need minimal preparation before eating[184,191-194]. A ready-meal differs from a fast food meal as it requires heating (unless it is to be eaten cold), for example, frozen lasagne. Ready-meals have become more important as consumers prefer the convenience of these rather than home cooking[192] as time and culinary skills are not required[164]. Ready-meals can be high in energy, fat, salt and sugar and lack vegetables[184,195].

2.5.4 Trends in food prepared at home and away from home

Eating away from home in restaurants and consuming food items from fast food outlets has increased in recent decades in many countries, including low and middle-income countries[(196-203)]. Countries experiencing nutrition transition often have an increase in multinational fast food chains, with an associated increased consumption of processed foods high in fat, saturated fat, salt and sugar, and low in fibre[(74,197)]. Some countries conduct time-use surveys. Time spent in food preparation significantly reduced in the US between 1975 and 2006 [(204)] and in Germany between 1991 and 2002[(205)].

2.5.5 Composition of food prepared away from home

Compared to food prepared and consumed in the home, food obtained outside the home is generally more energy dense, higher in total and saturated fat and salt[(187,188,206)] and lower in micronutrients[(206)]. Fast foods are characterised by being energy dense, having large portion sizes[(189)], being low in nutrient density, high in total fat, saturated fat and sodium[(207-209)], highly refined starch and added sugars[(208)].

2.5.6 Relationship of consuming food away from home with dietary patterns

The diets of those considered frequent consumers of food prepared away from home are generally higher in energy, fat, sodium and sugar and lower in nutrients than those consuming food away from home less frequently. Most studies are from Western high-income countries so patterns may differ for other countries.

A systematic review identified twenty-nine studies of the dietary quality associated with eating away from home[(196)]. Eating away from home is associated with a higher total energy intake, higher fat intake and, two studies report an association with a lower intake of micronutrients. A positive association between higher socioeconomic status and greater energy contribution from foods away from home is observed. The findings reported from four studies from lower middle countries conflict with the observed associations from the review. In these, the foods consumed away from home are mainly traditional foods and eating away from home is associated with higher diet quality, less energy from fat, higher intakes of iron and vitamin A, and more dietary diversity.

Street foods are ready-to-eat, processed or fresh foods that are prepared or sold in streets and other similar places rather than a permanent store[(210)]. As street foods are cheap and prepared quickly, these have become more important in many low and middle countries experiencing rapid urbanisation. Street foods can save labour and fuel costs, and require fewer cooking facilities and storage at home. A systematic review of twenty-three studies, most from sub-Saharan Africa, examined the nutritional value of street foods[(210)]. Most items are based on traditional and cultural foods, though processed foods are also sold. The majority of studies report that street foods make an important contribution to the energy and protein intakes. Nutrient data on saturated fat and salt intakes were not available. The composition of street foods varies between countries, cities and vendors.

2.5.7 Relationship of consuming food away from home with risk factors of diet-related diseases

The World Cancer Research Fund[(189)] found an association between the consumption of fast foods and a higher risk of weight gain and obesity, concluding that the energy density of fast foods is an important determinant of body mass. Fast food is considered a probable risk for cancer, due to increased energy intake.

Studies that separate fast food restaurants from full-service restaurants are more likely to find a positive association with weight status and fast food consumption. Most studies that examine the association between eating away from home and weight status are cross-sectional, so are subject to reverse causality where individuals with obesity may eat less away from home to control their energy intake, or not be seen eating takeaways. If foods consumed at home are also of low nutritional quality there may be no difference in weight status between the place of food preparation[(211)]. A systematic review[(212)] of eight prospective cohort studies, mainly in the US (six studies), suggests a positive relationship between the consumption of food away from home and weight gain, particularly for fast foods rather than restaurant foods. In twenty-five high-income countries[(213)], the increase in annual fast food transactions per capita was positively associated with an increase in mean population BMI between 1998 and 2008.

In a multi-country study of children and adolescents that include low and middle-income countries, a small statistically significant association is observed between increased frequency of fast food consumption and a higher BMI in children aged six to seven years[(214)]. The opposite association is found in adolescents, though the results may have been affected by under-reporting, varying definitions of fast food and reverse causation.

An analysis of two large prospective cohort studies in the US report frequent consumption of meals prepared at home is associated with a lower risk of developing type 2 diabetes, partly due to less weight gain over time[(186)].

The association between fast food prices and BMI is not clear, with studies reporting higher prices positively correlated with a higher BMI[(215)], a trend in the lowering of relative fast food prices associated with a trend in an increase in adult weight[(216)], and little evidence that fast food price changes affect adult BMI[(217)]. A systematic review[(127)] found higher fast food prices are associated with lower weight outcomes, particularly among adolescents.

2.5.8 Factors influencing preparation of food at home

Major influences on healthy meal choices include cost, convenience[(21,218)], taste and healthiness[(61)]. Food preparation is influenced by dietary knowledge, skills, attitudes, preferences and culture, along with availability of cooking fuel, equipment and additional ingredients[(61,219,220)]. Availability of healthy food can be limited due to lack of access to supermarkets[(221)], higher costs in some geographic locations and lack of transport[(219)].

In a number of countries, the increased consumption of food prepared away from home is associated with urbanization, more households with both parents working, smaller households, households without children, higher incomes, more affordable and convenient fast food outlets and increased advertising by foodservice chains[203,222,223].

Feeling time poor is becoming widespread in industrialised countries[224]. Time and money are interdependent, so a low-income household requires more time to maintain a household. Higher prices for foods prepared at home can influence individuals to spend more time in shopping and food preparation, using cheaper products that may require more food preparation[225]. Time scarcity can be measured objectively (time-use survey) or subjectively by a person's reported experience[226].

Food manufacturers have responded to feelings of time scarcity by developing and promoting a wide range of convenience ingredients and meals[61,224]. Households purchase these as they are perceived as better value for money, because of a dislike of cooking, and due to variable family eating times[61,191,227]. The use of convenience items requires less cooking skills, fewer ingredients and the items usually have a longer shelf life so less planning and shopping trips are required[183,194]. However, consumers are dependent on manufacturers for nutrient balance[61]. Heavily processed ingredients and meals are often higher in sugar, fat or salt and lower in nutrients and fibre[194].

As preparation of meals using pre-prepared ingredients is common[191] and the time spent preparing foods has reduced over time[228], the cost of preparing meals using pre-prepared components is important to include in a comparison of meal costs. A home-assembled meal is a step in-between no meal preparation and moderate meal preparation. It is defined for the meal approach in this thesis as, 'a range of partially pre-prepared items that requires minimal assembling'.

2.5.9 Time involved in food provision

Time is required to prepare meals at home or to purchase meals out of the home. The household production theory developed by Becker[229] views the household as a consumer and producer of the final goods. The household considers how to choose the best combination of commodities to maximise household utility subject to time, resources and technology constraints. The household supplies labour to the market and uses time and resources (equipment and individual skills) to support engagement in the labour market, including food procurement, preparation and consumption. Time and goods (food) are combined to produce outputs (meals) that are consumed directly by the household but not sold in the market[229], or ready-meals are purchased[223]. Food consumption is constrained by the indirect cost of time and the direct cost of money[61]. Time is a valued fixed resource allocated to produce income and for household activities and leisure[230]. At the individual level, costs are associated with the allocation of personal resources, while benefits are the overall satisfaction from the decision[58]. Preparing food at home may produce better tasting food, fresher food or provide satisfaction and fulfilment from using skills and providing for a household, as well as the social interaction of preparing a meal[183,220,231].

Factors reducing the time available for food preparation include working parents, being a single parent household, working an inflexible job or shift work and having a low-income[232,233]. Factors enabling time available for food preparation include availability of help from household members, working a flexible job, working fewer hours, cooking skills and self-efficacy[61,106].

Households may cope with time pressures through purchasing more meals away from home and using convenience ingredients and meals when preparing family meals[230,234]. In the US, as household income increases, less time is spent in food preparation, as time can be scarcer than money[235,236]. The way households prioritise their time can influence food production. Households who place less value on preparing food at home, compared to other valued activities and priorities, will use more convenience and fast foods[230].

Self-reported food-related time use, restaurant use and indicators of a healthy diet were explored in a large US population-based study[227]. More time spent on home food preparation (preparing, cooking, cleaning) is associated with higher diet quality. Less time spent in food preparation is associated with more money spent on food away from home, and being in the workforce.

2.5.9.1 The cost of time

Time is an essential factor when obtaining or preparing meals. Therefore, including the cost of time provides a realistic assessment of the cost of the meal to a household, though there are few studies reported in the literature that incorporate the cost of time. The cost of time in food preparation at home has been estimated by costing the home activity at the rate it is priced in the market, for example the hourly wage rate of a food preparer[237].

The Thrifty Food Plan (TFP) requires basic, inexpensive, mainly unprocessed foods and ingredients that require time, skills and some equipment to prepare. An analysis[233,238] of the money and time requirements associated with the TFP costed time by the mean wage for cooks. When only monetary expenditure is considered, 62% of households spent enough money to meet the TFP target, but when time costs are included, only 13% spent enough to meet the TFP target[233]. It is estimated that eighty minutes a day is required to prepare recipes from the TFP[236]. An Institute of Medicine committee examined the time cost of meal preparation[221] and recommends that the cost-time trade-offs involved in purchasing and preparing a nutritious diet be recognised. The resource constraints of many low-income households, such as accessibility to healthy food, increases the time required to acquire food.

The cost, preparation, cooking time and nutrient content of foods can be evaluated using data from the US Food Value Analysis website[190,239]. Information on food prices is sourced from the United States Department of Agriculture (USDA) Centre for Nutrition Policy and Promotion Food Prices Database and the AC Nielsen Homescan database. The active preparation time is priced with a range of hourly rates[190,232,239]. The time-exclusive and time-inclusive price of the 100 home recipes involving preparing basic ingredients and 143 recipes involving assembling processed ingredients was calculated[58]. Time was calculated as the hands-on preparation time at the median hourly wage for food preparation and serving-related occupations. Cooking and clean-up times were not included. The time-exclusive price is similar for the home and processed recipes, except for vegetables where the home recipes are more expensive. However, when time is included, the cost is higher for the home recipes than the processed versions.

As there are few studies on the cost of meals with the inclusion of time, a decision is required on which tasks are costed in the meals approach (Table 6) and the process for estimating the time required for home-cooked and takeaway meals. It is recommended to test a range of recipes prepared for each meal prepared at home in a standardised way to provide a range of preparation times. It is difficult to estimate a standard time and cost of purchasing groceries and takeaways as purchasing patterns and locations will differ for households. Therefore, it would not be feasible to include the cost of cooking fuel and transport to purchase groceries or takeaways in the estimation of time. The time to purchase and wait for a meal at a takeaway outlet can feasibly be recorded.

Table 6: Time involved for the consumer in obtaining meals

Meal prepared at home	**Meal prepared away from home**
Shopping	Travelling to outlet (unless home-delivered)
Storing	Order meal
Preparation	Waiting for meal
Cooking	
Serving	
Clean up	

A standard dollar amount is required to estimate the cost of time. The median hourly wage for food preparation and serving-related occupations is used in studies that measure the cost of time(58,233,238).

Other research groups recognise the gap in the methodology. One group states they will further develop their research on economical healthy choices to compare typical fast foods or ready-to-eat foods with home-made recipes prepared with healthy ingredients(177). Other researchers recommend research be conducted to evaluate the time used to prepare a healthy meal compared to pre-prepared convenience foods(164,221).

2.5.10 Influence of price on demand

Fiscal policies, such as a tax on fast food, have the potential to reduce demand and therefore consumption of fast food(240), encouraging people to prepare potentially healthier foods at home. Own-price elasticity of demand for food away from home is required to be relatively high, and the cross-price elasticity of substitution between types of food away from home and between types of food prepared at home is required to be relatively low. Estimates of the price-elasticity of demand between four types of food establishments ranging from fast food to fine-dining are small. Food consumed at home is relatively inelastic. Consumers are not likely to substitute one type of food away from home for another so taxing fast food has the potential to shift consumption of fast food to meals prepared at home(240).

2.5.11 Summary of the influence of cost and time on meal preparation

There has been an increase in eating away from home and consuming food items from fast food outlets in many countries including lower, middle and higher income countries. Eating away from home is associated with consuming diets of lower quality compared to eating meals prepared at home. The food industry has responded to feelings of time scarcity with convenient meal solutions, but these tend to be of lower dietary quality than meals prepared at home. Therefore, moving people to consume more meals prepared at home could contribute to healthier diets. Cost and convenience are major influences on meal choices. As time is required when obtaining and preparing meals, it is important to consider the influence of time when recommending meal options. There is often a perception that takeaway meals are cheaper and quicker than preparing a meal at home.

There are few studies in the literature that account for the cost of time when analysing the cost of meals requiring varying degrees of time for preparation or obtaining the meal. Other researchers recommend research be conducted to evaluate the time and cost component of meal preparation.

In order to develop the INFORMAS protocol, the meals approach will explore and develop methodology to compare the cost of popular takeaway meals and their healthy home-cooked counterparts as outlined in Table 7.

Table 7: Further research required for the development of the meals approach

Issue	*Description of issue*	*Research required to address issue*
Definition of healthy meal	No existing criteria cover required nutrients and composition of meal	Need to develop definition and criteria for a healthy meal
Determine size of meal for reference household	No definition	Need to develop system to determine size
Identify popular takeaway meals	Identify available sources of data	Explore feasibility of using nutrition survey, HES, and market research data
Process to select recipes	A range of recipes can reflect a meal and can vary in cost. A range of prices for each meal is required to perform tests of statistical significance	Develop a process to select a range of recipes for each meal
Define time	Define the components of time to use and the rate to cost time.	Identify time components of preparing and obtaining meals and decide which components are feasible to incorporate
Select takeaways for price collection	Unsure of variation between outlets	Collect takeaways from a range of outlets, weigh meals and components, collect prices

2.6 Studies of the cost and affordability of healthy and current diets

2.6.1 Introduction

The INFORMAS food prices foundation paper[19] recommends to measure the cost differential between healthy and less healthy diets and measure affordability of diets at the household level. This literature review section outlines data sources and tools used to assess and compare the cost and affordability of healthy diets compared to less healthy diets, and to monitor the relative change in costs over time.

Studies investigating the cost and affordability of diets use different approaches to identify the diet, define healthiness and calculate the cost, according to the study research question. This may involve developing a hypothetical diet from commonly consumed foods, or using data from observational or intervention studies on what people are actually eating. Researchers developing a hypothetical diet select items for the diets from national food consumption or expenditure surveys, foods recommended in food-based dietary guidelines, use expert judgement, or advice from focus groups. The healthiness of the diets can be defined by food-based dietary guidelines, nutrient reference values and healthy eating indices. An overview of studies is provided with details in Table 8 and Table 9.

Few studies have analysed the affordability of a healthy diet compared to a less healthy or 'current' diet, leaving the question 'Are healthy diets cheaper than the current diet?' largely unanswered. Methods described in the literature are specific to the information on current dietary patterns and food-based dietary guidelines available in the individual country. Useful tools were identified in these studies to guide development of methodology for the INFORMAS protocol that could be utilised by different countries according to the information available and the food environment.

2.6.2 Comparisons of healthy and current diets by developing hypothetical diets

Studies comparing a healthy diet to the diet currently consumed by the population are described in Table 8. Commonly consumed foods are usually derived from nutrition surveys or household expenditure surveys. The healthy diet can be developed by substituting items in a typical diet with healthier items, by developing a diet to meet food-based dietary guidelines, or based on a typical diet of those who meet dietary guidelines. Some research groups used focus groups to guide development. All the healthy diets in Table 8 are based on food-based dietary guidelines, unless otherwise specified. Each study compared the cost of one healthy diet with one current or less healthy diet. The diets were developed by the researcher, used actual foods reported consumed in a nutrition survey or used linear optimisation to model diets with a set of food and nutrient constraints (further described in 2.6.3.7).

A 1994 Australian study used many of these methods[158] when comparing the cost of three dietary patterns compared to the average Australian diet. A substitution diet was developed by substituting less healthy food choices in the average diet with healthier alternatives (lower in fat, fibre, or salt). The diet meeting dietary guidelines was based on the average diet identified from nutrition survey data of those individuals whose self-selected diets complied with the Australian Dietary Targets. The 12345+ healthy eating plan was designed to meet the Dietary Targets and Recommended Dietary Intakes. The authors conclude that healthy eating is not necessarily more expensive, but that restructuring the diet rather than a direct substitution approach results in a cheaper diet.

2.6.2.1 Developing diets to meet food-based dietary guidelines

Most countries have food-based dietary guidelines which provide evidence-based recommendations for a healthy diet. Most studies measuring the cost of a healthy diet utilise these. A healthy basket and a current basket were developed as a pilot to test a standardised pricing and affordability method to be used across Australia[(241)]. The healthy diet is based on the recommended servings in the foundation diet for each age/gender group of the Australian Guide to Healthy Eating and the acceptable macronutrient distribution ranges. The healthy diet contains foods from the five food groups and an allowance for unsaturated oils and spreads, but no ‘discretionary’ foods.

The current diet is based on the quantities and proportions of foods reported consumed in the Australian Health Survey 2011-2012 for each age/gender group in the five household scenarios. The diets were developed by the researcher and include takeaways and alcohol. The amounts were checked against the nutrient results from the Australian Health Survey. The quantities were not adjusted for under-reporting so intake and therefore cost may be underestimated[(242)]. The foods in both baskets are considered culturally acceptable, widely available and accessible ‘every day’ foods. The diets were priced in stores in a high and low socio-economic area in one large city. All households spent more on the current diet than they would have if purchasing the healthy diet. Over half (53-64%) of the household budget for the current diet is spent on energy-dense, nutrient-poor discretionary choices. In another Australian study, a sustainable healthy diet is more expensive than a typical diet as some foods high in fat and sugar are less expensive[(243)] than the more sustainable items.

The cost of a seven-day diet for an economical version of the US MyPlate dietary guidelines was compared to a plant-based olive oil diet with no animal protein and more servings of vegetables, fruits and whole-grains[(244)]. The diets were developed by the researcher and were equivalent in energy and most nutrients. The MyPlate diet costs 28% more than the plant-based diet. One-fifth of the cost of the MyPlate diet is from lean animal protein. One-tenth of the cost of the plant-based diet is from extra virgin olive oil (60g per day).

An economic model was used to simulate the current Danish diet and the New Nordic Diet from HES data[(147)]. Five income classes of households were modelled using a per adult-equivalent basis where one child is assumed to be equivalent to 0.7 adults. The healthy New Nordic diet would cost about 16% more than the current diet with the largest relative difference for low-income households. The price differential would be smaller if the emphasis on organic and Nordic origin products is relaxed.

A healthy diet was based on the actual foods eaten by a group of people in a study who met UK Food Health Policy Guidelines in 1990[(168)]. The less healthy diet was derived from the diet of a low-income group in the National Nutrition Survey who did not meet dietary guidelines. The healthy diet cost 63% to 73% more than the current diet.

2.6.2.2 Developing diets by substituting items

A healthy diet can be simply developed by substituting items from a typical diet for healthier items. The diets are based on commonly consumed foods so are likely to be realistic. A modest-but-adequate food budget was developed by adjusting a typical diet identified from a UK HES to meet the dietary guidelines using ordinary foods(245). There is little difference in cost between diets but for the healthy diet more is spent on breads, cereals, fish and potatoes and less on meat, poultry and fats.

Some studies are based on the US Thrifty Food Plan (TFP). The average cost of a standard basket based on the US TFP and a healthier basket was calculated(246). Though the TFP is a healthy eating plan, it does not have sufficient whole grains or the leanest meats. Healthier substitutes were identified for dairy, meats, canned fruit, fats, breads, and grain products. The cost of the healthier basket is 18% higher due to higher costs of whole grains, lean ground beef, and skinless poultry.

Two studies in South Africa modified the usual household diet determined by dietary surveys to develop a healthy diet to meet dietary guidelines by substituting healthier versions of the regular items. Compared to the usual diet, the healthier diet cost 9% to 12% more in urban areas(146,247) and 69% more in rural areas(165).

2.6.2.3 Using focus groups to develop the basket

There may not be sufficient information on commonly consumed foods and dietary patterns to develop healthy and current diets. Focus groups provide additional knowledge, can check acceptability of diets, particularly for specific population groups, and support a rationale for inclusion or exclusion of items. They can be biased by popular beliefs and lack robustness. The methodology for developing reference baskets in European Union countries uses focus groups to check the acceptability and feasibility of the baskets(248). The food reference budget developed in Spain(249) used focus groups in this way.

A healthy diet was developed to be culturally acceptable to people on a low-income(250). Information on foods purchased from the Canadian Food Expenditure Survey was provided. Focus groups determined the commonly consumed foods from a list. Supermarkets and grocery stores were chosen to price items, as this is where people do the majority of their shopping.

2.6.2.4 Summary of studies comparing healthy and current diets

A range of methods are used to develop hypothetical healthy and current diets. The healthy diet requires guidelines to describe a healthy diet such as food-based dietary guidelines. The current diet is based on existing data on eating patterns such as a nutrition survey. The diets can be developed using different methods with each having strengths and limitations. The diet developed by the researcher is not confounded by factors associated with eating patterns such as income, but is affected by the subjectivity of the researcher. The diet based on actual foods is affected by confounding factors but is realistic. A diet selected by linear optimisation is objective but the programme does not ensure the diet is realistic as a daily menu.

Table 8: Details of studies costing healthy and current diets

Author	Study population	Source of dietary data	Diets	Source of price data	Result	Type of price collected for each food
Donati et al 2016[251]	Adolescents Italy	Nutrition survey for current diet	Healthy and sustainable diet compared to current diet, created by linear programming	4 retail stores most frequented by participants	Possible to create a healthy and sustainable diet at same cost as current diet	Specified brand
Lee et al 2016[241]	5 reference households Australia	Nutrition survey for current diet and common foods	Current diet with 68 foods Healthy diet that meets dietary guidelines with 38 foods	Retail stores Randomly selected high and low socio-economic areas, selected store from 1 of each 3 chains in each area	Current diet cost 66-99% more than healthy diet, depending on household composition	No generics * Standard package size
Flynn & Schiff 2015[244]	2000 calorie diet for an adult US	Foods recommended in food-based dietary guidelines (MyPlate)	MyPlate Plant-based olive oil diet Diets isocaloric	1 retail store Sampling not stated	Plant-based diet 28% cheaper than MyPlate	Cheapest *
Jensen et al 2015[147]	Population aged 4-75 Denmark	HES	Healthy diet: New Nordic Diet Current diet developed from HES Created by a combination of models	HES	New Nordic Diet cost 16% more than current diet	Branded and generic Average unit price

Author	Study population	Source of dietary data	Diets	Source of price data	Result	Type of price collected for each food
Friel et al 2013[252] Barosh et al 2014[252]	2 parents & 2 children Australia	National survey & HES Healthy basket adapted from typical diet	Healthy, sustainable (48 items) versus typical (53 items)	82 retail stores Regional representative sample Selected zones in areas and collected from all stores	Healthy basket cost 4-30% more than current diet depending on area	Cheapest *
Germani et al 2014[253]	Expenditure on food from HES Italy	Nutrition survey	Mediterranean diet Current diet	Food price database	Mediterranean diet similar price to current diet but proportion spent on food groups differed	Food price database
Temple et al 2011[165]	Rural South Africa	Nutrition survey	Usual diet developed from nutrition surveys. Healthy diet developed from usual diet	21 supermarkets and small food stores in 14 rural towns	Healthy diet cost 69% more than usual diet	Not stated
Temple & Steyn 2009[146]	Urban South Africa	Nutrition survey	Usual diet developed from nutrition surveys. Healthy diet developed from usual diet	3 retail stores Popular supermarket in each of 3 residential areas	Healthier diet cost 9-12% more than usual diet	Item a local person likely to purchase
Jetter & Cassady 2006[246]	Cross sectional price survey US	Thrifty Food Plan	1995 TFP versus healthier diet adapted from TFP	25 retail stores Variation in deprivation of areas Sampling not stated	Healthy diet cost 18% more than TFP	Cheapest

Author	Study population	Source of dietary data	Diets	Source of price data	Result	Type of price collected for each food
Conforti & D'Amicis 2000[148]	Modelling Italy	Usual diet from HES	Modelled healthy diet	HES	Healthy diet 20% cheaper than usual diet	HES
McAllister et al 1994[158]	Diets based on average diets of study populations from regional nutrition surveys Australia	Based on quantified FFQ from regional nutrition surveys, modelled diets or based on diet plan	1. Healthy diet by substitution 2. Average diet of participants who comply with dietary guidelines 3. 12345+ diet plan Compared to average diet from nutrition survey	4 retail stores Sampling not stated	12345+ plan slightly cheaper than average diet per MJ, Substitution and dietary guidelines diets more expensive than average diet per MJ	Cheapest
Mooney 1990[168]	Participants in nutrition survey meeting dietary guidelines England	Low income participants in national nutrition survey not meeting guidelines	Foods for healthy and usual diet for a week	9 largest retail stores	Healthy diet cost 63-73% more than usual diet depending on neighbourhood	Large, medium, small package sizes Price type not stated
Nelson & Peploe 1990[245]	2 parents & 1 child UK	National food survey, HES	Healthy diet by substitution from current diet	Retail stores Number not stated	Healthy and typical baskets similar price	Average of brands with highest sales volume

HES = Household Expenditure Survey

* Use of discount or standard price not stated

2.6.3 Studies of the cost of healthy diets

Some countries have a national healthy food basket for which the cost is calculated annually and compared over time. The purpose is to assess the cost of a healthy diet, food affordability and monitor trends rather than a comparison with a less healthy diet. The cost and affordability of a healthy diet can be analysed for different income groups, households and regions. The diets are described in Table 9. Details of their affordability are described in Table 10. All diets are based on commonly consumed foods and meet the dietary guidelines of the respective country. As many of these diets are used regularly over time, the methodology has been tested so has informed the diet approach of this thesis.

The price collection of the foods is guided by a protocol which usually states brand, package size, inclusion of discounts, exclusion or inclusion of generic labels, and missing food items. Retail prices are collected manually, electronically, in-store, on-line, using catalogues or a food price database. The protocol may state the number of retail outlets for price collection, type and size, time of year of data collection and consideration of seasonal products.

2.6.3.1 New Zealand

The University of Otago(254) has conducted an annual food cost survey since 1972. The weekly cost of purchasing a healthy diet for men, women, adolescents, and children is calculated for a basic, moderate and liberal diet. Some discretionary foods and pre-prepared meal items are included. The basic cost category assumes all foods will be prepared at home, contains the most commonly consumed fruits and vegetables and the lowest priced items. The moderate and liberal cost diets allow for more variety, convenience foods, imported foods, some fruits and vegetables not in season, and specialty foods. The diets do not account for takeaway or restaurant foods, ready-made meals, special dietary needs, access to cooking equipment, spices and condiments.

The foods in the diet were reviewed in 2014 to account for changes in consumption identified by the 2008/09 National Nutrition Survey(89). For each food category, a weighted average was calculated which differed to previous food cost surveys where a simple average was used. For example, if apples accounted for half of the frequency of fruit consumption then apples would be half of the amount costed for fruit consumption. Compared to the previous household diet, the overall cost of the diet is lower for some age/sex groups, partly because reported energy levels reduced and the use of the composite method meant more of the cheaper foods are included, such as cheap seasonal fruit. Using the weighted average means the diet is more likely to reflect the types and amounts of foods actually consumed, and therefore more likely to reflect the cost of the current diet than the previous method.

2.6.3.2 Australia

Six major food-pricing tools are used in Australia(43) to measure changes in food prices over time, to compare differences in food prices within a region, and to survey availability of foods, particularly remote areas. All the current tools are developed from dietary guidelines. All tools, except the revised

Queensland Healthy Food Access Basket (HFAB), include several less healthy foods to reflect a realistic diet.

Currently a Healthy Diets Australian Standardised Affordability and Pricing method (ASAP) method is being developed co-operatively to enable replication of pricing the basket across states and territories. The method involves development of two baskets to compare the cost and affordability of a healthy diet with the current diet(241). The methodology being developed has contributed to the methodology developed for the diet approach in this thesis.

The original Queensland HFAB(55) meets the nutritional requirements of a household for two weeks and provides 70% of dietary requirements. Energy rich 'non-core' foods (margarine, oil and sugar) are added to bring the energy content to 95% of the requirements. Frozen and canned foods are included to reflect availability in remote areas. The HFAB was redeveloped in 2014(255) to be consistent with the 2013 Australian Dietary Guidelines. The eating plan is aspirational with more wholegrain cereals and only lean meat cuts. A Victorian Healthy Food Basket(52) was adapted from the original Queensland HFAB for Victorian purchasing trends.

The Western Australia Food Access and Cost Survey(256) has foods common with other Australian food baskets. Using the same prices, the cost of the Food Access and Cost Survey was compared to the foods in the Queensland HFAB and the Northern Territory baskets with similar results for each basket.

2.6.3.3 United States

The Thrifty Food Plan (TFP)(87) is a nutritious representative diet at a minimal cost. It is used as a basis for the Supplemental Nutrition Assistance Program. The Low-Cost, Moderate-Cost, and Liberal Food Plans reflect current dietary recommendations, food consumption patterns and food composition data at different cost levels(257). All plans have more vegetables, fruits, and milk products and less moderation foods (fats, oils, sweets, snacks, takeaways) compared with reported consumption. Prices are based on what low-income people actually pay for food, using Nielsen's Homescan panel that matches food purchases to prices charged and income. Costs are updated monthly using the CPI.

A mathematical optimisation model was used to develop the plans representing actual food consumption patterns that also meet Recommended Dietary Allowances and cost limits by modifying the average consumption patterns from NHANES of 15 age and sex groups. The weighted average price per 100g of each group was determined based on the average consumption by all people in the group within the expenditure quartiles. For example, the average price of citrus fruits was based on the consumption of oranges, grapefruit etc.

2.6.3.4 Canada

A National Nutritious Food Basket(88) was developed in 1998 to monitor the cost and affordability of food for various age and sex groups. Data from the national nutrition survey was used to calculate the frequency of foods consumed. The food pricing is undertaken by regions with the flexibility to modify the basket and develop protocols to meet a region's food patterns but not to compare regions. There is a guide to developing a food costing protocol with the amount of each food for one week. Most provinces in Canada monitor the cost of food and food affordability.

2.6.3.5 Monitoring the costs of baskets over time

Changes in the cost of healthy diets and food groups have been monitored over time. The cost of the Queensland HFAB increased 63% from 2000 to 2010. From 2000 to 2006, the cost rose 50% across Queensland which was higher than the CPI for foods in Brisbane which rose by 32.5%[(258)]. From 2006 to 2010 the cost rose 9.7%, which was lower than the increase in the CPI for foods except for very remote areas[(259)]. Between 2006 and 2010 the price increases were greatest for the bread and cereals group (40.2%) and dairy foods (21.5%) but fruit decreased by 27.7%.

The cost of the Queensland HFAB in New South Wales increased from summer 2006 to summer 2008 then deceased to winter 2009, in line with the CPI for foods[(260)]. Most food categories increased in cost with the greatest increase for dairy foods and breads and cereals.

The cost of the Illawarra Healthy Food Price Index rose from 2000 to 2009 by 38.4%[(31)], which was similar to the rise in the CPI for food of 37.6%. The cost increase varied across food groups with the price for fruit increasing 64%. The cost of the Northern Territory basket increased 48% from 1998-2007 [(261)]. In Western Australia, the cost of the basket increased 2.9% from 2010 to 2013 with a larger increase in remote areas[(262)].

It is useful to be able to identify food groups that have changed in price at a different rate than other food groups. When the price of healthy foods, such as fruit and vegetables, increase at a relatively higher rate than the CPI, this provides important information to advocate for tools to promote affordability. Including the current diet will enable the change in price of healthier food groups to be compared with less healthy foods groups.

Table 9: Details of studies of the cost of healthy diets

Basket	Source of diet data	Diets/foods	Source of price data	Type of price collected for each food
NZ University of Otago annual food cost survey[89]	National nutrition survey	150 foods	Supermarkets in 4 centres annually Highest volume, includes both major companies	Cheapest No discount
Australia Queensland healthy food access basket[55,255]	Popular foods	44 foods	Retail outlets Depends on survey: largest store in largest town in each district; convenience sample; random selection town based on population, popular store	Cheapest No generics No discount Standard package size
Australia Illawarra healthy food price index[263]	National nutrition survey	57 foods	Retail outlets 5 locations based on deprivation Largest supermarket, largest butcher, green-grocer each shopping centre	Cheapest No discount
Australia Victorian healthy food basket[52]	Queensland HFAB AC Nielsen HES	Adapted from Queensland HFAB 44 foods	Retail outlets Sampling varied between studies	Cheapest brand for most studies No discount No generics
Australia Food access and cost survey Western Australia[256]	Other healthy food baskets Reports on top selling brands	430 items 190 foods	Retail outlets 1 store each chain in statistical area, all stores in very remote areas Areas selected by systematic random sampling according to size	Multiple brands, including generic Discount and usual price

Basket	**Source of diet data**	**Diets/foods**	**Source of price data**	**Type of price collected for each food**
Australia Northern Territories[261]	Core food groups Consultation with grocery suppliers and nutritionists	29 foods	Retail outlets 1 major supermarket & corner store in each district centre, remote stores	Not stated
US Thrifty, low, moderate, liberal food plans[87,257]	NHANES	Modelling to meet nutrition guidelines and cost constraints	Food price database	Average retail price
Canada National Nutritious Food Basket[88]	National survey data	67 foods	Retail outlets Determined by regions Convenience sample to reflect urban/rural mix, include all major chains	Cheapest Discount
Scotland Healthy eating indicator shopping basket tool[53]	Scottish diet report	35 foods	466 retail stores Stratified random sampling 9 survey areas to represent range SES & location 466 stores	* ** Standard package size
Ireland 2004[264]	HES	Not stated	National price: Online supermarket Local price: 13 outlets, sampling not stated	Separate analysis with and without generic *
Spain 2016[249]	National food survey Focus groups	Not stated	Supermarket in 1 city	Complex calculation of average and cheapest products

* Use of discount or standard price not stated

** Inclusion of generic labels not stated

2.6.3.6 Systematic review of the cost of healthy and current, less healthy diets

Rao et al[56] conducted a systematic review and meta-analysis of the prices of healthier versus less healthy diet patterns. Fifteen intervention or cross-sectional nutrition studies that reported the mean retail price of diet patterns stratified by healthfulness were included. The number of participants ranged from 30 to almost 80,000. Prices were adjusted for inflation and World Bank purchasing power parity and standardised to the US dollar.

Price comparisons were made for categories of food-based dietary patterns. Overall, the healthiest category of diet cost $1.48 more per day than the lowest category. This difference is slightly larger when comparing dietary patterns per 2000kcal, with healthier diets costing $1.54 more per day.

Some studies categorised the healthiness of diets from population studies based on criteria relating to sugar, fat, or fibre. The price of the healthiest category of diet meeting the criteria was compared to the lowest category. When the total cost per day of the diets was compared, there is no difference in cost. However, when the diets are compared per 2000kcal, the healthier diets cost $1.56 more per day. For certain metrics of healthiness, the selected unit of comparison alters the results, especially those based largely on fat content as this provided more calories.

Similar results are obtained when the analyses are repeated adjusting for intensity of contrast in healthfulness. Diet patterns that differ by a single nutrient are rated as lower intensity than contrasting diet patterns. Evaluating single or selected nutrients does not fully consider food-based dietary patterns. The review is subject to the limitations of the studies, the lack of studies and the varying definitions of healthy food or diets. These limitations need to be considered when developing a methodology to compare the cost of a healthy diet with the current diet, for example the price metric, energy level of the diets and the definition of the healthy diet.

2.6.3.7 Dietary modelling to measure diet costs

Various forms of dietary modelling have been utilised to measure the cost of a diet. Often linear optimisation is used to arrive at one solution that meets the nutrient and food constraints of the model. A nutri-economic model was used to assess and identify the most affordable food choices for an Italian adult using 71 foods from a national prices database[177]. The price and nutritional quality of foods within the cereals group and the legumes group are similar. The nutritional quality of seasonal fruits and vegetables vary while prices are similar. Products of animal origin have similar nutritional qualities but prices vary. The products considered the best nutri-economic choices are milk, oily fish and poultry. Two balanced weekly menus of similar nutritional quality were analysed. The menu with cheaper options for foods of animal origin cost 30% less. A review[98] found legumes, nuts, oils and whole-grain cereals have good ratios of nutritional quality to price, based on a nutritional profile model of beneficial nutrients and nutrients to limit.

A usual diet pattern was developed using commonly consumed foods identified from the Italian Household Budget Survey[148]. Modelling with nutritional and food habits constraints generated a pattern following recommended daily allowances and nutritional guidelines incorporating familiar foods. The healthy diet is 20% cheaper than the usual diet pattern. In NZ, modelling of eight scenarios found that low sodium, low cost, nutritious diets using familiar food items are achievable and cheaper than a typical diet[(265)].

Linear programming allows testing of the impact of different levels of healthiness, cost or acceptability on the other constraints. In two studies using linear programming, as costs become constrained, diets contain less fruit, vegetables, meat and dairy and more sweets, added fat and refined cereals[(266,267)]. In three studies using linear programming[(47,268,269)] the minimum cost of the diet increases as the nutrition and acceptability constraints increase. A healthy diet can be met at a low cost but as the diet became more acceptable, the price increases. In Denmark, a low cost diet that met nutrient recommendations was modelled with only twelve foods[(269)]. Ensuring the diets also met dietary guidelines doubles the cost, and ensuring the diets were culturally acceptable triples the cost.

Save the Children[(270)] have a tool to enable estimation of the minimum cost of diets for household members with nutritional and acceptability constraints using a FAO food composition database and WHO recommendations for individual energy nutrient requirements. Locally available seasonable foodstuffs and prices are entered along with household composition and the maximum amount of each food various household members can realistically consume.

2.6.3.8 Summary of studies of the cost of healthy diets

Some research groups use linear programming (mathematical optimisation models) to define diets that meet nutrition recommendations for a minimum cost[(47)], while others only price a few key food groups such as fruit and vegetables, or food staples[(271-273)]. Many define diets based on objective nutritional criteria excluding less healthy or indulgence foods[(52,53)]. Others define diets based on data of normal food purchasing patterns, particularly when the focus is on food security, and to ensure the diets are realistic and acceptable[(54,55)]. Diets are often developed for specific age and gender groups, common household types or the cultural preference of the region.

As many of these diets have been used regularly over time, the methodology has been tested. Aspects are incorporated in the methodology for the INFORMAS diet approach, such as basing the healthy diet on food-based dietary guidelines and nutrient reference values. Some of the methodology is considered too complex to be used for routine monitoring, such as weighting the commonly consumed foods by consumption.

2.6.4 Population studies

Rather than constructing diets, dietary data collected from individuals participating in intervention, cohort or cross-sectional studies can be used to compare the cost of diets stratified by healthiness. These studies are from free-living participants whose food choices are influenced by many inter-related factors, such as those with a higher level of education have a higher income and a healthier diet. This is often interpreted as a heathier diet costs more, when the interpretation should be that those with a higher income spend more on diet. The comparison can be analysed by the cost of the total diet or the diet adjusted to equal energy. The results reported from population studies are mixed, finding either no difference in cost between healthy and less healthy diets, healthier diets are more expensive or healthier diets are cheaper.

2.6.4.1 Intervention studies

A number of diet intervention studies costed the usual diet at the beginning of the trial and compared this to the cost of the healthier diet at the end of the trial. The healthier diet is often lower in energy. Most (8 of 12 studies) reported that the total cost of the intervention diet is a similar cost to the usual diet(274-281) though one of the intervention diets is more expensive per MJ(279). The total cost of the intervention diet is higher in two trials(282,283) and lower in another two trials(284,285), though one is the same price per MJ(284).

2.6.4.2 Observational studies

A number of observational studies compared the cost of those eating a healthier diet to those eating a less healthy diet. Some studies measured the cost of the diet and some adjusted the energy of the diets to be isocaloric or measured the cost per kJ. A range of indicators are used to assess the healthiness of the diet based on nutrients or dietary patterns or adherence to food-based dietary guidelines, the DASH diet or a Mediterranean diet. Most studies found that those with a healthier diet spend more on food(49,91,93,95,155-157,286-295). One study found(281) little difference in overall cost.

Data from the NHANES has been used to compare the costs of the participant's diets with nutritional quality. Foods consumed were linked to a national food prices database. Two studies(92,296) found that if more is spent on the diet the nutritional quality is higher.

A number of studies analysed data from French national or regional food consumption surveys. Retail prices were collected by some, or all, of the following: retail data from a market research company, French National Institute of Statistics, supermarket websites. Analyses were undertaken using measures of healthiness, energy density and nutrient density. Energy cost was measured per 10MJ. Diets of lower energy density are associated with higher nutrient density and higher diet costs(50,297-301).

One observational study monitored the cost and healthiness of Spanish diets from 2000 to 2010(302). An improvement in diet quality, measured by adherence to a Mediterranean diet and energy density, and better body weight management is associated with an increase in diet cost (adjusted for energy). The price of healthy foods increased at a higher rate than less healthy foods.

Differences in the proportion of spending on food groups was reported with the healthiest diets generally spending more on core food groups and less on high-fat dairy and meat, discretionary foods and beverages(155,281,287,288,302). Diet cost increased with diversity in the UK(157,303).

2.6.4.3 Population sub-groups

Studies reporting the characteristics of those who eat the healthiest diets found they are more likely to be vegetarian, have a higher energy intake, lower BMI, are older(91,155) have a higher socioeconomic status[157], higher income and higher educational achievement[295]. In the UK, those consuming the recommended levels of fruit and vegetables have higher diet costs[295]. In contrast, a Dutch study found no differences in diet costs by income level[291]. The relationship between energy density, nutrient intake and dietary cost in Japan differs to the Western diet. Higher diet costs are associated with healthier food and nutrient intake patterns, except for sodium, alcohol and cholesterol[304-306]. Those with higher diet costs have higher educational achievement, higher household expenditure, a smaller household, are older or more active[304].

For any level of diet cost, there is a wide variation in diet quality. Some observational studies found certain sub-groups show nutrition resilience[103], as they consume a healthier diet that does not cost more than those consuming a less healthy diet. Improvements in diet might be achieved without increased spending, by selecting foods with higher nutritional quality for their price. Researchers analysing NHANES data found that older adults, women, Mexican-American and other Hispanic adults achieve higher quality diets at a lower cost than other groups[103,104]. There is variation in diet quality between quintiles and within each quintile of diet cost in the US Nurses' health study[93]. Those with a healthier diet spend more on nuts, soy and beans, and whole grains and less on red and processed meats and high-fat dairy.

In France, some low-income participants have a higher quality diet than others at no additional cost[292]. A German study divided a sample of children and adolescents in half according to diet quality[293]. There is no significant association between diet costs and diet quality in the lower diet quality records.

When considering nutrients per calorie and nutrient per unit cost, some foods are more affordable than others. In South Africa, there are many foods that have both a low cost of dietary energy and low energy density (for example, oats and beans)[146]. In the US and France, higher proportions of dairy products, citrus fruit, nuts, beans or cereals are not linked to higher diet costs[103]. The affordability of fruit and vegetables in eighteen countries of a range of income levels was estimated. The consumption of fruit and vegetables is lower when the cost compared to income is relatively higher[307].

2.6.4.4 Population sub-groups

Many of the intervention studies report the healthier diet of the intervention is a similar cost, or slightly more than the usual diet. This differs from observational studies of people's usual diet that observe obesity and poor diet quality are linked to lower income populations with the implication that healthy diets are more expensive than less healthy diets[98]. The diets in intervention studies are determined by the intervention so may not be reflective of usual healthy or current eating patterns. The cost of diets observed from population studies is confounded by factors such as income and education, so a healthy diet may be more expensive but this could be due to educated people on a higher income choosing a more expensive diet.

2.6.5 Defining healthy diets

The INFORMAS food prices foundation paper[19] identifies a lack of standard definitions of healthy and unhealthy diets. A system is required to consistently define foods and diets, differentiating foods and beverages that are more likely to be part of a healthy diet from those foods that contribute to a less healthy diet[308]. Some definitions used in the literature are food-based with foods grouped in categories while some are nutrient-based. Definitions are usually based on national food-based dietary guidelines and/or nutrient reference values[309].

2.6.5.1 Food based dietary guidelines

The 2004 WHO Global Strategy on Diet, Physical Activity and Health encourages governments to provide food-based dietary guidelines to advise national nutrition policy, nutrition education, intersectoral interventions and collaborations[310].

> 'Dietary Guidelines are sets of advisory statements that give dietary advice for the population in order to promote overall nutritional well-being and to address all diet-related conditions. They have usually been expressed as food groups'[7].

Dietary guidelines should be based on current dietary practices and public health problems as well as nutrient requirements and recommended intakes[7]. Dietary guidelines allow information to be communicated to consumers in terms of the way food is eaten using common language[311]. In 2016, a review found 83 of 215 countries had official national food-based dietary guidelines with low income countries less likely to have guidelines[312].

Relative consistency is demonstrated between messages provided by the dietary guidelines of various countries[76,311,313,314]:

- variety and balance
- a variety of fruits and vegetables
- more fruits and vegetables, legumes
- a variety of whole grains
- whole foods, less energy-dense processed foods
- moderate dairy, lean meats and poultry
- less added sugar, salt and saturated fat
- emphasis on plant oils
- moderate alcohol intake.

Guidelines are usually based on broad food groups[315] generally grouped as grains, vegetables, fruits, meat and alternatives, milk and dairy products, and fats and sugar. Sub-groups may be used when foods within a group vary substantially in nutrient content, for example whole and refined grains[315]. In developing countries, foods may be classified according to function. In Fiji, foods are grouped as: protective (fruit and vegetables), energy (grains, root crops, small amount fats and oils), body building (meat, fish, poultry, eggs, legumes, nuts)[316].

Different dietary patterns can be consistent with good health so dietary guidelines vary among population groups and regions. Dietary guidelines need to be based on the country's culture, social and economic factors[317] taking into account usual dietary patterns, local foods, food processing, preparation and cooking methods. A single global food guide is likely to be too simplistic, and would be very difficult to implement and promote to the public[311,318]. Therefore, a country should use its own food-based dietary guidelines where available.

If food-based dietary guidelines are not available, or do not provide sufficient guidance, those of a similar country can be used to develop the diet for food pricing. Alternatively, the WHO population nutrient intake goals[319] with recent revisions of goals for fat[319,320], free sugars[321] and sodium, along with the WHO recommendations for vitamins and minerals[322] can be used. These are based on current scientific knowledge concerning the relationships between dietary factors and the most common diet-related chronic diseases worldwide[319]. The goals are listed in Appendix One.

An individual country's sodium target or the WHO target of no more than 2000mg per day is an appropriate target[323] for the healthy diet. Australia and NZ[11], Canada and US Nutrient Reference Values[324] have an upper limit for sodium of 2300mg per day. Most healthy food diets described in section 2.6 do not meet the sodium recommendation for their country[55,88,257,263,325], so an amount close to the target, below the median or mean population intake, or another target is used. These countries consume a typical Western diet.

A healthy diet needs to meet food-based dietary guidelines with quantified recommendations of servings from food groups. This is the recommended procedure for developing a reference budget for EU countries[248]. To guide the development of a menu, the recommended number of servings per week for a food group is required, for example, 2 servings of fruit (120g = 1 serve). Some food-based dietary guidelines provide a comprehensive guide to the number of servings and the definition of a serving size by weight or volume for different age and gender groups. The advice provided in other guidelines is less quantifiable so the guidelines of a similar country could be used instead.

2.6.5.2 Nutrient reference values

The healthy diet will meet the nutrient reference values of their own country for: energy, fat, carbohydrate, protein, saturated fat, fibre, total sugar and sodium. Most healthy diets described in the this literature review aim to meet nutrient reference values though this is not always possible for some nutrients[52,55,88].

2.6.6 Defining the current diet

The current diet reflects the dietary pattern currently consumed. Recent nutrition survey data are required to identify current nutrient intakes and food group consumption. The average nutrient intake and contribution to energy (where relevant) is identified for the relevant age/sex group of each member of the reference household for: energy, fat, carbohydrate, protein, saturated fat, fibre, total sugar, sodium and alcohol.

The number of servings or grams of each food group currently consumed is used to guide selection of the type and amount of foods in the menu. Ideally the consumption of fruit, vegetables, meat and alternatives, wholegrain and refined grains, reduced fat and full-fat dairy, fats and oils and discretionary foods is identified. If this is not available, a FFQ can indicate the proportion in which the most commonly consumed foods in a food group need to be included. For example, if apples are consumed more frequently than oranges this would be reflected in the current menu.

2.6.7 Energy requirements of the reference household

When hypothetical diets are constructed to assess diet costs, the content of the diet is anchored to the energy and nutrient requirements of an individual in the household. Observational studies that compare the actual diet costs of populations often compare the cost per unit of energy, as well as the daily energy intake with the individual diets divided into categories standardised for energy to allow for activity, sex and body size differences.

Studies that use hypothetical healthy and current diets to assess diet costs determine the energy requirements of the diet in different ways: the energy requirement represents the current energy levels of the population for the current diet and the recommended energy level for the healthy diets(46); there is less energy in the healthy diet(165,168); the cost per 10MJ(158) is calculated. In some studies energy is not reported(246,252). A food budget standard (326) uses the median height for the age/sex group and the corresponding mid-point in the healthy weight range. Then a physical activity level of 1.5 is chosen accounting for some regular exercise. A study comparing the cost of the current diet with an intervention Mediterranean diet uses BMI to calculate the estimated energy requirement to assess under or over-reporting(285).

A systematic review(56) of diet costs using hypothetical diets or observational studies found the price differential between healthier and less healthy food-based diet patterns is similar when measured per day ($1.48) and per 2000kcal ($1.54), with the healthier diets significantly more expensive. There is no significant difference in price between healthier and less healthy nutrient-based diet patterns when measured per day ($0.04) but there is a significant difference when standardised to 2000kcal ($1.56) with the healthier diets significantly more expensive.

Jones and Monsivais(57) recommend using the cost per unit of energy to compare the costs of different diets. The total diet should be within a specified level of energy intake based on age, sex and physical activity levels.

As the methods to determine energy requirements vary in the literature, a decision is required on the method to use for the INFORMAS protocol. Decisions centre on whether to have the members of the reference households for each diet at the average BMI of the current population or at a healthy BMI and similarly whether physical activity is set at the current population level or the recommended level. Further decisions are needed on whether to use reported energy intake from dietary surveys to define total energy intake or to back-calculate energy intake from body weight and physical activity level (PAL is the multiple of resting metabolic rate expended for active movement).

2.6.8 Measurement of the affordability of diets

Very few studies compare the affordability of the current diet to a healthy diet. Food is only one aspect of household expenditure and food costs can be more flexible compared to fixed and non-negotiable costs like rent, electricity, heating, health and transport costs[84,85,94]. Higher income groups spend more on food, but this can represent a smaller proportion of their total expenditure[301,327]. It is the relative cost of food compared to disposable household income that influences food purchasing, especially among those on lower incomes. An income level(s) must be selected that enables affordability to be calculated at a level that provides useful information at the household level. Ideally the affordability measure can also be used across countries.

Income benchmarks used by researchers include household income, poverty level, minimum wage, income from government support or minimum income standards. Many countries have national income surveys, though definitions of income may vary. Some studies use data from household income surveys, calculating affordability for common household types and different percentiles of income. A measure of income needs to be selected for the INFORMAS diet approach that is appropriate for high, middle and low-income countries. Household income, wages and a poverty level are considered.

There is no accepted benchmark for the proportion of diet that should be spent on food, and this will depend on the proportion of income required for other expenses, particularly housing. Kettings et al[30] cite that the only Australian benchmark available for an acceptable proportion of disposable income of a low-income family to be budgeted on food was one quarter or 20-25% of income, though this was from 1991.

Changes in affordability can be measured over time, though the benchmark can also change, for example an increase in the minimum wage. When comparing food affordability between countries it is important to use a benchmark with a similar definition. Many potential benchmarks are relative to the wealth and spread of income within a country. For example, minimum wage may be close to the poverty level in some countries, but well above the poverty level in other countries. To aid in comparisons between countries, wages can be converted to purchasing power parity dollars (PPP$)[4].

2.6.8.1 Household Income

Household income is measured at the household level, and includes wages and government transfers, income from self-employment, property income, income of services for own consumption (such as imputed rents and unpaid domestic services) and current transfers (government sponsored social insurance schemes, employer sponsored benefits, social assistance benefits, transfers from other households or non-profit institutions such as unions)[4]. Income can include profit/loss from business, investment income, private cash transfers (child support, workers' compensation, income from annuities)[5].

Disposable income represents the income available to a household after deduction of income tax and transfers such as pension contributions, employment insurance contributions, union and professional fees, child/spousal support payments and work-related child care expenses[5,6]. Data on disposable income is available for some countries[4], including all Organisation for Economic Co-operation and Development (OECD) countries[328].

Income is usually received by individuals and shared within the household so household income, rather than individual income, reflects distribution of income. The simplest method of adjusting for differences in household size is on a per capita basis. There are economies of scale from living together so equivalence scales are applied to indicate the economic resources available to each individual within a household[4], allowing households of different size and composition to be compared.

2.6.8.2 Wages

Wages refer to gross remuneration in cash and in kind paid to employees. The proportion of household income received from wages is higher in high-income countries, with self-employment a large share of household income in lower-income countries. In high-income countries, government income support is an important contribution to income[4].

Common measures of income are the minimum wage and average wage. The minimum wage is the legal minimum that all employers must pay[329]. The Wage Indicator Foundation compiles a minimum wage database with information for 63 countries that have a minimum wage[330]. The International Labour Organisation provides a database of the minimum and mean wage of each country, in the currency of the country[4].

2.6.8.3 Poverty level

An absolute poverty line remains fixed over time, adjusted only for inflation, so represents the same purchasing power every year. Almost all absolute poverty lines are set in terms of the cost of purchasing a basket of goods[138,331]. A relative poverty line is used in most countries to identify those in poverty. These are revised over time, typically reflecting social consensus about what constitutes poverty. The poverty line will be relatively higher in higher-income countries and rises as median income rises[331]. OECD countries use the median income as a reference for poverty[332].

2.6.8.4 Minimum income standards

Minimum income standards (or budget standards) translate defined needs into the required budgets for a defined standard of living[333] considering social norms and actual expenditure[326]. Household costs based on the prices of baskets of goods or services are estimated, for example food, clothing, utilities, housing, transport, household goods and services, leisure goods and services[54,334]. The baskets are combined to represent the income required by households of different composition to reach the living standard. A living wage is calculated to meet the basic costs of living in a specific community such as food, shelter, clothing, transportation, child-care, emergencies and other expenses[329].

2.6.8.5 Use of food affordability measures

Affordability of diets assesses whether a specified diet is affordable for a defined income level of a defined individual or household. The European Commission has proposed member states develop reference budgets to aid in the design and monitoring of adequate income support(151). The Government of Slovenia ensures that welfare payments are sufficient to cover the costs of a healthy food basket(335). In the US, the cost of the TFP is used as a basis for the Supplemental Nutrition Assistance Program(87). A Minimum Income Standard for the UK is used in policy debate and to set the living wage(336).

2.6.8.6 Development of a measure of food affordability for the diet approach

INFORMAS requires a consistently defined benchmark that reflects the income of the household that can be used by different countries and has a reliable source of data collection. The preferred measurement is equivalised disposable household income, as it accounts for all the income of a household after tax and other compulsory expenses(337). Some potential benchmarks are relative to the wealth and spread of income within a country. For example, minimum wage may be close to the poverty level in some countries, but well above the poverty level in other countries. A poverty level varies between countries so is not a suitable benchmark. Wages do not include all household income, particularly in lower-income countries, therefore these are less useful for comparing food affordability between countries. A country may choose to use minimum wage, income support or the poverty level as an additional indicator.

The OECD reports median disposable household income for OECD countries in the country's own currency(337). The World Bank reports poverty measures but not median income(338). Other countries can use the most recent household income survey. The OECD definition of disposable income is(328):

> 'Disposable income encompasses all income sources. It therefore includes net transfers from Government (cash transfers net of direct taxes paid by households) in addition to market income, which covers both labour income (wages, salaries and self-employment income) and income derived from capital.'

The OECD equivalence scales are commonly used which divides household income by the square root of household size. For example, a household of four persons has needs twice as large as a household of one(328).

When comparing food affordability between countries, it must be noted that household income can be difficult to determine in developing countries due to under-reporting, the informal nature of work, seasonal and part-time work(339).

2.6.9 Studies measuring the affordability of diets

The development of the healthy diets used in the following studies is described earlier in this chapter. Details of the households and affordability measures used in each study are outlined in Table 10. Not all studies report whether the income benchmark was before or after tax.

One study compares the affordability of a healthy diet to the current less healthy diet. The pilot of the Healthy Diets Australian Standardised Affordability and Pricing methods conducted in Brisbane found the healthy basket would require 18% of median household disposable income but 28% for low income households, while the current diet would require 20% or 32% of income respectively[241]. Another Australian study found the cost of a healthy and sustainable basket[243] is less affordable than the typical basket.

Monitoring affordability of the healthy diet over time provides useful information to advocate for changes to income support or the minimum wage, or fiscal policies to improve the affordability of diets. In Australia, affordability of the Illawarra Healthy Food Basket remained relatively constant at around 30% of average household income[31] from 2000 to 2009, though this is more than households in the lowest quintile of income typically spend on food. The average cost of the Victorian Healthy Food Basket increased 6% from 2012 to 2014[340]. There was little change in the affordability of the Northern Territory Market Basket from 2000 to 2011[261].

Linking the cost of a healthy diet with income support can indicate whether support is adequate. In the US, the Supplemental Nutrition Assistance Program is insufficient to purchase a healthy diet based on the TFP[341,342]. A typical low-income household spends less on fruit and vegetables than required to meet the TFP[343]. This is more powerful when other household costs are taken into account. The cost of the National Nutritious Food Basket was collected from 2002 to 2010 for six time periods in Nova Scotia[344]. Affordability scenarios are calculated by deducting essential monthly expenses (housing, power, childcare, transport, clothing etc) estimated from household expenditure surveys. For each time period, the findings demonstrate that all household types receiving income support have a significant monthly deficit if they purchase a basic nutritious diet. In England, a minimum income for healthy living includes a nutritious diet as well as health, housing, household goods, clothing, utilities and recreation. In 1999[90] the minimum income required for a single working male was higher than the minimum wage, and considerably higher than income support. A later study found that an older person's minimum income requirements are 50% greater than the state pension[345].

In South Africa[165] the cost of eating a healthy diet for many households requires 30% of total household income, though it is possible to select a healthy diet that requires 10-15% of household income[247].

Affordability of fruits and vegetables can be measured separately. In Vanuatu, this was measured using prices from the Vanuatu CPI[339]. The minimum cost to purchase the recommended amount of fruits and non-starchy vegetables requires 9.6% of the household budget, and 26.3% of the food budget. Households in the lowest decile require 41% of their total food budget to meet the recommendation. Actual expenditure on fruits and vegetables reported in the Household Expenditure Survey is sufficient for only one-fifth of households.

2.6.9.1 Summary of measuring the affordability of diets

For the INFORMAS food pricing protocol, it is recommended that median household income is used to measure affordability of diets across countries as it can be consistently defined. In addition, countries can choose other income levels to measure affordability of interest to the country, such as income support or minimum wage. A limitation of only measuring the affordability of the diet is that other major costs such as housing are not considered.

Table 10: Affordability of healthy diets

Author	**Diets**	**Percentage of household income required to purchase diet for specified household ^**	**Stores where foods are priced**	**Type of price collected for each food**
New Zealand				
Robinson 2011[40]	Otago food cost survey	*8 low-income households varying size* Minimum wage: 14-44% Welfare income: 24-52%	Otago food cost survey Supermarkets	Cheapest No discount
Australia				
Lee et al 2016[241]	Healthy basket meeting dietary guidelines Less healthy basket reflecting current eating patterns	*Family of 4, Low/high deprivation* Healthy: Median disposable household income: 14%/22% Minimum wage, income support: 20%-31% (26%-27%) Current: Median income: 16% - 24% Minimum wage, income support: 24%-38% (30%-31%)	6 retail stores	No generics * Standard package size
Barosh et al 2014[243]	Healthy and sustainable basket Typical basket	*Family of 4* Average disposable household income Lowest/highest income quintile Healthy basket: 40-48% / 8-9% Typical basket: 33-44% / 6-8%	82 retail stores	Cheapest *

Author	Diets	Percentage of household income required to purchase diet for specified household ^	Stores where foods are priced	Type of price collected for each food
Landrigan et al 2010 & Pollard et al 2014(256,262)	Western Australia Food Cost and Access Survey	*Family of 4* 2010 Income support: 47% Average income: 16% 2013 Income support: 44% Average income: 14%	156 stores, major supermarkets and corner stores State-wide convenience sample	Multiple brands including generics Discount and shelf price
Palermo et al 2016(52,340)	Victorian HFB	*Family of 4* Income support: 31%	115 stores randomly selected, random selection of 26 local government authorities based on deprivation of area	Cheapest No discount No generics
Rossimel et al 2016(52,346)	Victorian HFB	*Family of 4* Income support: 30% Household income: 15% (inner city), 19% (suburbs)	68 supermarkets, 24 greengrocers, random sample 22 local government authorities in 1 large city	Cheapest No discount No generics
Wong et al 2011(325)	Victorian HFB	*Family of 4* Income support: 33% Average disposable household income: 28% lowest income tertile vs 9% highest tertile	Regional representative Stratified sampling deprivation of areas 122 stores 61 supermarkets, 27 green grocers, 34 butchers	Cheapest No discount Some brands specified Standard package size
Pattieson & Palermo 2010(347)	Victorian HFB	Income support Family of four: Mean 33% Other households: Range 15% -30%	110 grocery stores, all in 8 local government areas	No generics *

Author	**Diets**	**Percentage of household income required to purchase diet for specified household ^**	**Stores where foods are priced**	**Type of price collected for each food**
Palermo et al 2008[348]	Victorian HFB	Income support Family of four: 40% Other households: 19% -37%	34 supermarkets Convenience sample Rural Victoria	Cheapest No discount No generics Standard package size
Chapman et al 2014[260]	Queensland HFAB	*Family of 4* Average disposable household income 2006: 34% 2008: 29% 2009: 24% Lowest quintile income: 48-64%	Convenience sample 149 stores (2006) 105 stores (2008) 129 stores (2009) New South Wales	Cheapest * Standard package size
Renzaho 2008[55,349]	Queensland HFAB (modified)	Family of 6: Not affordable on weekly allowance high-rise estate residents	29 stores within 5km of high-rise estates in 1 city	Cheapest No discount Standard package size
Williams 2010[31,263]	Illawarra HFB	*Family of 5 2000-2009* Income support: 31% - 30% Average earnings: 29.8% - 30.2%	Range of retail outlets	Cheapest No discount
Kettings & Sinclair 2009[30]	Similar to Illawarra HFB	*Family of 4 /Single parent & 2 children* Income support: 38%/34% Average disposable household income: 16%/22%	Convenience sample 2 online, 1 retail supermarket Victoria	Lowest price *

Author	**Diets**	**Percentage of household income required to purchase diet for specified household ^**	**Stores where foods are priced**	**Type of price collected for each food**
Tsang et al 2007[26]	Illawarra HFB	*Family of 5* Income support: 31%, Average earnings: 35%	11 shopping centres, largest supermarket, green-grocer, butcher in 5 areas of city, Regional convenience sample, contrast deprivation South Australia	Cheapest No discount No generics
Department of Health Northern Territory 2011[261]	Northern Territory HFB	*Family of 6* Income support 26% urban stores 38% remote stores	Retail outlets 1 major supermarket & corner store each district centre, remote stores	Not stated
US				
McDermott & Stephens 2010[218]	Meeting dietary guidelines	*1 parent & 1 child* Medium annual income for area Healthy diet: 18% Convenience diet: 37%	3 large chains Number not stated	Cheapest
Sheldon et al 2010[342]	TFP	Food stamp allowance did not cover cost of TFP for 3 household scenarios	21 in area Selection not stated	Cheapest
Neault et al 2005[341]	TFP Adapted healthier TFP	*Family of 4* Healthy diet cost 30% more than food stamp allowance, TFP cost 5% more	9 stores recommended by key informants	Not stated

Canada				
Newell 2014[344]	NNFB	2002, 2004/2005, 2007, 2008, 2010, 2012 Income from minimum wage inadequate to purchase NNFB after essential non-food expenses deducted for household of 4, single mother & 3 children, affordable for single male Improvement in affordability over time as minimum wage increased	Stratified random sample Number not stated	Cheapest Discount
Vozoris et al 2002[27]	NNFB	Income support inadequate to cover basic expenses for family of 4, single male. Income barely adequate single mother & 2 children	Not stated	Not stated
Rankin 2001[250]	Healthy diet developed by focus groups Met recommended nutrient intakes and food-based dietary guidelines	Cost of food and other expenses not affordable for single mother & 2 children. Only adequate for family of 4 if both parents worked full-time.	30 supermarkets and grocery stores Stratified random sample of areas for size and income level in 1 large city	Cheapest Discount
Kirkpatrick & Tarasuk 2007[350]	NNFB	Average household expenditure on food 132% of NFB. Inadequate expenditure on food to meet NNFB by 32% households.	HES	HES

England				
Lloyd et al 2011[351]	Healthy diets for British and Indian households	*Single parent & 2 children* Income support British basket: 28-52% Indian basket: 28-34% National average: 10-12% income spent on food	Local stores and supermarkets in defined neighbourhood	Not stated
Bowyer et al 2009[352]	Eatwell plate White British diet Turkish diet Black African diet	*Single parent & 2 children* Income support White British: 19-26% Turkish: 25-29% Black African: 25-30%	37 food retailers in central hub of 3 areas	Cheapest
Barratt 1997[353]	7 day diet of 1 woman matching current diet targets	*Single person* Income support: 25-32% Average weekly household spending on food: 12%	10 supermarkets, 8 small stores in area Sampling not stated	Cheapest Most economical package size
Nelson & Peploe 1990[245]	Basket to meet nutrient reference values	Income support 2 parents & 1 child: 52%	Retail stores	Average of brands with highest sales volume
Ireland				
Flynn et al 2012[354]	Dietary guidelines	*Range of stores* Income support Family of 4: 25-56%	3 types of stores Selection not stated	Cheapest *
Friel et al 2006[54]	Dietary guidelines	Income support Family of 4: 69%	Online supermarket and 13 supermarkets representing major chains	Market brand or generic *

Other				
Parlesak et al 2016[269] Denmark	Healthy diet	*Family of 4* Income support 10-18% of income	5 discount retailers, 2 online retailers, sampling not stated	Cheapest *
Temple et al 2011[165] South Africa	Healthy diet	*Household of 5, Rural area* Lowest half of income: 57%	21 retail stores	Not stated

^ Affordability for other household types is reported in some studies. Affordability for a family of four is selected to report in this table.

* Use of discount or standard price not stated

HFB: Healthy food basket

TPF: Thrifty Food Plan

NNFB: Canadian National Nutritious Food Basket

2.6.10 Summary of studies of the cost and affordability of healthy and current diets

INFORMAS proposes to monitor the cost and affordability of diets over time and between countries. This will enable the relative price and affordability to be monitored and provide evidence to advocate for economic and fiscal policy responses of government to improve affordability of healthier diets.

Common approaches reported in the literature to calculate the cost of diets are a hypothetical, representative healthy food basket or the use of data from observational or intervention studies where diets are stratified by healthiness. The use of population studies is limited by confounding of factors influencing choices and therefore diet costs, such as income. This is avoided when constructing a healthy diet and the current diet. The cost of healthy diets is monitored regularly in some countries. However, there are few studies that compare the cost of the current diet with a healthy diet and none of these studies monitored the cost over time.

The advantage of the diet approach over the foods approach is that the content of the diets is anchored by the energy and nutrient requirements of an individual in a reference household. The current diet selected from a food intake survey is typical of the population diet and consists of commonly consumed foods combined in proportions to reflect current macronutrient intakes. The healthy diet is developed to meet food-based dietary guidelines and nutrient reference values

The methods described in the literature are specific to the information on current dietary patterns and food-based guidelines available in a country. Methodology that could be used by different countries according to the type of information and the food environment is required for the INFORMAS protocol. The aspects that require further development and testing while implementing the NZ diet costs study are outlined in Table 11.

Table 11: Further research required for the development of the diet approach

Issue	*Description of issue*	*Research required to address issue*
Select reference household	Standard household required to develop diets	Select reference household
Determine principle for setting energy requirement of diet	Provides anchor for amount of foods in diet Range of possible methods	Investigate influence of different methods
Define healthy diet	A healthy diet is defined in a range of ways in diet cost studies	Investigate differing scenarios, e.g., with or without discretionary foods, alcohol and/or takeaways
Define current diet	Few studies have developed a current diet so methods require further development and testing	Develop and test methods guided by nutrition surveys and other relevant information
Select a measure of household income	A range of measures are used in diet affordability studies	Test the feasibility of using equivalised disposable household income

2.7 Collection of food prices

Food prices are collected for the foods, meals and diet approaches. In order to accurately price an item, details are required to ensure the item and price is consistently identified. The item must be clearly described. Decisions centre on the type of price to collect (discount or shelf price), inclusion of generic labels and how to deal with missing items.

2.7.1 Describing the item to be priced

A description should provide the brand name, variety, package size, food product description and whether an alternative item is to be priced if the item is not available in the stated package size or brand[355,356]. The brand is not stated if the cheapest item is collected. The item priced should be similar in quality to the specified item, and available at the selected stores.

In store, there may be more than one item that meets a product description, unless it is at the highest level of disaggregation. For example, a tin of peaches may be canned in juice or syrup, with a range of brands and product sizes. There is a balance between pricing the identical item in different stores with the potential for missing items, or using more flexible definitions for food items around package size, flavour or brand[164].

Some foods have one common package size (loaf of bread) while others are available in a variety of sizes (for example, soft drink). The package size chosen needs to be a common or medium package size or the size required for the reference family. Studies described in Tables 2, 3, 8, 9 and 10 usually specify pricing a medium package size, or if not available, a similar brand or package size. Bulky or very large packages are not usually included, as households may not have adequate transport or storage. Comparisons over time require a balance of consistency and flexibility to ensure the shopping list reflects current commonly consumed foods. When comparing prices over time, any changes in quality, ingredients, reformulation or packet size should be noted[357].

A few studies report assessing the quality of food items, particularly fruit and vegetables and studies assessing accessibility. For example, the Queensland HFAB collects prices in remote areas where the quality of fruit and vegetables is variable[259].

2.7.2 Branded, popular and generic items

A generic label encompasses all products sold under a retailer's brand[358]. Generic labels yield a higher profit for the store, as there are no marketing or advertising costs[359]. These items are becoming increasingly common[360] and are often cheaper than a branded product[260,356,360-362]. Generic and branded labels may differ nutritionally for particular food categories, though some items have similar a nutrient content, as there is often one single manufacturer. The additional price of the branded items may be due to higher packaging and marketing costs[362].

Of the food pricing studies described in Tables 2, 3, 8, 9 and 10 that reported how the brand is selected, some collect the price of only branded labels excluding generic labels, some include generic labels while others collect the price of the cheapest item, either branded or generic. The nutrient content of both items needs to be checked using the Nutrient Information Panel to ensure that the products are similar (for example, added salt, sugar). As the amount of variation between similar items (e.g., canned apricots) will differ for different food items, it may be necessary to state a range that the nutrient of interest must fall between for the generic label to be considered a suitable alternative to cost. The range can be absolute (g, mg) or relative (percentage). For example, canned peaches <10g sugar per 100g.

The most popular brand can be identified from market research data, food intake surveys or shelf space. A US study(164) found the product with the most shelf space more likely to be consistent in brand and package size across store types compared to the product with the lowest unit price. The product with the most shelf space is typically a popular package size, not the smallest or largest size.

2.7.3 Food price to be collected

The price to be collected needs to be stipulated. This could be the cheapest price, most popular brand, the shelf price or the discount price. Food prices can be collected from a food price databases, CPI, retail stores or supermarket websites. Some sources provide the price per 100g which is useful for selecting the cheapest price of a range of brands. Alternatively, prices can be gathered from surveys on food expenditure using the average price paid (mean price weighted by the quantity purchased).

Many studies described in Tables 2, 3, 8, 9 and 10 stipulate collection of the cheapest item by assessing the product with the lowest unit price. The cheapest brand represents the cheapest available price to consumers. The most popular brand is representative of the price that consumers are most likely to pay. Some studies include collection of discount prices, some do not, while others specify collection of both prices. If the discount price is collected it must be a price that is available to all customers, for example the price displayed at the shelf rather than requiring a coupon. Several prices (such as different brands or package sizes) are collected in some studies and the average price calculated.

Discount prices vary over time(355) so the use of discount prices can underestimate the cost of the diet if the number of items on discount, or if the size of the discount, is particularly high compared to other times of the year. The use of the original price can overestimate cost as many foods are frequently discounted in some countries and some discounts may be available most of the year(363). Items that are easy to store with a longer shelf life are more likely to be discounted(364) and then purchased because a household can stock-pile the foods(365). Discount prices are collected for the New Zealand FPI(1) and the Australian CPI(357). In New Zealand, the Otago Food Cost Survey includes generic labels and excludes discounts(89).

Prices collected from more than one source can be averaged, weighted by the type of outlet, area, size of the store or frequency of purchase(366), or based on the proportion of the expenditure in the household expenditure survey(164).

The type of price collected, type of brand collected, and the inclusion of generic labels, varies in food pricing studies. Therefore, further exploratory work is required to decide on the appropriate type of price to collect, to explore the feasibility of identifying a common brand, and to understand the impact of exclusion or inclusion of generic labels and/or discounts on the cost of healthy and less healthy foods and diets.

2.7.4 Taxes and set prices

The tax on a food needs to be identified. In countries, such as NZ, where the same GST is applied to all products this is straightforward. In Australia, GST is not added to basic healthy foods with a detailed food list available to identify these foods(126). In Fiji, there is a complex tax system with exemptions for certain items such as fresh produce sold at the market. Customs tariff lists show different crackers could be categorised as ‘crispbread’, or ‘all other biscuits’ which have different rates of excise tax(367). Some basic items are price-controlled to ensure basic foods are more affordable(368).

2.7.5 Missing items in price collection

Missing items can provide important information on availability, so should not be ignored(164). They can be accounted for by imputing missing values using sample means or by excluding, though this is likely to lead to error(355). Consumer NZ conducts a survey of supermarket prices regularly(369). If the specified brand and pack size is not available, a similar item is substituted and priced in all the retailers surveyed.

2.7.6 Serving size information sources

Regulations regarding serving sizes vary between countries. Some require a recommended serving size to be displayed on the Nutrient Information Panel(370). Canada(371) and the US regulate food and beverage sizes providing acceptable ranges for serving sizes(372). Non-government agencies may provide serving size guidance. The serving sizes for the same products can vary depending on the source of the serving size. The European Union food labelling laws do not require mandatory serving size labelling(370). Food-based dietary guidelines may recommend serving sizes that are multiplied to provide the recommended consumption for a day (for example, 5 x 75g servings of vegetables per day) which provide a guide when developing a healthy diet for the diet approach.

2.7.7 Calculation of edible portion

Edible portion and yield factors are required to convert the edible amount of a food to the amount to be purchased. Edible portion factors are important for fruits, vegetables and nuts (skins, seeds, shells etc) and meat, fish and seafood (bones, skin etc). Yield factors are applied to foods to allow for weight changes during cooking due to changes in the water or fat content of the food.

$$\frac{\text{100g edible portion}}{\text{yield factor}} = \text{amount raw product}$$

Diet costing studies usually assume that most foods purchased are consumed, though some add a factor to account for wastage. An allowance is added to the USDA food plans to account for plate waste or spoilage, ranging from 5% for the TFP to 30% for the liberal-cost diet(87,257). Retention and yield factors for a country may be available, or existing data from another country can be used(373-375).

2.7.8 Number of items for price collection

Collecting prices is a balance between the required time associated with survey costs and having sufficient items to represent a typical, varied diet. One item within a category can be priced to represent another item, for example ham could represent processed pork meats. Most healthy diets in the studies reported in section 2.6.3 contained between 30 and 70 items. In a review of sixteen market baskets(355), the number of food items ranged from 22 to 108. The number of foods priced in studies of the cost of foods reported in section 0 range from four pairs(167) to 131 foods in eight categories(171). The prices of only 10% of the items specified in a full audit were collected with no significant differences in median scores between the brief and the full audits(376), reducing median in-store auditing time by 25% to 50%.

Some guidance is required on the number of items to select. As the number of foods in diet costing studies varies considerably, further exploratory work is required to understand the impact of the number of foods selected in the healthy and current diets.

2.7.9 Price collection methods

In the majority of studies, items are priced at a retail store. Prices are also collected online, from price databases(98,148,156,282,305,306,377,378), till receipts(379), supermarket catalogues(155) or supermarket sales data(169). Databases developed from barcode scanning may be limited to packaged foods. Commercial databases are available for purchase from market research companies.

2.7.9.1 Selection of retail stores

The purpose of a study and available resources influences the number and type of stores from which prices are collected. Those studies that compared prices by location or type of store selected stores to answer the research question.

The process to select stores, and the number of stores, in the studies reported in sections 2.4 and 2.6 vary considerably, partially depending on the research question, the retail environment within a location, variability between stores and available resources. The process to select stores ranges from a complicated sampling process of enumerating all stores in the area and randomly selecting stores, to convenience sampling or selecting all stores in the area. Other selection methods are to select one store from every major chain, select the largest supermarket in the region (volume), advice from key informants or focus groups, select popular stores or to select stores where survey participants shop. Households do not always shop at a store in their neighbourhood(380). The number of outlets in the studies reported in sections 2.4 and 2.6 range from one to 1230. About half the studies surveyed less than ten stores. If the sampling process is not robust, or only a few stores are sampled, the prices may not be representative[355]. The greater the price variability within a given type of outlet, the larger the number of outlets of that type that should be included.

Food prices have been collected by researchers or university nutrition students. A participatory approach was used in Nova Scotia using community groups and those who experienced food insecurity to collect the food prices[41]. Stores can be classified by size or type, such as grocery, supermarket, discount supermarket or convenience store[381]. Useful indicators may be the number of cash registers, square footage or annual sales.

2.7.9.2 Store selection process

The INFORMAS protocol needs to provide guidance on the recommended retail selection process. It is difficult to provide specific instructions as the type of food retailers to be sampled will depend on the common type of retail store in a country. More than one store type may need to be included. For example, in Thailand supermarkets control half the food sales but traditional fresh markets remain important for purchase of fresh foods with dry packaged foods usually purchased at supermarkets[382]. The INFORMAS monitoring of food prices is national, however an individual country may be interested in the price of foods by geographic location, urban or rural, or the income level or ethnicity of a neighbourhood. Enumerating stores can be time-consuming, especially over a large geographic area when it may be difficult to check the store is still trading. Selection can be based on a census area and then a random sample or a convenience sample chosen within the area. Stores with a high volume will capture more food purchases, therefore price changes in these stores will affect a higher proportion of the population. If resources are limited, the three largest supermarkets in the largest city could be selected.

Some studies focus on the price of fruit and vegetables from a range of outlets from supermarkets to roadside stalls using various sampling methods. Different selection processes are used: probability-proportional-to-size sampling for markets based on the number of food vendors[383], identifying the nearest market to the selected supermarket[273], or identifying all fresh produce stores and selecting a number in a defined area[346].

2.7.9.3 Time of year for price collection

The studies reported in sections 2.4 and 2.6 that are repeated, collected prices at the same time each year, over a period of one day to three weeks. Seasonal products can be defined as those products for which both prices and the quantities sold vary considerably throughout the year[363]. Collection of prices for the Canadian Nutritious Food Basket is recommended for May as the CPI for food in May closely reflects the annual average CPI, a measure considered appropriate for estimating the months in which food prices would be least affected by seasonal variation in costs[384].

Prices for foods in the NZ FPI are collected monthly with prices for fresh fruit and vegetables collected weekly due to fluctuations[385]. Prices for processed foods in the Australian CPI are collected quarterly, and prices for fresh foods collected monthly[357]. In Victoria Australia, fruit and vegetable prices varied the most over three years of price collection compared to other food categories, but there was no trend in overall cost for summer compared to winter(340).

The food prices need to be collected at the same time each year to account for seasonal prices. Some common fruits or vegetables may not be able to be priced depending on availability. Public holiday period or festivals should be avoided as prices may increase. Ideally the foods priced should be available at the selected stores with the same item surveyed across stores nationwide, though if regional brands are common this may not be possible.

2.7.9.4 Reliability of price collection

A few studies reported on the reliability of the price collection where a different researcher collected prices on a sub-sample of stores or items(160,259,386). Inter-observer variation can be reduced by sufficient training(384) and by using a protocol that specifies the product to price with an alternative suggested if the product is not available.

2.7.9.5 Summary of price collection

Different types of prices have been collected in the literature therefore the NZ study will explore the implications on diet cost of using discount or shelf price and the generic or popular brand. The source of price data will depend on the nature of the food retail environment within a country, or if a food prices database is available. For NZ, fresh fruit and vegetables will be priced at a supermarket and a fresh produce store to assess if there is a cost differential.

2.8 Summary of literature review

The food environment is influenced by government, food industry and society at a local, national and international level. Changes in the food environment, particularly an increase in the production, marketing and consumption of energy-dense processed foods and changes in work patterns contribute to dietary patterns that are a risk factor for obesity and NCDs. The relative cost of food compared to household disposable income is important, especially among those on lower incomes with food more flexible than other fixed costs such as housing. Greater total spending on foods is associated with healthier diets but diets of poor quality are consumed by people of all income levels. Cost is one of the most important considerations for consumers when purchasing food. Food purchasing may be influenced by people’s perception of availability and price.

INFORMAS offers a way to monitor changes in the price differential between healthier and less healthy foods, meals and diets over time providing evidence for advocacy for fiscal policies and a way to monitor the effects of taxes or subsidies on foods, meals and diets.

Household economic surveys and food intake surveys are useful data sources. The availability and nature of data sources and information required to determine the cost of food, meals and diets will determine whether these can be monitored within a country. Monitoring the cost and affordability of diets requires more extensive information than monitoring the cost of foods and meals as a food intake survey is required.

Complementary methods are identified for the foods approach. Comparing the cost of a healthier and less healthy item of a pair will assess the price differential between direct food substitutes with clear nutritional differences. Comparing the change in price over time of healthier and less healthy food groups, and different categories of degree of processing will indicate whether healthier foods are changing in price at a different rate to less healthy foods.

Pre-prepared and fast food meals tend to be energy dense. Home-cooked meals are potentially healthier but lack of time is a barrier. The meals approach to compare the cost of popular takeaway meals and their healthy home-cooked counterparts while accounting for the cost of time is a novel approach.

The advantage of the diet approach over the foods approach is that the content of the diets is anchored by the energy and nutrient requirements of an individual in a reference household. While monitoring the cost and affordability of a healthy diet over time is routine in some countries, there is no monitoring of the cost of a current diet over time or methodology flexible for use by different countries. Monitoring the cost of both a healthy and current diet provides a tool to model the impact of economic and fiscal policy responses of government to improve and affordability of healthier foods and diets.

The foods to be priced need to be carefully described to ensure a similar food is priced in different outlets and over time. This will be reflected in the protocol developed for the NZ food prices study. Further exploratory work is required to decide on the appropriate type of price and brands for data collection and to understand the impact of the choice of brand and price on the cost of healthier and less healthy foods and diets, and the impact on diet cost of the number of foods selected for the healthy and current diets.

The price of items can be collected directly from retail outlets, or if available, from a food prices database. The food retail environment varies between countries, particularly for fresh produce, which influences the selection of the number of type of retail outlets. The impact of the retail outlet selected for the price collection of fruit and vegetables on the diet cost will be explored in the NZ retail environment.

3 IDENTIFICATION OF COMMONLY CONSUMED FOODS IN NZ

3.1 Introduction

Commonly consumed foods are required for each approach to reflect the foods commonly purchased. As the sources of commonly consumed foods may differ between countries, two data sources to identify the commonly consumed foods in New Zealand are compared; household expenditure survey data and food consumption data from a national nutrition survey. The food consumption dataset is time-consuming to analyse due to the way foods are classified into food groups and recipes, but enables specific foods to be identified. The household expenditure dataset provides information on expenditure rather than consumption with less disaggregation of foods. The commonalities and differences between the resulting foods are compared. The process of selecting the commonly consumed foods is outlined in Figure 1.

3.1.1 Developing a method to select commonly consumed foods

Sources of commonly consumed foods identified from the studies outlined in sections 2.4 and 2.6 are food consumption surveys, household economic surveys, market research and local knowledge. The most appropriate source will depend on the way the data is presented. The level of disaggregation of food groups will vary with the source, for example, yoghurt, or sweetened yoghurt, or Yoplait strawberry low-fat yoghurt.

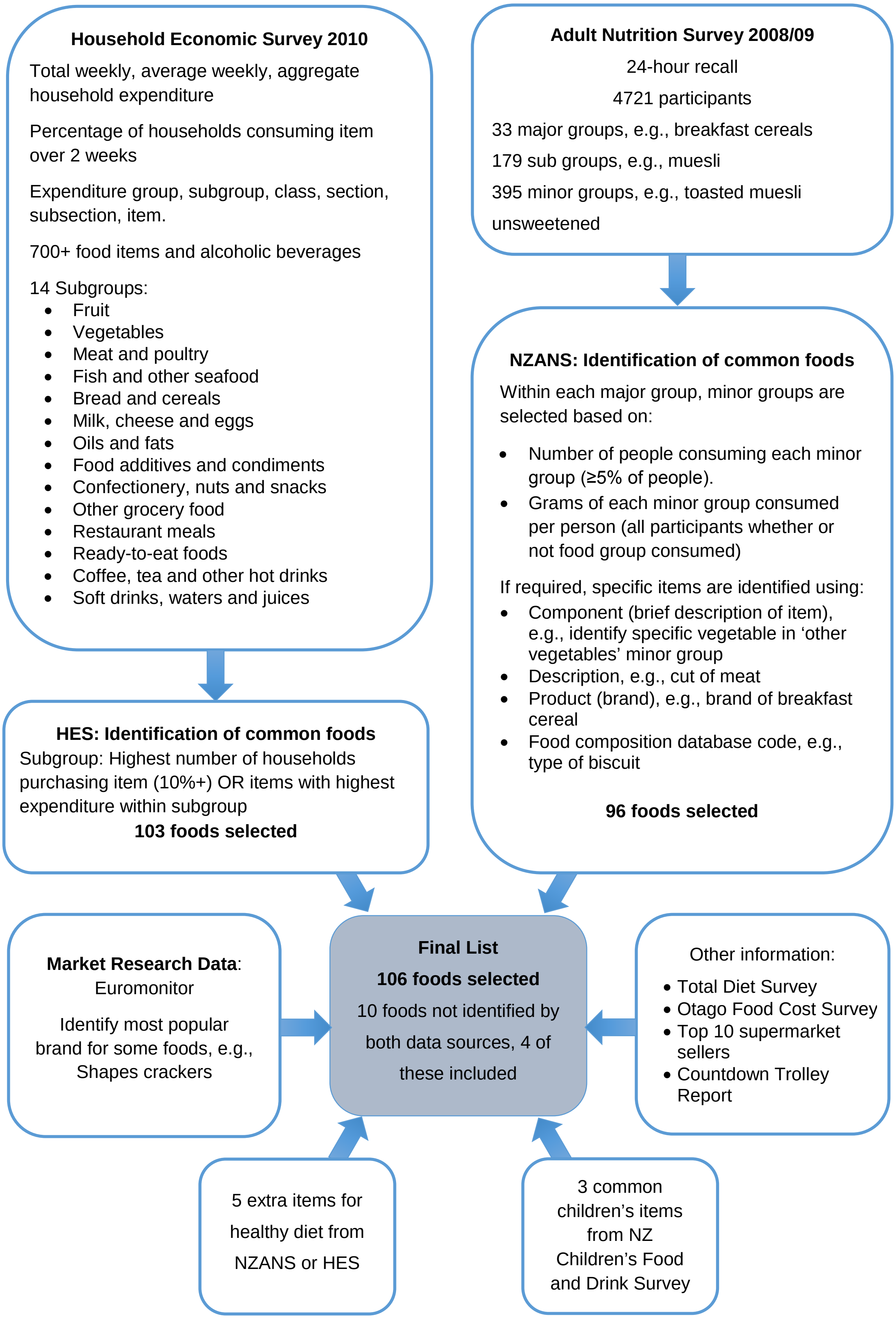
The foods selected in studies are generally commonly consumed foods determined from national nutrition surveys, household expenditure surveys, retail sales or by the researcher. Often the study methodology reported in the literature does not specify how the foods are chosen but states they are commonly consumed foods, staple foods or meet dietary recommendations. Items selected to price pairs of foods are the same type of food or belong to the same food group.

A decision may be required to select a specific item to price if the required level of detail is not available. A combination of data sources can be used, for example a nutrition survey to identify the commonly consumed food, and market research data to identify the most common brand. The commonly consumed foods identified may differ depending on the source of information used. Therefore, two separate sources of information in NZ, the Household Expenditure Survey (HES) and a food consumption survey (NZANS) are independently used to identify commonly consumed foods.

An arbitrary decision is required to identify when a food is considered commonly consumed. One research group defined frequently consumed foods as those foods consumed at least once a month by 30% of the adult population from a food frequency questionnaire and by 5% or more of those reporting the item in a 24-hour recall. A 24-hour recall is more likely to exclude some foods consumed regularly but not daily[(326)]. For this NZ research, foods consumed by at least 5% of people in the NZANS 24-hour recall are considered commonly consumed. Defining the number of grams considered commonly consumed for an item depends on the category, for example, bread is consumed in higher amounts than butter. A further optional step is to weight the amount of a food in a sub-group by the percentage that it contributes to the food group, but could require additional work to recode and aggregate foods.

There are limitations when identifying commonly consumed foods. Similar foods reported in food consumption data may be coded in different ways. For example, a chicken rice dish could be coded to the individual food groups of the individual ingredients, by the main ingredient (rice or chicken) or as a mixed dish. If HES data are used then the expenditure of a food may not indicate the proportion consumed as this depends on the price. A more expensive food item will have a higher expenditure in proportion to the amount consumed. It can be difficult to match a price with a sub-group, for example wholegrain bread, if there is a wide range of products and prices for which individual expenditure is not known.

Figure 1: Process to select commonly consumed foods in NZ



3.2 Methods: Selection of commonly consumed foods in NZ

Commonly consumed foods and beverages were identified separately from the Household Expenditure Survey (HES)[387] and the Adult Nutrition Survey (NZANS)[388]. Differences in the composition of the lists were identified. Market research data (available at no cost) was used to identify brands if possible. The draft methodology for selecting and describing the commonly consumed foods is in Appendix One. The rationale for inclusion or exclusion is explained in Appendix Two.

3.2.1 Household Expenditure Survey

A detailed dataset was provided by Statistics New Zealand[387] with data for 2010 with the components provided described in Figure 1. The extent of disaggregation within the fourteen subgroups varies. For some subgroups, such as fruit, an individual food could be selected (e.g., mandarin). For others, such as grains, the subgroup was not sufficiently disaggregated to allow selection (for example, cake, specialty bread). Some items are categorised as ‘nfd’ (not further determined) or ‘nec’ (not elsewhere categorised). Some of these items may have been part of another category, for example, ‘bread nfd’ could have been white, wholemeal, roll etc.

To select the most commonly consumed foods within each subgroup, the foods with the highest number of households purchasing the item, or the highest expenditure were identified. Generally, foods with higher expenditure also have a higher frequency, but some expensive foods have a high expenditure in relation to the number of households purchasing the food, for example, expenditure for grapes was higher than kiwifruit but grapes were purchased by fewer households. The percentage of households purchasing the item is specified for each category depending on how often foods in the category are purchased and the range of items in the category.

3.2.2 Adult Nutrition Survey to identify commonly consumed foods

A successful application was made to use the confidential unit record files of the 2008/09 NZANS[388]. The analysis was conducted in SPSS. In the dataset, each food component reported in the 24-hour recall had been matched to a food group (Figure 1).

Most foods were identified as common by the number of people consuming the food (popular) and the amount consumed. A few foods were identified as popular but only a moderate amount was consumed, or vice versa. Inclusion of the food depended on how many other items were identified as common within that category. For some minor food groups, further analysis of the dataset was required to identify specific items as outlined in Figure 1. Further details on the methodology for selecting and describing the commonly consumed foods are in Appendix One.

3.2.3 Source of information of foods commonly consumed by children

The national Children’s Nutrition Survey (NZCNS) was conducted in 2002, thirteen years prior to this research. There have been no later 24-hour recalls conducted on a national sample. A food frequency questionnaire was completed as part of the New Zealand Children’s Food and Drink Survey in 2008[389].

The sample size for five to ten year-old girls was small (100), so the data was used to detect any differences from the commonly consumed foods identified for adults. A scoring system that applied a weighting factor to standardise to a daily rate[390] was used to provide an overall figure for the frequency of a food.

3.2.4 Brands of commonly consumed foods

For packaged foods, further details were required on the brand to enable a product to be identified at point-of-sale. For some items, this information was able to be sourced from the NZANS (dairy products, breakfast cereals, non-carbonated beverages). For other items, Euromonitor data was used. The Euromonitor database accessed from the University of Auckland[391] reports the percentage value of the category and percentage sales for units of brands within a category. For some categories, this enabled identification of a specific item, for example, Arnotts Shapes was the most popular cracker. For other categories, a specific brand could be identified, for example, Watties was most popular brand for canned fruits and vegetables. Other items identified from Euromonitor were spreads, oils, carbonated beverages, bread, frozen vegetables, rice, eggs, canned tuna and snacks.

3.2.5 Other sources of information on commonly consumed foods

Some additional sources of information were used to aid decisions. The Ministry of Primary Industries released a consultation paper on the 2016 New Zealand Total Diet Study (TDS)[392] with a list of key foods developed from the 2008/09 NZANS and the 2002 NZCNS. The purpose of the study was to assess exposure to agricultural compounds, contaminant elements and selected nutrients from representative foods so some less commonly consumed foods were monitored such as shellfish.

The commonly consumed foods selected were compared to those foods used in the University of Otago Food Cost Survey[89], which were selected from the NZANS.

Occasionally the top supermarket sellers are publically reported. The most popular items in a newspaper article in the Sunday Star Times[393] and Countdown Trolley report[394] were checked for inclusion of the commonly consumed foods.

3.3 Results: Commonly consumed foods in NZ

The commonly consumed foods were finalised after comparing the foods identified by the HES and the NZANS. Most were identified by both sources. The differences were in the types of items within a food group, for example cut of meat. Some of the food items identified by only one source were on the borderline of being defined as a common food by the other method.

For some of these items, the item selected as common based on the NZANS had a similar frequency to other forms of the item (for example, middle, shoulder bacon) so the item also selected in the HES was selected for the final list (middle bacon). Two items were identified in only one list (courgette in HES and silverbeet in NZANS) and were included. Some convenience items (pasta sauce, cooked chicken) were just below the threshold for the NZANS but were identified in the HES so were selected to ensure convenience foods were represented.

Foods identified in the HES are less disaggregated for some food groups. For example, Edam cheese, trim milk, regular milk, semi-trim milk, regular soft drink and diet soft drink were not identified in the HES because the categories of cheddar type cheese, fresh non-flavoured milk and soft drink are too broad.

Some of the differences are due to the choice made of the cut of meat or variety of fish. The NZANS identified common cuts and fish varieties (rump steak) while the HES grouped the cuts (grilling or frying beef, chicken pieces) and only provided a few categories of fish with 'fish not further defined' and 'not elsewhere categorised' being two of the most common categories. Prices of cuts of meat and fish varieties range considerably.

Three additional foods identified as commonly consumed from the New Zealand Children's Food and Drink Survey[389] were added (Appendix Two). Some additional items were added (Appendix Two) to ensure there were sufficient foods in the healthy diet to meet the recommendations in the Eating and Activity Guidelines[395] to include legumes, choose low-fat dairy products and choose whole-grains.

3.3.1 Other sources of information on commonly consumed foods

Twelve foods in the 2016 Total Diet Survey (TDS)[392] are not included in the list of commonly consumed foods because consumption is low in the NZANS (sushi, soya milk, tofu, yeast spreads, frozen berries, melon, fish cakes and fish fingers, caffeinated cold beverage) or are represented by similar foods (honey, frozen green beans). The consumption of legumes is low in the NZANS. Hummus was identified as popular by TDS and was added to the list of commonly consumed foods for the healthy diet. The only commonly consumed foods not in the University of Otago Food Cost Survey[89], are pears, sultanas, hummus, canned soup and mayonnaise. There are no foods identified in the Food Cost Survey that should have been added.

A newspaper article[393] listed the top ten supermarket sellers identified from market research data. The items, or variations of the items are all included in the commonly consumed foods list (cola, canned spaghetti, white bread, wholegrain bread, baked beans, bananas), except lemonade. The top forty foods were not listed but the article stated that Weet-Bix, milk and wholemeal bread were in this list.

The Countdown Trolley report[394] top ten produce items purchased over the past year are in the commonly consumed foods list (bananas, tomatoes, broccoli, carrots, avocado, cucumbers, onions, capsicum, grapes), except for strawberries. The top ten grocery items are in the commonly consumed foods list (white bread, standard milk, wholemeal bread, butter, ham, hot roast chicken), except for coleslaw and fresh cream. The most common wine purchased is sauvignon blanc, and mince was the most common meat followed by chicken (pieces with bone in, breast fillets). This additional information confirms the commonly consumed foods on the list and aided some decisions: roast chicken replaced whole frozen chicken, coleslaw ingredients were in the final list and cream and strawberry consumption were not high in the NZANS so were not included.

Table 12: NZ commonly consumed foods used in the foods and diet approaches

Food	Girl 7 years	Boy 14 years	Adult woman	Adult man
Fruit				
Apples, fresh				
Bananas, fresh				
Grapes, fresh				
Kiwifruit, fresh				
Mandarins, fresh				
Nectarines, fresh				
Oranges, fresh				
Peaches, canned lite syrup				
Peaches, canned no added sugar				
Pears, fresh				
Sultanas				
Vegetables				
Avocados, fresh				
Broccoli, fresh				
Cabbage, fresh				
Capsicums, fresh				
Carrots, fresh				
Cauliflower, fresh				
Corn, frozen				
Courgettes, fresh				
Cucumber, fresh				
Kumara, fresh				
Lettuce, fresh				
Mixed vegetables, frozen				
Mushrooms, fresh				
Onions, fresh				
Peas, frozen				
Potatoes, fresh				
Potato fries, frozen,				
Pumpkin, fresh				
Silverbeet, fresh				
Tomatoes, fresh				

Food		**Girl 7 years**	**Boy 14 years**	**Adult woman**	**Adult man**
Tomatoes, canned regular					
Tomatoes, canned no added salt					
Grains					
Bread, white					
Bread, wholemeal					
Bread, wholegrain					
Pita bread					
Muffin					
Cornflakes					
Muesli					
Rice bubbles					
Breakfast wheat biscuits					
Rolled oats					
Pasta dried					
Wholemeal pasta					
Instant noodles					
Rice, white					
Rice, brown					
Spaghetti, canned					
Spaghetti, canned lite					
Cake, fruit					
Biscuits, gingernut					
Biscuits, Tim Tam					
Crackers Shapes					
Crackers, wholegrain					
Dairy					
Cheese, Colby					
Cheese, Edam					
Milk, trim					
Milk, standard					
Yoghurt, full-fat flavoured					
Yoghurt, natural, low-fat					
Cottage cheese					

Meat, poultry, seafood, eggs, legumes, nuts
Eggs
Beef, corned silverside
Beef steak, blade
Beef steak, rump
Beef mince, regular
Beef mince, lean
Chicken breast fresh
Chicken drumstick
Chicken, whole, pre-cooked
Lamb shoulder chops
Lamb, middle loin chop
Pork leg roast
Bacon, middle rashers
Ham
Sausages
Luncheon sausage
Fish fillets, fresh
Tuna, canned in oil
Tuna canned in water
Fish fillets, frozen
Baked beans, regular
Baked beans, lite
Lentils, canned
Hummus
Peanuts, plain
Almonds, plain
Fats & oils
Butter
Margarine, monounsaturated
Olive oil
Canola oil
Snacks
Chocolate, dairy milk block
Sweets, jelly
Ice cream, plain

Muesli bar, fruit nut chocolate
Potato crisps
Salted peanuts
Sauces, dressings, spreads, sugars
Jam
Peanut butter, added salt
Peanut butter, no added salt/sugar
Vegetable soup, canned
Pasta sauce
Mayonnaise, regular
Tomato sauce, regular
Tomato sauce, lite
White sugar
Beverages
Milo
Cola
Diet cola
Fruit drink
Orange juice
Drink Powder
Bottled water
Takeaways
Meat pie
Hot chips
Battered fish
Pizza
Burger
Alcohol
Wine, medium white
Beer, lager, draught, bitter

Key

- Item in minimal approach
- Item in healthy and current diets
- Item only in current diet
- Item only in healthy diet

3.4 Discussion

The most useful information sources on commonly consumed foods will vary between countries, depend on the frequency of household expenditure and national food consumption surveys, and the degree of data disaggregation. For less aggregated data some decisions, and therefore assumptions, are required to select the item to price. For example, if all yoghurts are classified as one item, a decision is required on whether to price sweetened or unsweetened and low-fat or full-fat yoghurt. Most food consumption surveys report consumption at an individual level, though not all surveys include both adults and children(396). A household expenditure survey reports expenditure at a household level(133). Other data such as market research data or supermarket sales is at a population level though is unlikely to be freely available. A combination of sources can be used. Media articles, supermarket reports and other surveys may provide additional information to assist in decision-making.

Separate analyses of two surveys conducted at a similar time, the 2010 NZ HES(387) and the 2008/09 NZANS(388), were undertaken to identify commonly consumed foods. The NZANS data enables commonly consumed foods to be identified for age and sex groups whereas the HES is at the household level. Most of the commonly consumed foods identified by both sources are the same with four foods only identified by one method. The NZANS microdata is disaggregated to a greater extent than the HES data so more detail is provided, for example the HES reports cheese expenditure but the NZANS could identify that Colby cheese is the most frequently consumed cheese. However, the identification of commonly consumed foods is more time-consuming than using the HES data. Market research data(391) was used to confirm or clarify some items, for example the brand of popular chocolate biscuits.

Mixed dishes reported as consumed in the NZANS(397), where a detailed description was not provided, were assigned to the food group containing the main ingredient of the dish, so the amount consumed for each food group may have been an over or underestimation. For example, pizza was assigned to bread-based dishes but also contains cheese, which was not assigned to the cheese group.

The NZANS(397) and the NZ Children's Food and Drink Survey(389) were conducted seven to eight years prior to this research, so may not reflect the commonly consumed foods and dietary patterns currently consumed.

The commonly consumed foods identified by both methods are similar, therefore the two lists were combined. This list was checked against other sources of information to try and capture all commonly consumed foods. A rationale for the inclusion and exclusion of foods was provided. There is a balance in determining the number of foods between the resources required for price collection and having enough foods to be representative of the diet. For INFORMAS food price monitoring, either a HES or a national food consumption survey will be recommended as an appropriate source to identify commonly consumed foods. The nature of the way the data is reported, particularly the degree of disaggregation of items, will determine the ease of identifying commonly consumed foods and the number of arbitrary decisions required to identify a specific item to price.

Generally, a HES is conducted more frequently than food consumption surveys so can provide up-to-date data. If the detailed dataset can be provided then this is a useful option to identify commonly consumed foods, particularly if there is no recent food consumption survey data. However, the detail of information provided by an HES may not be sufficient to classify foods according to healthiness or degree of processing, or to match to products in a food composition database. Therefore, some assumptions are required to select foods to price.

The commonly consumed foods selected from the HES and ANS will be used for the foods and diet approaches in the NZ food prices and diet cost studies. Further detail on takeaway meals is required to identify popular takeaway meals. The final INFORMAS protocol will recommend that either a nutrition survey or a household expenditure survey, or both, are used to identify common foods. The survey selected will depend on the age of the survey and the degree of disaggregation of the data. Alternatively, market research data can be used, if available.

4 FOODS APPROACH: MEASURING THE COST OF HEALTHIER AND LESS HEALTHY FOODS

The INFORMAS food prices foundation paper(19) proposes that the minimal (foods) approach will assess the 'differential price of healthy and less healthy foods'. This section explores current methodology and the development of an approach to answer 'How can the cost of healthier and less healthy foods be compared and measured over time, and between countries?'. This approach is then tested in NZ (NZ food prices study) to test the feasibility of the methodology and to answer ''Do healthier foods cost more than their less healthy counterparts?'.

Methods used by studies that report the price of healthier and less healthy foods in the literature are described in section 2.4 and potential tools are identified. The recommended methodology to identify and select foods, classify foods as healthier and less healthy and compare prices in a fair manner to enable a consistent approach was developed, and is described in section 4.1. The draft protocol developed for the INFORMAS food prices module is outlined in Appendix One. The feasibility of this protocol was tested using common NZ foods. The implementation is described in section 4.2 and the results are presented in section 4.3. The potential use of the foods approach is discussed in section 4.4 along with changes made to the methods.

Four aspects of the foods approach were identified from the literature as requiring further investigation:

- Studies commonly compare the cost of pairs of healthy and less healthy items but the methodology requires development.
- Different classification methods can be used to classify foods by healthiness with a classification system required to be selected that is feasible for different countries.
- Different price metrics provide differing price differentials for foods with one price metric to be selected for the INFORMAS protocol.
- The food price index is a potential source of monitoring data with the feasibility of using the index requiring further investigation.

Two tools for selecting and classifying foods were identified from the literature and further scoped and developed in NZ.

- Pairs of similar foods that differ in nutrient content using prices collected from the supermarket.
- Monitoring the cost of foods classified by healthiness over time using prices from the NZ Food Price Index.

4.1 Developing the methods

4.1.1 Developing a method to select and price pairs

The pairs' component is included in the foods approach because it is a common method reported in the literature and is outlined in the INFORMAS food prices foundation paper(19). The pairs' component can identify the difference in price between similar products with a contrast in healthiness, so can indicate the cost (or savings) of switching to healthier alternatives. The description of the methodology used for the studies of pairs varies or provides insufficient details to use for the foods approach. Therefore, methodology was developed for the INFORMAS protocol on how to select and compare the cost of pairs and is described below.

4.1.1.1 Defining healthiness of pairs

Studies comparing pairs of foods identify the healthier foods as meeting food-based dietary guidelines or being lower in fat, higher in fibre, lower in salt and/or lower in saturated fat. Generally, the matching item of the pair does not meet dietary guidelines. One study(247) looked at simple substitutions that could improve the healthiness of the diet.

4.1.1.2 Principles to select pairs

Principles were developed to guide selection of pairs (Table 13). A healthier and a similar less healthy item of each pair act as comparators. The pairs' component analyses the price differential between the healthier and less healthy versions of an item, rather than the overall healthiness of the food compared to other foods. Therefore, the difference in nutrients within the pair, and the policy relevance of this contrast was required to be identified, rather than the healthiness of an item based on a nutrient profiling tool. For example, both white rice and brown rice can be considered as part of a healthy dietary pattern, however brown rice is a better option. This difference may not be identified by a nutrient profiling tool.

Using nutrient criteria is problematic because there is not one set of criteria that can be used for all items and nutrients of interest. Instead principles to develop pairs are to consider how the pair contributes to a potential policy action (Table 13) and a difference in nutrient composition for the nutrients of interest: saturated fat, salt, added sugars, wholegrain (higher fibre).

Table 13: Principles to select pairs of healthy and less healthy foods

Principle	Example	Rationale
Be based on the same main ingredient(s) or components.	Trim milk and standard milk.	Similar products with a contrast in healthiness.
Have the same end purpose.	Butter and margarine are both spread on bread.	When one item is usually consumed as part of a main meal and the other a snack (pasta, instant noodles) a consumer would not choose one or the other at a meal occasion.
Be a choice made at the point of purchase within the same food group.	A choice of a fruit bun or croissant for a snack rather than a banana or croissant.	This provides a similar serving size for each item and allows a comparison per 100g. If the items are from different food groups, the serving size may be difficult to identify as can vary depending on the source of serving size data.
Have a difference in a key nutrient(s) or ingredient. Is the healthier item lower in saturated fat, salt, added sugar or wholegrain (higher in fibre)?	Wheat biscuits and cornflakes have a difference in fibre.	Using nutrient criteria is problematic because one set of criteria can not be used for all items and nutrients of interest.
Relate to a potential policy option.	A pair such as a plain and a chocolate biscuit is not a useful comparison, as if plain biscuits were more expensive making them cheaper would not contribute to a healthier diet.	If there were a price difference, would taxing the less healthy item or subsidising the healthier item be a useful strategy?

The wholegrain and refined counterparts of breads and cereals are obvious pairs. Food-based dietary guidelines encourage a proportion of breads and cereals to be whole-grain but do not exclude consumption of some refined grains such as white rice and pasta. However, refined grains would be classified as the less healthy item of the pair. Conversely, for other items the healthier alternative may not be recommended, for example a plain, sweet biscuit compared to a chocolate-coated biscuit.

An ideal healthy beverage is water, which has no direct cost to the consumer. However, the inclusion of an item of no cost is problematic as there is no price comparison. In countries with unsafe tap water, bottled water would be the healthier item of the beverages pair. For this analysis water is not included and a diet beverage is compared with a sugar-sweetened beverage. Some healthier items may not be considered part of a healthy diet. For example, reduced-salt soy sauce is still high in sodium and lite sour cream is high in saturated fat.

4.1.2 Classifying foods as healthier and less healthy

A range of methods are used in the literature to classify foods by healthiness. Two systems are selected based on differing systems of classification.

4.1.2.1 Classifying foods using the WHO Europe nutrient profiling tool

A classification system is required to identify foods as healthier or less healthy. The tool needs to be easy to use, able to be used by different countries, only use information on the foods that is readily available and relate to a diet-health relationship. A category-specific model is considered quicker to use than a model based on scoring.

The WHO Europe nutrient profiling tool is selected because it is designed to be used by different countries and is category specific, with only some items requiring additional nutrition information. This tool is used by the INFORMAS food composition and food promotion modules, so provides consistency. The nutrient thresholds are for total fat, saturated fat, total sugars, added sugars and salt, which covers the main nutrients of concern for INFORMAS, i.e. saturated fat, added sugars and salt(19).

4.1.2.2 Classifying foods by degree of processing

An emerging method (NOVA) for classifying food is by degree of processing according to 'the nature, purpose and extent of industrial food processing rather than in terms of nutrients and food types'(3). This framework forms the basis of the recent Brazilian Dietary Guidelines(10). Consuming meals prepared with wholesome foods is associated with good health and low risk of disease, while consumption of ultra-processed energy-dense foods such as sugary drinks, energy-dense snacks and fast food is associated with obesity and NCDs(3,189,319).

Sales of ultra-processed foods increase with urbanisation and opening of countries to foreign investment and market deregulation. Per capita sales of ultra-processed foods increased in twelve Latin American countries from 1999 to 2013 with a corresponding increase in obesity(3). A study of 25 OECD countries found an ecological association between increased sales of ultra-processed foods and increased body mass index (BMI) over ten years(213). Studies use this classification to investigate the proportion of the population's dietary energy according to the degree of processing(73,172) and the expenditure on foods of varying degrees of processing(173).

4.1.3 Comparing components of the foods approach

As described in Table 14, each component has limitations and answers a different research question so the components are complementary.

- Pairs: What is the price differential between direct food substitutes with clear nutritional differences?
- Food Groups
    a. Healthier and less healthy foods: What is the change in price differential over time between healthier and less healthy food groups?
    b. Degree of processing: What is the change in price differential over time by degree of processing?

Table 14: Advantages and disadvantages of the components of the foods approach

Component	Advantages	Disadvantages	What does it indicate?
Pairs of foods – healthier and less healthy	Easy to categorise each item as an obvious difference in nutrient content e.g. whole/trim milk. Comparator provided by each item of the pair.	Some food groups, e.g., fruit, takeaways, may not be represented. Difficult to have sufficient realistic examples that reflect real choices with a contrast in nutrients.	Indicates whether manufacturers are pricing the healthier option differently.
Food groups Healthier and less healthy foods Degree of processing	WHO Europe nutrient profile model and NOVA classification provides guidance to classify foods. Includes all food groups.	Only for comparison over time rather than analysing the cross-sectional price differential between healthier and less healthy food groups.	Useful for comparing the change in price of healthier and less healthy foods and food groups over time.

4.2 Methods: NZ food prices study

The foods approach was implemented in NZ using two components (pairs, healthier/less healthy foods and degree of processing) to test the methodology outlined in Appendix One. The draft INFORMAS protocol developed for this research recommended that the foods approach only be used to monitor prices over time, except for the pairs approach. This research focuses on the methodology to select, classify and compare foods. The prices initially collected by the researcher from supermarkets are not monitored over time due to time constraints for a second collection so are only used for the pairs approach and to investigate the influence of price metrics. However, the price of items in the FPI became available towards the end of the research, which enabled an additional analysis of the change in prices over time for groups of foods classified by healthiness. There are insufficient foods in the FPI to compare prices of pairs.

The common food items are identified in NZ from surveys as described in chapter 3. Alcohol is not included in the foods approach analysis.

4.2.1 Selection of pairs

The list of pairs commonly used in the literature (section 2.4) is useful to develop a list of potential pairs (Table 15). The studies were conducted in England, US (5), Australia, NZ, South Africa, American Samoa and Saudi Arabia. The pairs in this research were selected by choosing items from the list of commonly consumed foods (chapter 3) that could be paired with a similar item. All common pairs identified in the literature are included in the NZ study except for low-fat and regular sausages as all sausages have a high sodium level.

Table 15: Common pairs of foods identified in the literature

Healthier item	**Less healthy item**
Lean mince	Regular mince
Chicken breast no skin	Chicken drumsticks with skin
Brown rice	White rice
Wholegrain bread	White bread
Breakfast wheat biscuits	Cornflakes
Flake cereal	Toasted muesli
Low-fat milk	Regular milk
Edam cheese	Cheddar cheese
Canned fruit salad in juice	Canned fruit salad in syrup
Diet soda	Regular soda
Spread high in monounsaturated fats	Butter

Twenty-five pairs were considered with three pairs not included in the final selection (Table 16). The difference in nutrient content between natural muesli and toasted muesli is minimal. There is only one brand offering salt-reduced soup, which is higher in sugar than the regular soup so is not considered a healthier option. The price of four yoghurt types was collected. It was considered sufficient to compare the two yoghurts with the largest contrast in nutrients (full-fat sweetened yoghurt and plain unsweetened low-fat yogurt).

The nutrient composition of the item was sourced from the Nutrient Information Panel for products where sodium or sugar varied between individual products, and the NZ food composition tables[398] for items not labelled (fresh produce) or with a consistent composition (rice, pasta). The availability of a generic label for each pair was assessed in a large supermarket.

Table 16: Pairs of healthier and less healthy foods in NZ

Food group	Healthier item	Less healthy item
Grains	Wholegrain bread	White bread
	Brown rice	White rice
	Wholemeal pasta	Plain pasta
	Breakfast wheat biscuit (wholegrain)	Cornflakes (refined)
	Wholegrain crackers	Flavoured cracker
	Canned spaghetti, lite	Canned spaghetti, regular
Dairy	Low-fat milk	Regular milk
	Low-fat plain yoghurt	Full-fat sweetened yoghurt
	Edam cheese	Colby cheese
Meat, poultry, seafood, nuts, legumes	Lean mince 6% fat	Regular mince 20% fat
	Blade steak	Corned beef
	Tuna canned in spring water	Tuna canned in oil
	Chicken breast, no skin	Chicken drumsticks
	Unsalted peanuts	Salted peanuts
Beverages	Diet soda	Regular soda
	Water	Fruit drink
Fruit Vegetables	Lite peaches canned with no added sugar (artificial sweetener)	Peaches canned in light syrup
	Tomatoes canned, no added salt	Tomatoes canned, added salt
	Baked beans canned, lite	Baked beans, canned
Fats	Margarine	Butter
Other	Peanut butter, no added salt or sugar	Peanut butter, added salt
	Tomato sauce, lite	Tomato sauce, regular

4.2.2 Classification into food groups by healthiness

The commonly consumed foods were classified as 'healthier' and 'less healthy' using the WHO Europe nutrient profile tool(308). The commonly consumed foods were classified according to the degree of processing(10): minimally processed, processed culinary ingredients, processed, ultra-processed (Table 17). The culinary ingredients are not included in the analysis as there are only four items in the category (butter, two oils, sugar) and because these foods are recommended to be used in moderation in combination with minimally processed foods, rather than consumed alone(10).

Table 17: Classification of foods according to degree of processing

Degree of processing	Definition	Examples
Natural or minimally processed foods	Natural foods have not been altered following their removal from nature. Minimally processed foods have undergone minimal processing and have no added oils, fats, sugar, salt or other substances.	Vegetables, fruit, rice, whole-grains, flour, pasta, unsalted nuts, meat, poultry, legumes, eggs, plain yoghurt, fresh milk.
Processed culinary ingredients	Products extracted from natural foods or from nature. Used to create dishes and meals.	Oil, fats, sugar, salt.
Processed products	Products manufactured by industry from natural or minimally processed foods with the addition of salt, sugar, oil etc.	Vegetables preserved in salt or vinegar, fruits preserved in sugar, salted, smoked or cured meat or fish, cheeses, breads (wheat flour, yeast, water, salt).
Ultra-processed products	Industrial formulations made from substances extracted from foods, food constituents or synthesised from food substrates. Added or introduced substances that substantially change their nature or use, or contain little or no whole foods. Typically energy dense and nutrient-poor, high in saturated fat, trans fats, free sugars and sodium.	Soft drinks, takeaways, sugary baked goods, ice-creams, sweetened breakfast cereals, cereal bars, sweetened yoghurts, ready-to-eat meals, confectionary.

Adapted from Brazilian Dietary Guidelines[10], Monterio et al 2012[399], Pan American Health Organisation[3]

4.2.3 Price collection for pairs and exploring price metrics

The sampling protocol provides a description of the product, brand name, variety and package size. An alternative brand or package size is provided if the stated one is not available. For fresh fruits and vegetables that are priced per item (for example, head of broccoli, cabbage, avocado), three items are weighed and averaged to minimise handling and time, as conducted in similar studies[383,400,401].

In order to explore the impact of varying the type of price and brand on the cost of foods and diets, the following prices were collected: discount, non-discount price, most popular brand, generic label, cheapest item.

The prices were collected in a provincial city (Nelson) from three supermarkets, one of each of the major chains. The collection took place in the summer in February 2015. The prices of some takeaway items were collected from separate outlets.

4.2.4 Monitoring change in prices classified by healthiness using the Food Price Index

In February 2017, the prices of all 155 foods in the NZ FPI from 2007 became publically available[402]. This provided an opportunity to monitor the cost of foods over time. The prices are collected monthly from 56 supermarkets as well as greengrocers, fish shops, butchers and convenience stores across twelve regional centres. For this research, the foods in the FPI are classified as healthier and less healthy, and by degree of processing. Over the ten-year period, foods were added and removed from the FPI and some package sizes changed. This analysis only included foods that are present in the same package size throughout the time period (34 foods excluded), therefore some key items are not included: dried pasta, juice, potato crisps, muesli bars, bacon, tomato sauce, sports drinks. Tea and coffee are excluded (3 items) as these do not provide energy and baby products (2 items) are excluded. Takeaway items (14 items) are not included as there is no weight provided so the price per 100g can not be calculated. Six further items do not have a weight provided. The item description is insufficient to classify eight items as healthier or less healthy and three items by degree of processing. The six culinary ingredients are not included in the degree of processing analysis.

A mixed model for repeated measures analysis using spatial power covariance structure and the Kenward-Roger degrees of freedom method was used to analyse if there is a significant difference in the mean price per 100g of healthier versus less healthy or ultra-processed and processed versus minimally processed foods between 2007 and 2017. The mean price of each of the three categories was calculated per month. The data for 2007 was for 11 months, and for 2017 for one month. The effect of seasons on the difference in the mean price of healthier versus less healthy foods was also assessed in the model. The seasons are defined as: summer (December to February), autumn (March to May), winter (June to August), spring (September to November).

4.2.5 Calculation of prices of pairs, price metrics and the FPI

Each item of a pair is similar, so using price per 100g is appropriate to allow the consumer to determine whether two products serving the same purpose differ in price[57]. The price of the items of each pair was converted to price per 100g as some package sizes are not the same size within each pair. The percentage difference in price between the healthier and less healthy item was calculated for the mean price of each pair (from the three supermarkets) as follows:

- Same common brand (not generic) for each item of the pair
    - With discount
    - Without discount
- Generic label for each item of the pair
    - With discount
    - Without discount
- Cheapest brand for each item of the pair, brands may differ within a pair
    - With discount
    - Without discount

$$\frac{\$/100\text{g healthier item} - \$/100\text{g less healthy item}}{\$/100\text{g less healthy item}}$$

The appropriateness of each price metric was tested. The mean price of each food group was calculated per 100g, per serving and per 100kJ per edible portion. Yield factors for meat, fish and poultry were sourced from the (NZ)[403] USDA[374], UK[375] and German[373] food tables. The price of the items classified as core or discretionary and by degree of processing was converted to price per 100g edible portion, price per serving and price per kJ.

The prices of the items in the FPI used for monitoring the price over time were converted to price per edible 100g.

4.3 Results: NZ food prices study

4.3.1 Pairs of healthier and less healthy foods

4.3.1.1 Meeting the principles to select pairs

The principles outlined in section 4.1.1 were met as follows:

Principle: Relate to a potential policy option.

- Moving consumption to the healthier product of each pair would provide a reduction in saturated fat, added sugar or sodium or an increase in fibre. Originally a water cracker was chosen as a healthier option compared to a savoury cracker higher in fat and sodium. However, a water cracker is still high in sodium and is not nutrient dense. A wholemeal crisp-bread was chosen instead with a high health star rating.

Principle: Be based on the same main ingredient(s) or components.

- All pairs meet this principle.

Principle: Have the same end purpose.

- Plain pasta compared to instant noodles was considered but instant noodles are often consumed alone as a snack while plain pasta is part of a meal.

Principle: Be a choice made at the point of purchase within the same food group.

- All pairs meet this principle.

Principle: Have a difference in a key nutrient(s): saturated fat, salt, added sugar, fibre.

- As there is little difference in the nutrient profile and ingredients of some toasted and natural mueslis this pair is not included. Frozen potato fries and frozen crumbed fish were considered but there is little difference in nutrient content between different products.

Principle: Have a difference in the form of the food item recommended in food-based dietary guidelines (if specified in guidelines): low or reduced fat, wholegrain, lean meat etc.

- For some pairs, both items are recommended though the healthier item is a better choice.

Principle: The healthier option should be a food that is recommended under the country's food-based dietary guidelines.

- A few pairs do not meet this principle but are included as considered policy relevant. Tomato sauce is not a core food but is very popular so switching to tomato sauce lower in sodium and sugar may be a more realistic policy option than reducing consumption. Diet soda may not be considered healthy as the acidity provides a risk to dental caries[(404)] but is a preferable option to sugar-sweetened soda.

Principle: Be readily available.

- All items were available at the selected supermarkets.

4.3.1.2 Price of pairs

A total of 22 pairs are included in this study. When each item of the pair is of the same brand (no generics, no discount) half the pairs are the same price with the healthier item more expensive for eight pairs (Table 18, Table 19). However, when the cheapest price for each item of the pair is selected (brands may differ), only four items are the same price and the healthier item is more expensive for fifteen pairs. Of the eleven pairs that have a generic label available for both items, most (eight) are the same price. Two pairs have a generic label available only for the less healthy item (baked beans, pasta). When taking the cheapest available item for each item of the pair, the healthier item cost, on average, 42% more than the regular item (Figure 2). This average difference is much less (8%) when taking a branded item for each item of the pair, and disappears when selecting a generic label for each item of the pair.

PAK'n'SAVE discounts products through multi-buys rather than a discount price on a single item, so the price is presented at the non-discount price to include PAK'n'SAVE for the same brand and generic labels. The cheapest price includes discount prices.

Table 18: Relative price differential between each item of NZ pairs

Price type	Same brand – no discount	Cheapest price – includes discounts	Generic labels – no discount
Number of pairs	22	22	11
Each item of pair same price per 100g	11	4	8
Less healthy item of pair cheapest per 100g	8	15	2
Healthier item of pair cheapest per 100g	3	3	1
% higher price of healthier item compared to less healthy within each pair			
- Average	8%	42%	1%
- Standard error of the mean	5%	15%	5%
- Range	-38% to 67%	-59% to 228%	-49% to 28%

Note: Generic pairs – both items in pair were generic

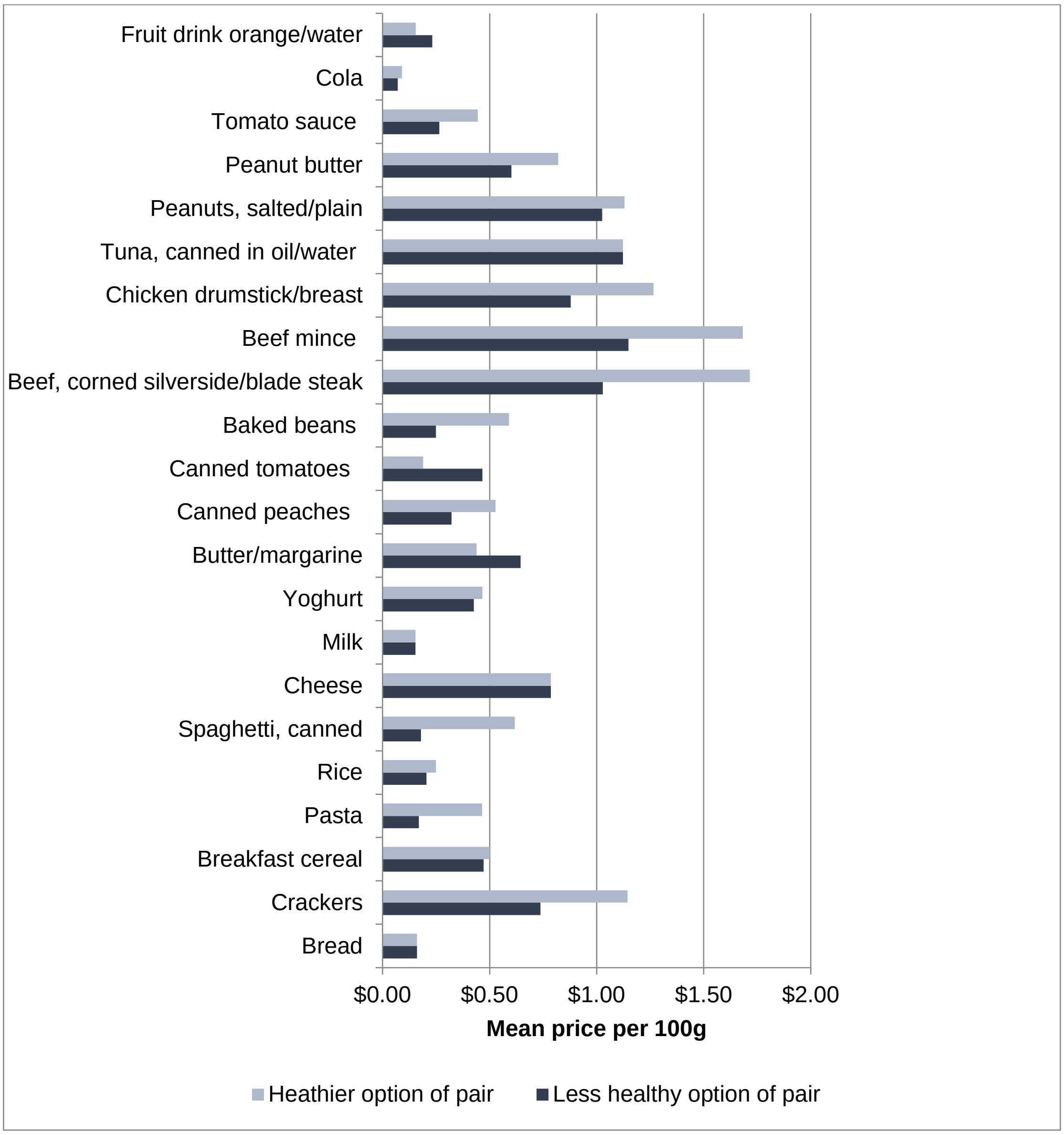
Table 19: Differences in price between each item of the NZ pairs (branded products, no discount)

Same price	Less healthy item cheaper
Bread	Rice
Pasta	Canned spaghetti
Milk	Baked beans
Cheese	Yoghurt
Canned peaches	Mince
Canned tomatoes	Beef
Canned tuna	Chicken
Peanuts	Fruit drink/water
Peanut butter	**Healthier item cheaper**
Tomato sauce	Cornflakes/Breakfast wheat biscuits
Cola/diet cola	Cracker/Whole-grain cracker
	Butter/Margarine

When the cheapest price of each item is compared (Figure 2), rather than the price of the same brand, there is a reversal for eight items (crackers, cereal, pasta, peaches, peanuts, peanut butter, tomato sauce, cola) from the healthier counterpart cheaper or the same price, to becoming more expensive. Canned tomatoes reverse in the opposite direction.

When both items are generic, all but one (breakfast cereal) of the eleven pairs have the same direction of price differential as when both items are branded (bread, rice, milk, cheese, margarine/butter, tuna, peanuts, peanut butter, tomato sauce, cola).

Figure 2: Mean price of NZ pairs per 100g (cheapest price, 3 prices per item)



4.3.1.3 Classification of foods by healthiness in NZ

It was straightforward to classify most of the foods by the WHO Europe nutrient profile model (Table 20) as healthy or less healthy. Some foods were not classified due to a range in the nutrient composition between brands. This meant some brands meet the nutrient criteria while others do not. The items not included are: toasted muesli (sugar level varies), soup, rotisserie chicken, crumbed frozen fish fillets (sodium level varies) and pasta sauce (sugar and sodium level varies).

It was straightforward to classify most of the foods by degree of processing (Table 21), though for some foods the ingredient list was required to assess the level of processing and added ingredients, for example canned foods. Products that were difficult to classify are those using minimally processed foods and culinary ingredients with a preservative added. For example, canned products may differ in their classification depending on added ingredients: fruit canned in juice, fruit juice canned in syrup (water and sugar), canned tomatoes with or without added salt.

Most foods classified as healthier (87%) are classified as minimally processed or processed: fresh and frozen fruit and vegetables, meat and alternatives, milk and yoghurt, canned fruit and fish, cheese. Some foods classified as healthier (12%) are classified as ultra-processed: some breads and breakfast cereals. Most foods classified as 'less healthy' (84%) due to added salt, fat or sugar, are also classified as 'ultra-processed', except for sugar and butter (culinary ingredients), bacon and ham (processed), fruit juice (minimally processed).

Table 20: Inclusion of foods in analysis classified as healthier and less healthy from two price collections: commonly consumed foods identified from NZANS and HES priced in supermarkets (cross-sectional) and foods in Food Price Index (monitored over time)

Healthier Foods								
Fruit	*Super-markets*	*FPI*	**Grains and cereals**	*Super-markets*	*FPI*	**Meat, seafood, poultry, legumes, nuts**	*Super-markets*	*FPI*
Apples, fresh	✓	✓	Bread, white	✓	✓	Eggs	✓	✓
Bananas, fresh	✓	✓	Bread, wheatmeal	✓	✓	Beef, corned beef	✓	✓
Grapes, fresh	✓	✓	Bread, wholegrain	✓	✓	Beef steak, blade	✓	✓
Kiwifruit, fresh	✓	✓	Pita bread	✓	X	Beef steak, rump	✓	Porter-house/sirloin
Mandarins, fresh	✓	✓	Breakfast wheat biscuits	✓	✓	Beef mince	✓	✓
Nectarines, fresh	✓	X	Rolled oats	✓	X	Lamb loin chops	✓	✓
Oranges, fresh	✓	✓	Rice, white	✓	✓	Pork leg roast	✓	✓
Peaches, canned	✓	✓	Rice, brown	✓	X	Pork loin chops	X	✓
Pears, fresh	✓	✓	Pasta, regular	✓	X	Roast lamb/hogget	X	✓
Pineapple, canned	X	✓	Pasta, wholemeal	✓	X	Chicken, whole frozen	X	✓
Sultanas, dried	✓	✓				Chicken breast	✓	X
Vegetables			**Milk, cheese, yoghurt**			Chicken drumstick	✓	X
Alfalfa sprouts	X	✓	Cheese, Colby	✓	Mild	Fish fillets, fresh	✓	✓
Avocados, fresh	✓	✓	Cheese, Edam	✓	X	Tuna, canned	✓	✓
Beans, fresh	X	✓	Milk, trim	✓	Calcitrim	Salmon, canned	X	✓
Broccoli, fresh	✓	✓	Milk, standard	✓	✓	Mussels, live	X	✓
Cabbage, fresh	✓	✓	Yoghurt, full-fat flavoured	✓	X	Mussels, marinated	X	✓
Capsicums, fresh	✓	✓	Yoghurt, natural low-fat	✓	X	Lentils canned in spring water	✓	X
Carrots, fresh	✓	✓	Cheese, processed slices	X	✓	Baked beans, lite	✓	X

Cauliflower, fresh	✓	✓	Cottage cheese	X	✓	Peanuts, plain	✓	X
Celery, fresh	✓	✓	Cheese, Camembert	X	✓	Almonds, plain	✓	X
Corn creamed style	X	✓				Peanut butter, plain	✓	X
Courgettes, fresh	✓	✓						
Cucumber, fresh	✓	✓	**Fats and oils**					
Lettuce, fresh	✓	✓	Margarine, mono-unsaturated	✓	X	Bottled water	X	✓
Kumara, fresh	✓	✓	regular fat					
Mixed vegetables, frozen	✓	✓	Olive oil	✓	✓			
Mushrooms, fresh	✓	✓	Canola oil	✓	X			
Vegetables	*Super-markets*	*FPI*						
Onions, fresh	✓	✓						
Parsnips, fresh	X	✓						
Peas, frozen	✓	✓						
Potato fries, frozen	✓	✓						
Potatoes, fresh	✓	✓						
Pumpkin, fresh	✓	✓						
Silverbeet, fresh	✓	X						
Tomatoes, canned	✓	✓						
Tomatoes, fresh	✓	✓						
Less healthy foods								
Snacks, cereals, processed meats	*Super-markets*	*FPI*	**Fats and oils, dressings, spreads**	*Super-markets*	*FPI*	**Sweetened beverages**	*Super-markets*	*FPI*
Instant noodles	✓	✓	Jam	✓	✓	Milo, powder	✓	Drinking chocolate
Biscuits, plain	✓	✓	Tomato sauce	✓	X	Cola	✓	Soft drink

Biscuits, chocolate	✓	✓	Butter	✓	✓	Diet cola	✓	Soft drink
Muesli bar	✓	✓	Mayonnaise	✓	X	Fruit drink	✓	X
Crackers, savoury	✓	✓	White sugar	✓	✓	Drink powder	✓	X
Muffins	✓	Muffins & buns	Peanut butter, salted	X	✓	Orange juice	✓	X
Cornflakes	✓	✓	Pasta sauce	X	✓			
Potato crisps	✓	X	Soy sauce	X	✓			
Chocolate, diary milk block	✓	✓	Honey	X	✓			
Chocolate, boxed, loose	X	✓	Cream	X	✓			
Chocolate novelty bars	X	✓	**Takeaways and ready meals**			**Processed meats**		
Sweets - jelly beans	✓	✓	Battered fish	✓	X	Bacon, middle rashers	✓	X
Ice cream, plain	✓	✓	Hot chips	✓	X	Ham	✓	X
Pastry, frozen sheets	X	✓	Burger	✓	X	Sausages	✓	✓
Soup, canned	X	✓	Pizza	✓	X	Salami	X	✓
Salted peanuts	✓	✓	Meat pie	✓	X			

✓ Item in analysis (Food from FPI described if a variation of the item priced in the supermarket)

X Item not in analysis

Table 21: Inclusion of foods classified by degree of processing in analysis from two price collections: commonly consumed foods identified from NZANS and HES priced in supermarkets (cross-sectional) and foods in Food Price Index (monitored over time)

Minimally processed	*Super-markets*	*FPI*	**Processed**	*Super-markets*	*FPI*	**Ultra-processed foods**	*Super-markets*	*FPI*
Apples, fresh	✓	✓	Lentils, canned in spring-water	✓	X	Bread, white	✓	✓
Bananas, fresh	✓	✓	Peaches, canned	✓	✓	Bread, wheatmeal	✓	✓
Grapes, fresh	✓	✓	Cheese, Colby	✓	Mild	Bread, wholegrain	✓	✓
Kiwifruit, fresh	✓	✓	Cheese, Edam	✓	X	Cake, fruit	✓	✓
Mandarins, fresh	✓	✓	Bacon, middle rashers	✓	X	Biscuits, plain	✓	✓
Nectarines, fresh	✓	X	Ham, sliced	✓	X	Biscuits, chocolate	✓	✓
Oranges, fresh	✓	✓	Beef, corned beef	✓	✓	Biscuits, crackers	✓	✓
Pears, fresh	✓	✓	Tuna, canned	✓	✓	Muffins	✓	X
Pineapple, canned	X	✓	Hummus dip	✓	X	Cornflakes	✓	✓
Sultanas, dried	✓	✓	Pita bread	✓	X	Muesli, toasted	✓	✓
Orange juice	✓	X	Potato fries, frozen	✓	✓	Breakfast wheat biscuits	✓	✓
Alfalfa sprouts	X	✓	Cottage cheese	X	✓	Instant noodles	✓	X
Avocados, fresh	✓	✓	Camembert cheese	X	✓	Spaghetti, canned	✓	✓
Beans, fresh	X	✓	Salted peanuts	✓	✓	Yoghurt, full-fat flavoured	✓	✓
Broccoli, fresh	✓	✓	Salami	X	✓	Sausages	✓	✓
Cabbage, fresh	✓	✓	Mussels, marinated	X	✓	Fish fillets, frozen	✓	✓
Capsicums, fresh	✓	✓	Salmon, canned	X	✓	Baked beans	✓	X
Carrots, fresh	✓	✓	Peanut butter, salted	X	✓	Margarine, monounsaturated regular fat	✓	X
Cauliflower, fresh	✓	✓	Tomatoes canned, salt or no salt	X	✓	Chocolate, diary milk block	✓	✓
Celery, fresh	X	✓				Sweets, jelly beans	✓	✓

Minimally processed	*Super-markets*	*FPI*	**Processed**	*Super-markets*	*FPI*	**Ultra-processed foods**	*Super-markets*	*FPI*
Courgettes, fresh	✓	✓				Muesli bar, fruit nut chocolate	✓	X
Cucumber, fresh	✓	✓				Potato crisps	✓	X
Kumara, fresh	✓	✓				Ice cream	✓	✓
Lettuce, fresh	✓	✓				Jam	✓	✓
Mixed vegetables, frozen	✓	✓				Tomato sauce	✓	X
Mushrooms, fresh	✓	✓				Mayonnaise	✓	X
Onions, fresh	✓	✓				Milo powder	✓	Drinking chocolate
Parsnips, fresh	X	✓						
Peas, frozen	✓	✓	**Processed culinary ingredients**			Cola	✓	Soft drink
Potatoes, fresh	✓	✓	Butter	✓	✓	Diet cola	✓	Soft drink
Pumpkin, fresh	✓	✓	Olive oil	✓	✓	Fruit drink orange	✓	X
Silverbeet, fresh	✓	X	Canola oil	✓	X	Drink powder	✓	X
Tomatoes, fresh	✓	✓	Sugar	✓	✓	Meat pie	✓	X
Tomatoes, canned, no salt	✓	X	Flour, white	X	✓	Battered fish	✓	X
Rolled oats	✓	X	Honey	X	✓	Hot chips	✓	X
Pasta	✓	✓	Vinegar	X	✓	Burger	✓	X
Rice, brown	✓	X				Pizza	✓	X
Rice, white	✓	✓				Salad, takeaway, vegetable	X	✓
Milk, trim	✓	Calcitrim				Cheese, processed slices	X	✓
Milk, standard	✓	✓				Chocolate, boxed, loose	X	✓
Yoghurt, natural low-fat	✓	X				Chocolate novelty bars	X	✓
Eggs	✓	✓				Pastry, frozen sheets	X	✓

Minimally processed	*Super-markets*	*FPI*	**Processed**	*Super-markets*	*FPI*	**Ultra-processed foods**	*Super-markets*	*FPI*
Beef steak, blade	✓	✓				Pasta sauce	X	✓
Beef steak, rump	✓	Porterhouse /sirloin				Soy sauce	X	✓
Beef mince	✓	✓				Soup, canned	X	✓
Pork leg roast	✓	✓						
Pork loin chops	X	✓						
Roast lamb/hogget	X	✓						
Lamb shoulder chops	✓	✓						
Chicken, whole frozen	X	✓						
Chicken breast	✓	X						
Chicken drumsticks	✓	X						
Fish fillets, fresh	✓	✓						
Peanuts, plain	✓	X						
Mussels, live	X	✓						
Almonds, plain	✓	X						

✓ Item in analysis (Food from FPI described if a variation of the item priced in the supermarket)

X Item not in analysis

4.3.2 Comparison of price metrics

4.3.2.1 Cost of healthier and less healthy foods using three price metrics

The cost of each item calculated per 100g, per serving and per 100kJ is presented in Table 22. The price differential between the mean price of healthier food and less healthy food items differs for each price metric (Figure 3). Healthier food is cheaper than less healthy food when measured per 100g, about 20% more expensive when measured per serving and three times more expensive when measured per 100kJ.

When the price is measured per 100g (Figure 4), grains, fruit and vegetables, and dairy are the cheapest food groups, followed by less healthy foods with meat, fish and nuts the most expensive food group. When measured per serving, the pattern is similar though the mean price of fruit and vegetables and less healthy foods is the same. The pattern changes considerably when measured per 100kJ with grains still the cheapest, followed by dairy and less healthy foods, with fruit and vegetables the most expensive.

When the food groups contributing to less healthy food are disaggregated, takeaways are the most expensive per 100g (along with meat, fish and nuts) and per serving and of intermediate price per 100kJ. Sweetened beverages are one of the cheapest groups per 100g and moderately priced per serving and per 100kJ.

Table 22: Mean price of NZ food groups using three price metrics (cheapest price)

Food group	# items	$/100g	$/serve	$/100kJ
Fruit & vegetables	30	$0.58	$0.72	$0.49
Grains	10	$0.26	$0.16	$0.03
Dairy	6	$0.46	$0.46	$0.11
Meat, seafood, poultry, eggs, legumes, nuts	16	$1.78	$1.89	$0.24
Fats and oils	3	$0.55	$0.08	$0.02
Total healthy (Standard error of the mean)	**65**	**$0.82** **($0.10)**	**$0.87** **($0.13)**	**$0.30** **($0.05)**
Snacks, baked goods, sweets, processed meat	15	$0.94	$0.45	$0.08
Sweetened beverages*	6 (5)	$0.38	$0.28	$0.09
Fats, dressings, spreads, sauces	5	$0.92	$0.06	$0.04
Takeaways	5	$1.79	$2.80	$0.16
Total less healthy (Standard error of the mean)	**31**	**$0.89** **($0.13)**	**$0.73** **($0.22)**	**$0.09** **($0.01)**

*Diet coke not included in analysis per 100kJ

Figure 3: Mean price of healthier and less healthy NZ foods using three price metrics

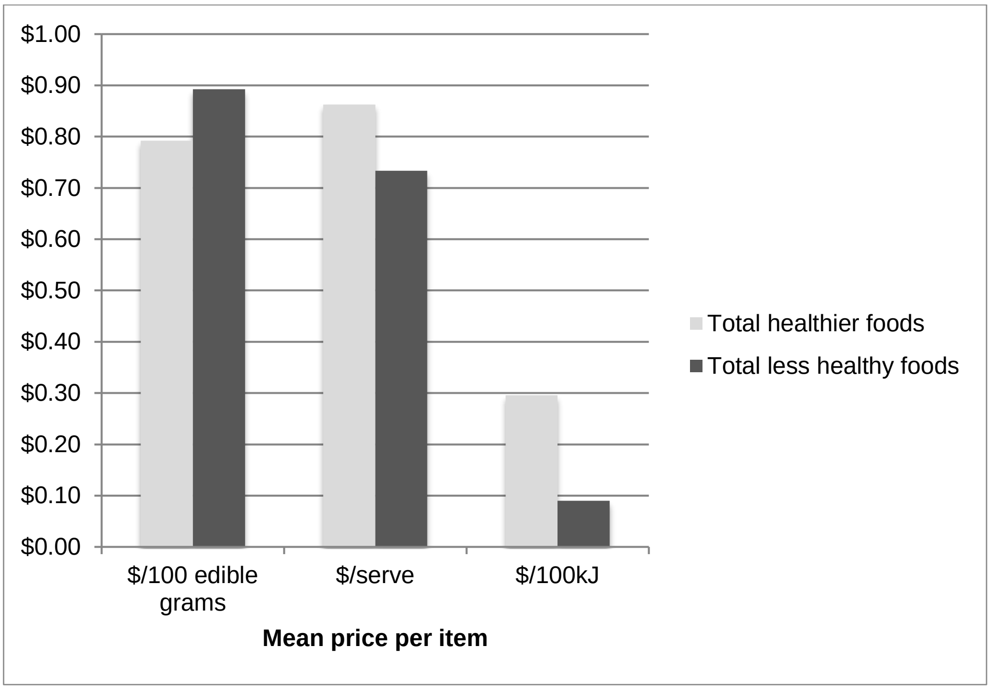
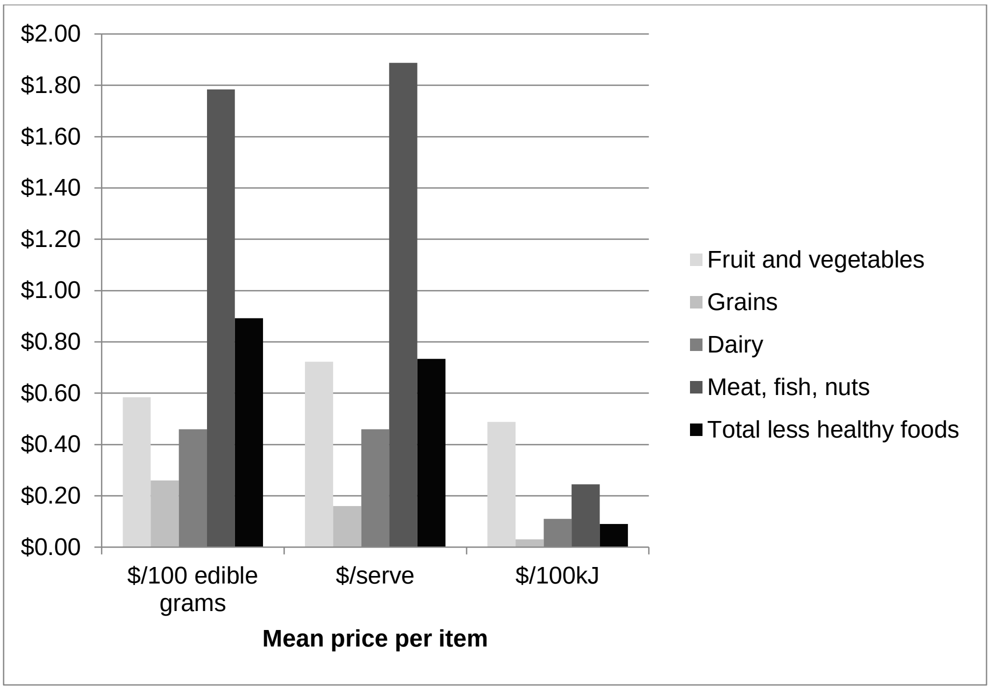


Figure 4: Mean price of NZ food groups using three price metrics



4.3.2.2 Cost of foods classified by degree of processing using three price metrics

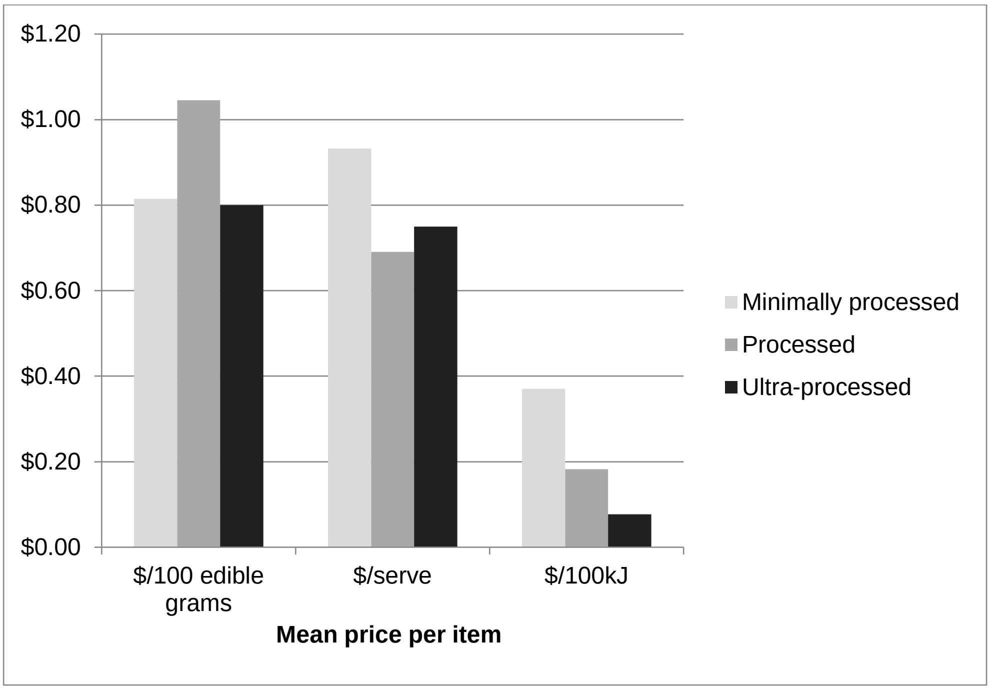
The cost of the foods classified by degree of processing for three price metrics are presented in Table 23 and Figure 5. The mean cost of the processed foods is higher than the other categories when priced per 100g. The mean cost of minimally processed and ultra-processed foods is similar. When analysed per serving, this pattern changes with the minimally processed foods the most expensive category. The mean cost per 100kJ of the minimally processed foods is the most expensive category, followed by processed foods with ultra-processed foods the cheapest.

Table 23: Mean price of NZ foods classified by degree of processing using three price metrics (cheapest price)

	Number of items	$/100g Mean (SE)	$/serve Mean (SE)	Average serving size g	$/100kJ Mean (SE)
Minimally processed (Standard error of the mean)	47	$0.81 ($0.11)	$0.93 ($0.14)	121g	$0.37 ($0.07)
Processed (Standard error of the mean)	11	$1.05 ($0.16)	$0.69 ($0.16)	76g	$0.18 ($0.03)
Ultra-processed* (Standard error of the mean)	36 (35)	$0.80 ($0.11)	$0.75 ($0.20)	96g	$0.08 ($0.01)

*Diet coke not included in analysis per 100kJ

Figure 5: Mean price of NZ foods classified by degree of processing using three price metrics



4.3.3 Monitoring over time using the FPI

4.3.3.1 Healthier and less healthy foods

Eighty-eight of the 155 items from the FPI were classified as healthier (n=63) or less healthy (n=25) by the WHO Europe nutrient profile model. There is a highly statistically significant trend of increasing food price over time (p= 0.0179) (Figure 6, Table 24). The trend over time is the same for healthier and less healthy foods (p=0.7813 for the interaction). There is no significant difference in price between healthier and less healthy foods per 100g (p=0.2489).

There is a highly statistically significant difference in food price overall between different seasons (p<0.001). The type three test of fixed effects found there is a statistically significant interaction (p=0.014) between seasons and foods classified as healthier and less healthy (Figure 7). This means the effect of season on food price is not the same between healthier and less healthy foods. The price of healthy foods fluctuated more by season compared to less healthy foods.

Figure 6: Change in price over time of healthier and less healthy foods in NZ

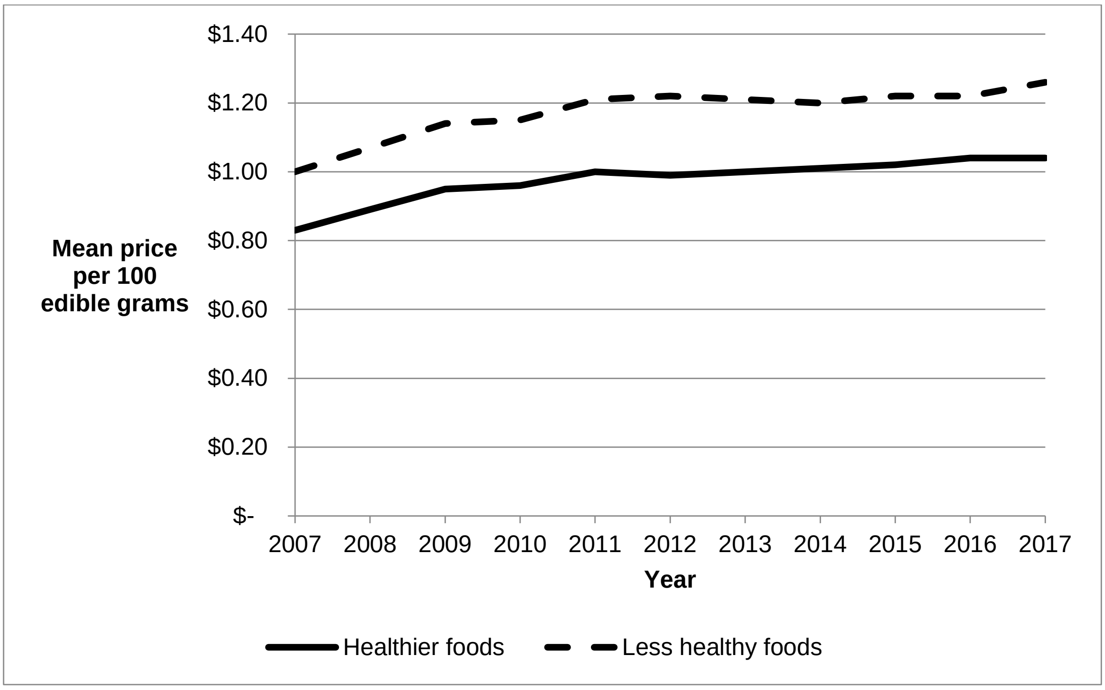


Figure 7: Change in price of over time of healthier and less healthy foods according to season in NZ

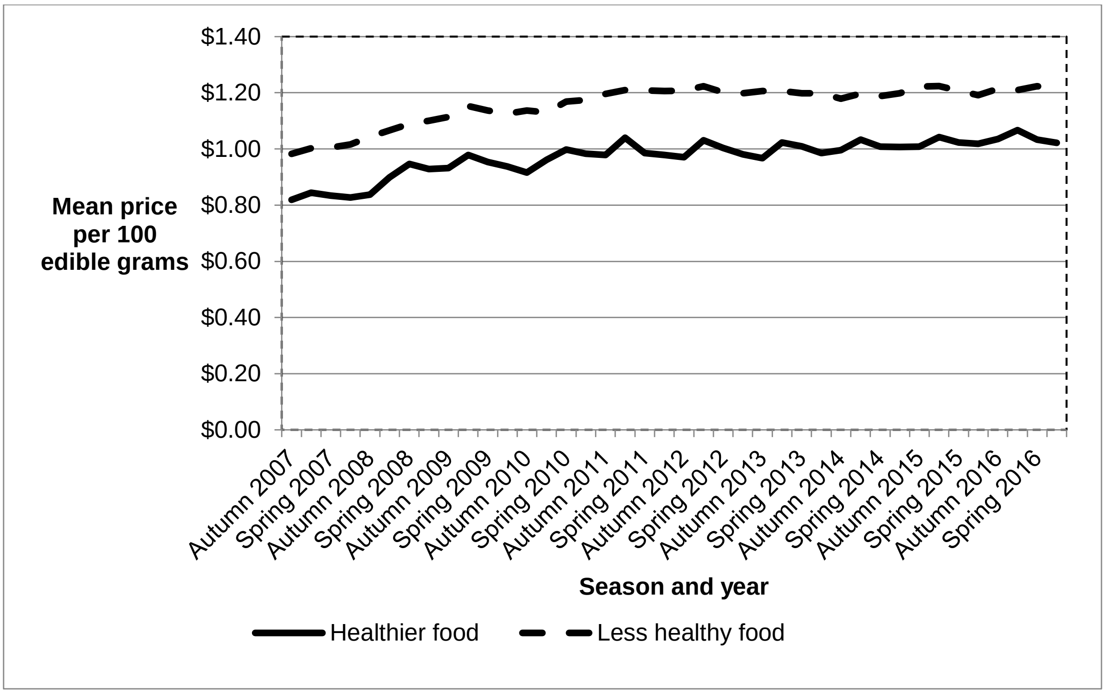


Table 24: Solution for fixed effects for prices of healthier and less healthy foods

Effect	Healthy	Season	Estimate	Standard error	Degrees freedom	t value	Pr > |t|
Intercept			0.8226	0.0984	143	8.36	<.0001
Healthy	unhealthy		0.1802	0.1595	97.6	1.13	0.2613
Healthy	healthy		0	.	.	.	.
Season		Autumn	-0.00475	0.0036	1.00E+04	-1.32	0.187
Season		Spring	0.01048	0.0036	1.00E+04	2.91	0.0036
Season		Winter	0.02116	0.004157	1.00E+04	5.09	<.0001
Season		Summer	0	.	.	.	.
cTime			0.001942	0.000819	1013	2.37	0.0179
Healthy*Season	unhealthy	Autumn	0.01485	0.006755	1.00E+04	2.2	0.028
Healthy*Season	unhealthy	Spring	0.006757	0.006755	1.00E+04	1	0.3172
Healthy*Season	unhealthy	Winter	-0.00237	0.0078	1.00E+04	-0.3	0.7611
Healthy*Season	unhealthy	Summer	0	.	.	.	.
Healthy*Season	healthy	Autumn	0	.	.	.	.
Healthy*Season	healthy	Spring	0	.	.	.	.
Healthy*Season	healthy	Winter	0	.	.	.	.
Healthy*Season	healthy	Summer	0	.	.	.	.

4.3.3.2 Degree of processing

Eighty-seven of the 155 items in the FPI were classified by degree of processing with 29 classified as ultra-processed, 13 as processed and 45 minimally processed foods. There is a highly statistically significant trend of increasing food price over time (p=0.0243) (Table 25).The trend over time is the same between the three categories of processing (interaction p=0.8837) (Figure 8). There is a statistically significant difference in price between foods of different degrees of processing but the price of ultra-processed food is not significantly different to minimally processed food. Processed food is on average $0.51/100g more expensive than minimally processed food (p = 0.0157).

The type three test of fixed effects found there is a statistically significant interaction between seasons and degrees of processing (p<0.001). This means the effect of season on food price is not the same between different degrees of processing (Figure 9). The price of minimally processed foods fluctuates more by season compared to processed and ultra-processed food.

Figure 8: Change in price over time of NZ foods classified by degree of processing

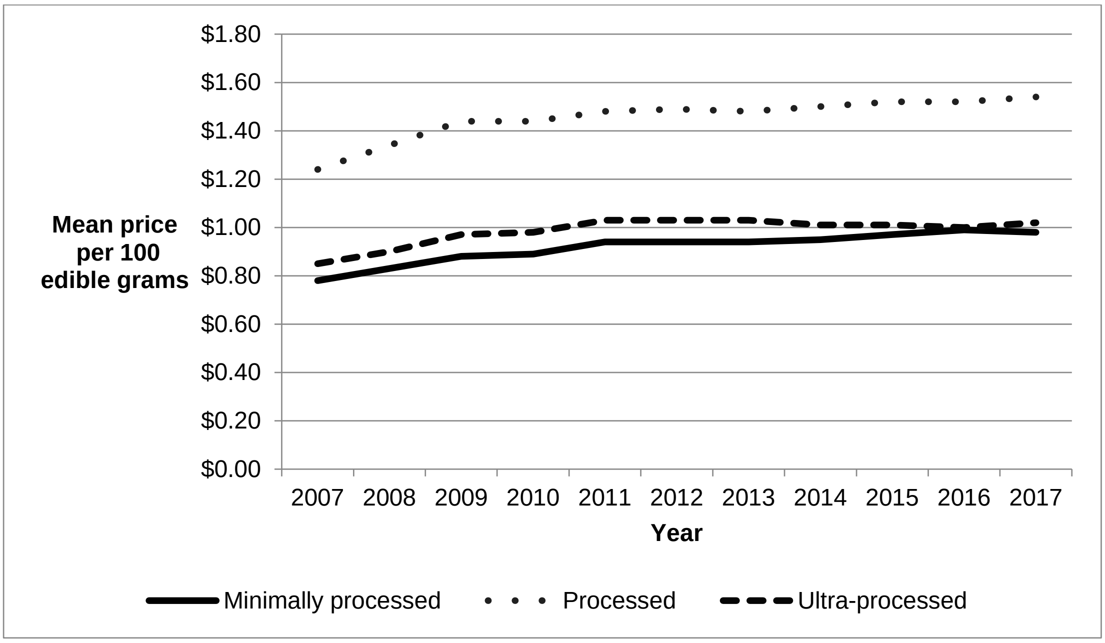


Figure 9: Change in price over time of NZ foods classified by degree of processing by season

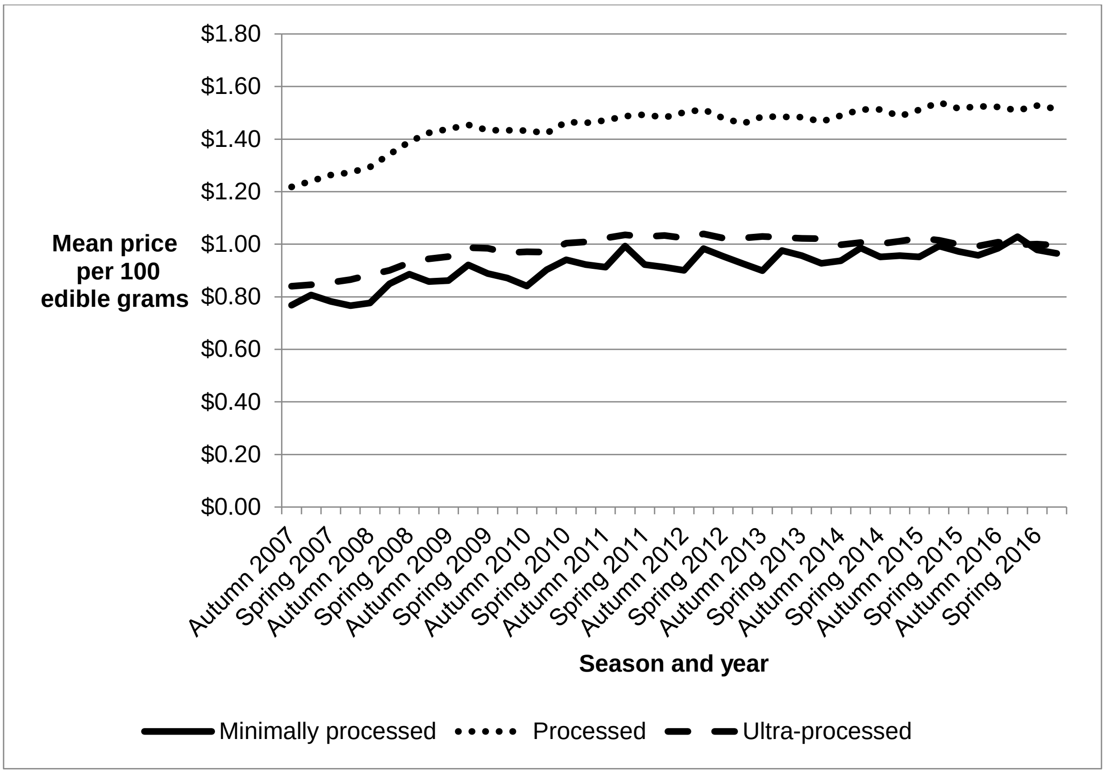


Table 25: Solution for fixed effects for prices of foods classified by degree of processing

Effect	Processing	Season	Estimate	Standard error	Degrees freedom	t value	Pr > |t|
Intercept			0.7759	0.1097	129	7.07	<.0001
Processing	p		0.5098	0.2073	95.9	2.46	0.0157
Processing	u		0.0522	0.1568	95.9	0.33	0.7398
Processing	m		0	.	.	.	.
Season		Autumn	-0.00537	0.004203	1.00E+04	-1.28	0.2017
Season		Spring	0.01208	0.004203	1.00E+04	2.87	0.0041
Season		Winter	0.0289	0.004853	1.00E+04	5.96	<.0001
Season		Summer	0	.	.	.	.
cTime			0.001826	0.000809	974	2.26	0.0243
Processing*Season	p	Autumn	0.005601	0.008877	1.00E+04	0.63	0.5281
Processing*Season	p	Spring	0.002436	0.008877	1.00E+04	0.27	0.7837
Processing*Season	p	Winter	-0.02105	0.01025	1.00E+04	-2.05	0.04
Processing*Season	p	Summer	0	.	.	.	.
Processing*Season	u	Autumn	0.01296	0.006713	1.00E+04	1.93	0.0535
Processing*Season	u	Spring	0.000384	0.006713	1.00E+04	0.06	0.9544
Processing*Season	u	Winter	-0.01561	0.007752	1.00E+04	-2.01	0.044
Processing*Season	u	Summer	0	.	.	.	.
Processing*Season	m	Autumn	0	.	.	.	.
Processing*Season	m	Spring	0	.	.	.	.
Processing*Season	m	Winter	0	.	.	.	.
Processing*Season	m	Summer	0	.	.	.	.

P = processed, u = ultra-processed, m = minimally processed

4.4 Discussion: Foods approach

Four aspects of the foods approach were tested: pairs; classifying foods by healthiness, price metrics and the feasibility of monitoring prices over time using the FPI.

4.4.1 Pairs

The pairs meet the principles for selection of pairs outlined in section 4.1.1. When branded items are selected, the healthier item costs eight percent more than the less healthy item and for almost half of the pairs, the healthier and less healthy items are the same price. When the cheapest item is selected, irrespective of brand or generic label, the healthier item costs forty-two percent more than the less healthy item, as the cheapest generic label is not always available in the healthier version. For some commonly consumed foods such as milk, cheese, bread and pasta, there is no price differential therefore price is not a barrier to selecting the healthier item.

Comparing the price when both items of a pair are of the same brand indicates whether a manufacturer is pricing the healthier product differently compared to the less healthy product, possibly due to a pricing strategy or a difference in production cost. Comparing the price when each item of a pair is the cheapest item indicates a choice likely to be made by a consumer, if the products are a similar quality. Therefore, it would be useful to collect both the price of the branded item and the cheapest item to provide direction on an appropriate policy action.

A 2007 NZ study compared the cost of nine categories of foods(169). For five of these, the healthier item is more expensive, and for three, the healthier item is cheaper. A 2010 NZ study(325) compared eight pairs with no difference in price between the healthier and less healthy item for three pairs. All three studies found little difference in the price of regular and low-fat milk, and lean meats are more expensive. The relative price differential between breads is different in each study. The 2007 study and this study found healthier cereals are cheaper than less healthy cereals. This research differs from the 2007 study for some pairs. Margarine is cheaper than butter and the price of the healthier cheese, soft drink and canned fruit is the same price, rather than more expensive than the less healthy option. Canned tuna is the same price rather than cheaper. The healthier soft drink is more expensive than the less healthy soft drink in the 2010 study.

In all but one of the studies of pairs described in section 2.4.2, overall the cost of the healthier item is more than the cost of the less healthy item. When looking at individual pairs, some healthier items are cheaper or cost the same as the less healthy item. A review of nine studies of pairs reported the healthier options cost more, except for milk, with lean meats and whole grain versions of food contributing most to the price differences(381).

If possible, each item of the pair should be of the same brand. This will reduce variation in price between brands. In NZ there is variation in price when only one item is a generic label. As expected, there was less variation between equivalent items of a pair when selecting only branded or only generic labels. If the cheapest price is selected, less healthy equivalents tend to be cheaper than the healthier counterpart. If the items in the pair are a different brand a price variation may be due to the difference in brands rather than the difference in healthiness.

It is important to keep note of any items where a healthier alternative is not available, as this may become an action to advocate that food manufacturers or retailers provide a healthier alternative.

4.4.2 Classifying foods by healthiness

The classification systems selected for this research, the WHO Europe nutrient profiling model and degree of processing are feasible to use to classify foods by healthiness with the Nutrient Information Panel assisting some decisions. The systems are currently used by multiple countries.

4.4.3 The use of different price metrics

In this research, grains, fruit and vegetables, and dairy are the cheapest food groups per 100g and per serving, followed by less healthy foods, with meat, fish and nuts the most expensive food group. There is more variation between metrics in those groups where the serving size is much smaller or larger than 100g. The pattern changes when measured per 100kJ with grains still one of the cheapest groups as these are relatively energy dense and fruit and vegetables the most expensive as these are not energy dense. These patterns are similar to those found in other studies(178,256,405-407), though in a US study dairy is relatively more expensive per 100g(408) and in a UK study(79) dairy is intermediate in price for all measures. NZ is a large dairy producer which could lead to relatively cheaper dairy prices than in other countries.

Most of the studies that classify foods by degree of processing only analysed the cost per 100kJ using household expenditure studies. The pattern is similar to the UK(173) with the cost of the minimally processed foods highest per 100kJ and the processed and ultra-processed foods cheapest. The pattern differs in Brazil with the cost of minimally processed foods, processed and ultra-processed foods similar per 100kJ(173). It is more economical in Brazil to prepare meals from minimally processed and processed foods than purchasing ultra-processed foods, compared to the UK.

Jones and Monsivais(57) recommend choosing the price metric to suit the research purpose. When the research compares similar foods, price per 100g is appropriate to allow the consumer to determine whether two products serving the same purpose differ in price. This metric does not account for the way a food is consumed and how much it contributes to energy. Serving size is appropriate when estimating the likely impact on consumer costs, as it compares foods in the amount likely to be consumed where foods may differ in energy and mass. Serving size data is required which may not be available or differs between countries. Price per unit energy is appropriate when the comparison is related to the amount of sustenance the food can contribute. The comparison of foods eaten in quantities that provide substantially different amounts of energy is less relevant to consumer behaviour.

For the INFORMAS food prices protocol, the actual price metric is less important when monitoring over time as it is the differential in the relative change in price that is compared rather than the absolute difference. Therefore, it is recommended to calculate the price per 100g as this is the easiest metric to calculate as data on serving size or energy is not required.

4.4.4 Monitoring over time using the FPI

For foods in the NZ FPI, there was no significant difference in the rate of price change between healthier and less healthy foods, or between minimally processed, processed and ultra-processed foods between 2007 and 2017. Not all foods in the FPI were able to be included in the analysis. Thirty-four foods were not in the FPI for the ten-year period or the package weight changed. Takeaways were not included in the analysis as the weight of the item was not provided and the description of some items did not provide sufficient details to classify by healthiness or by degree of processing. The UK(79) and Australian(181) studies of the CPI excluded restaurant meals.

It was not possible to use the FPI prices for the pairs approach to monitor the change in price over time. The description is not specific enough for some items to identify the healthier or less healthy item of a pair (for example, soft drink could be regular or diet), or the healthier item is not in the index (for example, brown rice). Statistics New Zealand is not able to provide further details (personal communication, 2017). Most foods considered very common in NZ are included in the FPI, however dried pasta was not included until July 2008 so was not included in the analysis.

Other research groups successfully used the CPI to monitor food prices over time indicating that it is feasible to use in these countries (UK, Australia)(79,181). As prices are influenced by a wide range of factors it is not expected that trends in price changes would be similar across countries. Unlike this research, prices of healthier foods in the UK increased at a higher rate than less healthy items(79). In the UK, from 1997 to 2009 the average price of a junk food basket fell about 15%, while the price of a fruit and vegetables basket increased by about 7% relative to all foods(180).

A new initiative in Australia re-classified foods in the CPI in line with the food groups in the Australian Dietary Guidelines(181). The rate of change between 2001 and 2014 for all food was 2.9%, which was similar for discretionary items (3.0%), fruit (3.0%) and oils and fats (2.9%). Vegetables had a higher rate of price change (3.8%), while grains and cereals (2.4%), milk and alternatives (2.5%) and meat and alternatives (2.2%) had lower rates.

The FPI is a useful tool as price data is provided, however the description of the foods must be in sufficient detail to be able to classify foods according to healthiness. In some countries, discussion with the agency collating price indices may be required to ensure the description is sufficient.

5 MEALS APPROACH: MEASURING THE COST OF POPULAR TAKEAWAYS WITH THEIR HEALTHIER HOME-COOKED COUNTERPARTS

5.1 Introduction

The INFORMAS foundation paper[19] on monitoring food prices proposes that the cost of a reference ‘healthy meal’ be compared to the cost of a similar but ‘less healthy’ meal (of equivalent weight). Meal patterns and the location of where a meal is prepared (at home or away from home) can affect diet quality and cost[409]. Adopting a meals-based approach provides a context through combining foods as meals. This chapter explores development of an approach to answer ‘How can the cost of popular takeaway meals and their healthy home-cooked counterparts be compared and measured over time, and between countries?’.

The literature review found no established methodology to define and analyse the cost of meals prepared across the spectrum of food preparation. Exploratory work was undertaken in NZ by the candidate using common takeaway meals to develop a novel method to compare home-made and takeaway meals which is briefly described in section 5.2 and detailed in Appendix One. This approach is then tested in the NZ meals cost study to answer, ‘‘Do healthier home-cooked meals cost more than their popular takeaway counterparts?’ as described in section 5.3. The results are presented in section 5.4.

5.2 Developing the methods for the meals approach

The exploratory work is briefly described in this chapter with further details in Appendix Three. The popular takeaway meals were identified from easily accessible data sources. Meal criteria were developed to select healthier home-made meals. The cost of the meals was calculated with and without time. Healthier home-assembled meals using pre-prepared components were added to the comparison, as convenience ingredients and meals are an important meal solution, particularly when time is scarce. The limitations and challenges of the methodology are discussed. An excerpt of the draft INFORMAS food prices protocol for the meals approach is found in Appendix One.

5.2.1 Developing criteria for healthy meals

Due to the lack of a standard definition of a meal and little guidance from the literature for specific guidelines to define a meal and develop the home-made and home-assembled meals, some arbitrary decisions were required to develop the guidelines, as described in Table 26. Nutrient criteria were required to ensure that the meals prepared at home were in line with food-based dietary guidelines. Five classification systems were considered as outlined in Table 27. The meals in the exploratory work were compared to the nutrient classification systems as reported in Appendix Three.

Table 26: Guidelines to develop home-cooked meals

Guidelines for home-made and home-assembled meals	Rationale
Meal for four.	INFORMAS reference household is 2 adults and 2 children. Common number of servings in recipes.
The weight difference of the home-made, home-assembled and takeaway meals is within 100g for each meal within a meal option.	Anchor the meals by weight.
Beverages are not included.	The healthy option for the home-made meal would be water that may be of no cost, so pricing comparisons are difficult.
Desserts not included.	Takeaway desserts are less common. Simplifies the meal comparison.
Include 3 servings of vegetables per person (non-starchy and starchy).	The dinner meal is a common meal for consumption of vegetables.
Include discretionary foods and unsaturated oils in small amounts.	For flavour and cooking, e.g., tomato sauce on burger, oil to cook fish and wedges.
Recommended serving per person of meat, fish, poultry, (100-120g) nuts, eggs, legumes, dairy.	Meet Eating and Activity Guidelines[395].
No added salt unless required for a function (e.g., rising).	Reduce sodium content.

Table 27: Nutrient classification systems used to compare healthiness of home-made and takeaway meals

System	Use	Classification or additional guidelines	Nutrient criteria
Food and Beverage Classification system 2007[410]	Classification of foods and meals offered at early childhood food service and school food services in NZ	Everyday Sometimes Occasional	Energy <1000kJ per 100g Saturated fat <5g per 100g Sodium <450mg per 100g
Canadian Heart and Stroke Foundation[411]	Meals		Fat <20g per meal Saturated fat ≤2g per 100g Sodium <960mg per meal
UK traffic light signpost labelling[412]	Signpost labelling Ready-meals category	Green Amber Red	Green: Fat <3g per 100g Saturated fat ≤1.5g per 100g Sodium ≤300mg per 100g

NZ Heart Foundation recipe criteria[413]	Meal recipes	Maximum raw weight meat, poultry, fish Do not include butter, cream or meat fats	Saturated fat ≤5g per serve Sodium ≤600mg per serve
Tick ready-meals[193]	Ready-meals		Energy ≤2200kJ per serve Saturated fat ≤2g per 100g or ≤6g per serve Sodium ≤300mg per 100g ≤900mg per serve 1+ serving vegetables or 3g+ fibre per serve

Criteria for home-cooked meals were developed and tested using the meals in Appendix Three, with the final criteria shown in Table 28. Vegetables are an important component but providing more than two servings of non-starchy vegetables on a pizza or as burger fillings was difficult. Therefore, the criterion was set at a minimum of two servings of non-starchy vegetables, or 600g per meal. Starchy vegetables were not included as potatoes were a main component of some meals but not others.

Table 28: Nutrition criteria developed for home-cooked meals

<6g saturated fat per serving
<900mg sodium per serving
Minimum 150g vegetables (2 servings) where appropriate for the dish
Minimum 5g protein per serving with a maximum raw weight: 125g red meat, 150g skinless poultry, 150g fish

The maximum level of saturated fat of <6g per serving is based on the level for ready-meals used by the Australia/NZ Pick the Tick programme[193], the NZ Heart Foundation recipe criteria[413] and the Traffic Lights signposting criteria[412]. Two of the home-made meals in the exploratory work are slightly over the maximum level, however as it is a common maximum level it is considered suitable.

The maximum level of sodium of <900mg per serving is based on the level used for ready-meals for the Australia New Zealand Pick the Tick programme[193], with other criteria having higher or lower maximum levels. All the home-made meals in the exploratory work are below this level.

The minimum level of protein of 5g per serving is based on the level for ready-meals used by the Australia/NZ Pick the Tick programme[193]. None of the meals in the exploratory work are above the maximum weight guide for meat, poultry and fish. All the home-made meals supply a lot more than 5g of protein.

There is no maximum level for added sugar as this tends to be lower in main meals compared to snacks. There is no minimum level for fibre as meeting the minimum vegetable servings would ensure some fibre. Only the Pick the Tick ready-meal criteria had criteria related to fibre, 1+ serving vegetables or 3g+ fibre per serving.

5.2.2 Selecting takeaway and home-cooked meals

The exploratory work shows it is possible to identify popular takeaway meals and select their healthier home-made and home-assembled counterparts, but there are some assumptions required and limitations are identified.

The HES is an easily accessible information source used to identify popular takeaway meals. The takeaway meals chosen for the exploratory work in New Zealand has the highest expenditure in the HES. Three are meals from fast food chains as the meal composition is standardised across franchises. The meals are fried chicken meal, pizza and burger with chips, and fish and chips. Recipes required for similar, healthier home-made meals are easily identified from popular recipe books and websites.

The exploratory work only includes one recipe for each meal option. However, there are numerous options for home-assembled or home-made meals, so if a particularly cheap or expensive home-made meal is selected this would not reflect a typical meal. Therefore, a range of home-made recipes and home-assembled combinations should be selected to improve the robustness of the comparison in the NZ meals costs study.

It was challenging to select a serving size for each meal. In the exploratory work, the home-cooked meals were selected to be within 10% of weight of the takeaway counterpart, though this was not possible with fish and chips and pizza. Adding vegetables to the meals prepared at home adds extra weight compared to the takeaway meals, particularly the fish and chips and chicken meals so this was not considered a feasible selection method. An alternative method to determine the serving sizes of the meals is required. For the NZ meals cost study, the main components of the takeaway meals will be determined (for example, 4 pieces of battered fish, 600g fries) and used to determine the amount of these components in the meals prepared at home (e.g., 4 servings fish at 120g, 600g oven-baked potato wedges). As the takeaway meals had few vegetables, the vegetables will be an addition to the home-cooked meals.

5.3 Methods: NZ meals costs study

5.3.1 Identification of popular takeaway meals

Data from the Household Expenditure Survey and NZ Adult Nutrition Survey were used to identify popular meals. A survey of 144 independent takeaway outlets in Auckland by two students assisted in identifying popular ethnic meals.

5.3.1.1 Household Expenditure Survey

A detailed dataset of the New Zealand HES data from 2010[387] was examined to identify popular takeaway choices. The percentage of expenditure of the ready-to-eat food and drink group was calculated for each item. The items listed in the survey with expenditure over 1% are presented in Table 29. Takeaway hot drinks were not included.

Table 29*:* Share of expenditure of ready-to-eat category from NZ Household Expenditure Survey

Meal	**% expenditure 2010 HES**
Combinations of ready-to-eat foods not elsewhere classified	14.3%
Ready-to-eat, takeaway and fast food not defined, or not elsewhere classified	10.8%
Other ethnic food	9.8%
Burgers	8.5%
Fried fish	6.1%
Pizzas	5.7%
Fried and other chicken	4.9%
Bread rolls	4.5%
Chinese food	4.3%
Sandwiches (fresh)	3.3%
Takeaway salads	2.5%
Meat pies	2.5%
Hot chips	1.5%

Though expenditure on meat pies and hot chips was lower compared to other ready-to-eat items, the percentage of households purchasing the item in 2010[(387)] was high with 17.6% of households purchasing meat pies and 13% hot chips compared to 9.3% for Chinese food and 11.7% for pizza.

5.3.1.2 Adult Nutrition Survey

The NZANS data[(388)] was used to identify the items most frequently consumed away from home: burgers, fried fish, hot chips, fried chicken, pizza. The most frequently consumed ethnic meals (those meals pertaining to a particular culture) were difficult to identify due to the range of names and the way food items are categorised. The main categories considered 'ethnic meals' are rice dishes, fried rice, chow mein, noodle dish, curry, stir-fry, chop suey and sweet and sour pork.

5.3.1.3 Survey to identify popular ethnic takeaway meals

Further information was required to select the specific ethnic meals. Two students surveyed a convenience sample of 144 takeaway outlets in a variety of locations in Auckland to assess the popular meals sold. Large fast food chains were not surveyed. The type of outlet was recorded, the menu was collected or photographed and a staff member at each outlet was asked to name the most popular meals sold (up to five). The NZ 2013 Index of Deprivation was identified for each outlet[(12)]. Many outlets sold a combination of items. The most common type of ethnic outlet was Chinese followed by Indian and Thai. There were less than ten of each of the other types of outlets. The most popular outlets are described in Table 30.

Table 30: Takeaway outlets identified from Auckland survey

Type of takeaway outlet	**Number of outlets**
Fish and chips and/or burgers	31
Chinese	26
Indian	17
Thai	16
Chinese, fish and chips, and burgers combined	14

5.3.1.4 Selection of popular takeaway meals

Similar takeaway meals were identified from the NZANS and the HES (Table 31). The HES identifies 'Chinese foods' and 'other ethnic food' separately. When fried rice and chow mein are considered as 'Chinese foods', and curry as 'other ethnic' this confirms the popular meals identified from the NZANS.

Table 31: Identification of popular NZ takeaway meals: Decisions and rationale

Decision	**Rationale**
Included: Burgers Fried fish Fried chicken Chinese food Pizza	Highest expenditure takeaway meals reported in HES. Popular takeaway meals identified in NZANS.
Included: Hot potato chips	Low expenditure reported in HES as low cost food but number of households purchasing item high. Popular takeaway food identified in NZANS.
Included: Thai curry and rice Indian curry and rice	A high expenditure for other ethnic food is reported in HES but the type is not defined. Popular takeaway meals identified in NZANS. Most common ethnic outlets reported in survey of Auckland takeaways: Chinese, Indian, Thai.
Not included: Bread rolls, pies	Focus on main dinner meals

5.3.1.5 Identification of popular fast food chains

The market share of sales in NZ of different brands of pizza chains and other quick-service restaurants was identified from market research data(414) and is reported in Table 32. The fast food chains selling fried chicken, burgers or pizza with the largest market share in NZ were Domino's, McDonald's and KFC.

Table 32: Fast food outlets brand share in NZ

Pizza chains	**Home delivery & takeaway pizza % category**	**Other quick-serve restaurant chains**	**Fast food % category**
Domino's	12%	**McDonald's**	15.8%
Pizza Hut	9%	**KFC**	12.4%
Hell Pizza	9%	Subway	10.5%
		Burger King	8.4%
		Noodle Canteen	2.7%
		Pita Pit	2.7%

5.3.2 Description of meals

A description of the selected meals is provided in Table 33 with the rationale for selection described below.

5.3.2.1 Description of chicken meal

The Colonel's pack appears to be aimed at a family of four and does not contain a beverage. One tub of coleslaw was added as this is a common side item.

5.3.2.2 Description of fish and chips

A survey of 150 fish and chips shops and fast food outlets in NZ in 1998 and 1999 reported a wide range of prices and serving sizes of chips(415). The mean serving size of hot chips was 326g at an independent outlet and 190g at a fast food chain. The independent outlets provide more grams per dollar of hot chips (238g) compared to a fast food chain (82g). The NZ Chip Group recommends the use of a standard scoop, which is 330g uncooked weight, or 165g per serving and 660g for a meal for four people(416). The weight of a piece of battered fish listed in the Concise New Zealand Food Composition Tables(398) is 146g.

5.3.2.3 Description of takeaway butter chicken

Butter chicken, chicken Tikka Masala and chicken Korma are the most popular items identified in the Auckland survey of takeaway outlets. The popular items identified in the NZANS are curries and chicken dishes, particularly butter chicken. Therefore, butter chicken and rice were selected.

5.3.2.4 Description of takeaway Chinese meals

There is a lot of variation in the most popular meals identified in the Auckland takeaway outlet survey, and smorgasbords are reported as the most popular meal sold. The popular meals were analysed with and without the smorgasbord items. Chicken and pork are the most common meats featured in the popular dishes. Noodles are identified as the most popular item in the Chinese outlets surveyed. As chow mein is a noodle dish, this was selected to represent noodle dishes and could be prepared at home without specialised cooking equipment. Beef, pork and chicken are the most common meats. Beef is selected as chicken is a major component of two of the popular takeaway meals. Most of the pork dishes use barbeque pork, which could be difficult to match to a home-made recipe as specialised cooking equipment would be required.

5.3.2.5 Description of takeaway burger meal

Burger and fries were identified as popular items from the NZANS. Purchasing a Share Box is cheaper than purchasing the individual items. The $20 Share Box contains drinks, however the recommended drinks in a home-made meal would be water so the drinks are not included in the nutrient analysis. Even if the drinks are priced at $0.00, it is still cheaper to purchase the ShareBox.

5.3.2.6 Description of takeaway pizza

The most popular pizza in the $4.99 range is Hawaiian in seven of eight Domino’s stores contacted. The most popular type of pizza from analysis of the NZANS is Meat Lovers and Supreme, followed closely by Hawaiian (included takeaway and homemade pizza). In addition, a vegetarian pizza (Vege Trio) was purchased to match to the home-made vegetarian option. Domino’s were contacted via Facebook and replied “As the majority of our stores are franchise-owned, prices do vary between stores. Individual stores offer different special offers”. Prices obtained online from a list of stores generally did not vary.

5.3.2.7 Description of takeaway Thai meals

Pad Thai and Thai curry were identified as the most popular Thai dishes in the Auckland takeaway outlet survey. Thai curry was selected as this is considered easier to cook at home than Pad Thai. Sampling of meals from takeaway outlets indicated a wide range of prices and weights and there were few Thai outlets in high deprivation areas. It is difficult to match the Thai curry to a home-made meal and be under the maximum level of saturated fat in the meal criteria as coconut cream is high in saturated fat. Therefore the Thai meal was excluded from the NZ meal costs study.

5.3.3 Defining the meal size

The McDonald’s ShareBox and the KFC Colonel’s Dinner contain four or eight of the key items so appeared to be aimed at a family of four. The other meals are not marketed at a particular number of people so an arbitrary decision is required on the size of a meal for a household of four (2 adults, 2 children) (Table 33).

Table 33: Selected NZ takeaway meals for meals approach

Meal description	Outlet	Meal name and serving size (4 people)
Fried chicken	KFC	Colonel's dinner: 8 pieces chicken 1 large chips 1 large potato and gravy Plus 1 large coleslaw
Fish and Chips	Independent	4 x battered fish 2 x scoops chips
Indian meal	Independent	Butter chicken and rice 2 containers of each
Chinese meal	Independent	Beef or steak chow mein 2 containers of each
Pizza	Domino's	3 x pizzas (24 small slices)
Burger and chips	McDonald's	$20 Value ShareBox 2 x Big Mac 2 x Cheeseburger 4 x small fries 2 x medium soft drink 2 x small soft drink

5.3.3.1 Nutrition information

Nutrition information for the takeaway meals from quick-service restaurants (KFC, McDonald's, Domino's) was sourced from the relevant websites(417-419). The nutrient composition of a KFC chicken piece was calculated as the average of the nine pieces of edible chicken from a bird(417). The nutrition information for fish and chips, butter chicken and beef chow mein was sourced from the Concise NZ Food Composition Tables(398).

5.3.4 Selecting takeaway outlets

5.3.4.1 Sampling

The number of meals to sample to distinguish the difference in cost considered a price difference between home-made, convenience and takeaway meals is not known. However, a meaningful difference in price will vary between households, due to differing value placed on nutrition, use of time, cost and other influences on meal selection.

A deprivation score is assigned to geographical areas according to the NZ Deprivation Index 2013. NZDep2013 small areas consist of one or two Statistics NZ meshblocks(12). On the NZDep2013 deprivation scale, 1 is least deprived and 10 is most deprived.

Initially four areas were investigated, two with lower deprivation scores and two with higher deprivation scores. A census area unit with a reasonable number of outlets was selected to make sampling feasible[420]. The Food Outlets Database compiled by Auckland University, and an internet search, were used to compile a list of outlets in each chosen census area unit. The approximate location of outlets was plotted. ‘Hot spots’ where the outlets are clustered were identified and one ‘hot spot’ randomly selected to begin sampling. The start point at one end of a street was randomly selected. If the layout of the outlets was not a strip layout, other possible approaches were identified and a starting point randomly allocated. The major retail areas were explored on foot with Google Street View used to identify further outlets. Takeaway outlets were visited until the quota of two each of Thai, Indian, Chinese and fish and chip outlets was reached in each area.

Due to the price and weight variation in the meals, an additional six Indian, Chinese and fish and chips outlets were selected (18 in total) to provide a larger sample. As the previous outlets were either in an area of low deprivation (1-3) or high deprivation (8-10) the outlets were selected in an area of medium deprivation (5) and identified in the same manner as described above.

5.3.4.2 Data collection in store

The rationale for the data collection procedure is outlined in Table 34. The procedure for data collection for each meal at each outlet is:

- Purchase smallest amount possible (1 container, 1 serving or value box).
- Record time joined queue, finished payment, and received meal.
- Collect menu or take photo.
- Note price of family deals, ask staff usual meal purchases for a family of 4 (where possible).
- Order and collect the meals in person. (Drive-through and online ordering was not explored.)
- Photograph meal.
- Weigh meal.
- Separate and weigh major edible components where possible (rice, bun, meat, vegetables, base, toppings, sauce etc).
- Weigh each component.

Table 34: Takeaway outlet selection and data collection: Decisions and rationale

	Decision	Rationale
Time of day to collect takeaways	Dinner, 5pm onwards.	Meals in some independent outlets differ in price and size between lunch and dinner. Chose dinner only, to reflect larger meal and reduce variation in meal size.
Selection independent takeaway outlets	Chow mein, butter chicken, fish and chips. 2 low deprivation areas: quota 2 meals per area. 2 medium deprivation areas: 3 meals per area. 2 high deprivation areas: 2 meals per area. Chose areas accessible to researchers with a reasonable number of outlets.	Assume meals purchased are representative of takeaway meals in Auckland. Assume all outlets in area are identified. Areas were chosen to ensure a range of deprivation scores as prices may have differed between areas.
Collection meals	Collect meals until quota filled. Collection over two different time periods (23 November to 10 December 2015, 9 to 22 March 2016). 2 researchers	Assume prices of takeaways fairly stable over the time period. Collected over 2 periods due to availability of researchers. Assume researchers followed same procedure as used same protocol.
Purchasing takeaway meals from fast food franchises	Only purchase 1 meal.	Meal standardised across franchises. McDonald's and Domino's meals are value meals with a set price across franchises. KFC prices are the same across franchises. Assume wait time would be similar in other outlets.
Purchasing takeaway meal from independent outlet	Purchase smallest meal.	Reduce wastage and cost. Assume wait time would be the same for larger meals. Scaled price and weight.

5.3.5 Developing meals prepared at home

Criteria developed for the feasibility study were used to guide the development of meals. Some arbitrary decisions were required when selecting meals and recipes, as outlined in Table 35, and applied consistently across meals. The key characteristics of the popular takeaway meals were identified to guide selection of the recipes for the home-made meals and the key components of the home-assembled meals. For example, beef chow mein must have noodles, chicken, sauce and vegetables. The weight of each of the key components in the meals prepared at home was similar to the takeaway meal counterpart. As the takeaway meals had so few vegetables, once 600g of vegetables was added to the meals prepared at home, most were heavier than the takeaway meals but provided less energy. Therefore, an additional analysis was conducted to standardise the meals to one kilogram.

5.3.5.1 Meal criteria

The development of the meal criteria was described in section 5.2. The criteria are for a meal to serve four people.

- Meal component: grain/starchy vegetable; meat or alternative; non-starchy vegetables.
- 25-30% daily energy
- Minimum 600g non-starchy vegetables
- Raw weight approximately 500g red meat, 600g skinless poultry, 600g seafood
- ≥ 20g protein
- ≤ 24g saturated fat
- ≤ 3600g sodium

For the INFORMAS diet approach, the energy requirement for the reference household of four is calculated as 39.9 MJ per day for a moderate activity level. A meal of 25-30% of daily energy would be 9.98-11.97 MJ.

5.3.5.2 Selecting home-made meals

The draft INFORMAS protocol describes the methodology in detail (Appendix One). The rationale for the protocol methods is described in Table 35. A method for selecting the recipes for each meal was developed by a summer student. A range of recipes for two of the meals was completed by the student along with background work for the other meals. The remaining meals were selected and modified by the researcher.

Table 35: Process to develop home-made meals: Guidelines and rationale

	Guidelines	**Rationale**
Meal	Main dinner meal. No dessert, entrée or drinks.	Adding other meal components increases variation so difficult to disentangle reasons for price differences. Meals often don't include dessert, entrée. Recommend drink with a meal is water, which has no cost for home meals.
Meal component	Grain/starchy vegetable; meat or alternative; non-starchy vegetables.	Common component of a meal providing a variety of food groups. Main meal is an important meal for vegetable consumption.

	Guidelines	Rationale
Meat, fish, poultry, dairy	The meat/fish component will be the same type and cut (e.g., beef steak) as the takeaway meal, though a healthier cooking method may be used.	Amount of meat, fish or chicken in recipes varies so standardise amount in meal to meet meal criterion.
Amount of potato, rice or noodles	Standardise amount in home meals.	Similar amount in home meals to takeaway meal.
Vegetables	Add popular seasonal vegetables, frozen vegetables or pre-prepared coleslaw.	To provide 600g non-starchy vegetables.
Selection of recipes for home-made meal	Exclude some recipes.	Similar to selected recipes, contain unusual ingredients, unlikely to meet criteria, complex method, too many ingredients or pre-prepared ingredients.
Equipment	Use common household cooking equipment.	Realistic for household, no slow cookers, barbeques, stand-alone grills, deep-fryers.
Ingredients	Exclude less common ingredients (e.g., lime, fresh coriander, lemongrass paste, hoison sauce) or substitute for common ingredients (e.g., paprika for smoked paprika). Standardise amount and type of oil as canola unless a specific oil required for flavour. Delete sugar and salt not essential for flavour or rising. Replace some fresh herbs with dried herbs, e.g., rosemary, thyme.	Not readily available or acceptable for households or for garnish. Some recipes do not specify amount or type. Test recipe to determine sufficient amount, canola oil common. Reduce salt and sugar in recipe. Most fresh herbs not readily available and flavour not compromised. Fresh parsley used as not expensive and widely available.
Pre-prepared items	No pre-prepared items unless difficult to prepare at home	Differentiate home-made and home-assembled meals.
Flavours, sauces	Specifiy ingredient key to flavour of meal. Choose lower sodium ingredients when readily available.	
Preparing meals	Cooke selected recipes for each meal.	If recipes have similar methods, could estimate preparation time.

5.3.5.3 Selection of recipes

Recipes for each home-made meal were sought from popular recipe books, magazines and websites(421-425), particularly those that emphasise healthy meals. Sources were selected from an initial brainstorm between the researchers, consultation with a Home Economics teacher and a google search of 'popular recipe websites NZ'. Recipes were identified that contained the key characteristics identified for each takeaway meal, for example fish fillet with a coating. A list of eight to ten recipes was compiled for each meal, or until there was little further variation in either ingredients or methods as additional recipes were identified. Most recipes were four servings, otherwise the recipes were scaled accordingly. The process required some arbitrary decisions on whether to include or exclude recipes and ingredients. The professional judgement of the lead researcher (nutritionist) was used in consultation with the summer student. The decisions required are summarised in the Table 36 to Table 41 for each meal. A detailed example of the recipe selection process is in Appendix Four using the fish and chips meal as an example.

Table 36: Development of home-made chicken meals: Decisions and rationale

	Decision	**Rationale**
Recipes	14 selected	4 excluded as too many ingredients or items high in added sugar.
Potato	Mashed potatoes 1. With trim milk 2. With trim milk and margarine 640g cooked potatoes	KFC meal has mashed potatoes and fries. Only one form potato required, fries are in another meal. Most recipes mashed potatoes with milk, or milk and butter/margarine. Same amount of potatoes in KFC meal, similar to recipes for 4 people.
Chicken pieces	500g edible chicken Used chicken breast or drumstick (raw 595g breast, 794g drumsticks) Chicken with a crispy coating. Bake or pan-fry not deep-fried	Based on meal criteria rather than KFC amount. Chose chicken cuts commonly available. Used breast if recipe stated boneless and drumstick if recipe stated bone and skin. A wider range of chicken cuts could have been included, but would require more prices. Amount of edible chicken calculated by cooking and weighing chicken pieces. Takeaway chicken coated. Fried chicken requires specialised equipment.

Vegetables	600g coleslaw 1. Basic recipe: cabbage, carrot, cucumber 2. Added capsicum and spring onion Dressings: home-made oil/vinegar, purchased mayonnaise	Common vegetables used in coleslaw. 2 recipes to reflect range of recipes. Amount to meet vegetable criterion. 2 common dressings. Used purchased mayonnaise as a household unlikely to make it.

Table 37: Development of home-made fish and chips meals: Decisions and rationale

	Decision	**Rationale**
Recipes	9 selected	Reflects range of coatings (breadcrumbs, egg, flour, corn chips). Five excluded as similar to other recipes.
Amount of potato	625g cooked 2T canola oil	Based on amount in recipes and takeaway meal.
Fish	500g raw fish for recipes Fish with a coating, no batter.	Similar to 472g fish (4 pieces) from takeaways. Takeaway fish coated. Battered fish difficult to cook and high in fat.
Vegetables	300g cooked broccoli 300g cooked carrot	Common vegetables usually in season. Amount to meet vegetable criterion.
Additional ingredient	Corn chips with no added sodium	Other corn chip varieties very high in sodium.
Preparing meals	4 recipes prepared Cooked by researcher 1 & 2	

Table 38: Development of home-made butter chicken meals: Decisions and rationale

	Decision	**Rationale**
Recipes	8 selected	7 excluded as time-consuming, used prepared sauces, high in cream or coconut cream.
Amount and type of rice	Brown rice 240g raw	Brown rice higher in fibre. Based on amount in recipes for 4 people.

Butter chicken sauce	No spice pastes or pre-prepared sauces. Minimal coconut cream. Evaporated light milk replaced cream. Common ingredients: tomato paste, canned tomatoes, garlic, onion, lemon, black pepper, paprika, cumin, turmeric, nutmeg, garam masala, ginger, chilli, coriander, evaporated light milk, plain yoghurt.	To be used in home-assembled meals. To meet saturated fat criteria.
Vegetables	300g cooked broccoli 300g cooked carrots	Common vegetables usually in season. Amount to meet vegetable meal criterion.
Chicken	Chicken breast 600g raw (500g cooked)	Readily available, easy to prepare. Chicken pieces with bone and skin time-consuming to prepare.

Table 39: Development of home-made chow mein meals: Decisions and rationale

	Decision	**Rationale**
Recipes	9 selected	2 excluded as use a flavour sachet or unusual ingredients.
Noodles	Rice noodles with no added salt 1 packet	To meet sodium maximum level. Packets served 4.
Vegetables	600g vegetables suitable for stir-frying Common vegetables: mushrooms, cabbage, carrot, green beans, celery, frozen corn, bean sprouts, spring onions, capsicum.	Used common vegetables in recipes. If insufficient vegetables increased amount or added other common vegetables. Excluded vegetables not readily available, or often not in season. Amount to meet vegetable criterion.
Beef	Beef stir-fry Beef schnitzel 500g raw (480g cooked)	Both cuts available, easy to prepare, suitable for stir-frying. Amount recommended in meal criteria.
Ingredient	Key flavours: soy sauce, sweet chilli sauce, vinegar, garlic, ginger, chilli, sesame oil. Regular soy sauce	Ingredients of most chow mein recipes reviewed. Reduced sodium soy sauce not readily available.

Table 40: Development of home-made burgers: Decisions and rationale

	Decision	**Rationale**
Recipes	9 selected	5 excluded as uncommon ingredients, sour cream (high saturated fat), onion soup mix (high sodium), similar recipe or patties fell apart on testing.
Bun	White burger bun	Wholegrain burger buns not readily available.
Meat patty	Excluded patties with legumes. Reduced mince to 450g raw. Common ingredients: egg, breadcrumbs, oats, onion, garlic, herbs, grated carrot, pepper, sauces. Reduced amount of sauces where feasible.	Reduce variation in recipes, sufficient recipes with beef. 500g too much for 4 burgers, reduced saturated fat content as difficult to meet criteria. Reduce sodium.
Breadcrumbs	3 minutes to make fresh breadcrumbs. Purchased dry breadcrumbs.	Various ways to make fresh breadcrumbs. Time-consuming to make by hand so averaged time by hand and by food processor. Cost of dry breadcrumbs slightly more than purchasing bread. Time-consuming to make so assumed households would purchase pre-prepared.
Fillings	Cheese, tomato, lettuce, grated carrot, beetroot, gherkin, onion.	Popular fillings from recipes, common ingredients.

Table 41: Development of home-made pizzas: Decisions and rationale

	Decision	**Rationale**
Pizza base	3 home-made pizza bases 2x 30cm diameter bases Scone dough, quick yeasty base, traditional yeast base.	Pre-prepared base used in home-assembled meals. Selected most common bases in recipes.
Sauce	7 sauces selected from recipes. Chose lower sodium tomato product if available. Common ingredients: tomatoes, tomato paste, herbs, garlic, onion. No pre-prepared sauces.	4 excluded as similar, use fresh tomatoes (not always in season) or complex recipe. Reduce sodium content. Pre-prepared sauce used in home-assembled meals.

Toppings	Cheese Olives, mushrooms, onion, capsicum, courgette (vegetarian). High sodium toppings restricted. 445g vegetables	Selected from recipes, local knowledge and popular Domino's pizza toppings. Excluded toppings not readily available. Toppings selected to meet sodium criteria if possible. Excluded ham on pizza as sodium too high. Inclusion of vegetables but difficult to fit 600g vegetables on a pizza.
Preparing meals	5 pizzas prepared by researcher 2	

5.3.5.4 Selecting home-assembled meals

Meals using pre-prepared items save time, therefore present an option for a household that is between a home-made meal and a takeaway meal for degree of preparation required. The definition of a home-assembled meal used in this research is 'a meal that is a combination of pre-prepared meal components that require some preparation and assembling; the meals are not a ready-to-heat meal, though the individual components may only require heating'.

The draft INFORMAS protocol describes the methodology in detail (Appendix One). The rationale for the principles that guide the protocol methods is described in Table 42. The description of each meal is provided in Table 43 to Table 48.

Some of the components of the home-assembled meal were the same as the home-made meal when there was no pre-prepared option at a reasonable price or that was quick to prepare, (e.g., fresh chicken, burger toppings, most pizza toppings, rice), or because the pre-prepared option was also used for the home-made meal (e.g., burger bun).

A range of brands was identified for each meal component, for example three brands of frozen crumbed chicken. Items were selected to enable the meal to closely meet the nutrient criteria, where possible, as many of the items were not low in sodium. If a sauce was high in sugar this was noted as there was no nutrient criterion for sugar.

Table 42: Process to develop home-assembled meals: Guidelines and rationale

	Guideline	**Rationale**
Meal	As for home-made	
Size of meal	As for home-made	
Meal component	As for home-made including 600g non-starchy vegetables.	
Meat, poultry, fish, dairy	Select similar amount to that used in home-made meal if possible	Also determined by size of pre-prepared component and the number of items in a package. Amount of edible meat, chicken or fish may be lower due to coating or other ingredient.
Nutrient criteria	As for home-made. Added maximum level for individual products likely to be high in sodium and saturated fat.	Some components too high in sodium and saturated fat.
Package size	Use package size as serving size when close to the amount required in the meal (e.g., 500g coleslaw package).	Assume a household will purchase a pre-prepared product in a suitable package size and use all contents.
Amount of preparation	Meal requires assembling of components, not a ready-to-heat meal.	Some of the takeaway meals do not have ready-to-heat options (burger, fish and chips) but all can be matched to a range of pre-prepared ingredients requiring minimal preparation.
Equipment	As for home-made	
Preparing meals	Cooked a selection of combinations.	Same process for each type of item as only required opening packet, placing on cooking dish, turn/stir and serving.

Table 43: Development of home-assembled chicken meals: Decisions and rationale

	Decision	**Rationale**
Chicken type	Crumbed schnitzel or tenderloin Sodium <600mg per serve Flavoured or plain	Crumbed or coated chicken pieces used in other meals, rather than nuggets or bites. Keep meal below maximum sodium level.
Chicken amount	Three brands selected: 4 x 150g = 600g 4 x 100g = 400g 4 x 100g = 400g	The serving size varied as it was assumed only whole portions of a chicken piece would be served. As some boxes contain 6 fillets, the whole box is included as some family members may have 2 fillets.
Amount of potato	640g cooked	To match amount in other meals.
Type potatoes	Cheapest frozen mashed potatoes	Exclude dehydrated potatoes as quick option as less acceptable taste.

Vegetables	Coleslaw pack 450g or 500g Deli coleslaw 500g	Slightly less than coleslaw in home-made meal but realistic to buy one packet for meal.

Table 44: Development of home-assembled fish and chips meals: Decisions and rationale

	Decision	**Rationale**
Fish type	Crumbed, not battered fish fillets Sodium <400mg per 100g	Fish fillets used in other meals, not fish cakes or fingers. Home-made meal used crumbed not battered fish. Keep meal below sodium criteria.
Fish amount	Three brands selected: 6 x 71g = 425g 6 x 80g = 480g 4 x 120g = 480g	The serving size varied as it was assumed only whole portions of fillets would be served. As some boxes contain 6 fillets, the whole box was included as some family members may have 2 fillets.
Amount of potato	625g	To match amount in other meals.
Type potatoes	Cheapest brand for any cut of chips with no added sodium No flavours	Price does not differ for different cut of same brand. Only one brand has added salt. All use unsaturated oils. Flavoured chips have added sodium.
Vegetables	600g cheapest frozen vegetable mix 600g cheapest mix with carrot and broccoli Selected common package size 1kg	To represent the cheapest mix. Similar to the vegetables in the home-made version.

Table 45: Development of home-assembled butter chicken meals: Decisions and rationale

	Decision	**Rationale**
Chicken	Chicken breast 600g raw, 500g cooked	Considered pre-cooked chicken but very expensive. Boneless, skinless chicken breast available and easy to prepare. Chicken pieces with bone and skin time-consuming to prepare.
Rice	White rice 240g raw	White rice has a shorter cooking time. Amount matches home-made meal.
Butter chicken sauce	Sauce that required no further sauce ingredients. Sauces with sodium <500mg/100g, saturated fat <5g/100g.	Some sauces require coconut cream and other ingredients to be added so less convenient. Chose criteria to aid selection of those lower in sodium, saturated fat. Noted sugar content.

Vegetables	600g cheapest frozen vegetable mix 600g cheapest mix with carrot and broccoli Selected common package size 1kg	To represent the cheapest mix. Similar to the vegetables in the home-made version.

Table 46: Development of home-assembled chow mein meals: Decisions and rationale

	Decision	Rationale
Beef	Beef stir-fry Beef schnitzel 500g	Both cuts available and easy to prepare. Suitable cuts for stir-frying.
Noodles	Noodles with <400mg sodium per meal Cooked weight of each packet: 700g, 680g, 900g. Included pre-cooked noodles No instant noodles	Some noodles high in sodium. Include cooked weight of total packet of noodles as household likely to use the entire packet, though one meal had more noodles. Pre-cooked noodles convenient. High sodium content.
Flavour sachet	Chose 3 sauces with the lowest sodium per serving.	All sauces high in sodium so chose the lowest sodium sauces.
Vegetables	Cheapest stir-fry mix.	Similar to the vegetables in the home-made version. Suited for stir-frying.

Table 47: Development of home-assembled burgers: Decisions and rationale

	Decision	Rationale
Bun	White burger bun	Wholegrain burger buns not readily available.
Meat patty	Sodium <400mg/100g Saturated fat <7g/100g Fresh or frozen Plain or flavoured	Criteria chosen to select patties lower in sodium and saturated fat.
Fillings	Fillings used for home-made burger.	No pre-prepared options for fillings. Simple and quick to prepare (grate carrot, chop tomato, chop onion, slice cheese).

Table 48: Development of home-assembled pizzas: Decisions and rationale

	Decision	Rationale
Base	Pre-prepared bases No mini pizzas, gluten-free or pre-sauced. Sodium ≤350mg/100g. 3 bases:3 x 22cm, 2 x 26cm, 2 x 30cm	Chose commonly available bases in a size appropriate for the meal. Bases vary in thickness with wider base thinner.
Sauce	Wattie's low sodium sauce	Other sauces very high in sodium.
Toppings	Toppings used for home-made pizza. Grated cheese, Edam or Mozzarella.	No pre-prepared options for fillings except for grated cheese. Fillings simple and quick to prepare. Pizza cheese too high in saturated fat.

5.3.6 Collecting prices of ingredients

The rationale for collecting the prices is outlined in Table 49. A list of the ingredients for all the meals was compiled. The amount to purchase was calculated from the edible portion as described in section 2.7.

A package size was specified for each item, either a common package size or, for items only used in small amounts, the smallest package size. If a produce item was not priced per kilogram, three of each item was weighed in each store and a mean price calculated. The cheapest item that would satisfy the purpose in the recipe was selected and priced. When deciding which item was cheapest, the package size had to be similar, though this may vary by up to one-third, for example 400g or 300g breadcrumbs.

The prices were collected from three supermarkets by the summer student, and from three supermarkets by the researcher. Two of each of the three major chains were selected in high and low deprivation areas similar to the areas where the takeaway prices were collected. The data collection was within a two-week period.

Table 49: Development of price collection: Decisions and rationale

	Decision	**Rationale**
Selection of ingredients	Readily available item. Items for home-made meals needed to be available at 5 of 6 supermarkets and items for home-assembled meals at 2 of 6 supermarkets Maximum levels for saturated fat, sodium and sugar specified for some items.	Range of brands available for an item varied between supermarkets. If a range of nutrient composition between brands, a maximum amount was specified, e.g., <400mg sodium/100g, or a descriptor was added, e.g., no added sodium.
Price of ingredient	Cheapest price including generic labels.	Consumers often choose on price, difficult to determine common brand for each ingredient.
Supermarket selection	6 Auckland supermarkets, 1 of each chain in a high & low deprivation area	Supermarkets from each of the 3 major chains in areas where prices for takeaway meals collected.
Time costed	Preparation time only. Did not include unattended cooking, shopping or transport time.	Could have included cooking time, however other activities can be carried out during this time. Difficult to calculate time for shopping and transport as will vary between households depending on location, frequency of shopping etc.
Other costs	Did not include cooking fuel or transport costs.	Could have included cooking fuel but oven cost for the meals low at about 26 cents(426). Transport costs depend on location.

5.3.7 Data analysis

The ingredients of each home-made meal were entered into FoodWorks(427) with the NZ Food Composition Database using the cooked weight. The nutrient content of each recipe was calculated. If there was no nutrient data, a new food was entered using the nutrition information from the Nutriweb database(428) or the product Nutrition Information Panel (NIP), for example, low sodium tomato paste, barbeque sauce, sweet chilli sauce. The nutrient content of each component of the home-assembled meals was sourced from the NIP as the specific brands and product were not in the food composition database. The nutrient content of each meal combination was calculated. The mean nutrient content of each meal option was calculated, for example home-made fish and chips.

The mean price from the six supermarkets was calculated. Some items were not available at all supermarkets, particularly items for the home-assembled meal. A matrix of the combinations was constructed for each meal. For example: chicken recipe C + potatoes A + coleslaw B. The price of each component and variation was calculated.

The cost of each meal was calculated taking into account the time to prepare the meal and waiting time for takeaways. The median hourly wage for food preparation and serving-related occupations was used in studies that have measured the cost of time(58,233,238), therefore the cost of time was calculated using the minimum wage of $15.25(429). In NZ this is similar to the average hourly rate of a kitchen hand(430). The preparation time (minutes) was multiplied by the hourly wage.

As the weight of the meals varied, the cost of each meal was also calculated per kilogram, without the cost of time. The mean cost, standard error, 95% confidence intervals (±1.96 * SE) and range were calculated for each meal and costs compared between the different types of meals (takeaway meals, home-made meals and home-assembled meals). Differences in mean cost between meals were considered to be statistically significant if the 95% confidence intervals surrounding the two estimates did not overlap. Three of the takeaway meals were a fixed price at all fast food outlets so did not have confidence intervals. The analysis was conducted with and without including the cost of time.

5.4 Results: NZ meals cost study

5.4.1 Introduction

The costs of the individual meals are reported, followed by comparisons between the different types of meals (takeaway, home-assembled, home-made). The differences reported are statistically significant at the 95% confidence interval unless otherwise stated. There are no confidence intervals for the items collected from fast food chains as the cost was the same across outlets. A summary of the costs of meals without time is presented in Figure 10, per kilogram is reported in Figure 11 and with time in Figure 12.

5.4.2 Chicken meals

The takeaway chicken meal is more expensive than the home meals, though the differential between the home-made and takeaway meals is smaller when time is costed, falling from a difference of 46% to 24% (Table 50, Table 56). The home-made meal is the cheapest meal when time is not included and per kilogram, and is slightly more expensive (14%) than the home-assembled meal when time is included.

The home-made meals meet the meal criteria. The home-assembled meals are slightly too high in saturated fat and too high in sodium due to the amount in all components, and do not quite meet the criterion of 600g non-starchy vegetables due to the package size of coleslaw being smaller. The takeaway meal is very high in energy, saturated fat and sodium and only provides 240g non-starchy vegetables, as one-third of the coleslaw is dressing. The takeaway meal provides the most edible chicken, with the home-assembled meal providing half the edible chicken of the home-made meal as the actual amount of chicken in the frozen crumbed chicken is only 54%.

Table 50: Chicken meals: description, cost (mean), nutrients (mean)

	Home-made Mean (range)	**Home-assembled Mean (range)**	**Takeaways Mean (range)**
Description	Coated chicken pieces Mashed potato Coleslaw with dressing	Frozen crumbed chicken schnitzel or breast Frozen mashed potatoes Coleslaw with dressing	KFC family meal: 8 Chicken pieces Coleslaw Potato & gravy Hot chips
Number of meals priced	80 combinations: 10 chicken, 8 coleslaw (4 coleslaw, 2 dressings)	9 combinations: 1 potato, 3 chicken, 3 coleslaw	1 outlet (set price all outlets)
Cost no time ($)	$15.26 ($9.57-$19.67)	$17.80 ($15.75 - $20.56)	$28.40
Cost with time ($)	$21.69 ($15.16-$26.04)	$19.07 ($17.02-$21.84)	$28.65
Time (minutes)	25 (22-28)	5	1
Weight (edible grams)	1974 (1882-2156)	1590 (1490-1740)	1804 (includes skin not bones)
Energy (kJ)	8005 (6873-9627)	8228 (6822-9905)	14020
Fat (g)	47 (28-66)	91 (61-132)	189
Saturated fat (g)	16 (11-20)	28 (24-34)	44
Carbohydrate (g)	148 (116-212)	204 (150-292)	209
Protein (g)	174 (153-205)	87 (79-101)	196
Sodium (mg)	1559 (596-3289)	4542 (4123-4995)	5507
Non-starchy vegetables (g)	600	488	240
Amount edible chicken flesh (g)	500	250	678 (no skin)

5.4.3 Fish and chips

The home-assembled fish and chips meal is cheapest meal option (Table 51, Table 56) being 38% cheaper than the home-made meal and 35% cheaper than the takeaway meal. There is no significant difference in cost between the home-made and takeaway meal exclusive of time, but the takeaway meal becomes cheaper when time is included. The takeaway meal is the most expensive when costed per kilogram.

The pre-prepared frozen fish fillets are cheaper to purchase than the fresh fish and coating ingredients, however the home-made meal provides a lot more fish flesh. When the meals are standardised for weight, the home-assembled meal remains the cheapest with the takeaway meal twice the price of the other meals. When the cost of time is added, the home-assembled meal is still the cheapest and the takeaway meal becomes 16% cheaper than the home-made meal.

The home-prepared meals meet the meal criteria (Table 51). The takeaway meal is very high in saturated fat, however does not exceed the maximum level for sodium (<3600mg per meal), though often consumers add additional salt to chips

Table 51: Fish and chips meals: description, cost (mean), nutrients (mean)

	Home-made Mean (range)	**Home-assembled** Mean (range)	**Takeaways** Mean (range)
Description	Coated fish fillets Potato wedges Carrots & broccoli	Frozen crumbed fish fillet Frozen potato fries Frozen vegetables	Battered fish – 4 pieces Hot chips – 2 scoops
Number of meals priced	9 combinations: 9 fish, 1 potato, 1 carrots and broccoli	6 combinations: 1 chips, 3 fish, 2 vegetables	14 outlets
Cost no time ($)	$15.13 ($14.33-$16.20)	$10.95 ($9.46-$12.92)	$16.90 ($12.00-$25.20)
Cost with time ($)	$22.22 ($20.92-$24.41)	$12.22 ($10.73-$14.19)	$19.11 ($13.78-$29.01)
Time (minutes)	28 (25-33)	5	9 (5-15)
Weight (edible grams)	1816 (1741-1924)	1687 (1650-1705)	1122 (700-1518)
Energy (kJ)	10334 (9516-11308)	9021 (8281-9594)	11760
Fat (g)	72 (57-89)	66 (59-71)	163
Saturated fat (g)	9 (7-20)	9 (8-10)	79
Carbohydrate (g)	282 (260-316)	244 (186-294)	235
Protein (g)	147 (135-161)	92 (83-101)	97
Sodium (mg)	844 (354-1371)	1318 (949-1563)	2671
Non-starchy vegetables (g)	600	600	0
Amount edible fish (g)	425	248	237 (475 with batter)

5.4.4 Butter chicken

The home-made butter chicken meal is a similar price to the home-assembled meal until the cost of time is added, resulting in the home-made meal being 29% more expensive (Table 52, Table 56). The takeaway meal is more expensive when time is not included (17% more than home-made meal, 20% more than home-assembled meal). When time is included, the cost is similar for the takeaway and home-made meals, and cost 19% and 29% respectively more than the home-assembled meal.

None of the home-made butter chicken meals exceed the maximum levels for saturated fat and sodium and are lower in these nutrients than the other butter chicken meals (Table 52).The mean sodium content of the home-assembled meals exceeds the maximum sodium level. The mean saturated fat content of the home-assembled meals does not exceed the maximum level, however four of the ten meals slightly exceed the maximum level due to the saturated fat content of the sauce. The home meals provides sufficient vegetables while the takeaway meal has no visible added vegetables and is higher in sodium and saturated fat than the home meals.

Table 52: Butter chicken meals: description, cost (mean), nutrients (mean)

	Home-made Mean (range)	**Home-assembled** Mean (range)	**Takeaways** Mean (range)
Description	Chicken pieces Homemade sauce Broccoli, carrots Brown rice	Chicken pieces Pre-prepared sauce Frozen vegetables White rice	Butter chicken Rice
Number of meals priced	8 combinations: 1 rice, 8 sauces, 1 chicken, 1 vegetable	10 combinations: 1 rice, 5 sauces, 1 chicken, 2 vegetables	14 outlets
Cost no time ($)	$18.10 ($16.79-$20.03)	$17.37 ($15.64- $19.02)	$21.71 ($19.00 - $30.00)
Cost with time ($)	$25.21 ($24.07-$27.40)	$19.40 ($17.67-$21.06)	$24.00 ($19.76 - $31.78)
Time (minutes)	28 (23-30)	8	9 (2-21)
Weight (edible grams)	2362 (2076-2768)	2213 (2155-2250)	1644 (1424-1920)
Energy (kJ)	10211 (9087-11376)	9715 (9030-10612)	11062
Fat (g)	64 (34-89)	66 (58-72)	113
Saturated fat (g)	14 (11-17)	22 (14-32)	52
Carbohydrate (g)	261 (250-273)	250 (217-276)	260
Protein (g)	187 (178-196)	160 (153-168)	131
Sodium (mg)	929 (648-1097)	2622 (2412-3022)	3513
Non-starchy vegetables (g)	600g	600	0
Amount edible chicken & coating (g)	450	450	308

5.4.5 Beef chow mein

The home-made beef chow mein meal is cheaper than the home-assembled meal by 10% until the cost of time is added, resulting in the home-made meal being 12% more expensive (Table 53 & Table 56). The takeaway meal costs 15 to 37% more than the home-assembled meal for all costing options. The takeaway meal is more expensive than the home-made meal when time is not included, and a similar cost when time is included.

The maximum levels of saturated fat and sodium are not exceeded for the home-made meals, except one meal is slightly too high in sodium (by 44mg) (Table 53). The maximum sodium level is exceeded for the home-assembled meals due to the mean sodium content of some of the combinations of sauces and noodles. Only eight of the thirty combinations do not exceed the level, though ten are above by less than 300mg.

Table 53: Beef chow mein meals: description, cost (mean), nutrients (mean)

	Home-made Mean (range)	**Home-assembled** Mean (range)	**Takeaways** Mean (range)
Description	Beef Noodles Fresh vegetables Herbs, spices, sauces	Beef Noodles Frozen vegetables Flavour sachet	Beef & noodles (2 meals)
Number of meals priced	36 combinations: 2 beef, 2 noodles, 9 sauces/vegetables	30 combinations: 2 beef, 5 noodles, 1 vegetables, 3 flavour sachets	14 outlets
Cost no time ($)	$16.94 ($15.20-$19.09)	$18.63 ($16.00-$21.84)	$22.02 ($17.00-$26.00)
Cost with time ($)	$22.78 ($21.04-$24.94)	$20.30 ($17.78-$23.37)	$24.21 ($19.03-$30.58)
Time (minutes)	23	7	9 (5-18)
Weight (edible grams)	2141 (2049-2311)	1971 (1700-2190)	1542 (872-2148)
Energy (kJ)	7499 (6851-8282)	9628 (8407-11047)	9638
Fat (g)	45 (34-59)	49 (37-64)	168
Saturated fat (g)	13 (11.5-14.5)	12 (11-14)	62
Carbohydrate (g)	185 (172-203)	209 (125-310)	93
Protein (g)	156 (153-160)	172 (150-205)	86
Sodium (mg)	2807 (2042-3644)	3946 (2759-5477)	5089
Non-starchy vegetables (g)	600	600	725 (assume all non-starchy)
Amount edible beef (g)	480	480	280

5.4.6 Burgers

The home-assembled burger is the cheapest meal option when priced with and without time (Table 54, Table 56). The home-made and home-assembled meals are not significantly different in price per kilogram. The takeaway meal is the most expensive when priced with and without time, particularly per kilogram when the cost is three times more than the home-prepared meals.

The maximum level of saturated fat is exceeded for most of the home-made and home-assembled meals due to the saturated fat in the meat patty and cheese, despite Edam cheese being used (Table 54). The mean sodium level is exceeded for the home-assembled meals but not the home-made meals. The takeaway meal is higher in sodium and saturated fat than the home-prepared meals. The home-made and home-assembled meals provide sufficient vegetables while the takeaway meal only has 180g of non-starchy vegetables.

Table 54: Burgers: description, cost (mean), nutrients (mean)

	Home-made Mean (range)	**Home-assembled** Mean (range)	**Takeaways** Mean (range)
Description	Beef patty – home made Burger bun Fillings: lettuce, tomato, carrot, onion, beetroot, gherkin, cheese	Beef patty – frozen, prepared Burger bun Fillings: lettuce, tomato, carrot, onion, beetroot, gherkin, cheese	McDonald's family pack 2 Big Macs 2 Cheeseburgers 4 small fries
Number of meals priced	9 combinations: 9 burgers, 1 filling, 1 bun	4 combinations: 4 burgers, 1 filling, 1 bun	1 outlet
Cost no time ($)	$12.68 ($11.91- $13.89)	$10.48 ($8.74-$12.18)	$20.00
Cost with time ($)	$16.89 ($14.46-$18.97)	$12.77 ($11.03-$14.47)	$21.53
Time (minutes)	17 (10-20)	9	6
Weight (edible grams)	1628 (1528-1740)	1500 (1480-1560)	908
Energy (kJ)	9852 (9194-10191)	9115 (8688-9484)	10817
Fat (g)	82 (77-85)	80 (58-100)	132
Saturated fat (g)	29 (27-30)	29 (18 - 38)	37
Carbohydrate (g)	230 (211-240)	230 (221-243)	244
Protein (g)	163 (154-169)	115 (98-128)	95
Sodium (mg)	3256 (2741-3713)	3927 (3538-4234)	4691
Non-starchy vegetables (g)	600	600	83
Amount edible beef cooked (g)	360	260	180

5.4.7 Pizzas

The home-made pizza is the cheapest option without time and per kilogram (Tables 55 & 56). The takeaway pizza is the most expensive for all costing options. When the cost of time is added, the home-made and home-assembled pizzas are a similar price.

The mean sodium and saturated fat maximum levels are not exceeded for the home-made or home-assembled meals (Table 55). Two of the home-made recipes exceed the maximum sodium level by less than 500mg. The toppings in the meals are identical so the additional sodium in the home-made meals is from the bases (raising agents) and the sauces. The takeaway pizza is very high in sodium with more than twice the sodium of the home-assembled meal but does not exceed the saturated fat maximum level. The pizzas prepared at home provide 445g of vegetables while the takeaway pizza provides a 216g of vegetables.

Table 55: Pizzas: description, cost (mean), nutrients (mean)

	Home-made Mean (range)	**Home-assembled** Mean (range)	**Takeaways** Mean (range)
Description	Home-made base Home-made sauce Toppings vegetarian	Pre-prepared base Pre-prepared sauce Toppings vegetarian (pre-grated cheese)	3 Domino's $4.99 pizzas Vege Trio
Number of meals priced	21 prices: 7 sauces, 1 topping, 3 bases	3 combinations: 1 sauce, 3 bases, 1 filling	1 outlet
Cost no time ($)	$6.76 ($5.91-$7.83)	$11.40 ($10.06-$13.16)	$14.97
Cost with time ($)	$15.55 ($13.20-$18.93)	$14.45 ($13.11-$16.21)	$18.53
Time (minutes)	36 (30-47)	12	14
Weight (edible grams)	1473 (1237-1674)	1213 (1100-1290)	1272
Energy (kJ)	9259 (8490-10485)	9603 (7256-10947)	15577
Fat (g)	67 (57-88)	65 (57-72)	48
Saturated fat (g)	23 (22-25)	24 (24-25)	22
Carbohydrate (g)	316 (291-333)	315 (223-362)	660
Protein (g)	84 (76-93)	95 (82-102)	136
Sodium (mg)	3124 (2627-3950)	2665 (2314-2868)	5881
Non-starchy vegetables (g)	445	445	216

5.4.8 Meeting meals criteria

The home meals all have a grain/starchy vegetable component, meat or alternative/dairy component and non-starchy vegetables. All of the meals prepared at home, except pizza, contain at least 600g non-starchy vegetables. The pizza meals have 445g of non-starchy vegetables, but it was difficult to add more vegetables to the pizza bases due to space.

All of the meals have considerably more than the minimum of 20g protein. Four of the takeaway meals provide half to three-quarters of the amount of protein as their home-made counterpart. The maximum saturated fat level is not exceeded by most of the home-made and home-assembled meals, except the burgers and home-assembled chicken meal. The maximum saturated fat level is exceeded by all of the takeaway meals, except pizza. The maximum sodium level is exceeded by all but one takeaway meal (fish and chips).

The maximum sodium level is not exceeded by most of the individual home-made meal recipes. Apart from pizza, the home-assembled meals have 10% to 191% more sodium than the home-made meals with most of the individual home-assembled meals not exceeding the maximum level for sodium.

Twenty-five to thirty percent of daily energy (9.98-11.97 MJ) for the reference household is provided by two of the home-made meals, one of the home-assembled meals and three of the takeaway meals. The remaining meals provide less than 25% of daily energy except the takeaway chicken meal and takeaway pizza, which provides more than 30% of daily energy. All but four of the meals are at least 22.5% of the daily energy.

The weight of each meal varies, with most of the home-prepared meals weighing more than the takeaway meal counterpart due to the added vegetables. The pizza is the lightest of all the meal options. The takeaway burger is also one of the lightest despite having a burger and fries for each person.

5.4.9 Comparing the cost of meals

For three of the takeaway meals (pizza, KFC chicken meal, McDonald's burger meal), the cost is standardised across outlets so only one price was collected. Of the three takeaway meals that vary by outlet, the fish and chip meal has the largest range in price with the cheapest meal less than half the price of the most expensive meal. The price of the cheapest butter chicken and beef chow mein is about two-thirds of the most expensive meal. The weight of the smallest fish and chip and beef chow mein takeaway meals is less than half that of the heaviest meal with less variation for butter chicken.

5.4.9.1 Cost of meals without time

The cost of the home-made meals is significantly cheaper than the takeaway meals for five of the six meal options (Figure 10). The takeaway fish and chips meals costs significantly less than the home-made counterparts. The cost of the home-assembled meals is significantly cheaper than the takeaway meals counterparts.

Three of the home-made meals cost less than the home-assembled meals (chicken meal, beef chow mein and pizza), one is not significantly different between home-made and home-assembled (butter chicken) while two of the home-made meals cost more than the home-assembled meals (fish and chips, burger). The relative difference in price (Table 56) between home-made and home-assembled meal counterparts is wide, ranging from -69% (home-made cheaper) to 38% (home-assembled cheaper). When the meals are standardised to one kilogram, the range widens from -105% to 28%.

The takeaway meals cost between 10% and 55% more than the home-made meal counterparts (without time), with the largest difference being for the takeaway meals purchased from fast food chains (chicken meal, burgers, pizza). The takeaway meals cost 15% to 48% more than the home-assembled meals. When the meals are standardised by weight to one kilogram the relative difference in cost remains similar (Figure 11).

The largest relative differences between the cheapest and most expensive meal counterparts occurs between the chicken meals (takeaways cost 46% more than home-made), the burger meals (takeaways cost 48% more than home-assembled) and pizzas (home-assembled pizza costs 55% more than home-made).

The addition of vegetables reduces the price per kilogram. When the cost is calculated without vegetables, the pattern of results is similar to the price per kilogram with vegetables, but the relative differences are smaller.

5.4.9.2 Cost of meals with preparation or waiting time

When the cost of time is added (Figure 12) all the home-assembled meals were significantly cheaper than other options (12-82%) except for pizza, where the home-assembled and takeaway pizzas are a similar cost. The home-assembled meals are quicker to prepare than all the home-made meals and four of the home-assembled meals require less time to prepare than ordering and waiting for the takeaway meal counterpart. The relative difference in cost between takeaways and home-assembled meals is similar whether or not the cost of time is included. The relative cost difference between home-made and home-assembled meals shifts when time is included, with a range of 8% to 82% as the home-assembled meals are quicker to prepare.

The inclusion of the cost of time reduces the relative difference between the cost of takeaway and home-made meals, with the home-made meal costing from 24% less to 16% more than the takeaway meal. Three of the home-made meals are significantly cheaper than the takeaway counterpart (chicken meal, burger, pizza), one is significantly more expensive (fish and chips) while the other two meals are not significantly different in price (butter chicken, beef chow mein).

The home-made meals take 17 to 36 minutes to prepare (average time of each meal option) while the preparation time for the home-assembled meals (5 to 12 minutes) is similar to the waiting time for the takeaway meals (1 to 14 minutes). The home-assembled meals using pre-prepared ingredients are relatively quick to prepare (5-12 minutes). The home-made meals require at least 45% more preparation time than the other meals.

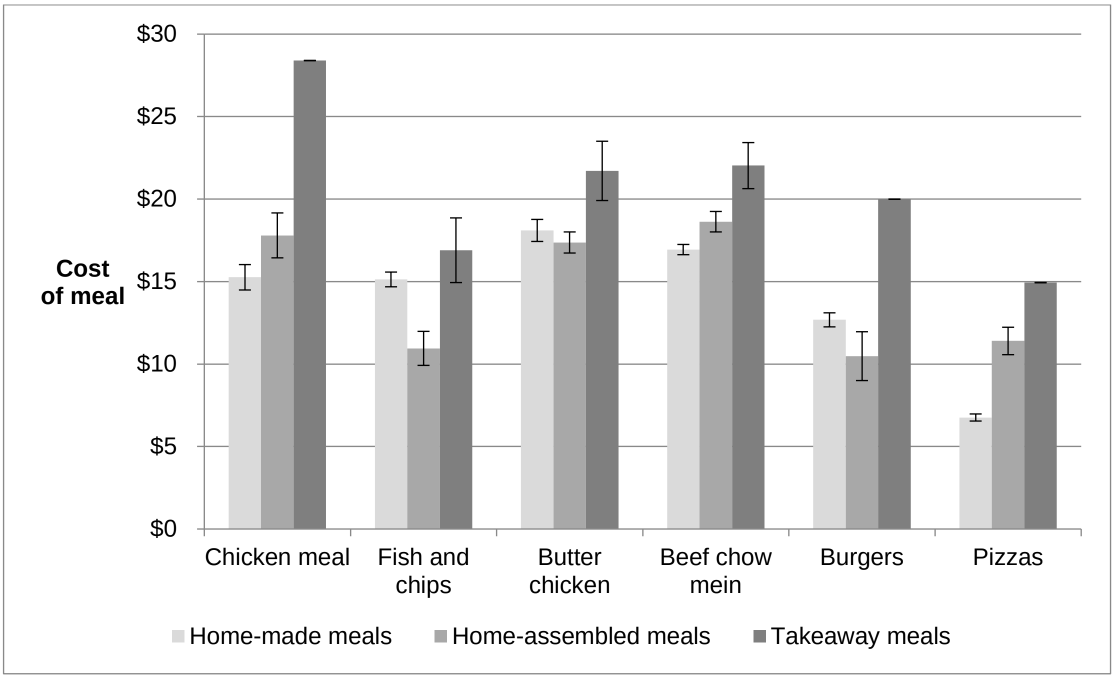
The fish and chip home-made meals are more expensive than the takeaway meals by 16%, as fish and chips is one of the cheapest takeaway meals and the home-made meals take a relatively long time to prepare. However, the home-made fish and chips meals provide almost twice as much fish flesh than the other similar meal options, as half of the takeaway fish consists of batter. The takeaway meal is the most expensive option for the chicken meal (24% more than the home-made meals), burger (22% more than the home-made meals) and pizza (19% more than the home-made meals). The costs of the home-made meal and takeaway options are not statistically different for the butter chicken and beef chow mein meals.

When time is included, the largest relative differences between the cheapest and most expensive meals occur between the fish and chip meals (home-made 82% more than home-assembled) and the burger meals (takeaway 41% more than home-assembled).

Table 56: Relative difference between mean costs of meals: without time, per one kilogram, with time

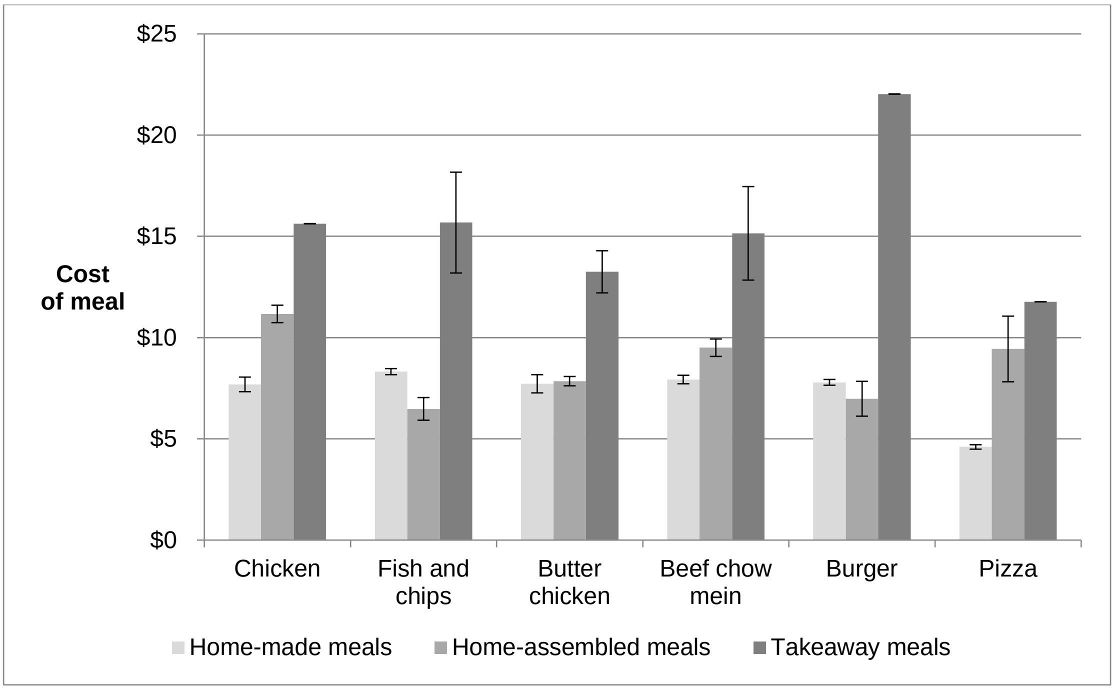
	Cost	**Takeaways versus Home-made**	**Takeaways versus Home -assembled**	**Home-made versus Home-assembled**
Chicken	No time	46%	37%	-17%
	1 kg	51%	29%	-45%
	With time	24%	33%	14%
Fish and chips	No time	10%	35%	38%
	1 kg	47%	59%	28%
	With time	-16%	36%	82%
Butter chicken	No time	17%	20%	4%
	1 kg	42%	41%	-2%
	With time	-4%	19%	29%
Beef chow mein	No time	23%	15%	-10%
	1 kg	48%	37%	-20%
	With time	6%	16%	12%
Burger	No time	37%	48%	21%
	1 kg	65%	68%	12%
	With time	22%	41%	32%
Pizza	No time	55%	31%	-69%
	1 kg	61%	20%	-105%
	With time	19%	22%	8%

Figure 10: Mean cost of meals without time



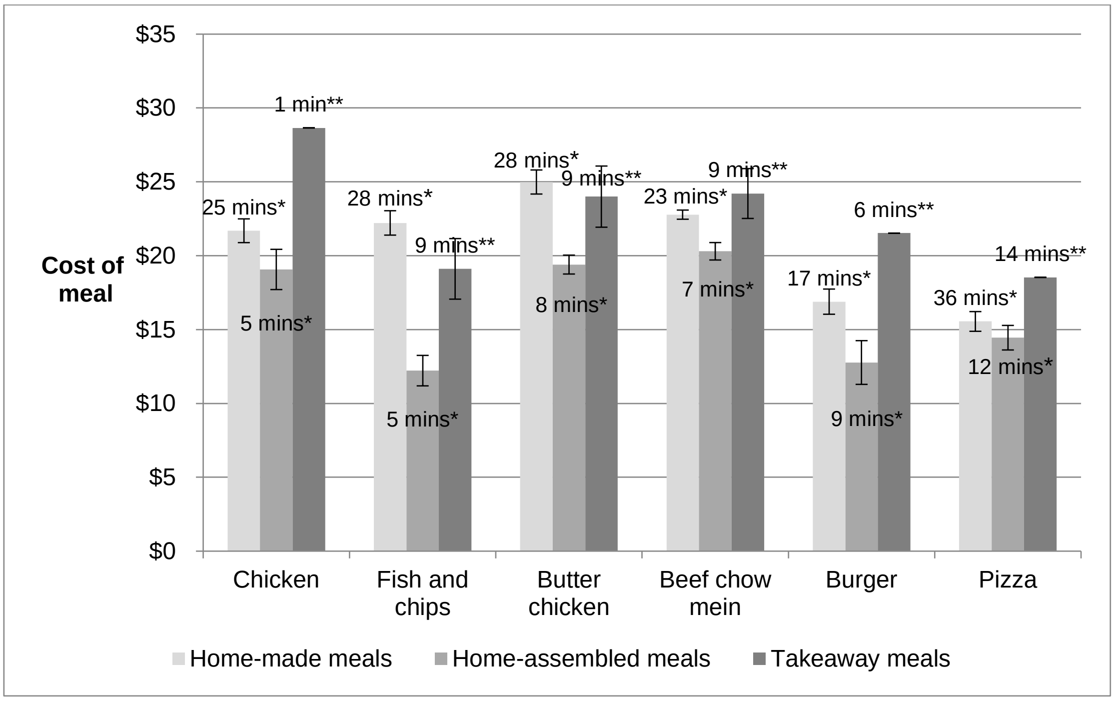
Confidence interval calculated from standard error

Figure 11: Mean cost of meals standardised to 1kg



Confidence interval calculated from standard error

Figure 12: Mean cost of meals with time



Confidence interval calculated from standard error

* Mean minutes to prepare meals

** Mean minutes to wait for meal

5.5 Discussion: Meals approach

This research provides a method to compare the cost of meals across the spectrum of preparation from home-made to home-assembled to takeaway meals. The cost differential between each meal option can be compared at one point, monitored over time and compared with cost differentials in other countries.

This analysis has shown that, in general, healthier home-cooked and home-assembled meals are cheaper than their takeaway counterparts, when either the cost of the complete meal, or the cost standardised for weight is calculated. Adding the cost of relevant preparation and waiting time made the home-assembled meals the cheapest option and either the home-made or takeaway meals the most expensive. The home-cooked meals require more preparation time than home-assembled meals.

Home-assembled meals are potentially a better option than takeaway meals, as they are 15% to 48% cheaper, quick to prepare and can provide a healthy meal if pre-prepared ingredients that are lower in saturated fat and sodium are chosen. Frozen vegetables and pre-prepared coleslaw provide cheap, quick vegetable options in this study. Three of the home-assembled meals provide one-third to one-half less edible fish, beef or chicken than the home-made meal, as this was a smaller proportion of the item (crumbed fish, crumbed chicken, burger patty).

The home-made meals are in line with the meals criteria. The home-assembled meals meet all or most of the criteria, although most provide 10% to 191% more sodium than the home-made meals. Most of the takeaway meals provide few or no vegetables and exceed the maximum saturated fat and sodium levels. There are exceptions: takeaway pizza do not exceed the maximum saturated fat level, takeaway fish and chips do not exceed the maximum sodium level, beef chow mein provide more than 600g non-starchy vegetables. Four of the takeaway meals provide only half to three-quarters of the protein of the home-made meals.

Though the statistical difference at the 95% level of confidence is calculated to compare home-made, home-assembled and takeaway meals, what is important is the meaningful difference in cost between the meals that would influence the consumer's decision to choose one of the meal types over the others. This is challenging to quantify, as meal preparation is a trade-off between the cost of purchasing food and time available as well as taste, culture and other influences. Households differ on the value placed on nutrition, the provision of a home-made meal and the priority of food in the budget(219,222,223). For some members of the household, the provision of home-cooked meals provides benefits such as enjoyment of cooking, personal engagement, social interaction, relaxation, a nurturing role and the opportunity cost of time for other activities, while others consider meal preparation a chore with little time prioritised or available(183,220,231,236).

People perceive that takeaway meals are more convenient and cost less than similar healthier home-cooked meals(59-61). Cost comparisons between home-made and takeaway meals, and guidelines to prepare healthy takeaways at home, are provided by nutrition educators and the popular literature to counter this perception(431-433). Feelings of time scarcity, changing family structures and increased participation in the labour force by women, contribute to the increase in eating meals prepared outside the home and the use of more pre-prepared ingredients and meals(222,223,226,230). Fiscal measures, such as a tax on fast food, have the potential to shift consumers to preparing more meals at home(240). This research provides a methodical, timely analysis to contribute to relevant discussions.

5.5.1.1 Time to prepare and obtain meals

Hands-on preparation time is used rather than the full cooking time as the individual can be conducting other activities during this time. However, the cook is still required to be present and the cooking time adds to the time before the meal is available to eat. The time to shop for ingredients and transport time to and from food stores or takeaway outlets is not calculated, as this time can vary between households depending on location and frequency of shopping, and it is assumed purchase of ingredients would be part of a regular household shop.

All the home-made meals took at least 60% more time to prepare than the time to acquire takeaway meals. Four of the home-assembled meals require less time to prepare than ordering and waiting for a takeaway meal. The cost of time is calculated in various studies by pricing the home activity at the rate at which it is priced in the market(237). This research uses a standard cost of time of the minimum wage, as this is similar to the hourly wage rate of a food preparer(430), though it is the time cost of the person at their perceived time value which is considered when making meal decisions.

There are few studies reported in the literature that incorporate the cost of time when comparing the cost of meals. A US study[58] evaluated the cost of various pre-prepared and home-made ingredients (e.g., apple sauce) and meals (e.g., lasagne). The time to prepare the items was calculated and the hourly wage of a food preparer used as the cost of time. When the cost of time was included, the processed items cost less than the home recipe for all items, particularly grains, vegetables and fruit. In this current research, five of the home-assembled meals are cheaper than the home-made meal when time was included. The cost to prepare the Thrifty Food Plan was met by 62% of low-income households, but when the time costs were included only 13% could afford the required foods[233].

The cost of electricity for the meals is estimated to be low at about $0.26 per meal[426] so is not considered an important factor. In developing countries cooking equipment and cooking fuel may be expensive making street food an economical option[100].

Time scarcity is a social determinant of health, which is often overlooked. Households with working parents, single parent households, inflexible jobs or shift work can contribute to less time for food preparation[232,233] with households reducing time pressure through purchasing more meals away from home and using convenience ingredients and meals [230,234]. Scarcity can be a relative measure, which is socially contextualised by the value and expectations of time placed on people. An Australian longitudinal study reported that the feeling of being time poor reduced healthy eating behaviours, while an objective measure of being time poor (time-use survey) had no association[226]. A study using two US survey data sets estimated the price-elasticity of demand for different types of food purchased away from home and concluded that an increase in the price of fast food may shift consumption to home-prepared meals[240].

5.5.2 Feasibility of the methodology

The methodology developed for this research is novel with meal criteria developed along with steps to identify popular takeaway meals and to select a range of recipes and components for healthy home-cooked meals.

The criteria that the meal must contain components from at least two food groups and the home-prepared meals must contain non-starchy vegetables, provided guidance to ensure the end product was a meal rather than a snack. The home-made meals were developed to include the key components of the takeaway meals with the addition of vegetables. For example, the components of the fish and chips prepared at home are similar to those of the takeaway meal, crumbed fish and oven-fried chips, with the addition of seasonal vegetables. Some cooking methods were modified to be suitable for home use. For example, fish was pan-fried or oven-based rather than deep-fried as this requires special equipment, careful attention and a lot of oil.

It was challenging to determine the appropriate meal size, as there is no consensus on what is considered a meal[182,409]. A suggested energy level for the meal is 25-30% of daily energy. Only six of the eighteen meal options met this percentage. The meals were also standardised for weight (1kg) and the relative cost differences between meals is similar to the non-standardised cost differences. Therefore the energy criterion was removed from the meal criteria.

The McDonald's and KFC meals are marketed to a family of four. Different households of four may choose varying amounts of the other takeaway meals. To overcome this variation, the home-made and home-assembled meals were matched to the takeaway meals in terms of the amount of rice, noodles or potatoes, but as additional vegetables were added some of the home-prepared meals weighed more than the takeaway meals.

The meal criteria are based on a range of existing criteria for recipe development or ready-meals. All the home-made and home-assembled meals, expect pizza, meet the recommendation of a minimum of 600g non-starchy vegetables (150g per person). This contributes to the WHO population goal of ≥ 400g non-starchy vegetables and fruit per day(319). The addition of vegetables to the home-prepared meals is straightforward, apart from the limited size of the pizza bases for adding vegetables.

The suggested minimum level of 20g of protein per meal is to differentiate the meal from a snack. By stating that the meal needs to contain a meat and alternatives/dairy component, all meals contain considerably more than 20g protein. The criterion of an approximate raw weight (125g red meat, 150g skinless poultry, 150g fish) for the home-made recipes is suitable. In addition, each recipe has a similar amount of red meat, poultry or fish (for example, each home-made chicken meal recipe had 600g raw poultry). The protein criterion is not considered necessary and was removed from the meal criteria.

The maximum levels of sodium and saturated fat guided the selection of recipes. Some butter chicken recipes contain coconut cream or cream. In order to not exceed the maximum level of saturated fat, recipes with coconut cream or cream were excluded, or the cream was replaced with light evaporated milk or yoghurt. The pre-prepared butter chicken sauces with less sodium, saturated fat and sugar were selected in the home-assembled meals. Consequently, all of the home-assembled meals are under the maximum sodium level, though four of the ten meals are slightly too high in saturated fat. A pizza with ham and a vegetarian pizza were developed. The ham topping was too high in sodium so was not included in the results.

The maximum level for saturated fat of ≤24g per meal is based on criteria for ready-meals used by the former Australia/NZ Pick the Tick programme(193), the NZ Heart Foundation recipe criteria(413) and the UK front of pack Traffic Lights classification system(412). The meals containing cheese (burgers, pizza) are above the maximum level despite modification to be under the maximum level. The maximum could be increased to 7g per serving (28g per meal) to allow for a realistic amount of cheese in the cheeseburger and pizza. The WHO recommends saturated fat should be less than 10% of energy(319). Seven grams of saturated fat would provide less than one-third of this maximum level for someone consuming 9000kcal per day. The type rather than the amount of fat is key for INFORMAS, therefore a maximum level for total fat is not provided.

The maximum level for sodium is ≤3600mg per meal (4 people). All of the home-made meals have less than 3600mg sodium. Some of the home-assembled meals are below the level. The beef chow mein, burger and chicken meals exceed the maximum level of sodium due to the use of processed components with added sodium. As 900mg is already 45% of the recommended maximum daily amount of 2000mg(323), the maximum level will be retained. The Australia/NZ Pick the Tick programme[193] had a maximum of 400mg for ready-meals. Other maximum levels are both lower and higher than this so it was considered suitable[411-413].

There is no maximum level for added sugar, as this tends to be lower in main meals compared to snacks. As the sugar content of pre-prepared meal sauces can be high, the sugar level should be noted. There is no minimum level for fibre as meeting the minimum vegetable servings would ensure some fibre. Of the meal criteria investigated, only the Pick the Tick ready-meal criteria[193] specified a minimum fibre level of 3g+ fibre or alternatively 1+ serving (75g) vegetables.

The particular takeaway meals purchased from the quick-service restaurants are standardised in price across franchises so there is no variation in price. The composition of the meal was expected to be very similar across franchises. As meals from independent takeaway outlets ranged in price, weight and the proportion of meat or vegetables or sauce, a study strength was that each meal was purchased from fourteen independent takeaway outlets. To account for possible variations in price and composition of takeaway meals, the outlets were selected from a range of census area units using several sources of information, including physically visiting the area, so there was increased confidence that all the outlets in an area were identified.

Arbitrary decisions were required to determine the time components of obtaining meals to be included in the estimate of time for each meal. Preparation time is included for the home-cooked meals, and waiting time for the takeaway meals. The time to clean up after meals is not included and would be higher for home-cooked meals compared to takeaway meals. Unsupervised cooking time is not included as a person can undertake other tasks. The time to purchase groceries and the transport time required to purchase takeaways is not included as this would vary considerably between households and may be undertaken along with other tasks. Therefore the time calculation is not the true cost of all time involved for all meal types, but is a feasible calculation of time.

There was little published methodology to guide the meals approach with a need to define a healthy home-cooked meal and processes required to select recipes and takeaway outlets and to calculate the cost of time. This research developed and tested methodology to compare the cost of popular takeaway meals with home-made and home-assembled meals in a manner that can be repeated over time and in different countries. The steps were relatively straightforward to implement but it was time-consuming to collect the price of meals from independent takeaway outlets. The strengths and limitations of the meals approach and the implications of comparing the cost of meals are discussed in section 7.2.

6 DIET APPROACH: MEASURING THE COST AND AFFORDABILITY OF HEALTHY AND CURRENT DIETS

6.1 Introduction

The INFORMAS foundation paper(19) on monitoring food prices proposes that the monitoring will answer 'How can the cost of healthy and current, less healthy diets be compared and measured over time, and between countries?' The methodology to develop the INFORMAS protocol is described in section 6.2 and Appendix One. This approach is tested in NZ to answer, 'Is a healthy diet less affordable than the current diet?' with the implementation described in section 6.2 and the results presented in section 6.3. The potential use of the diet approach for INFORMAS is discussed in chapter 7.

A standard healthy diet and a standard current diet were developed. For some aspects, such as determining the energy requirements of the reference household, excluding generic labels, or the inclusion of alcohol or takeaways, scenarios were explored to determine the effect of the change on the cost of the diet.

Information was required to identify:

- Commonly consumed foods.
- The nutrient composition of the current diet, particularly macronutrients.
- Patterns of current food consumption, for example grams of food within a food group, proportion of wholegrain cereals.
- Food-based recommendations (food based dietary guidelines) including servings from food groups.
- Recommended nutrient intakes including adequate macronutrient requirements.
- Current height, weight and physical activity levels.

The steps to develop a healthy and current diet were:

1. Select a reference household.
2. Determine energy requirements.
3. Select commonly consumed foods.
4. Select nutrient and food group targets.
5. Develop a menu for each household member.
6. Compile a household shopping list.
7. Develop a sampling protocol.
8. Select stores.
9. Collect prices.
10. Calculate the affordability of the diet.

In the literature, the terms ‘plan’, ‘basket’, ‘survey’ and ‘diet’ are used to describe the combinations of foods that are priced to determine the cost of the diet. In this thesis, the term ‘’diet’ is used in this way for the NZ diet costs study. The terms ‘menu’ and ‘shopping list’ are used for specific steps in costing the diet.

6.2 Methods: NZ diet costs study

6.2.1 Selection of a reference household

A common reference household is required for the diet approach to define the nutrient and energy requirements of the healthy and current diets and to allow comparison of the affordability of diets across countries. The reference household used in studies of food affordability described in Table 10 depends on the purpose of the research. Common reference households are a family of four, five or six, a single person, a couple or a single parent with children. The European Commission found the most common reference households are couples with children and a single person[(151)].

Recommended INFORMAS reference household: Age years: 7 girl, 14 boy, 45 woman, 45 man, or, One-person household: 45-year old man

The household was selected arbitrarily to represent a broad range of age groups, rather than be representative of a typical household of an individual country. The ages of the reference households fit a different age range for the common age ranges for nutrient reference values, but were chosen arbitrarily within these groups. Pre-schoolers were not included in the reference household as there is less likely to be nutrition survey data, and if infants are being breastfed, this adds an additional complexity in estimating food intake. An older person was considered but often food consumption data is lacking for older age groups. Information on household income is more likely to be reported for a household with two adults.

Some countries have insufficient data to describe the current diet of children, so a reference household of one adult male could be used. Additional reference households can be added to answer further research questions.

6.2.2 Determining energy requirements

Total energy intake for members of the INFORMAS reference household can be estimated from body size or taken from dietary surveys. Alternatively, the costs of different diets can take total energy intake out of the equation by reporting the cost per MJ. Three scenarios will be tested based on methods used in other studies as described in section 2.6.7:

- Scenario One: Energy requirements based on current or recommended BMI and PAL.
- Scenario Two: Healthy diets ASAP method (dietary surveys).
- Scenario Three: Isocaloric diets (per MJ).

6.2.2.1 Scenario One: Energy requirements based on current or recommended BMI and PAL.

This scenario was developed for this research so required some additional investigation to identify the process. The method is complex to calculate so has been described using flow diagrams (Figure 13 to Figure 16) using NZ data for the reference household to illustrate the method. The information required to implement Scenario One is outlined in Table 57.

Table 57: Information required to calculate energy requirements of reference household

Information	Source
Height, weight, BMI, percentage meeting physical activity guidelines	National health survey
Online tool to calculate energy requirements	Body weight simulator(434)
Ideal BMI for children	CDC growth charts(435)
Recommended kJ/kg/day	FAO/WHO/UNU(436)
Equation to calculate kJ/kg/day for target weight and excess weight for children	Hall et al(437)

For the current diet, the energy intake is that which is required to maintain the current mean weight of each member of the reference household at the current physical activity level. This is calculated from the actual BMI rather than the reported energy intake. Under-reporting of food consumption, and therefore energy intake, is a major source of measurement error in dietary assessment(242).

For the healthy diet, the energy requirement for each member of the reference household is sufficient to maintain a healthy BMI and meet physical activity guidelines. For adults, a population mean BMI of 23 is used as this gives the smallest percentage of overweight and underweight(438). For children, the target weight is calculated from mean height and from the 50th percentile BMI from the CDC growth charts(435).

For adults for both diets, the energy requirements are calculated using the Body Weight Simulator(434) which requires height, weight and PAL. For children, for the healthy diet, the recommended energy requirements are calculated per KJ/kg per day using FAO/WHO/UNU(436) recommendations for moderate physical activity. For the current diet for children, the current weight is split into the target weight and the excess weight. The recommended energy requirements are calculated using the kJ/kg/day FAO/WHO/UNU recommendations for the target weight. A different calculation is used for the excess energy intake per unit excess weight in childhood (7-18 years) to distinguish the differing requirements for healthy weight from excess weight(437). The calculation using NZ data for the children of the reference household is shown in Table 58.

Table 58: Excess energy intake per unit excess weight in childhood

	Girls	Boys
kcal per day per kg	62 – (2.2 x age)	68 – (2.5 x age)
Calculation	62 – (2.2 x 7) x 4.18	68 – (2.5 x 14) x 4.18
Energy requirement	= 194.8 kJ/kg/day	= 137.9 kJ/kg/day

For the healthy diet, a physical activity level is required to calculate the energy requirement. The FAO/WHO/UNU[(436)] recommendations for energy requirements recommend a habitual physical activity level (PAL) of 1.70 or higher for adults as this is associated with a lower risk of obesity and NCDs. Therefore, this level was used for the INFORMAS protocol.

Estimating PAL from percentage meeting physical activity guidelines

Many countries do not have national population data on PAL but estimate the proportion of people who meet physical activity guidelines. The PAL is an individual requirement while the percentage meeting guidelines is a population target. Therefore, a method was devised to calculate PAL based on the percentage meeting the physical activity guidelines (discussion with physical activity expert Dr Ralph Maddison). The metabolic equivalents per hour for sleep, sitting and physical activity were calculated. The equation below estimates the PAL of a person meeting the guidelines (Table 59).

Table 59: Energy output for adults: current diet scenario one

Activity	Rate METs	MET per hour
8 hours sleep	0.9	7.2
20 minutes moderate-vigorous physical activity	5.0	1.7
8 hours sitting	1.3	10.4
7 hours 40 minutes light physical activity	2.2	16.9
Total 36.2 MET per hour plus 10% for thermic effect of food		39.8 METs (PAL 1.66)

Metabolic equivalents (MET.h = metabolic equivalents per hour)

As there is no population data for PAL in NZ, the estimated population PAL was estimated from the percentage of adults meeting the NZ physical activity guidelines for adults of ‘at least thirty minutes of exercise on five or more days in the past week’[(64)] (21 minutes per day). About half of adults meet the guidelines, so if there is a normal distribution of physical activity levels, half of the population meet a PAL of 1.66 or over and half meet a PAL of less than 1.66. Therefore 1.66 was used as the mean PAL for the current diet.

Most children meet the physical activity guidelines of 60 minutes of moderate to vigorous physical activity throughout the day[(439)] therefore the energy requirement was calculated at the same level of physical activity (moderate) for the healthy and current diet.

Figure 13: Energy requirement for adults for healthy diet based on ideal BMI and PAL

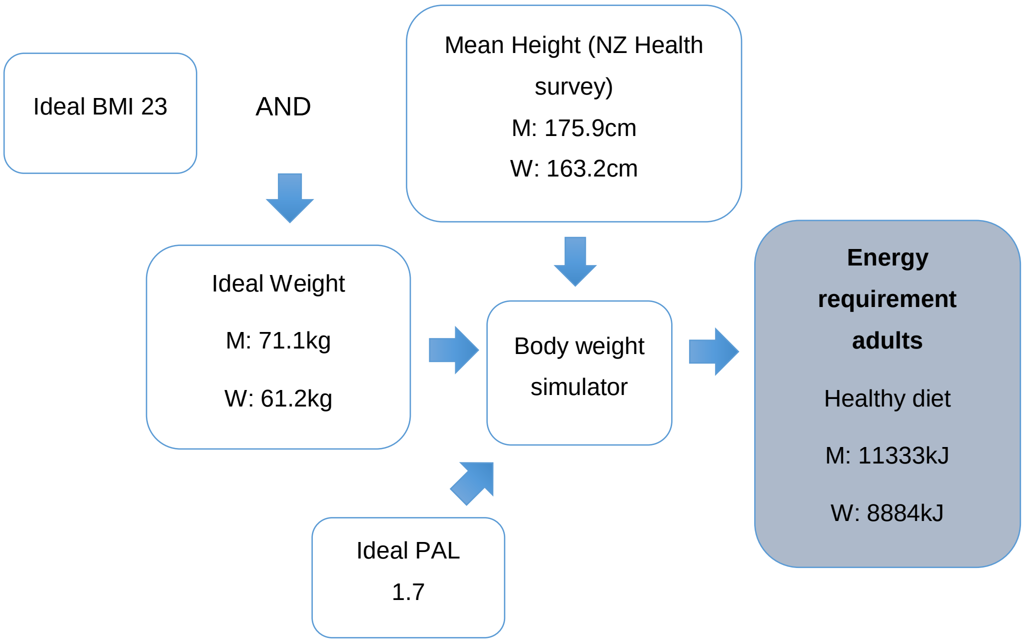


Figure 14: Energy requirement for children for healthy diet based on ideal BMI and PAL

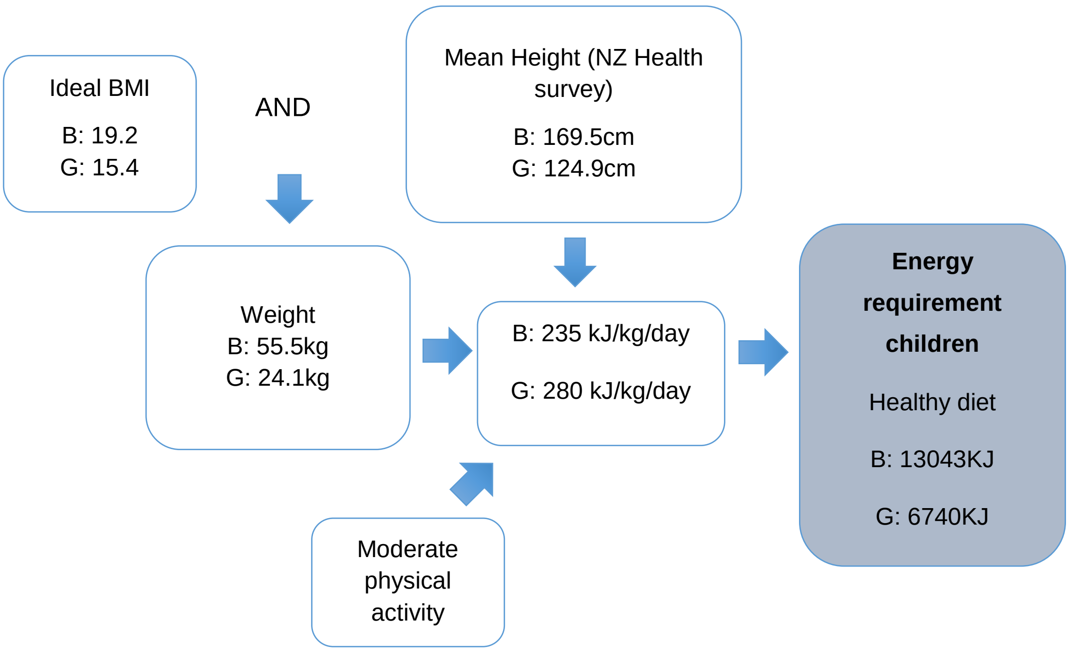


Figure 15: Energy requirement for adults for current diet based on current BMI

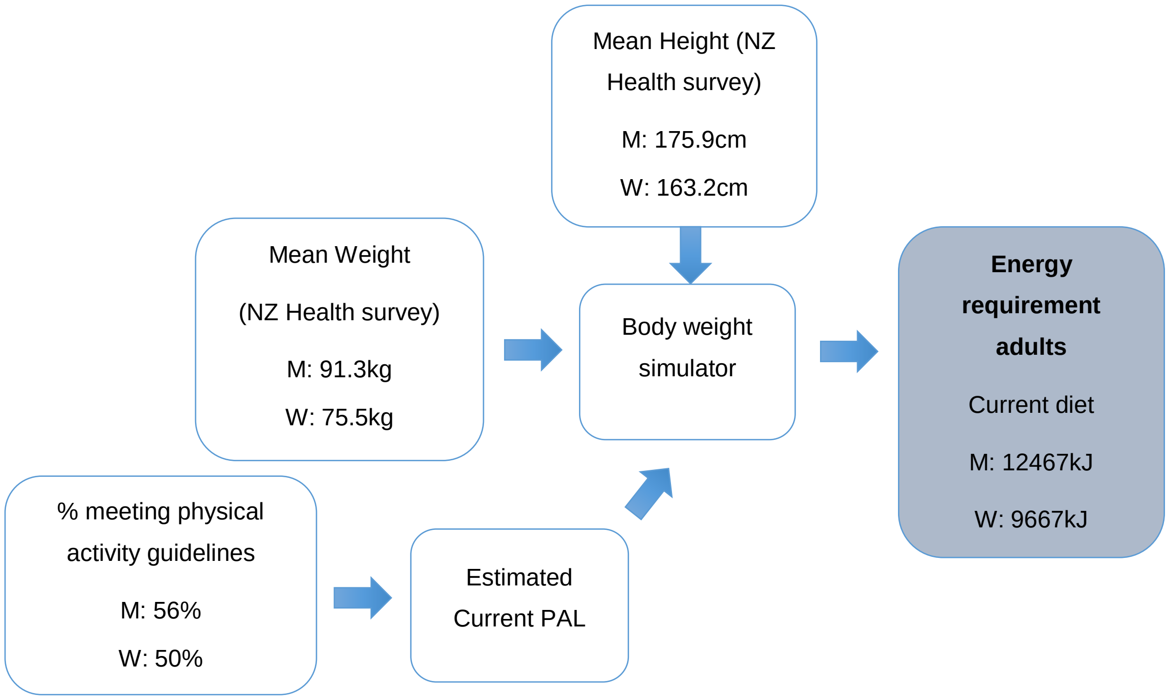
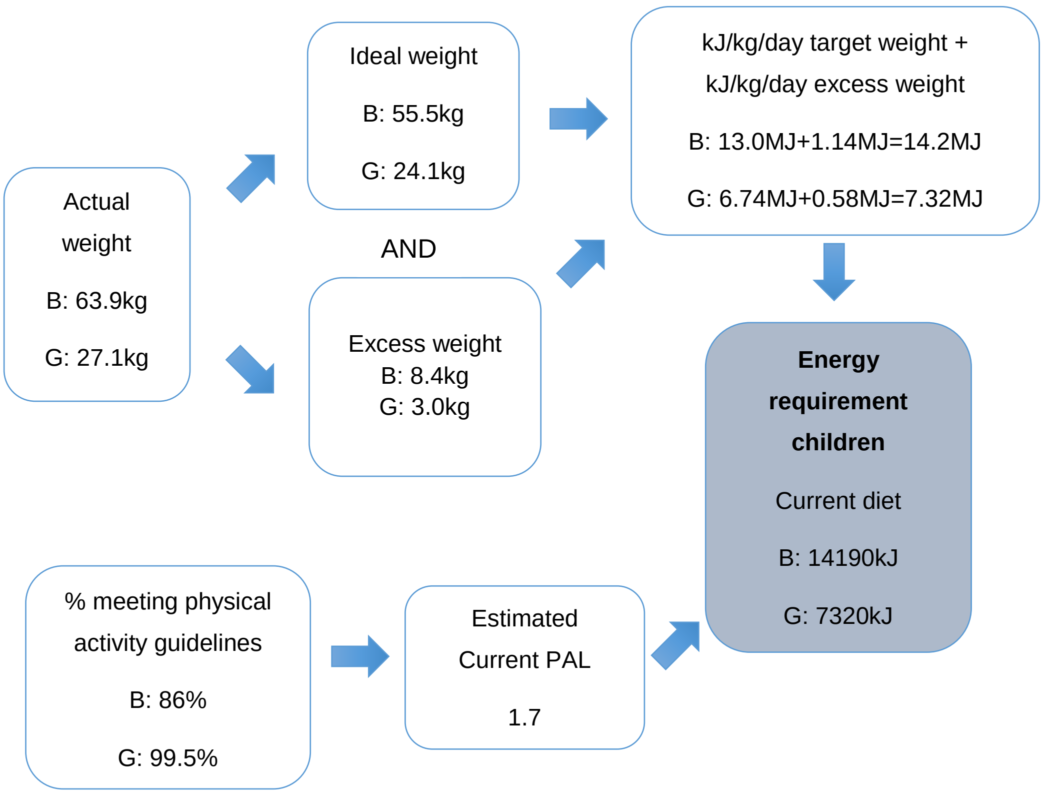


Figure 16: Energy requirement for children for current diet based on current BMI



Scenario Two: Reported energy intake, foundation diet

The Healthy Australian Standardised Affordability and Pricing (ASAP) tool uses similar methodology to develop a healthy and current diet to that developed for the NZ diet costs study. However the method to calculate the energy requirement does differ, therefore this was included as a scenario. The energy requirement of the healthy diet for adults and children is based on the estimated energy requirement for the Australian Foundation diet(9). The Foundation diets are modelled to meet the recommended daily intakes of ten key nutrients and to provide the estimated energy requirements of the smallest and very sedentary category (PAL 1.4) for each age and gender group. NZ does not have a Foundation diet so the energy requirements of the Australian Foundation diet are used, as in the draft ASAP tool(241). The only difference to the INFORMAS reference household is that the girl was seven years old, rather than eight years old in the ASAP household.

The energy requirement of the current diet for adults and children in the draft ASAP tool is based on the reported energy intake from a national dietary survey. The energy requirement of the current diet for this research (Table 60) is based on the reported energy intake from the NZ Adult Nutrition Survey(397) for the adults and the Children's Nutrition Survey(440) for the children.

Table 60: Scenario two: Reported energy intake from nutrition surveys for reference household members

	Energy requirement MJ
7-year girl	7.8
14-year boy	10.3
45-year woman	7.8
45-year man	11.4

6.2.2.2 Scenario Three: Isocaloric diets

The cost of the diets will be calculated at the same energy level (40MJ) using the cost per MJ of the current diet as described in Table 67 which uses scenario one for the calculation of energy requirements.

6.2.2.3 Summary of Scenarios

The energy requirement calculated using each scenario is reported in Table 61.

Table 61: Daily energy requirement for reference household members: Three scenarios

	Healthy diet (MJ)	**Current diet (MJ)**
Scenario 1: Recommended or current BMI & PAL	39.9	43.6
Scenario 2: Reported energy intake, foundation diet.	31.4	37.3
Scenario 3: Isocaloric diets	40.0	40.0

6.2.3 Selecting nutrient and food group targets

6.2.3.1 Nutrient targets

The nutrient targets for the healthy diet are sourced from the NZ Nutrient Reference Values for the acceptable macronutrient distribution range, suggested dietary targets (Table 62) and vitamins and minerals(11). There is no recommendation in NZ for percentage energy from fat or carbohydrate for children under fourteen years, so the development of the diet is guided by the serving sizes recommended in the Eating and Activity Guidelines(395). The Recommended Dietary Intake for protein for a seven year-old (20g) is used as a minimum amount of protein. Free sugars are not included due to the lack of information on the free sugar content of the commonly consumed foods.

The Nutrient Reference Values recommends an upper limit for sodium of 2300mg. The WHO(323) recommends <2000mg per day but this may be difficult to meet for a NZ healthy diet that includes commonly consumed foods with added sodium like bread. The average adult intake in NZ was 3386mg in 2012(441).

Table 62: Nutrient Reference Values for reference household members

Nutrient	7-year girl	14-year boy	45-year woman	45-year man
Fat % energy		20-35%	20-35%	20-35%
Saturated fat % energy		<10%	<10%	<10%
Protein % energy (or grams)	20g	15-25%	15-25%	15-25%
Carbohydrate % energy		45-65%	45-65%	45-65%
Fibre (grams)	18g	28g	25g	30g
Sodium (mg)	<1400mg	<2300mg	<2300mg	<2300mg

Values from Australian NZ Nutrient Reference Values for Acceptable Macronutrient Daily Ranges, Adequate Intake (fibre) and Upper Limit (sodium)(11)

6.2.3.2 Food groups

The INFORMAS protocol recommends following a country's food-based dietary guidelines to guide development of the menu. In NZ, the Eating and Activity Guidelines(395) provide some quantitative guidance for the recommended number of servings and some qualitative guidance on the type of food, for example mostly whole grains, mostly low and reduced fat milk products.

The serving size advice per day for adults recommends to eat at least:

- three servings of vegetables,
- two servings of fruit,
- six servings of grain foods,
- two servings of milk products,

- one serving of fish and other seafood, eggs, poultry or red meat or two servings of legumes, nuts or seeds.

The guidelines recommend choosing and preparing foods and drinks with unsaturated rather than saturated fats, low in sodium and with little or no added sugar.

6.2.3.3 Current diet: Nutrient targets

The current diet reflects the nutrient intake of New Zealanders, as determined by national nutrition surveys (Table 66). The median intake of the percentage of energy from macronutrients, fibre and sugar reported for the appropriate age group in the Adult Nutrition Survey 2008/09[397] (14-year boy, adults) and the Children's Nutrition Survey 2002 (7-year old girl) [440] are used. The data reported for the 15 to18 year-old boys is used for the 14-year old boy as this is considered similar and is more recent than the 2002 Children's Nutrition Survey. A later report estimates intakes of sodium for a different sample aged eighteen years and over using a 24-hour urinary collection[442]. As this methodology is more reliable than the spot urine used for the Adult Nutrition Survey, this data is used. The sodium intake calculated for 18 to 24 years men is used for the 14-year old boy. There is no estimated intake for children.

6.2.3.4 Current Diet: Food Groups

The amount of each food group and subgroup consumed by the members of the reference household (except 7-year girl) is calculated from the Adult Nutrition Survey microdata[388]. Food groups with very small amounts are excluded and some smaller groups are combined. A food can be categorised to different groups depending on the extent that the individual ingredients are disaggregated, for example, lasagne could be categorised as 'pasta dish' or 'pasta', 'beef', 'cheese', 'tomato' etc. Therefore, the amount consumed of a food group may be over or under-estimated. Other foods act as a proxy for the commonly consumed foods (e.g., toasted muesli for all muesli). It is estimated that 21% of men and 25% of woman are low-energy reporters[443]. The amount consumed from each food group was calculated.

There is no recent survey data to calculate the amount consumed from food groups for the 7-year girl, therefore there are no targets for most of the food groups. The only comprehensive data on children's nutrition is from the 2002/03 Children's Nutrition Survey[440]. The information on commonly consumed foods and consumption patterns is identified from a smaller national food frequency survey conducted in 2007, the NZ Children's Food and Drink Survey[389] as described in chapter 3. The diet was developed using these commonly consumed foods to meet the nutrient intake reported in the 2002 Children's Nutrition Survey[440]. The estimated intake of fruit and vegetables was calculated from a question in the NZ Health Survey[64] that reported the percentage of girls aged five to nine years meeting the guideline of two servings of fruit and three servings of vegetables per day. Eighty percent meet the guideline for fruit. Assuming the other twenty percent of children consume 1 serving per day, the overall intake is estimated as 1.8 servings. Half meet the guideline for vegetables. Assuming the other half consume 2 servings a day, the overall intake is estimated as 2.5 servings.

6.2.3.5 Discretionary foods: percentage of energy

The percentage of energy consumed from discretionary foods is not reported in the Adult Nutrition Survey(397). A method to estimate this was devised. The 33 major food groups from the Adult Nutrition Survey were coded as core or discretionary based on the NZ Eating and Activity Guidelines(395) and the Australian guide to discretionary foods(444). Non-alcoholic beverages are considered discretionary. Tea, coffee and water are part of this group but do not contribute energy if added milk and sweeteners are coded separately. Some food groups are a mixture of core and discretionary (for example, fats and oils equals butter and vegetable oil). For these groups, the sub-group is coded as core (olive oil, canola oil) or discretionary (butter).

The percentage of energy for the 33 food groups for the age and sex groups is reported in the Adult Nutrition Survey supplementary data tables(445), but not at the sub group level. Using the microdata, the grams consumed of each sub group was calculated. For those food groups which are a mix of core and discretionary, the proportion that the sub-group contributes to the total of the food group was calculated from the mean grams consumed (for example, butter 25%, oils 75% of fats and oils category). An assumption is made that this proportion would be a similar contribution to energy. This is a limitation as some of the core foods may be lower in energy. The proportion of foods consumed by children that are discretionary is not calculated due to the lack of recent survey data.

6.2.4 Developing a healthy diet and the current diet

Few studies develop a current diet as well as a healthy diet. It is important that the current diet reflects consumption of commonly consumed foods, as a price change will have more impact on the population than a less common food. Using a list of commonly consumed foods and principles provides some guidance for the development of menus but there are many possible combinations that could meet nutrient targets and energy requirements. The commonly consumed foods are a subset of all foods consumed, so some of the foods act as a proxy for a similar food. For example, ham represents processed meats (bacon, salami etc). Therefore, the final diet represents one option. A range of menus could be developed for each diet by one researcher, a range of researchers or by using a dietary modelling programme where foods are selected in an objective manner to meet nutrition and food group constraints. If a researcher selected the foods, subjective decisions may be made on the quality of foods, perceived likeness of the food and realistic combinations of foods(268).

6.2.4.1 Develop menus

One healthy and one current menu is developed for each household member based on commonly consumed foods. The current diet is developed first for each household member to meet the average intake of foods and nutrients, then adapted to meet food-based dietary guidelines for the healthy diet. An initial household menu can be developed with revisions made for each household member, as generally households eat similar meals(334,351).

It is important that the diets are developed in a similar way and are straightforward to develop while the arbitrary decisions required are minimized.

- It is important to compare two contrasting diets so no discretionary foods are included in the healthy menus. An additional scenario adding some discretionary foods can also be priced.
- If alcohol is commonly consumed it can be included in the current menu with the amount reflecting current consumption indicated by a national nutrition survey or household expenditure survey. The current and healthy menus could be priced with and without alcohol. If there is alcohol in the healthy menu the amount should not exceed the recommendations of the country.
- Tea, coffee, herbs, spices and other ingredients used in very small amounts are not included. Some baskets do include these, but for comparing countries and monitoring over time it is not necessary and increases the time required to collect prices.
- Wastage from all sources is not included. Edible portion is calculated which accounts for wastage from inedible food parts. Including wastage would add another step, many countries do not have robust data on wastage and wastage varies between countries.
- Standard cooking equipment and some limited cooking skills are required to prepare the menus.
- Indirect costs (knowledge, skills, kitchen equipment) are not included because these costs are difficult to estimate. Very few studies (section 2.6) account for indirect costs, and it is likely that the costs would differ between countries due to differing food environments.

6.2.4.2 Acceptable and representative diets

A healthy diet needs to be palatable and reflect cultural and social practices(326). There is a need to consider how far from the current diet is acceptable for the population. The possible inclusion of alcohol at a moderate level, or some convenience, takeaway or treat foods requires further exploration. Modelling has shown that as a diet becomes more acceptable, more foods are selected and the cost increases(47). Some diets use a small number of foods considered 'treat' foods(52,54,55) or alcohol(249) to create an acceptable diet.

6.2.5 Developing menu plans for NZ diets

A weekly menu was initially developed for the woman as a base diet. The nutrient composition of the menu was analysed using FoodWorks(427) using the NZ Food Composition Tables. Firstly, breakfast was planned for each day using common breakfast foods, then lunch, followed by dinner. There was one category of beverages and one category of snacks, which could be a combination of morning or afternoon tea or supper. As foods were placed in the menu, the contribution to food groups was noted in an excel spread-sheet. Pivot tables were used to calculate the grams from each food group and the number of servings. Oil and margarine were added separately to keep track of the total amount. The amount was adjusted to meet the target for percentage energy from fat.

Calculation of serving sizes

The NZ Eating and Activity Guidelines(395) recommend a number of serving sizes from each food group (Table 63). The serving sizes vary within a food group, for example one serving of vegetables ranges from 50g cooked vegetables to 135g potato, and one serving of grains ranges from one cup of cornflakes (30g) to one cup of rice (150g).

To make menu development simpler, a standard serving size was calculated from the average of the range of serving sizes outlined in the Eating and Activity Guidelines. For the adult male healthy diet, the number of servings calculated this way was 67.8. This was similar to the amount calculated if the serving sizes of the individual foods in the grains group were calculated (69.8). Therefore, the standard serving size was considered appropriate to use.

The number of servings of starchy and non-starchy vegetables was calculated separately and combined for the total number of vegetable servings. There was no standardised serving size for ‘meat and alternatives’ and ‘dairy’ food groups because of the variation of the foods within these groups in energy density and volume. The related food groups in the NZANS were combined to use as a guide to the amount of each food group to place in the current diet (Table 64).

Table 63: Standard serving sizes from NZ Eating and Activity Guidelines

Vegetables	**Fruit**	**Grains**	**Protein foods**	**Dairy**
1 medium potato, kumara (135g)	1 apple, pear, orange (130g)	1 medium slice bread (26g)	1 medium fillet fish (100g)	glass of milk (250ml)
½ cup cooked vegetables (50-80g)	2 small plums, apricots (100g)	1 roll, pita, tortilla (50-80g)	½ can tuna (90g)	pottle of yoghurt (150g)
1 carrot (75g)	½ cup fruit salad (120g)	2 wheat biscuits (34g)	2 slices cooked meat (100g)	2 slices cheese (40g)
½ cup salad (60g)	½ cup cooked fruit (135g)	½ cup muesli (55g)	1 chicken leg (110g)	
1 tomato (80g)		½ cup porridge (130g)	⅓ cup nuts (50g)	
1 avocado (80g)		1 cup cornflakes (30g)	¾ cup legumes (135g)	
		1 cup cooked pasta, rice (150g)	1 egg (50g)	
		4 grainy crackers (40g)		
Standard serving size used to develop menus				
75g non-starchy 135g starchy	120g	65g	No standard serving size	No standard serving size

NZ Eating and Activity Guidelines[395]

Table 64: Combination of NZANS food groups used in current diet

Food group in diet	Survey food group	Notes
Vegetables	vegetables + potatoes, kumara, taro	
Fruit	fruit	
Dairy	milk + dairy (yoghurt) + cheese	The amount of cheese in the menu was higher than that calculated from the survey as cheese is likely to be part of other food categories (e.g., bread-based dishes, pasta dishes).
Grains	grains and pasta + bread + breakfast cereals	The amount of grains consumed in the survey is likely to be an underestimate. The food group 'bread-based dishes' was excluded as many items were discretionary foods.
Meat, poultry, seafood, legumes, eggs etc		The products in this group were spread amongst too many food groups to estimate consumption. When placing these foods in the menus, foods with a higher consumption in the category were placed in a higher proportion. For example, consumption of chicken and chicken dishes, and beef and beef dishes was higher than lamb, pork or seafood.

6.2.5.1 Development of current menu plan

The menu for the adult woman was developed for two weeks. The menus were adapted for the other household members according to the energy requirement and amounts of the food groups consumed. An example of the current menu is found in Appendix Five.

Creating the current menus was a balance of meeting the mean number of servings consumed for each food group as reported in the NZANS (Table 65) and the current nutrient intakes (Table 66). There was no attempt to match the minerals and vitamins to the current diet, as this would be too difficult. A food high in one particular nutrient could alter the nutrient profile considerably, such as a vegetable that is very high in *B*-carotene. For adults and the 14-year boy, the sodium content is similar to the estimated current sodium intake. The current sodium intake of children is not known.

The total fibre content of all diets is higher than the median intake reported in the NZANS, though the servings of fruit and vegetables were similar to the mean amounts reported. The mean energy content reported in the NZANS is lower than the energy in the current diet because the method to determine energy is based on BMI, not reported energy. It was difficult to reduce the fibre content and meet the servings of fruit and vegetables and proportion of whole grains.

The contribution of discretionary foods to energy in the diet is slightly different than the estimated current intake for the adult man (diet 41%, target 38%) and the 14-year old boy (diet 40%, target 43%). This is not surprising as the calculation of the current proportion of discretionary foods has limitations, as described earlier. It is difficult to meet the current proportion of energy from macronutrients if the discretionary foods were further altered.

6.2.5.2 Development of healthy menu plan

The healthy menu was adapted from the current menu. Some additional healthy foods, or the healthier versions of commonly consumed foods, were introduced to increase variety and meet recommendations in the NZ Eating and Activity Guidelines: cottage cheese, natural low-fat yoghurt, wholemeal pasta, wholegrain crackers, brown rice, lean mince, tuna canned in water, peanut butter with no added salt. To ensure the menu was acceptable for a teenage boy, and to increase energy and variety, canned spaghetti and cornflakes were added and cottage cheese was deleted. The percentage of whole grains is lower than the other diets as the fibre content is very high (55g).

An example of a healthy menu for the adult male is found in Appendix Five. Adjustments were made to the menus to ensure the minimum recommended servings from each food group (Table 65) and the nutrient targets were met (Table 66). The Nutrient Reference Values for key vitamins and minerals were met for all household members except for iodine, which is expected given the low iodine content of NZ food(442).

While there is a WHO recommended maximum level for free sugar intake(321), the food composition database does not differentiate between free sugars and naturally occurring sugars. Therefore, there is no target for sugar intake in the healthy diet. As there are no discretionary foods in the healthy diet (except cornflakes and canned spaghetti for the teenage boy) the free sugar intake is assumed to be low.

Sodium levels are below the maximum recommended level of 2300mg in the adult diets but above the level for the teenage boy by 644mg due to a higher intake of bread, breakfast cereals and dairy. The sodium level of the girl's diet is similar to the recommended limit of 1400mg. It would be difficult to reduce the sodium intake and incorporate realistic proportions of the commonly consumed foods.

The fibre intake of all the healthy diets is at least forty percent above the minimum recommended amount. This is due to the amount of fruit, vegetables and grains to ensure the percentage of energy from carbohydrate intake is not below the recommended range.

The menus were compared with the Otago Food Cost Survey(89) weekly amount of food allocated to each sex and age group (man, woman, adolescent boy, 10-year girl). These amounts are based on the NZ Food and Nutrition Guidelines and Adult Nutrition Survey. Minor adjustments were made where the amount in the healthy menus differed considerably from the Otago Food Cost Survey weekly amounts.

The percentage of fat in the diet is in the lower range of the acceptable macronutrient distribution range. Additional fats for spreading and cooking were added so the amount of fats and oils in the diet is similar to the amount in the Otago food cost survey for the same household.

Table 65: Number of servings* per fortnight for healthy and current diets for reference household members

	Girl		Boy		Woman		Man	
	Healthy	Current	Healthy	Current	Healthy	Current	Healthy	Current
Fruit								
- target	28+	25	28+	16	28+	20	28+	16
- diet	28	124	40	16	38	20	38	16
Vegetables **								
- target	42+	36	42+	34	42+	50	42+	50
- diet	44	35	78	44	56	50	66	50
Dairy								
- target	28-42	na	42	20	28+	18	28+	18
- diet	28	21	46	22	32	18	36	18
Grains								
- target	70	na	84+	64+	84+	50+	84+	68+
- diet	86	48	158	88	114	70	134	84
(% wholegrain)	73%	35%	60%	23%	78%	41%	75%	29%
Legumes, nuts, seeds, seafood, eggs, poultry, red meat								
- target	14-28	na	28+	na	14+	na	14+	na
- diet	24	11	55	27	28	26	44	36
% energy from discretionary foods								
- target		na		40%		33%		38%
- diet		33%		43%		34%		41%

* Serving sizes are outlined in Table 63

** Includes starchy vegetables

na Data not available

Table 66: Energy and nutrients per day in healthy and current diets for reference household members

	Girl		Boy		Woman		Man	
	Healthy	Current	Healthy	Current	Healthy	Current	Healthy	Current
Energy MJ/day								
- target	6.7	7.3	13.0	14.2	8.9	9.7	11.3	12.5
- diet	6.7	7.3	13.0	14.2	8.9	9.7	11.3	12.5
% energy from fat								
- target								
- diet	na	33	20-35	35	20-35	34.5	20-35	34
	26	30	29	33	27	32	29	32
% energy from saturated fat								
- target	na	14	<10	14	<10	14	<10	13
- diet	7	13	7	14	6	12.5	7	12
% energy from carbohydrate								
- target	na	54	45-65	49	45-65	46	45-65	44
- diet	54	54	51	50	54	46	51	45
% energy from protein								
- target	na	13	15-25	16.5	15-25	17	15-25	17
- diet	20	15	20	16.5	19	17	19	18
Fibre g/day								
- target	18+	17	28+	21	25+	18	30+	23
- diet	32	23	54	35	42	27	50	30
Total sugars (free and natural) g/day								
- target	na	113	na	135	na	94	na	129
- diet	62	103	101	137	80	102	82	124
Sodium mg/day								
- target	<1400	na	<2300	3840*	<2300	2780*	<2300	3861*
- diet	1412	1920	2944	4075	1823	2575	2215	3534
% energy from alcohol								
- target	nr	nr	nr	nr	0	3.7	0	4.7
- diet						3.7		4.6

na = not available

nr = not recommended

* Ministry of Primary Industries report

6.2.6 Collecting prices

6.2.6.1 Compile a household shopping list

The foods consumed by each member of the household were combined. Foods were converted from an edible amount, as described in the menu, to the quantity required for purchase to allow for inedible parts (e.g., chicken bones) and yield during cooking (e.g., rice). For example, the edible portion of an avocado is 72% so to have 160g edible avocado, 220g of avocado is purchased.

All foods selected for each component of the food and diet approaches were compiled into one shopping list. For each item, the key nutrient, ingredient or product detail was specified on the shopping list to ensure a similar product was chosen. For selected items criteria were provided for a key nutrient to ensure the item priced was compatible. For example: sugar content of canned peaches (10-12g/100g); frozen fries straight cut with added sodium cooked in vegetable oil. Overall the sodium level in breakfast cereals and breads is similar between generic and branded labels so there was no need to distinguish items based on sodium level. An alternative branded item was provided in case the named brand was not available. If the package size was not available, the next closest size was selected. If there were a larger and a smaller size then the cheapest size available per unit weight was recorded.

The purpose of the research is to test the INFORMAS protocol for food prices. Therefore, a convenience sample of supermarkets was sufficient. The Health and Lifestyles Survey[107] found 44% of households use greengrocers (fresh produce stores). Fruit and vegetables were also priced at fresh produce stores to assess if the prices are different to supermarkets.

To ensure a wide range of available items, a supermarket representing each of the major chains (Countdown, PAK'n'SAVE, New World) was selected in the researcher's home city (Nelson). A neighbouring fruit and vegetable store was selected: Raeward Fresh (Richmond), Mean Greens (Nelson city), Benge & Co (Stoke). Each store was visited in person to seek permission.

The price of the three takeaway items (fish and chips, burger, pizza) was collected at the nearest outlet to each supermarket that sold the item (three prices for each item in total).

The sampling protocol was described in section 4.2.3. For each item, the price was collected for:

- the specified brand,
- a generic label (where available)
- cheapest price
- shelf price and discount price.

The price of each item was calculated per 100 edible grams. The mean price of each item was calculated from the three supermarkets, and separately from the three fresh produce stores. If an item was missing, the mean price was calculated from the other stores. If fruits or vegetables were sold by piece rather than by weight, three items were weighed using store scales and a mean weight calculated for that store.

The cost of the healthy and the current diet were calculated providing a point estimate for each diet. Therefore it is not possible to determine if the diets are statistically significantly different in cost.

6.2.6.2 Calculate the affordability of the diet

The methodology developed for the INFORMAS protocol recommends using the median household disposable income to compare affordability across countries. For NZ, two additional income scenarios were calculated for the reference INFORMAS household. These were based on common scenarios used in studies identified in the literature, and provide a measure of affordability for households receiving a lower income.

Scenario 1: Median disposable income for NZ sourced from the OECD website(328) for the working age population.

Scenario 2: Household receiving income support:

- Jobseeker Support(446)
- Accommodation Supplement(446)
- Family Tax Credit(447)

The maximum Accommodation Supplement available to a family of four receiving Jobseeker Support for area two was $125 per week(446). Area two was selected, as it was the second highest rate of the four areas.

Scenario 3: Minimum wage(429)

- 60 hours per week = one adult 40 hours + one adult 20 hours.
- Family Tax Credit calculated online using gross wages(447).

In NZ, in 2016, 78% of all workers were full-time and 85% of those in the age group of the adults in the reference household (40-50 years) were working(448). As many adults are in paid employment, it was decided to have one adult working full-time and one working part-time(449).

6.2.7 Scenarios

A range of scenarios were analysed to assess the effect of changing the type of price, the contents of the diet, the energy requirement, or GST on the cost of the diets. The term ‘standard diet’ refers to the originally constructed diet (Table 67) before the scenarios were included. The description and rationale of the scenarios are outlined in Tables 68 & 69 with additional information on the methods provided below.

Table 67: Description of standard diets

Description	Rationale
Cheapest price for item. Generic or branded labels included. Supermarket prices for fruit and vegetables. Discounts included. No alcohol or takeaways or discretionary food in healthy diet. Alcohol and takeaways in current diet. Energy calculated to maintain current BMI and physical activity level (current diet), and BMI of 23 for an active person (healthy diet)	59% of spending in NZ on discount items and generic labels increased in market share[450,451]. Alcohol and takeaways are currently consumed but are not required in a healthy diet.

6.2.7.1 Changing the price

There are a range of possible prices and brands that could be selected for each item. A range of scenarios were explored that alter an aspect of the price, and potentially the cost (Table 68).

Brand

There was a concern that the nutrient content of a generic label may differ from the branded counterpart for the items in the diet. Some of the common products were investigated in more detail, particularly those that may have added sodium or sugar. Products with only one ingredient (for example, rice) or if all brands of the item are less healthy (for example, cola) were not investigated. Nutrient information was sourced from the nutrition information panel.

The generic and branded products were similar in nutrient content for canned tomatoes, baked beans, canned tuna and canned peaches. It was important to state if the product had added salt, sugar or artificial sweetener. For breakfast cereals (wheat biscuits, cornflakes) and breads (white, wheatmeal, multigrain) the range of sodium levels in items was similar for generic and branded items so there was no need to distinguish items based on sodium. Overall there was little difference between generic and branded mueslis expect that generic mueslis had almost half the amount of sodium as branded mueslis. The amount of total and saturated fat, and sugar varied a lot between mueslis, both generic and branded.

Seasonal foods

The retail average prices for all but one of the fruits and vegetables in the diets is reported by Statistics NZ[385]. The average monthly price is reported and an estimate made of how the price compares relative to other months: cheap and stable, not quite as cheap, relatively expensive. A scenario was analysed excluding fruit and vegetables considered relatively expensive in February when the prices were collected: kiwifruit and mandarins. One fresh produce store did not stock kiwifruit because it was not in season.

Table 68: Scenarios of changing the price: Description and rationale

Scenario	Description	Rationale
No discount price	Cheapest price for item, generic or branded items included. Supermarket prices for fruit and vegetables. Discounts not included.	Usual available price reflects true change over time, rather than products on discount.
No generics (with discount)	Cheapest price for item, branded items only, no generic items. Supermarket prices for fruit and vegetables. Discounts included.	Some studies do not include generic labels. If selecting the cheapest price, this is often the generic product but may not reflect the most popular product.
No generics (no discount)	Cheapest price for item, branded items only, no generic items. Supermarket prices for fruit and vegetables. Discounts not included.	
Priced fruit and vegetables at fresh produce store	Fresh produce store prices for fresh fruit and vegetables.	Fresh produce stores are common outlets to purchase fresh fruit and vegetables in NZ[107].
Seasonal fruit only	Replaced non-seasonal fruit with seasonal fruit (all vegetables in season).	To investigate the impact of including non-seasonal produce on diet cost.
Policy Scenarios		
No GST fresh fruit and vegetables	GST removed from fresh fruit and vegetables in standard diet.	To simulate differential effect on healthy and current diets of removing GST.
No GST all fruit and vegetables (fresh, frozen, canned)	GST removed from all fruit and vegetables (fresh, canned, frozen) in standard diet.	
No GST core foods	GST removed from all core foods in standard diet.	

6.2.7.2 *Changing the foods in the diet*

There is a range of possible diets that meet the NZ Eating and Activity Guidelines, therefore a possible range of diet costs. Scenarios were explored that altered an aspect of the diet, and potentially the cost (Table 69).

Table 69: Scenarios of changing the diet: Description and rationale

Scenario	Description	Rationale
Healthy diet more vegetables & grains	Once the diet met targets for food groups based on dietary guidelines, more vegetables and grains were added, rather than all food groups, until energy targets were met.	There is a range of diets that meet NZ Eating and Activity Guidelines[395]. The two food groups for which the guidelines emphasis 'eat plenty' are vegetables and grains.

Scenario	Description	Rationale
Cheaper protein foods (meat and alternatives)	Both diets: the cheapest cut of meat and chicken, and type of fish was selected without compromising nutrition. Healthy diet: reduced amount of red meat and chicken and increased legumes.	Wide variation in cost of meat, chicken, seafood, legumes and nuts so the item selected could affect the cost of the diet. Healthy diet: includes a higher proportion of those options linked to a lower risk of chronic diseases (seafood, legumes, nuts)[395].
Discretionary foods in healthy diet	Added discretionary foods to healthy diet replacing 6% of energy, reduced amount of some foods. The food group targets for the healthy diet were met.	To make the diet more realistic.
No alcohol in current diet	Removed alcohol from current diet and replaced energy with other foods, no change in overall energy.	To compare to standard healthy diet with no alcohol.
Alcohol in healthy diet	A: Half the recommended maximum amount of alcohol for adult men and women[452] was added. B: Replaced energy in the healthy diet with alcohol at the same percentage energy from alcohol as current diet. Reduced amount of some foods so equivalent energy.	To make the diet more realistic, A healthy diet can include alcohol in safe amounts[452]. The amount of alcohol in both diets is below the maximum amount of alcohol recommended for adult men and women[452]. To compare to standard current diet with alcohol.
No takeaways in current diet	Removed takeaways from current diet and replaced energy with other foods. No change in overall energy.	To compare to standard healthy diet with no takeaways.
Takeaways in healthy diet	Replaced some foods in healthy diet with healthier takeaways, removed selected foods so equivalent energy.	To compare to standard current diet with takeaways.
Changing energy requirement		
Scenario 2: ASAP method	Energy calculated for a PAL of 1.4 for healthy diet, and based on current energy intake reported in NZANS.	Assess difference in cost when energy requirements calculated using differing rationales.
Scenario 3: Diets of equivalent energy	Calculated cost of both diets ($ per MJ) at 40 MJ per day.	Other studies comparing the cost of diets stratified by healthiness commonly standardised for energy.
Changing method: Prices for fewer foods	Fewer foods from each food group, most commonly consumed foods used as proxy for other foods in food group.	To reduce the time to collect prices

Legumes, eggs, nuts, seafood, poultry and meat group

The price of foods in this food group varies considerably per 100g and per serving, therefore the proportion of each food selected for the diet could alter the cost. For the healthy diet, the proportion of sub-groups from this food group was altered from the standard diet. The diet was not vegetarian and needed to include at least two servings from each sub-group per week. After two servings of red meat and chicken were added, additional legumes and fish were added. The energy and macronutrients are similar to the standard diet.

Alcohol

The standard healthy diet has no alcohol, while the standard current diet includes alcohol to meet the percentage of energy from alcohol currently consumed by adult men and women. Rather than revising the diets, the cost per MJ of the healthy diet without alcohol, and the current diet with alcohol was calculated. The energy level of the diets did not change. The calculations are described in the results section.

Takeaways

The standard current diet included takeaway foods as these are regularly consumed. Takeaways were added to the healthy diet for the same number of eating occasions as the current diet. Takeaways added were: roast chicken Subway, teriyaki chicken sushi, beef chow mein. Rather than revising the diets, the cost per MJ of the current diet without takeaways, and the healthy diet with takeaways, was calculated and is described in the results. The energy level of the diets did not change.

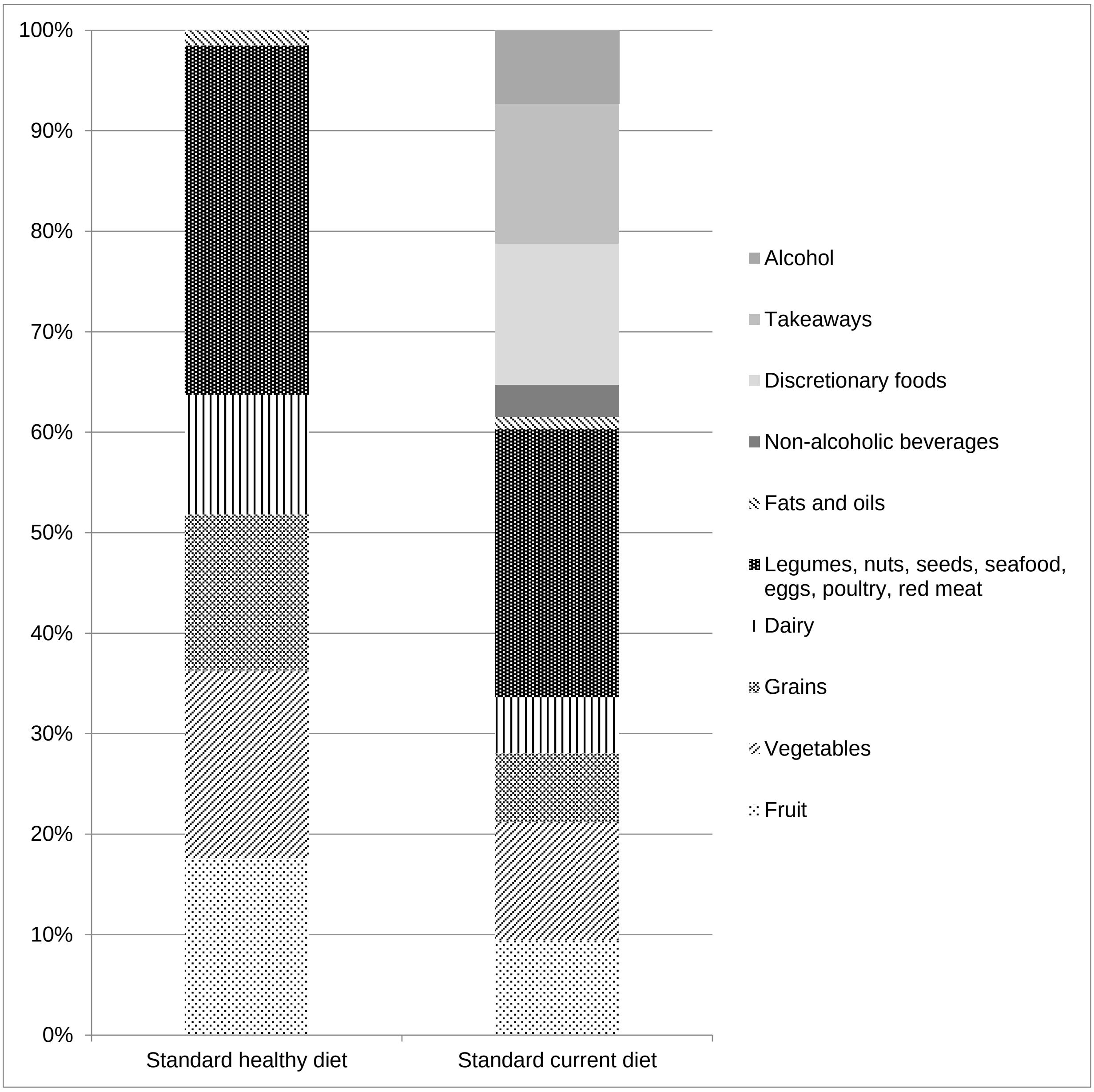
6.3 Results: NZ diet costs study

The cost of the diets was determined for a range of scenarios changing the type of price collected, the composition of the diet, the energy requirement or whether GST was removed off selected foods. One cost was determined for the standard healthy and the standard current diet and for each scenario. All diet costs are presented per fortnight for the reference household in NZ dollars. The scenarios are described in Table 68 and Table 69. The foods in the household diet are detailed in Appendix Six.

6.3.1 Standard diets

The cost of the standard healthy diet is similar in price to the standard current diet with a difference of $0.21 (Table 70). The food group of ‘legumes, nuts, seeds, seafood, eggs, poultry and red meat’ contributed the most to the cost of both diets at 34.8% of the healthy diet and 26.7% of the current diet (Figure 17, Table 74). Fruit and vegetables contribute a lot more to the cost of the healthy diet (36%) compared with the current diet (21%), as do grains and dairy. Two-fifths of the cost of the current diet is from less healthy (discretionary) foods and beverages. Alcohol and takeaways contribute one-fifth of the cost of the current diet.

Figure 17: Percentage of cost of standard healthy and current diets from food groups in NZ



6.3.2 Scenarios changing the type of price

The scenarios are variations of the standard diets (Table 67). Details of the price scenarios are described in Table 68. The cost of the price scenarios is reported in Table 70. A positive price difference indicates the less healthy diet is cheaper, and a negative price difference indicates the healthy diet is cheaper.

Table 70: Effect of changing the type of price collected on diet cost (per fortnight)

	Healthy diet	Current diet	Price difference (healthy – less healthy)	% Difference in price *
Standard cost Cheapest price - with discounts	$566.60	$566.39	+ $0.21	+ 0.04%
Cheapest price - no discounts	$581.96	$578.07	+ $3.88	+ 0. 7%
Branded items (no generics) - with discounts	$639.55	$674.72	- $35.17	- 5.5%
Branded items (no generics) - no discounts	$662.40	$692.51	- $30.11	- 4.6%
Fresh produce store for price of fresh fruit and vegetables	$539.65	$553.67	- $14.02	- 2.6%
Seasonal fruit only (supermarket price)	$557.11	$560.98	- $3.87	- 0.7%
Seasonal fruit only (fresh produce store price)	$532.43	$554.21	- $21.79	- 4.1%

* ($ healthy diet - $ current diet) / $ healthy diet

6.3.2.1 Price discount of food in retail stores

This analysis on discount prices excludes fruit and vegetables as prices fluctuate regularly according to season, supply and demand. PAK'nSAVE have multi-buys (e.g., three for $5) and everyday low prices (usual price) rather than regular discounts, so are not included in the analysis. One-quarter of the commonly consumed foods were on discount (Table 71) with the average discount price 83% of the usual price for branded items and 88% for generic items. Fewer generic items (one-fifth) were discounted, possibly because these items are already relatively low in price.

Table 71: Number of items in shopping lists with discounts

	New World supermarket (Nelson)	Countdown supermarket (Nelson)
Number of items on discount (total number of items)	26 branded (95) 11 generic (54)	27 branded (95) 8 generic (46)
Average % discount on item (range)	85% (67-99%)	84% (57-96%)

Collecting the discount price rather than the shelf price reduces the cost of each diet, particularly for the healthy diet and when branded items only are selected (Table 81). The cost of a healthy and current diet was similar when discount prices were included (standard diet). The healthy diet cost 0.7% more than the current diet when the shelf price was selected (Table 70). There is no clear reason as to why the selection of discount or shelf price affects the cost of the healthy diet more than the current diet.

6.3.2.2 Generic labels

The generic items cost, on average, two-thirds of the price of the common branded item (Table 72). Almost two-thirds of the packaged items had a generic counterpart. Most generic products were cheaper than the branded item (common brand stated on shopping list). The number of packaged items only included those with a Nutrition Information Panel so excluded butchery and bakery items packaged in-store, fresh fruit vegetables, meat, fish as well as alcohol.

Table 72: Generic items in shopping lists: number, price difference from common brand

	Nelson supermarkets		
	New World	**Countdown**	**PAK'n'SAVE**
% and number of packaged products on shopping list that have a generic label	67% 54	57% 46	69% 54
% generic items cheaper than branded equivalent	93%	91%	91%
Price difference between generic item and the equivalent branded item (both discount price) (generic/common brand) Mean Range	 65% 32-113%	 67% 34-122%	 NA
Price difference between generic item and the equivalent branded item (no discount price) (generic/common brand) Mean Range	 63% 29-96%	 65% 34-109%	 69% 27-114%

Recording the price of a generic product made a considerable difference to the cost of the diet. For the current diet, over $108 per fortnight is saved when generic labels are selected. For the healthy diet, over $72.95 is saved (Table 81). If only the price of branded items was recorded (no generic items) and discount items excluded, the healthy diet is 4.6% cheaper than the current diet, or 5.5% cheaper if discounts are included (Table 70). The current diet contains more packaged items than the healthy diet, therefore contain more generic items.

6.3.2.3 Fruit and vegetables

Fresh produce stores

Prices of the eight fresh fruits and sixteen fresh vegetables in the diets were collected from three supermarkets, and the nearest fresh produce store to each supermarket. The mean price was calculated separately for supermarkets and for produce stores. Overall produce is 13% cheaper at a fresh produce store than the supermarkets (per 100g), 10% cheaper for fruit and 14% cheaper for vegetables. Purchasing fresh fruit and vegetables from a fresh produce store rather than the supermarkets (standard diet) saves more in the healthy diet ($26.95) than the current diet ($12.72) as there are more fresh fruit and vegetables in the healthy diet (Table 81). The healthy diet is cheaper than the current diet by 2.6% (Table 70).

Seasonal fruit and vegetables

All vegetables in the diets were in season. Mandarins and kiwifruit were not in season during the collection period so were more expensive than usual. The cost of the diets with only seasonal produce was calculated[385]. Mandarins and kiwifruit were replaced with seasonal fruits in the diets. Mandarins replaced oranges, as these are a similar type of fruit. Two-thirds of the kiwifruit was replaced by apples, and one-third by pears, as consumption of apples was higher than pears. The energy content of the fruits was similar.

When out-of-season fruits were replaced with seasonal fruit, the current diet becomes cheaper by $5.41 and the healthy diet cheaper by $9.50 compared to the respective standard diets (Table 81). The healthy diet becomes slightly cheaper than the current diet using supermarket prices (0.7%) and becomes 4.1% cheaper than the current diet using fresh produce store prices (Table 70).

6.3.3 Policy scenarios

6.3.3.1 The effect of removing GST off selected foods

There is GST of 15% on all foods and beverages in NZ[65]. Removing GST from the price of fruits and vegetables, or from the price of core foods reduces the cost of the healthy diet more than the current diet, as there are more fruit and vegetables and core foods in the healthy diet (Table 73). For all GST scenarios, the healthy diet is cheaper than the current diet.

6.3.4 Scenarios changing the diet composition

Changes to the amount or type of foods in the diets were tested with a variety of scenarios. The current diet is constrained by the quantities of common foods consumed and to meet the macronutrient ratios reported in the NZ Adult Nutrition Survey, therefore not all scenarios were conducted for the current diet. The scenarios tested are described in Table 69. The results are reported in Table 73. The energy content of all the diets remained the same as the standard diet.

Table 73: Effect on diet costs when changing aspects of the diet or when removing GST off price of selected foods (per fortnight)

	Healthy Diet	Current Diet	Price difference (healthy diet – current diet)	% Difference in cost between diets*
Standard diets	$566.60	$566.39	- $0.21	- 0.04%
Healthy: Changed food groups (more vegetables, grains)	$578.18	$566.39	+ $11.79	+ 2.0%
Both diets: Cheaper protein foods	$513.02	$533.27	+ $20.25	+ 4.0%
Healthy: Discretionary foods replaced 6% of energy	$569.37	$566.39	- $2.98	- 0.5%
Both diets: No alcohol	$566.60	$537.59	- $29.02	- 5.1%
Both diets: Alcohol included (Scenario 1)	$587.07	$566.39	- $20.68	- 3.5%
Both diets: Alcohol included (Scenario 2)	$590.81	$566.39	- $24.42	- 4.1%
Both diets: No takeaways	$566.60	$533.27	- $33.33	- 5.9%
Both diets: Takeaways included	$671.08	$566.39	- $104.69	- 15.6%
Fewer items priced in diet	$567.26	$527.17	- $40.09	- 7.1%
GST scenarios				
No GST all fruit and vegetables (fresh, frozen, canned)	$540.25	$550.71	- $10.46	- 2.0%
No GST fresh fruit and vegetables	$541.78	$552.53	- $10.75	- 2.0%
No GST core foods	$492.72	$520.95	- $28.23	- 5.7%

* ($ healthy diet - $ current diet) / $ healthy diet

6.3.4.1 Changing food group proportions in the healthy diet

Once the minimum food group recommendations were met when developing the healthy diets, additional items were added from each food group until the individual energy requirement was met. An alternative way of developing the healthy diet was to add more servings of vegetables (3-5 per week) and grains (5-6 per week) to increase the energy intake once all the recommended serving sizes were met. The NZ Eating and Activity Guidelines[395] emphasise eating plenty of vegetables and fruits but only some meats and alternatives and dairy. The revised diets had fewer servings of dairy than the standard diet, though the recommended servings were met. The diet of the girl was not changed as the lower energy level meant that once the minimum food group recommendations were met the energy level was met.

The cost of the modified diet is $11.58 more than the standard healthy diet with an increase of $10.42 spent on vegetables, $5.70 on grains and a reduction of $4.21 spent on dairy (Table 74). The price difference between this revised healthy diet and the current diet is $11.79 (2.0%) (Table 73).

Table 74: Proportion spent on food groups for healthy diet scenarios (per fortnight)

	Standard healthy diet		**Healthy diet with more vegetables & grains**		**Healthy diet with discretionary foods**		**Healthy diet with fewer foods priced**		**Current standard diet**	
	Cost	% Cost	Cost	% Cost	Cost	% Cost	Cost	% Cost	Cost	% Cost
Fruit	$99.81	17.6%	$99.81	17.3%	$94.50	16.6%	$97.42	17.1%	$53.73	9.5%
Vegetables	$105.98	18.7%	$116.40	20.1%	$99.00	17.4%	$89.21	15.7%	$66.55	11.7%
Grains	$87.58	15.5%	$93.28	16.1%	$86.17	15.1%	$90.24	15.9%	$38.61	6.8%
Dairy	$67.48	11.9%	$63.27	10.9%	$65.55	11.5%	$70.94	12.5%	$31.67	5.6%
Legumes, nuts, seeds, seafood, eggs, poultry, red meat	$197.46	34.8%	$198.54	34.3%	$186.72	32.8%	$207.35	36.6%	$150.94	26.7%
Fats, oils	$8.29	1.5%	$6.88	1.2%	$8.14	1.4%	$12.10	2.1%	$7.00	1.2%
Discretionary					$29.28	5.1%			$217.89	38.5%
Total	$566.60	100%	$578.18	100%	$569.37	100%	$567.26	100%	$566.39	100%

6.3.4.2 Legumes, nuts, seeds, seafood, eggs, poultry and red meat

There is a wide variation in the cost per edible portion of foods in the 'legumes, nuts, seeds, seafood, eggs, poultry and red meat' group. The standard healthy and current diets were altered using cheaper items for each type of food. The same number of overall servings from this food group was retained. For example, some baked beans were replaced by lentils, almonds by peanuts and blade steak and rump steak replaced beef mince. The energy and macronutrients were similar to the standard diet. This food group contributes more to the overall cost than other food groups. Selecting cheaper versions of these items reduces the cost of the healthy diet more than the current diet, with the healthy diet becoming 4.0% cheaper than the current diet (Table 73).

This food group cost $197.46 per fortnight in the standard healthy diet and $143.87 in the revised diet (Table 75), decreasing in cost by 27%. The revised diet had less chicken and meat, and more fish and legumes. This food group cost $150.94 in the standard current diet per fortnight and $117.82 in the revised diet (Table 76), decreasing in cost by 23%. Processed meat was not included in the calculation as it was classified as less healthy.

Table 75: Number of servings and cost of revised healthy diet with cheaper protein foods (per fortnight)

Item (serving size)	Number of servings in standard healthy diet	Number of servings in revised healthy diet	Cost of standard healthy diet	Cost of revised healthy diet
Chicken (100g)	17.4	16	$33.23	$27.01
Red meat (100g)	25.6	16	$63.04	$31.67
Fish (100g)	17.4	22	$30.95	$33.88
Legumes (135g)	31.6	38	$35.67	$27.89
Eggs (55g)	30.7	24	$10.07	$7.92
Nuts (50g)	30	31	$24.49	$15.50
Total	152	147	$197.46	$143.87

Table 76: Servings, cost of standard and revised current diet with cheaper protein foods (per fortnight)

Item (serving size)	Number of servings (standard & revised diets)	Cost of standard healthy diet	Cost of revised healthy diet
Chicken (100g)	25.1	$48.73	$42.17
Red meat (100g)	36.5	$70.92	$49.28
Fish (100g)	10.9	$19.66	$16.79
Legumes (135g)	7.6	$2.54	$2.55
Eggs (55g)	17.2	$5.62	$5.67
Nuts (50g)	2.4	$3.45	$1.36
Total	99.7	$150.94	$117.82

6.3.4.3 Adding discretionary foods to the healthy diet

The energy level of the standard healthy diet requires more servings from the food groups than the minimum number of servings recommended by the NZ Eating and Activity Guidelines[395]. Therefore, a diet was developed with some of the additional energy requirement from discretionary foods and beverages, instead of the core food groups. The cost is only $2.77 more than the standard diet per fortnight (Table 81). Only a small number of discretionary foods were required to substitute 6% of energy (ice-cream, biscuits, instant noodles, juice, wine, beer, hot chips, muesli bar). Foods from all food groups were reduced in amount rather than a food completely removed. Consequently, the percentage spent on each food group (except fats and oils) reduced to incorporate the extra spending on discretionary foods (5.1% of cost).

The revised diet is slightly lower in fibre and percentage of energy from carbohydrates, slightly higher in percentage of energy from fats and the addition of alcohol provided energy. The amount of sugar and sodium is similar to the standard diet.

6.3.4.4 Inclusion or exclusion of alcohol in diets

Alcohol removed from standard current diet

Alcohol was removed from the standard current diet and the equivalent amount of energy was replaced with an increase in the amount of existing items. The modified current diet cost $28.81 less than the standard current diet which contained alcohol, and is cheaper than the standard healthy diet by 5.1% (Table 81).

Alcohol = 7.3% of cost of diet, 1039kJ per day, $41.67 per fortnight

Cost per MJ diet with food only, no alcohol = $0.88 per MJ

Cost per MJ diet with food and alcohol = $0.93 per MJ

Add 1039kJ back to diet at $0.88 per MJ x 14 days

Cost when alcohol removed from diet = $524.78 ($566.39 - $41.61)

+ $12.81 (replace energy from alcohol, 1039kJ * $0.88 x 14)

= $537.59

Alcohol in healthy diet

Scenario 1: Half maximum recommended amount

Half of the maximum amount of alcohol recommended by the Health Promotion Agency[452] was added to the diet for adults. This is ten standard drinks of wine (100ml) and fifteen standard drinks of beer (330ml) per fortnight for adults (1L wine, 4.95L beer).

Alcohol = 0.79MJ per day, $31.68 per fortnight

Energy of food component of scenario: 39.9MJ - 0.79MJ = 39.11MJ

Cost of food component of diet at 39.11MJ @ $1.01 per MJ = $555.40 per fortnight

Cost of 0.79MJ alcohol = $31.68 per fortnight

= $587.08

Scenario 2: Healthy diet has same percentage of alcohol as current diet

Alcohol was added to the healthy diet to reach the same percentage energy from alcohol as the current diet. This is below the maximum amount of alcohol recommended by the Health Promotion Agency(452). The amount added was 1.6L wine and 5.05L beer.

Alcohol = 0.95MJ per day, $37.77 per fortnight,

Energy of food component of scenario: 39.9 - 0.95MJ	= 38.95MJ
Cost of food component of diet for 38.95MJ @ $1.01 per day	= $553.04 per fortnight
Cost of alcohol 0.95MJ	= $37.77
	= $590.81

Alcohol is a more expensive component of the diet so removing or adding alcohol, while keeping energy constant through replacement or removal of other foods, changes the cost. The healthy standard diet (no alcohol) is a similar price to the current standard diet (with alcohol), but more expensive if both diets had alcohol (3.5% or 4.1%), or did not have alcohol (5.1%) (Table 73).

The current diet contains 1.875L wine and 5.290L beer per fortnight.

6.3.4.5 Inclusion or exclusion of takeaways in diets

No takeaways in current diet

Takeaways = $78.65 per fortnight and 3.72MJ per day
Cost of diet $0.93 per MJ with takeaways
Cost of diet $0.87 per MJ no takeaways: 43.6MJ * $0.8736 x 14 = $533.27

Takeaways are a more expensive component of the diet so replacing takeaways with other foods reduces the cost by 5.9% (Table 73) and the current diet was 5.9% cheaper than the healthy diet (Table 81).

Healthy diet with takeaways

Healthier takeaways (Table 77) were added to the healthy diet replacing the equivalent amount of energy. There were eighteen meal occasions of takeaways in the household current diet per fortnight, so this number of meal occasions was added to the healthy diet. The cost per MJ of the healthy diet without takeaways was calculated and the cost of the takeaways added.

Takeaways = $143.16 per fortnight and 2.72MJ per day
Energy of non-takeaway component of diet: 39.9MJ – 2.72MJ = 37.18MJ
Cost of non-takeaway component of diet for 37.18MJ * $1.01 per MJ = $527.93 per fortnight
Cost of 2.72MJ takeaways per day = $143.16 per fortnight
Total = $671.08 per fortnight

Adding takeaways to the healthy diet increased the cost considerably by $104.48 (Table 81) and the healthy diet cost $104.69 more than the current diet (15.6%) (Table 73).

Table 77: Takeaways in diets (per fortnight)

Revised healthy diet	**Standard current diet**
2892g Subway rolls 1276g sushi 2316g chow mein 6484g Total per fortnight	840g burger 1040g chips 620g battered fish 1230g mince pie 1240g pizza 4970g Total per fortnight
2.72MJ per day	3.72MJ per day

6.3.5 Changing the energy intakes of the reference household

Three scenarios of energy requirements were outlined in section 6.2.2. The cost of an isocaloric diet of 40MJ was calculated using the cost per MJ for the standard diets: $1.01 per MJ for the standard healthy diet, $0.93 per MJ for the standard current diet.

The healthy and current diets are a similar cost when the energy requirements are determined using the recommended or current BMI and PAL. The healthy diet is more expensive than the current diet when the diets are isocaloric by 8.5% (Table 78). The healthy diet is cheaper than the current diet by 8.7% when the energy requirements are determined using the ASAP method, i.e. recommended energy requirements for a foundation diet, or reported energy intake.

Table 78: Cost of diets for different scenarios of household energy intakes (per fortnight)

Scenarios	**Household energy per day**	**Calculation**	**Healthy diet**	**Current diet**	**Price difference (healthy diet – current diet)**	**% Difference in cost between diets***
Scenario 1: Standard diet: recommended or current PAL & BMI	39.9 MJ healthy 43.6 MJ current		$566.60	$566.39	+ $0.21	+ 0.03%

Scenario 2: ASAP method	31.4MJ healthy 37.3 MJ current	31.4 MJ x $1.0143 x 14 37.3 MJ x $0.928 x 14	$445.90	$484.55	- $38.65	- 8.7%
Scenario 3: Isocaloric diets calculated cost per MJ	40MJ	40 MJ x $1.0143 x 14 40 MJ x $0.928 x 14	$568.02	$519.62	+ $48.40	+ 8.5%

* ($ healthy diet - $ current diet) / $ healthy diet

6.3.6 Adding alcohol, takeaways and energy to the healthy diet

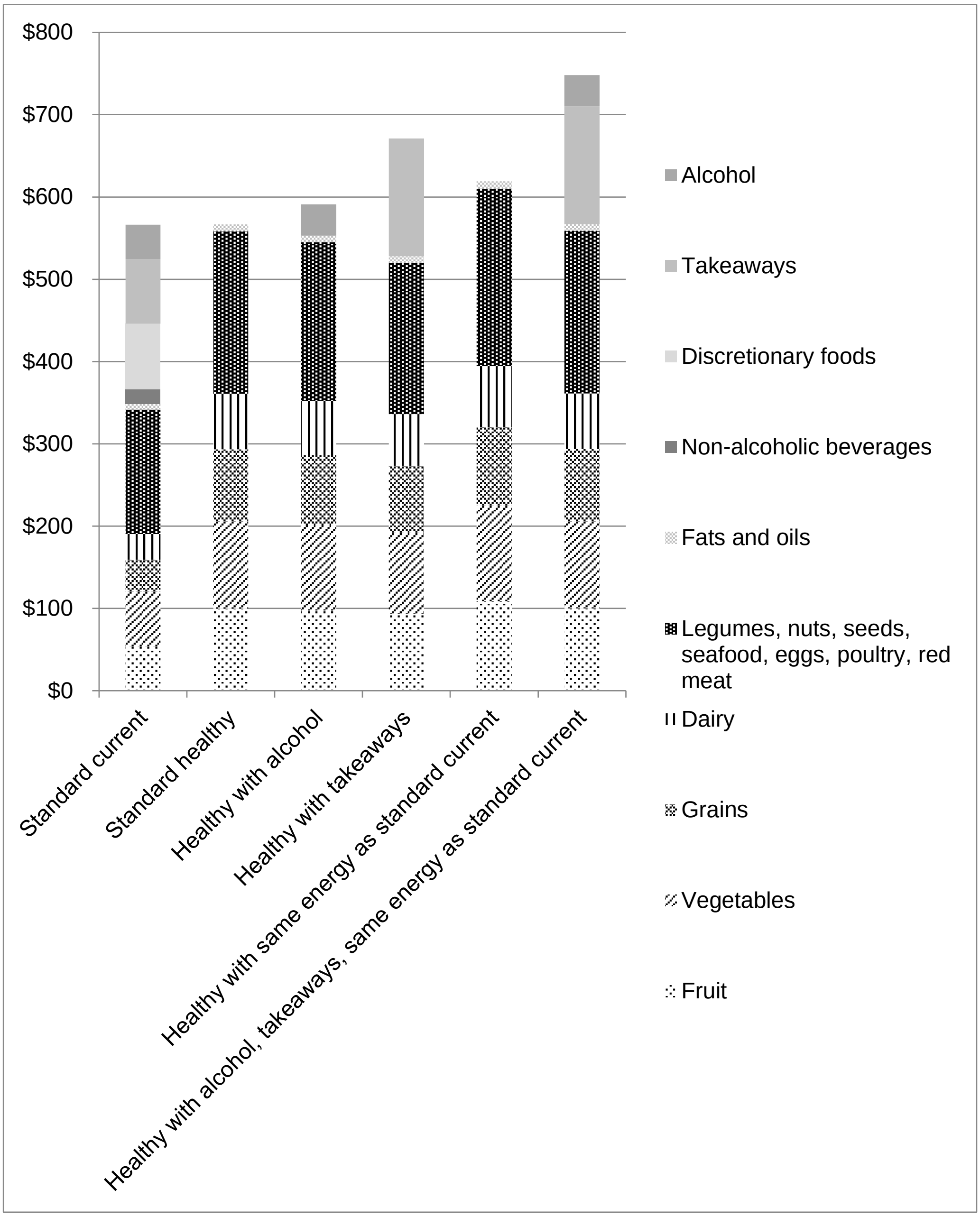
The standard current diet includes alcohol and takeaways, and is higher in energy than the standard healthy diet that has no alcohol or takeaways. The standard diets are similar in price. However, if the diets are equal in energy, have the same percentage of energy from alcohol and have the same number of meals with takeaways, the healthy diet costs considerably more (Table 79, Figure 18). The methodology for the individual scenarios described previously was used to replace some of the energy with alcohol or takeaways for the healthy diet, or calculate isocaloric diets using the cost per MJ.

Table 79: Replacing some energy with alcohol and/or takeaways, and adding energy to the standard diet (cost per fortnight)

Changes to healthy diet	Healthy diet	Current diet	Price difference (healthy diet – current diet)	% Difference in cost between diets*
Standard diet	$566.60	$566.39	+ $0.21	+ 0.04%
Replacing some energy with alcohol	$590.81	$566.39	+ $24.42	+ 4.1%
Replacing some energy with takeaways	$671.08	$566.39	+ $104.69	+ 15.6%
Replacing some energy with alcohol and takeaways	$695.41	$566.39	+ $129.027	+ 18.6%
Adding energy (total 43.6MJ per day)	$619.14	$566.39	+ $52.75	+ 8.5%
Replacing some energy with alcohol and takeaways, adding energy (total 43.6MJ per day)	$747.95	$566.39	+ $181.56	+ 24.3%

* ($ healthy diet - $ current diet) / $ healthy diet

Figure 18: Replacing some energy with alcohol and/or takeaways and adding energy to the standard diet (cost per fortnight)



6.3.7 Cost of diets with fewer foods priced

If there are fewer foods in the diet, the time and cost of data collection would be reduced. The foods consumed in the NZANS by the most people, and in the highest amount in the food group, were retained and acted as proxies for the other commonly consumed foods. For example: apples, bananas and oranges replaced other fruits. For the 'legumes, nuts, seeds, seafood, eggs, poultry and red meat' group, at least one type of each item was retained.

The number of foods was reduced from 68 to 39 in the healthy diet across all food groups (Appendix Seven). The only differences to the standard diet are slightly more servings per fortnight of grains (mean four per person) and vegetables (two per person), and less servings of dairy (two per person).

The number of foods was reduced in the current diet from 104 to 57 (Appendix Seven). Some discretionary foods were replaced by similar foods in the same food group. If regular and lower fat or sugar items were both used in the standard current diet, only the regular item was included in the diet with fewer foods, for example, regular milk, regular cola, Colby cheese. As some of the items replaced items lower in energy, the food group ratios were slightly altered with more grains (average 2 servings per person) in the standard diet.

The healthy diet with fewer foods is almost the same price as the standard healthy diet ($0.65 difference) (Table 81). In the diet with fewer foods, vegetables contribute $16.77 less to the total cost while meat and alternatives and fats/oils contribute $9.89/ $3.81 more respectively, with little change in the other food groups (Table 74). The current diet with fewer foods decreases in cost by $39.23 per fortnight (Table 81). The spending on total core foods is less ($44.66) while spending on discretionary foods is slightly more ($7.63) (Table 80). For both diets, pricing fewer types of fruits and vegetables reduces the overall cost of these, as the most common fruits and vegetables are also cheaper. The healthy diet became 7.1% more expensive than the current diet (Table 73).

Table 80: Cost of current diet and food groups with fewer foods priced (per fortnight)

Food Group	**Standard current diet**		**Current diet with fewer foods priced**	
	Cost	**% Cost**	**Cost**	**% Cost**
Fruit	$53.73	9.5%	$46.48	8.8%
Vegetables	$66.55	11.7%	$53.75	10.2%
Grains	$38.61	6.8%	$34.79	6.6%
Dairy	$31.67	5.6%	$33.64	6.4%
Legumes, nuts, seeds, seafood, eggs, poultry, red meat	$150.94	26.7%	$127.62	24.2%
Fats, oils	$7.00	1.2%	$5.37	1.0%
Total core	***$348.50***	***61.5%***	**$301.65**	**57%**
Non-alcoholic beverages	$18.02	3.2%	$17.30	3.3%
Snacks, sweets	$42.96	7.6%	$52.59	10.0%
Processed meats	$24.37	4.3%	$22.87	4.3%
Sauces, spreads, butter	$12.27	2.2%	$11.90	2.3%
Takeaways	$78.66	13.9%	$79.25	15.0%
Alcohol	$41.61	7.3%	$41.61	7.9%
Total less healthy	***$217.89***	***38.5%***	**$225.52**	**43%**
Total	**$566.39**		**$527.17**	
Number of foods	104		57	

6.3.8 Summary of scenarios: Effect on diet cost

The results are summarised in Tables 70, 73 and 81. The price of the diets changes considerably when generic items are not included in either diet, when takeaways are added to the healthy diet, and when cheaper forms of foods in the meat and alternatives group are selected in the healthy diet.

The price of either diet changes moderately when fresh fruit and vegetables are priced at a fresh produce store, when alcohol is added or removed, and for the current diet when takeaways are removed, cheaper forms of meat and alternatives selected or there are fewer foods in the diet.

The change to the cost of either diet is small when the discount price is selected or only seasonal fruit is selected. The change to the cost of the healthy diet is small when discretionary foods are added, when the proportion of food groups in the diet changes (more vegetables and grains) and when fewer foods are in the diet.

Adding takeaways to the standard healthy diet increases the cost more than removing takeaways from the standard current diet reduces the cost. The current diet increases in cost proportionally more than the healthy diet when generic items are not included as there are more packaged products offering a generic alternative in the current diet.

Removing GST off core foods reduces the cost of the diet considerably, particularly the healthy diet. The scenarios that change the price of fruit and vegetables affect the healthy diet more as there are more fruit and vegetables. Selecting cheaper versions of meat and alternatives reduces the cost of the healthy diet to a greater extent because some cheaper items like legumes replace more expensive red meat and chicken. Having fewer foods in the diet reduces the cost of the current diet but does not change the cost of the healthy diet.

The current diet is cheaper than the healthy diet when the diets are isocaloric, but more expensive, or a similar price, when individual energy requirements are considered by two differing methods. The standard healthy and current diets are similar in cost, but when equal in terms of whether alcohol and/or takeaways are included or excluded, then the current diet is cheaper.

Table 81: Effect of changing aspects of the diet or prices on cost of healthy and current diets (per fortnight)

Scenario	**Change in cost compared to standard diet**			
	Healthy diet		Current diet	
	Cost ($)	%	Cost ($)	%
No discount price	+ $15.35	+ 2.7%	+ $11.68	+ 2.1%
No discount price on diet with branded items only (no generics)	+ $22.84	+ 3.5%	+ $17.79	+ 2.6%
No generics (with discount)	+ $72.95	+ 12.9%	+ $108.33	+ 19.1%
Fruit & vegetables priced at fresh produce store	- $26.95	- 4.8%	- $12.72	- 2.2%
Seasonal fruit (purchased at supermarket)	- $9.50	- 1.7%	- $5.41	- 1.0%
Healthy diet with higher proportion vegetables and grains	+ $11.58	+ 2.0%	NA	NA
Cheaper protein foods, replaced some meat and chicken with legumes in healthy diet	- $53.58	- 9.5%	- $33.12	- 5.9%
6% energy from discretionary foods in healthy diet	+ $2.77	+ 0.5%	NA	NA
Removed alcohol from current diet (replaced with other foods)	NA	NA	- $33.12	- 5.1%
Replaced some foods with alcohol in healthy diet	+ $24.21	+ 4.3%	NA	NA
Removed takeaways from current diet (replaced with other foods)	NA	NA	-$28.81	-5.9%
Replaced some foods with takeaways in healthy diet	+ 104.48	+ 18.4%	NA	NA
Priced fewer foods in diet	+ $0.65	+ 0.1%	- $39.23	- 6.9%
No GST all fruit and vegetables	- $26.35	- 4.7%	- $15.68	- 2.8%
No GST core foods	- $73.89	-13.0%	- $45.44	- 8.0%

NA: Not applicable

6.3.9 Affordability of the current and healthy diets

The methodology developed for the draft INFORMAS protocol suggests using the median household disposable income to compare affordability across countries. Two additional income scenarios were calculated for the reference INFORMAS household of 2 adults and 2 children using the rates of income support and the minimum wage effective during the time of price collection.

6.3.9.1 Median household disposable income

The annual median disposable income for the working age population (18-65 years) for NZ was $41, 881 in 2012, which was the most recent data available[(328)]. The equivalised income (multiplied by 2 which is the square root of a household of 4) was $83,762.

6.3.9.2 Household receiving income support

Income per week after tax

Jobseeker support	$350.20
Accommodation supplement	$125.00
Family tax credit	$157.00
Total	**$632.20**

6.3.9.3 Minimum wage

The minimum wage on April 2016 was $15.25[(429)]. The household received a family tax credit of $167.00 per week but did not qualify for Accommodation Supplement, as income was above the threshold.

Income per week after tax

20 hours (1 adult)	$270.47
40 hours (1 adult)	$522.10
Family tax credit	$167.00
Total	**$959.57**

The percentage of income required for both diets is 44.8% for a household receiving income support (Table 82), 29.5% for a household receiving the minimum wage, and 17.6% for a household receiving the median household income.

Table 82: Household affordability of diets for income scenarios (per fortnight)

	Diet	Income support	Minimum wage	Median income	Diet cost
Total fortnightly income		$1264.40	$1919.14	$3221.62	
Percentage of household income required to purchase diet Cheapest price	Healthy	44.8%	29.5%	17.6%	$566.60
	Current	44.8%	29.5%	17.6%	$566.39
Percentage of household income required to purchase diet No GST all fruit and vegetables	Healthy	42.7%	28.2%	16.8%	$540.25
	Current	43.6%	28.7%	17.1%	$550.71
Percentage of household income required to purchase diet No GST core foods	Healthy	39.0%	25.7%	15.3%	$492.72
	Current	41.2%	27.1%	16.2%	$520.95

Household affordability = cost of diet/household income for one week

If GST is removed from core foods, the percentage of income required to purchase the diet for a household receiving income support would reduce more for the healthy diet (44.8% to 39.0%) than the current diet (44.8% to 41.2%) (Table 82). For households on a minimum wage, affordability would improve from 29.5% to 25.7% for the healthy diet and from 29.5% to 27.1% for the current diet.

6.4 Discussion: Diet approach

6.4.1 Cost and affordability of diets in NZ

In NZ, a standard healthy diet is a similar cost to the standard current diet. The standard diets include generic labels and discount prices with all items priced at a supermarket. The price selected for an item changes the cost of the diets, particularly if generic items are excluded. Alcohol and takeaways are included in the current diet, but not the healthy diet. When the diets are equal in terms of energy, amount of alcohol and number of takeaway meals the healthy diet costs considerably more than the current diet.

In NZ, takeaway foods and alcohol (for adults) are commonly consumed with alcohol contributing 4.7% and 3.7% of energy of the adult male and female diet respectively[397]. Alcohol and takeaways are expensive components of the diet so if these are either included or excluded in both diets, the healthy diet is considerably more expensive, when replacing some energy from other foods. Replacing six percent of the energy in the healthy diet with discretionary foods is a similar cost to the standard diet.

The current diet of many New Zealanders does not meet the Eating and Activity guidelines, being too low in fruit and vegetables and too high in saturated fat[397] and sodium[442]. There is a high prevalence of overweight and obesity in NZ[453]. Therefore, it is important to move from the current, less healthy diet to a healthier diet to improve health.

Affordability is similar for the healthy and current standard diets, as the diet cost is similar. The Household Expenditure Survey reports 18.8% of household expenditure is on food and non-alcoholic beverages, including food purchased away from home[150]. This is similar to this study where 17% of income is required to purchase either diet for a household receiving the median household income. Households receiving income support or the minimum wage would need to spend a higher proportion of their income on food (45%, 30% respectively).

6.4.2 Policy scenarios

The diets can be used to model the effect of potential changes in taxes and subsidies on both healthy and current diets. As price is a major influence on purchasing foods[21,22,107], reducing the cost of healthy food or increasing the cost of unhealthy foods may improve diet choice. In NZ, all foods have 15% GST added[65]. Basic healthy foods in Australia do not have GST added[126]. If GST were removed from basic healthy foods in NZ, the cost of the healthy diet would decrease more (13%) than the current diet (8%). Affordability of NZ diets for a household earning the median income would fall within the lower end of the range of affordability for the respective diets in Australia (NZ 15% healthy, 16% current). The impact would be most beneficial for a household receiving income support for the healthy diet, with affordability improving by 6%. If GST was removed from all fruit and vegetables, the cost of the healthy diet would reduce by 4.7% and the current diet by 2.7%. This would improve affordability more for the healthy diet than the current diet. If a proposed change to add GST to all foods in Australia was implemented, the cost of the Australian healthy diet would increase more than twice as much as the cost of the Australian current diet[241].

If the sugar sweetened beverages in the current diet were taxed at $0.50 per litre, as estimated in modelling in NZ[454], this would add $6.02 per fortnight to the current diet making it 1% more expensive than the healthy diet.

6.4.3 Feasibility of implementing the methodology in NZ

The NZ diet costs study followed the methodology developed for this research (described in section 6.2 with details in Appendix One) based on the INFORMAS foundation paper for food prices[19] for situations where recent detailed national dietary surveys and quantitative food-based dietary recommendations are not available. An Australian INFORMAS research group had this data available and tested methodology for a standardised diet pricing tool of a healthy and current diet in Australia[241]. Preliminary work by the researcher in Fiji to implement the protocol was discontinued, however the work provided valuable insights to understanding a food environment in a middle-income country. The limitations and strengths of the research are discussed in chapter 7.

The format and guidelines of food-based dietary guidelines can differ between countries[317]. The NZ food-based dietary guidelines have a range of serving sizes for the fruit, vegetable and grains groups[395], while the Australian guidelines provide one standard serving size for each food group[2]. A mean serving size was calculated in NZ for grains, fruits and vegetables to streamline calculation of servings from food groups. For countries that do not have food-based dietary guidelines, or lack quantitative recommendations, some dietary principles based on WHO recommendations are provided in the INFORMAS protocol. If this is not available, it is suggested that the diet has at least 400g fruit and non-starchy vegetables, and meets the recommended ratios of macronutrients from the country's nutrient reference values or the dietary principles.

The healthy diet developed in this research and the Australian healthy ASAP diet meet the Recommended Dietary Intakes or Adequate Intakes, except for iodine in NZ. The upper limit for sodium is 2300mg(11), however the healthy diet of the 14-year boy is higher than this due to a higher energy intake. The upper limit is lower for the 7-year girl at 1400mg with a similar amount in the healthy diet (1412mg). Other food baskets have more sodium than recommended(55,88,263,325).

The nature of nutrition survey data influences the feasibility of selecting a diet that reflects the current diet for the members of the reference household. The 2008/09 NZANS micro-data(388) is available at a level of disaggregation to allow identification of the grams of foods and sub-groups consumed, though it was time-consuming to analyse the data. The groups are not completely aligned to the food groups used in the Eating and Activity Guidelines(395) (vegetables, fruits, grains, dairy, legumes etc) as some of the survey food groups contain a mix of the items. For example, bread-based dishes include sandwiches, burgers and pizza which contain foods from a range of food groups. The dietary habits questionnaire from the NZANS(397) provides useful information on dietary habits, for example half the population usually chose reduced-fat milk.

This research uses a national nutrition survey to identify the current intake of three members of the reference household. The 2002 Children's Nutrition Survey(440) was used to match the nutrient content of the current diet for the 7-year girl, as this was the only information available. Dietary patterns and commonly consumed foods for the 7-year girl were from a 2007 national food frequency questionnaire(389) to provide more recent information. Most of the commonly consumed foods were the same as those identified for the other members of the household. There was no quantitative information to guide menu development. Therefore, the menu is based on the household menu adapted to fit with the commonly consumed foods identified in the food frequency questionnaire and to meet energy requirements and nutrient targets.

Some studies include an additional factor for herbs and spices(384) and include tea and coffee, therefore it was considered whether to include these in the diets. The cost of the herbs and spices used in the meals is estimated at $3.86 per fortnight for 14 main meals. These were not included in the NZ diets, as this would increase the time to collect prices and each item would only be used in very small amounts. In NZ, it is estimated that if the adult man and woman consumed three cups of tea at home per day, the additional cost per fortnight would be $3.60. As the amount of tea and coffee would be similar in both diets, this would not affect the price differential between diets. Tea and coffee do not contribute to the energy intake, and the milk and sugar that may be added are included in the diets. Therefore, it was not considered necessary to add tea and coffee.

6.4.4 Comparison to other surveys

6.4.4.1 Pacific diets in NZ

A student research project followed the diet approach methodology to develop a healthy and current diet for Pacific people in NZ with the guidance of a Pacific expert group[455]. The foods commonly consumed by Pacific people were identified from the NZANS and the expert group. The prices were collected from supermarkets, fresh produce stores and takeaway outlets where Pacific people commonly shop in Auckland. The expert group advised that as Pacific households are often larger, and Pacific people focus on choosing the cheapest price, that the cheapest price selected should be for a large package size.

The current diet cost $550 per fortnight for a household of four, which is $17 less than the NZ diet in this research. The healthy diet cost $526, which is $40 less than the NZ diet. There was a strong emphasis on collecting the cheapest price through selection of package size and store for the Pacific diets. Spending on meat and alternatives is higher in the NZ healthy diet compared to the Pacific healthy diet. Spending on fruit in the NZ healthy and current diets is higher, however prices were collected in different seasons. Spending on vegetables is higher for the Pacific healthy diet while spending on grains is higher for the NZ healthy diet, possibly because more of the staple Pacific foods are vegetables. Spending on alcohol in the NZ diet is higher than the Pacific diet as the NZ diet contains more alcohol.

6.4.4.2 Otago Food Cost Survey

The Otago Food Cost Survey[89] collects the price of a diet that meets the NZ Eating and Activity Guidelines. A diet is calculated at a basic, moderate and liberal cost depending on the type of food items added. The diet does not include alcohol or takeaways but includes some discretionary items. The cost per fortnight for a man, woman, adolescent boy and 10-year old girl was calculated. The household only differs from the INFORMAS household in that the girl is ten years rather than seven years. The costs of the standard healthy and current diets ($566) are between the cost of the basic ($494) and moderate ($658) diets.

The affordability of the Otago Food Cost Survey basic healthy diet for a household of four in NZ was estimated in 2011 for a range of income scenarios[40]. The income scenarios differed slightly and benefits were reformed in 2012 so a direct comparison of affordability is not possible[456]. A household with one adult working full-time on minimum wage would require 33.5% of income and a household receiving Jobseeker Support would require from 44% to 52% of income. The diet was less affordable than the diets in this research, though the household receiving minimum wage was working 60 hours per week. At that time (2011), the average NZ household spent 18% of their income on food.

6.4.4.3 Healthy diets Australian standardised pricing and affordability method

A healthy basket and a current basket were developed in Australia to test a standardised pricing and affordability method to be used across Australia[241]. The healthy diet is based on the foundation diet for each age/gender group of the Australian Guide to Healthy Eating. The current (less healthy) diet is based on the quantities and proportions of foods as reported in the Australian Health Survey 2011-2012 for the relevant age/gender group, including takeaways and alcohol. The price used to cost the diets was the most commonly available branded item (no discount). There is no GST on basic healthy foods in Australia. Key differences between the ASAP method and this research was the rationale for determining individual energy requirements, the type of price collected, the level of GST on core foods and the availability of recent detailed national dietary surveys and quantitative food-based dietary recommendations for the ASAP method. There is a bigger energy differential between the healthy and current diets in Australia compared to the NZ diets.

In Australia, the healthy diet costs approximately 12% less than the current diet for a family of four. In NZ, the cost of the healthy and current diets are similar. If there is no GST on core foods in NZ, the healthy diet would cost 6% less than the current diet. Compared to the NZ current diet, the proportion of expenditure in Australia is similar for grains, takeaways and dairy, is lower for fruits and vegetables and meat and alternatives, and higher for alcohol and discretionary foods. For the healthy diets, expenditure is similar for grains, meat and alternatives and fats, lower in Australia for fruits and vegetables and higher for dairy.

The affordability of the Australian diets(241) for a household of four was calculated in a high and low socio-economic area. The healthy diet requires 14% and 22% of the median household income for each area and the current diet 16% and 24%. The affordability of both diets in NZ for a household earning the median income falls within this range.

The affordability for a household earning the minimum wage was calculated. The Australian household worked 44 hours whereas the NZ household worked 60 hours. Affordability is similar to Australia at 26-27% of the healthy diet and 30-31% of the current diet, though if the NZ household worked only 44 hours the diets would be less affordable than Australia.

6.4.4.4 Studies comparing healthy and current diets

Variation in price differentials across studies would be expected across different countries, years, seasons and when different methods are used. The systematic review conducted by Rao et al(56) (described in section 2.6) reported that when healthiness is determined by food-based dietary patterns, the healthiest diet category costs $1.48 per day more than the least healthy category. When healthiness is determined by nutrients (sugar, fat, or fibre) there is no difference in cost per day.

Of the twelve comparisons between a healthy and current diet reported in the literature review (section 2.6), two studies found little difference in cost(245,253), six found the healthier diet is more expensive(146,147,158,168,246,247) and four found the healthy diet costs less(148,158,241,457). In addition, a diet developed to be healthier and sustainable is more expensive than the current diet(243). All studies compared the cost of one healthy diet with one current diet.

Two Italian studies used linear programming to identify healthier diets based on usual patterns. In the first study(148), a usual diet pattern was generated following Italian Recommended Daily Allowances and nutritional guidelines that incorporated commonly consumed foods identified from the food expenditure reported in the HES. The healthy diet has more vegetables, pasta, rice and fresh fish, and less meats, bread, sugars and cakes, and fats and oils than actual consumption. The healthy diet is 20% cheaper than actual consumption. The second Italian study identified a healthier and cheaper diet based on current consumption patterns of adolescents[(251)]. The model was constrained by nutrients, food portion, food consumption frequency, food association and food alternatives (to avoid combination of certain food items in a meal). The diet has no meat or fish to minimise costs, though the authors noted this may not be acceptable. The minimum cost diet costs 25% less than the current diet.

This research developed and tested methodology through the implementation of a NZ diet cost study to compare the cost of a healthy and the current diet. The decisions required were identified, methodology developed and the implications of decisions tested through scenarios. The implications of the diet approach and the strengths and limitations are discussed in Chapter 7.

7 DISCUSSION AND RECOMMENDATIONS

7.1 Overview

This research developed and tested methods for monitoring and comparing the cost and affordability of healthier and less healthy foods, meals and diets. An overview is provided in Figure 19 with the information and data sources required at each step indicated. The results of the NZ food, meals and diet costs study are presented. The policy and health promotion implications of monitoring are discussed with suggestions for further research. The strengths and limitations of the methods to select commonly consumed foods, the foods, meals and diet approaches and price collection methods are comprehensively discussed.

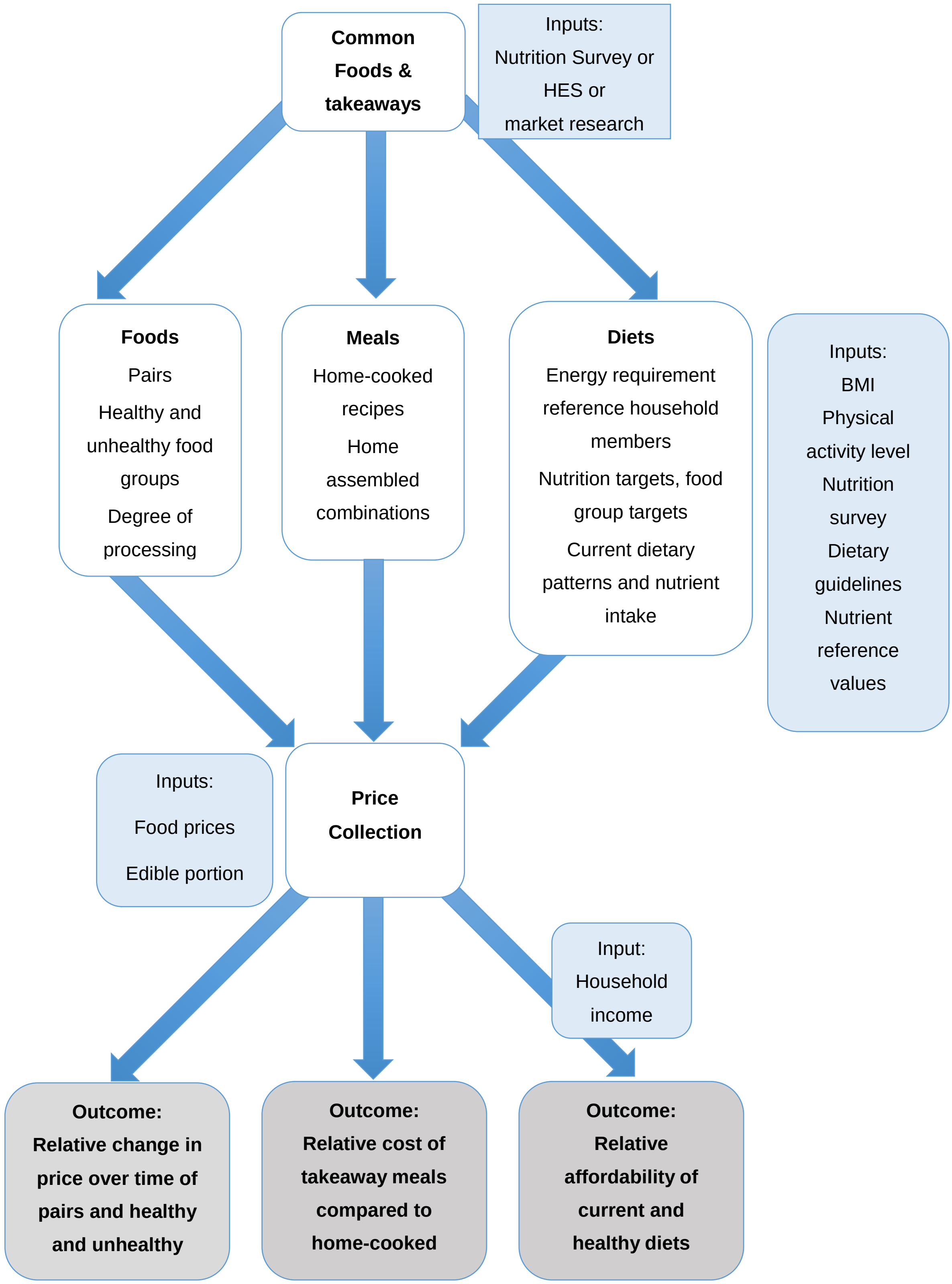
Monitoring is important to provide evidence to advocate for appropriate and effective fiscal options to encourage consumption of healthier foods, meals and diets. The recommended methods are standardised while offering flexibility for the range of available information and differing food environments in countries. A country can select one or more of the three complementary approaches according to capacity, information sources and priorities while following the same steps and methods to calculate costs. The sections describing the strengths and limitations sections of each approach provide alternative methods or data sources provided where relevant. The approaches were tested in NZ to explore the use of different data sources to identify the common foods, the feasibility of using nutrition survey microdata, differing sources of price information (food price index, retail outlets) and a range of diet and price scenarios were analysed.

The simplest approach is the foods approach as this requires the least amount of information. The foods approach monitors the price of foods over time in two ways. Firstly, the cost of pairs of foods with a healthier and less healthy counterpart is compared. Secondly, the commonly consumed foods are classified by healthiness using the WHO Europe nutrient profile model and NOVA degree of processing. The relative price differential between the healthier and less healthy foods, and between the degrees of processing are monitored over time. The pairs' comparison has a valid denominator with each item of the pair, but not the food groups' comparison which is only monitored over time. Currently the price of healthier and less healthy foods is not routinely monitored in countries. Therefore, the foods approach provides a standard method that can be simply implemented in a range of countries with limited resources, allowing comparisons over time and between countries.

The meals approach compares the cost of popular takeaway meals with their healthier home-cooked (prepared from 'scratch') and home-assembled (pre-prepared components) counterparts. As the literature on the cost of meals was explored, it became apparent there were few reported studies that compared the cost of a takeaway meal with a healthier home-made meal and even fewer that accounted for the cost of preparation time. This methodology can be used in differing food environments, whether the takeaway outlets are multinational chains or independent outlets. As this method is novel, it is recommended that the feasibility of repeating the price collection is tested in NZ and the implementation in a different food environment is tested in other countries.

The diet approach monitors the cost of a healthy and a current (less healthy) diet over time. A national nutrition survey is required and preferably food-based dietary guidelines, though WHO guidelines or those of a similar country can be used. The diets can be compared cross-sectionally as the reference household acts as a valid denominator. The comparison is a point estimate so it is not possible to be confident that any observed difference in cost is significant. The healthy diet meets food-based dietary guidelines and nutrient reference values. The current diet reflects the dietary patterns and nutrient intakes of a national nutrition survey. The affordability of the diets for households receiving the median disposable household income is calculated. The diet approach incorporates the tested methodology of the current routine monitoring of healthy diets in various countries with new methods to compare to a current diet in a manner that is flexible for the resources and information sources available within a country. As the type of price collected, composition of the diet and energy requirements can alter the diet cost, it is important to state what is being measured and be clear how this relates to the conclusion.

Figure 19: Overview of food pricing methodology



7.1.1 The cost differential between healthy and less healthy foods, meals and diets in NZ

The three approaches were implemented in New Zealand and the price differentials calculated. The foods approach included monitoring over time using food price data from the Food Price Index. Overall food prices increased, but there is no significant difference in the rate of change for healthy foods compared to less healthy foods, and between minimally processed, processed and ultra-processed foods. Twenty-two pairs were selected and the prices collected in supermarkets. The price of the healthier items of a pair tend to be more expensive or the same price as the less healthy item. The two approaches are complementary and measure different research questions. The pairs approach is a direct comparison of the absolute price differential between two items for a small group of foods. Monitoring prices over time measures the differential in the relative change in prices of foods classified by healthiness.

The meals prepared at home are generally cheaper than their takeaway counterparts, when either the cost of the complete meal, or the cost standardised for weight is calculated. Adding the cost of preparation or waiting time makes the home-assembled meals the cheapest, and either the home-made or takeaway meal the most expensive. Home-made meals can be healthy and cheap to prepare but do require time. Home-assembled meals are quicker to prepare than home-made meals and with careful selection can be healthier than takeaways, therefore a recommended option if time is tight.

The cost and affordability of the healthy diet is similar to the current diet, according to point estimates. Changing aspects of the diets and the type of price changes the relative difference in cost in both directions, and affects the price of the healthy and current diets to differing extents, particularly adding takeaway and excluding generic products. Adding takeaways to the healthy diet increases the cost considerably more than removing takeaways from the current diet reduces the cost. The inclusion or exclusion of alcohol has a moderate effect on the price compared to takeaways. The current diet increases in cost proportionally more than the healthy diet when generic items are not included. The scenarios that change the cost of fruit and vegetables affect the healthy diet more, as there are more fruit and vegetables. The healthy diet contains less energy than the current diet, however if the diets are isocaloric, the healthy diet is more expensive than the current diet.

In NZ this research found healthy food is not increasing in price at a faster rate than less healthy food. Healthier home-cooked meals can be prepared at a lower cost than their takeaway counterparts, even when accounting for the cost of preparation time. It is possible to eat a healthy diet for the same price as the current diet, though if alcohol or takeaways are included in the healthy diet this would become more expensive.

The focus of this research is on testing the methodology so the sample size for the price collection for the foods and diets approaches is small. Three supermarkets and three fresh produce stores in one small city were selected to collect the prices. The research does not attempt to analyse variations between rural and urban locations or differing levels of deprivation. A range of price types and brands (popular label, generic label, cheapest price, with discount, without discount), were collected to enable an analysis of the effect of the type of price on price differentials for foods and diets. A larger NZ study is collecting the prices to determine differences between store types and location.

The selection of takeaway outlets was partially a convenience sample as the areas were close to the researchers' homes. Within this, the census areas were identified and randomly selected within three levels of deprivation. Once an area was selected, takeaway outlets were randomly sampled.

Ideally the prices would have been monitored over time for all approaches to fully test the implementation of the methods. Fortunately, prices from the FPI for the past ten years became available at the end of the research, allowing the change in price of healthy and less healthy foods over time to be analysed. The prices were not used for the meals or diets approach as the takeaway items priced had no weight specified, and there were insufficient healthier versions of items for the healthy diet, such as brown rice.

The methodology to guide this research was developed based on the INFORMAS foundation paper on food prices(19), providing steps on implementing each approach. The use of different data sources and methodological approaches to compare the cost of foods, meals and diets was explored through reviewing the literature. Recommendations were made and tested to refine methods for use internationally by INFORMAS in order to compare changes in prices over time between countries. These are described in the discussion sections in the chapters of the individual approaches.

7.2 Implications

7.2.1 Policy implications of monitoring prices

Monitoring the price of foods, meals and diets over time complements the WHO NCD monitoring framework with the focus on health outcomes, risk factors (including obesity) and national system responses(17). This is relevant to nutrition, obesity and NCDs as price is a major influence on food choices(21,22) and lower diet quality is a risk for NCDs(319). Varying methodology leads to varying results(46), so a standardised method will allow valid cost-effective comparisons over time and between countries. If existing price data is available, such as Household Expenditure Surveys and the Food Price Index, these should be explored and utilised if possible using the standardised protocol reducing the resources required.

In addition to monitoring over time, cross-sectional comparisons can be made of the price differential between the healthier and less healthy pairs, meals and diets. For the pairs approach, there is unlikely to be a wide representation of foods, therefore the results should not be generalised to differences in cost of healthier and less healthy foods. As the cost of diets depends on the composition of the diet and the type of price collected, it is imperative that the definitions of the diets and scenarios are provided.

Monitoring the relative change in price of healthier and less healthy food, meals and diets over time provides evidence to influence and monitor economic policy responses of government to reduce the cost, or remove barriers to purchasing healthier foods such as taxes or subsidies(32), or improve incomes to improve food affordability. Removing taxes or providing subsidies for healthier foods, and taxing less healthy foods have the potential to change demand and therefore lead to healthier dietary choices[458].

Information on the cost of current and healthy diets is invaluable to demonstrating the impact taxes and subsidies will have on diets rather than food prices alone, as it captures the amounts of foods that people consume[19], as demonstrated in this study and the Healthy diets ASAP method research[241]. The impact of removing GST from fresh fruit and vegetables and/or from core foods, reduces the cost of a healthy NZ diet to a greater extent than the current NZ diet. The cost differential between meals and diets may differ in other countries depending on how GST is applied.

Policy changes which result in more disposable income can contribute to healthy food being more affordable. For example, enabling those on low incomes to have access to cheap, quality fresh fruit and vegetables, or by increasing income or decreasing essential expenses (housing, electricity) to allow more disposable income available for food. The cost of a healthy diet should be incorporated, along with other essential expenses, when setting rates for income support and the living wage. Accessibility to healthy food can be incorporated into price monitoring by including relevant locations. If there is insufficient availability of healthy foods, food systems can then be examined to identify areas to improve accessibility and affordability, for example, transport costs. While the healthy and current diet may be equally affordable in New Zealand, if household income is low, neither diet may be affordable, as 45% of disposable income is required to purchase a healthy diet for those receiving income support.

The contribution of food groups to changes in the cost of foods or diets can be identified to enable advocacy for policy changes to address price changes for particular foods. For example, if the price of fruit and vegetables increases more than the price of less healthy foods, then policies to make fruit and vegetables more affordable can be advocated.

Directly comparing, and monitoring the change in the price of pairs is relevant, as the pairs are chosen to reflect potential policy actions when price is a barrier to purchasing the healthier option, such as a difference in the tax component, pricing strategies for the healthy option by manufacturers and retailers, the effect of a generic label or discounted product, or a difference in the cost of producing the food. Lack of availability of a healthier item indicates a potential barrier to a healthy diet. Comparing the price indicates the cost (or savings) of switching to healthier alternatives.

Monitoring whether the cost of home-cooked meals increases at a faster rate than the cost of takeaway meals is important, as consumption of takeaway foods is increasing globally and consumption of energy dense food is a risk factor for obesity and NCDs[310]. Changing relative costs is one factor that could affect the consumption of takeaway meals. The authors of an econometric study concluded that US consumers were not likely to substitute one type of food away from home for another, and taxing fast food has potential to shift consumption of fast food to home-prepared meals[240]. The finding from this research that home-cooked foods are cheaper than takeaway meals and overcoming the perception that takeaways are cheaper both have the potential to move people to increase consumption of home-cooked meals which can improve diet quality[196].

Time is often overlooked as a barrier to eating healthy meals and diets, and if households require all adults to work full-time to cover necessary household costs, preparing meals from scratch, regularly purchasing fresh foods and planning meals ahead can be daunting. If healthy diets are a similar cost to the current diet, then it could be argued that no fiscal policy intervention is required. Incorporating the cost of time meant the meals are closer to reflecting the true cost of obtaining a meal for a household. As healthy meals can take longer to prepare than quicker convenience and takeaway meals, the barrier of time also needs to be considered. It is difficult to reduce the barrier of time, but reducing the price of foods that are time-consuming to prepare can act as an incentive to purchase these and may assist to overcoming the time component(58).

7.2.2 Health promotion messages

Communicating messages around the cost of healthy eating is vital as there is a widespread perception that healthier foods(459), meals(60), and diets(111,113,114) are more expensive than their less healthy counterparts. This research questions the widely held belief that takeaways are cheaper than home-made meals, and that less healthy diets are cheaper than healthy diets. This study found that healthier meals prepared at home are cheaper than their takeaway counterparts, and when the cost of time is included, some home-made meals are still cheaper. A healthy diet is a similar price to the current diet. An Australian study(115) found participants who perceived that some of the healthier versions of commonly consumed foods were more expensive were less likely to purchase them, even when there was no actual price difference. Households need to be convinced that healthy meals and diets can be selected at no additional cost by transferring spending from unhealthy foods and takeaways to those foods recommended by food-based dietary guidelines.

The value placed on certain foods, and how much time is prioritised for food preparation, is influenced by cultural norms around foods and dietary habits. Households may pay more for convenience as people work longer hours and more women are working(223); because convenience items are perceived as better value for money; a dislike of cooking and variable family eating times(61,191,227). There are other barriers to healthy eating such as low food literacy, low cooking skills and accessibility to fresh produce(219,221). Moving people to prepare meals at home could improve overall dietary quality. Further research on the price elasticity of healthy meals and takeaways and exploring the meaningful differences between cost and convenience of different types of meals is required, particularly to investigate how people value their time in relation to food preparation and purchasing takeaway meals.

A social marketing campaign is recommended that outlines the benefits of preparing home-made meals and addressing the barrier of time, while encouraging the use of home-assembled meals when time is limited, as an option for takeaways. Fast foods produced by multi-national corporations aggressively market their products as desirable and affordable, undermining the ability to make healthy choices(3). Social marketing campaigns can be successful provided certain factors are met regarding behavioural objectives, researching and segmenting the audience, showing a benefit in changing behaviour using a mix of strategies and being aware of competition(460).

The monitoring of food prices and identifying price differentials between healthier and less healthy meals and diets can be utilised as an educational tool to indicate the change in the cost of a household meal or diet by switching to a healthier meal or diet, how much is currently spent on food groups and to change perceptions that healthier diets are more expensive than less healthy diets. In NZ, the current diet indicates that a much lower proportion is spent on healthy foods than is required for a healthy diet, as it is spent on discretionary foods and beverages, alcohol and takeaways instead. Translating the results into visual resources with the cost portrayed would be a useful tool, as the cost of foods is such an influence on purchasing foods and planning meals.

The key messages for NZ that flow from this research are:

- Healthy foods are increasing in price at a similar rate to less healthy food.
- The healthier version of many staple foods is the same price as the regular version.
- Takeaways cost more than meals prepared at home.
- Meals using pre-prepared items can be as quick to prepare as buying a takeaway meal, and can be healthier.
- The cost of a healthy diet is similar to what households usually spend on food.

7.2.3 Implications for research and monitoring

Household expenditure surveys and food price index data have the potential to provide valuable information on food prices, but the data may not be sufficiently disaggregated or described in enough detail to identify items as healthier or less healthy. It is recommended that the relevant organization undertaking the surveys provide the data, or monitor the price data is such a way that the cost of healthier and less healthy foods can be monitored over time.

The value people place on their time and the effort required in relation to food preparation should be further explored. This would assist with the decision on the value to place on time when costing meals. There was uncertainty about the time values to include, so future research could include a sensitivity analysis of all time associated with meal production, from transport and time for grocery shopping, unpacking grocery shopping, preparation time, cooking time and time to clean up.

There are a range of possible healthy and current diets which meet food-based dietary guidelines and nutrient reference values (healthy diet) and the nutrient intakes and food group intakes of the population (current diet). The current research only provides point estimates for the comparison of a healthy and current diet, which does not provide confidence if an observed difference is significant. Therefore, for monitoring over time, an approach which allows a range of diets to be developed and compared, providing a comparison which can be compared significantly should be implemented. Monitoring the diets over time for different population groups, such as ethnic groups, or rural compared to urban diets, is useful to observe any differences in rates of change in the cost differential, and any impact on inequalities.

Social marketing is recommended to change the widespread perception that healthy eating is more expensive. The change in perception could be monitored over time to see if social marketing can change food purchasing, meal preparation practices and diets.

As this method is novel, it is recommended that it is repeated over time in NZ to test the feasibility of repeating the price collection, and tested in other countries to test implementation in a different food environment.

7.3 Strengths and limitations of the research

This research has thoroughly explored and documented the information required, steps for implementation and the decisions required to monitor the price of healthier and less healthy foods, meals and diets over time. Arbitrary decisions were required when developing the methods, and when implementing the methods.

Decisions were required when developing the methods for each approach regarding definitions and classification. The foods approach required classification systems according to healthiness to be selected. The meals approach required criteria to be developed for the healthier home-cooked meals. The diet approach required a decision on the principle to determine the energy requirement of the individuals in the reference household. Arbitrary decision points occurred at all stages of each approach from selecting commonly consumed foods and meals, the composition of the meals and diets, the type of price, using proxies of foods, the amount of foods in the diets, developing the menus, selecting the price, and sampling stores. This research identified the arbitrary decisions required and tested ways to mitigate these and understand the implications. These are outlined in Table 83 to Table 87 and the strengths and limitations discussed below illustrated by the findings from testing each approach in NZ.

7.3.1 Strengths and limitations of the selection of commonly consumed foods

The commonly consumed foods and takeaway meals were identified objectively using available data on food consumption or household purchasing, so the prices monitored were those most relevant to the population, though this is limited by the age of the data. The identification of commonly consumed foods is limited by the dataset and the way foods are disaggregated and assigned to food groups. In this research, different sources of information to determine the commonly consumed foods were explored. The use of either the HES or a national nutrition survey was sufficient to identify commonly consumed foods and popular takeaway meals. Therefore, a country would not be reliant on a national nutrition survey to conduct the foods or meals approaches. Many countries conduct a regular HES but not a regular national nutrition survey. This research used a range of sources to check that the commonly consumed foods and eating patterns identified from the survey were current, for example supermarket reports, market research data, other surveys.

The size of the shopping list is a balance between variety in the diet and time for price collection. Having proxy items will reduce the number of foods in the diet but may not represent the price of foods in the category. Having fewer foods in the diet means a change in the price of one item will have more influence on the diet cost compared to a diet with more foods. In this research, when there are fewer foods priced in the diet, the cost is similar for the healthy diet but decreases for the current diet. In linear optimisation studies[47], as more foods are added to the diet the cost increases.

Table 83: Decisions required for selection of common foods and meals

Issue	Decision	Rationale
Information sources of common foods are required.	Use the best information source available according to age and degree of disaggregation of data. Ideally the foods are consumed at an individual rather than household level.	Different countries have different information sources available.
Require criteria to determine if a food is commonly consumed	Where possible, the commonly consumed foods are identified by the number of people consuming the food or the amount consumed, according to the food group. An objective measure is required for each food group for each country.	The frequency and amount of consumption varies with the type of food group and the variety within the food group, and depends on the diversity of the food supply.
Need to decide on the number of foods to be included in the diets	The number of foods depends on the variety of foods consumed in a country's diet. Some items will act as a proxy for similar items.	There is a balance between having more foods to represent more of the common foods, with the time required to collect prices. One item can represent another similar item (e.g., ham represents ham, bacon and salami).

7.3.2 Strengths and limitations of the foods approach

There are numerous limitations to the foods approach documented by this research and from studies reported in the literature. When testing the foods approach, it became clear that it was only valid to monitor prices over time. A direct cross-sectional comparison between healthier and less healthy foods could only be made for the pairs' approach, as each healthier item is matched to its less healthy counterpart. Groups of healthier and less healthy foods are difficult to compare cross-sectionally because different denominators (grams, kJ, serve) give different results. The use of price data from a HES or FPI could provide prices of commonly consumed foods over time collected from a large national sample in a consistent manner.

The price metric chosen to assess the cost of foods alters the resulting price differential, with the price per energy unit differing the most from the price per 100g and price per serving, as is consistent with other research[46]. As the comparison of healthier and less healthy foods will only be used to monitor the rate of change in price, rather than the actual price difference between food groups, the price metric has less influence, as the relative change in price will be similar between metrics.

The pairs approach is limited by not having wide representation of foods, as it is challenging to include all food groups. Fruits, vegetables, eggs and confectionary may not have a less healthy or healthier counterpart. Results of the pairs approach should not be interpreted to represent the price differential between healthier and less healthy foods overall.

Table 84: Decisions required for the foods approach

Issue	**Decision**	**Rationale**
A system is required to classify foods by healthiness	Classify foods as healthier/less healthy using WHO Europe nutrient profile model, and by degree of processing.	Simple classifications systems that use different principles of classification. Currently used by multiple countries.
Principles are required to select pairs	Select pairs that are policy relevant to diet-health relationships and with a contrast in nutrients or ingredients. The number of pairs will depend on the food supply in a country.	The difference in nutrients is considered useful if it relates to food-based dietary guidelines, and therefore policy relevant.
There is a range of possible price metrics: per 100g, per kJ, per serve	Use price per 100g to monitor the cost over time.	Price per 100g is simple to calculate and allows the consumer to determine whether two similar products differ in price. Price per serving would also be suitable but serving size data may be inconsistent or not available. Price per kJ is less appropriate as the comparison is not focused on the amount of energy provided.

7.3.3 Strengths and limitations of the meals approach

The steps in the meals approach are comprehensive, with a range of home-cooked recipes and combinations selected that allow a statistical difference between meal types to be calculated. Arbitrary decisions were made when developing the methodology to define the healthier home-cooked meals criteria, the estimation of the time component and the cost of time. A change in any of these may alter the cost of the meals.

As each step is undertaken, further arbitrary decisions are required as outlined in Table 85. For example, burgers and chips were identified as a common takeaway meal but a range of burger and chip meals were available to price at a takeaway outlet. To reduce subjectivity, the home-made and home-assembled meals are based on the main items in the takeaway meal. A number of distinct recipes were selected for each meal option representing the common aspects of recipes identified and therefore a range of costs for each meal. The criteria and the steps to select and modify recipes provide some standardisation for recipe variations and ensure the meals are healthy and realistic to prepare.

It is assumed that the estimated time would be an accurate indication of the preparation time for an average household and that the waiting time would be similar across different outlets of a fast food chain. Time could be costed at the median wage rather than the minimum wage as this represents the median wage a person would lose if time was spent preparing the household meal rather than working. If the median wage is used, this would increase the cost of the home-made meals more than the home-assembled and takeaway meals, as the home-made meals require more time. It is the time cost of the person at their perceived time value which is important when considering whether to prepare a meal at home or purchase a takeaway meal. Further research is required to investigate the value people place on their time in relation to food preparation.

Table 85: Decisions required for the meals approach

Issue	Decision	Rationale
Determine size of meal for reference household	Use judgement guided by serving sizes of takeaways, recipes, own knowledge. Cost meals standardised to one kilogram.	There is no recommendation for the serving size or energy content of a meal as this depends on the complete diet. Standardising meal costs to 1kg allows a check to assess if the varying sizes of the meals are contributing to a price differential.
Selecting a specific takeaway meal	Choose a specific takeaway meal determined by the available information, such as popular outlet, cheapest options, value packs. The meal must be able to be matched to a home-cooked meal.	Information sources on popular meals may not be specific enough to identify the exact meal required to be priced at a takeaway outlet, therefore arbitrary decisions are required.
Select recipes for home-made meals and components for home-assembled meals to match takeaways	Include the key characteristics of the takeaway meal. Use common ingredients, kitchen equipment and basic cooking skills.	There is more than one possible meal, and therefore cost, so a range of recipes is selected for each meal option.
Determine criteria for healthiness of home-cooked meals	Develop simple criteria based on existing recipe criteria and the Eating and Activity Guidelines.	No existing suitable, simple criteria were identified.
Decide on the components to be included in the estimation of time for preparing and obtaining meals	Home-cooked meals: preparation time, supervised cooking time. Takeaway meals: waiting time.	The estimated time is simple to calculate but is not the true time cost. Travelling time to takeaway outlets and grocery stores and shopping time would be difficult to calculate.
Select a dollar value to cost time	Select a value similar to the wage of a food preparer.	The value reflects the cost of service for a takeaway meal.

Issue	Decision	Rationale
Select takeaway outlets for price collection	If a meal is from a fast food chain with standardised prices, only one outlet is selected. If a meal is from an independent outlet, a sample of takeaway outlets is selected.	Meals from multinational fast food chains are usually of a standard composition. Similar meals from independent outlets vary in composition and price.

7.3.4 Strengths and limitations of the diet approach

There are few studies reported that compare the cost of a healthy diet and a current diet. Many studies use observational data from large dietary surveys and compare the cost of the diets of those consuming the healthiest diets with those consuming the least healthy diets. Alternatively, when the diets in studies are constructed based on the commonly consumed foods of a population for the current diet, and food-based dietary guidelines for the healthy diet, this reduces the subjectivity of the choices made by individuals.

The studies reported in the literature vary in the inclusion of discretionary foods, alcohol or takeaways in the healthy diet, whether the healthy diet is aspirational or realistic, and whether the diets are isocaloric. The decisions required are documented (Table 86) when developing diets, when implementing the diet approach in NZ, and when using scenarios to test the effect of varying the diet contents on the cost of the diet and the cost differential between diets.

The energy requirement of the reference household for the healthy and the current diet needed to be defined. This influences the cost of the diet and the price differential because it is directly related to the quantities priced. If there is a large difference between these, the energy difference between the diets could be considerable. In this research, the energy requirement of the healthy diet is lower than the current diet and the diets are a similar price. When the diets are isocaloric, the healthy diet is more expensive than the current diet. A systematic review(56) also reports that healthy diets are more expensive when diets are isocaloric. However, unlike this study, the review found healthier diets are more expensive per day when food-based dietary patterns are compared.

The nature of food-based dietary guidelines may vary between countries, with less quantitative guidelines on food groups and serving sizes requiring more arbitrary decisions to be made. Nutrient reference values usually provide a range of recommended macronutrient intakes, for example 15-25% of energy from protein, which can be met by a range of diets. In this research, a scenario that changed the proportion of foods in the diets, while still meeting food-based dietary guidelines and nutrient reference values, only slightly increases the cost of the diet. When the proportion of foods within the meat, poultry, seafood, nuts and legumes group change, the healthy diet reduces in cost. The acceptability of the diet must be considered as the servings of legumes increased and these are not commonly consumed. An Italian study using a nutri-economic model(177) to assess nutritious and affordable food choice has a similar finding, though the cost reduces to a greater extent when the best nutri-economic choices are selected.

Complex data sources are required to identify current food consumption and eating patterns based on actual consumption. Ideally a national food intake survey with a 24-hour recall or diet record would be used but surveys assessing the diet using a quantitative food frequency questionnaire could be utilised. The initial work to develop the diets is time-consuming depending on the nature of the data sources, degree of disaggregation and the way the data is categorised. The ability to develop a current diet that reflects current dietary patterns is limited by under-reporting in nutrition surveys[(242)]. The energy requirement for the current diet based on the current BMI is higher than the energy intake reported in the NZANS, particularly for Pacific households. Therefore, the amounts of foods required in the current diet are proportionally higher than is reported consumed in the survey.

There is a range of possible healthy and current diets that can be created and therefore a range of possible costs, particularly as the creation of the diets requires subjective decisions by the researcher on the proportion of foods to place in the diet. This research only provides point estimates, as do other studies comparing the cost of a healthy and the current diet. Ideally, the variation in cost would be calculated so the full degree of overlap of healthy with current diets could be assessed with statistical analyses performed to provide a mean cost, a measure of spread and to test if there is a significant difference between healthy and current diets. Completing the individual scenarios is time-consuming and does not provide information on the variation of costs within each scenario. Therefore, building on this research, a novel programme is currently under development by the University of Auckland. This computer programme (DietCost) produces a large number of potential healthy and current diets and their costs. The programmes uses different combinations of a selection of commonly consumed foods, determined by a set of energy, nutrient, food group and food constraints for each household member. Currently, diet pricing studies use linear optimisation which results in one solution (cost) for each type of diet.

The standard healthy diet was aspirational containing no discretionary foods, takeaways or alcohol so provides a contrast to the current diet. The inclusion of moderate alcohol, healthier takeaways and limited discretionary foods may increase the acceptability of a healthy diet, and still meet food-based dietary guidelines and nutrient reference values, however it needs to be considered whether such a diet represents a healthy diet. In this research alcohol and takeaways are a more expensive component of the diet so the inclusion or exclusion of alcohol and takeaways can considerably change the cost differential between diets.

A scenario with alcohol should be analysed if alcohol is common and the country's dietary guidelines state alcohol can be part of a healthy diet. A scenario with some healthier convenience and/or takeaway foods should be analysed if these are common items. If the current diet is developed without alcohol and takeaways, this would not represent all foods and beverages that contribute to energy. The definition of the current diet is what people currently consume, not the cheapest possible less healthy diet.

Focus groups can provide valuable advice throughout the process to develop diets. In NZ, as part of a wider INFORMAS project, separate diets were developed for Maori and Pacific people living in NZ. Expert groups of Pacific and Maori nutrition professionals provided input into the selection of commonly consumed foods and menus, and the selection of outlets for the price collection. This was invaluable to identify some popular foods such as coconut buns, the type of food to price such as whole fish rather than fillets, and the way the menu was developed with a large shared meal on Sunday. Having expert or focus groups is a useful method to ensure that the tool is meaningful, reflects intakes and is particularly useful when data sources are lacking, or diets for particular population groups are developed[249,250,352,461].

Table 86: Decisions required for the diet approach

Issue	Decision	Rationale
Select a reference household	Household of four = 1 woman 45 years, 1 man 45 years, 1 boy 14 years, 1 girl 7 years	This may not be the typical household of a country but is used to compare across countries.
Determine the principle for setting the energy requirements for the diet	Reflect current BMI and activity levels for current diet, and ideal BMI (23) and PAL (1.7) for healthy diet.	The energy requirements reflect the current consumption to maintain the current BMI, and that for an ideal BMI for the recommended physical activity level. The energy requirement is not guided by the reported energy intake from a national survey due to under-reporting.
Define a healthy diet	The healthy diet meets the food-based dietary guidelines and nutrient reference values of the country.	These are evidence-based recommendations.
Decide if the healthy diet includes alcohol, healthier takeaways or discretionary foods	The standard healthy diet contains no alcohol, takeaways or discretionary foods.	The healthy diet is aspirational and provides a contrast to the current diet. Additional scenarios may be conducted, including alcohol and/or healthier takeaways and/or discretionary foods.
Identify current dietary patterns	Use national food consumption survey data and other information sources: e.g., sales data, experts, market research, other surveys.	The survey information may be out-dated or may not include adults and children. Additional information can be used.
There is a range of diets that could meet targets for a healthy diet and represent the current diet	Select one healthy and one current diet.	The current diet is constrained by meeting the amounts of foods reported consumed and the nutrient intakes reported from a national survey. A range of combinations could represent a healthy diet.

Inclusion of external costs	External costs such as wastage, condiments, time, energy (power), transport for shopping, storage, preparation, cooking utensils, shared food, gifts, home-grown food, condiments and non-caloric beverages are not included.	The time to identify and monitor external costs as part of an ongoing monitoring system would be considerable. Excluding these inputs could underestimate the cost of diets, particularly if costs are higher for healthy diets, which may require more preparation and shopping time, equipment or storage facilities.

7.3.5 Strengths and limitations of the price collection

Factors that contribute to price variation are location, season, climate, cost of transport and labour, price of commodities, market fluctuations, discounts and promotions(164). It may not be possible to state whether there is a true trend in price changes or a reflection of a temporary influence on price. Prices need to be monitored at the same time each year due to changes in price and availability of seasonal foods.

The collection of prices on a regular basis is straightforward, though the time commitment depends on the size of the shopping list and the number of retail outlets. Decisions are required regarding the source of price data and the price to be collected (Table 87).Prices may be available from a food prices database or a household expenditure survey. The prices are likely to represent an average price collected from a range of sources. Retail outlets with a high volume will capture more of the food purchased by the population. The price of an item may vary depending on the type of retail outlet. In NZ, the cost of fresh fruit and vegetables is lower (per kilo) when purchased at a fresh produce store compared to a supermarket. Other studies in NZ, US and Australia also found the cost of fruit and vegetables lower when purchased from fruit and vegetable markets or green grocers rather than supermarkets(273,346,381).

The cheapest price, which includes discounts and generic labels, should be collected where possible. Many studies described in the literature review stipulate collection of the cheapest item. If a prices database, such as prices from a HES are available, this will determine the type of price collected. This is important to note when comparing relative price differences between countries.

In this NZ research, the inclusion or exclusion of generic labels has a large impact on the cost of each diet, and the price differential between the diets as the generic items are, on average, two-thirds of the price of the branded item. Two-thirds of the packaged commonly consumed foods in this study had a generic counterpart. Excluding generic items increases the cost of the current diet more than the healthy diet, as the current diet contains more packaged items. It is important to check whether generic and branded items are similar in the ingredient and nutrient content.

When the prices are analysed using the cheapest brand, it is assumed that the product quality and nutrient composition of the cheapest brand selected is similar to other brands. By selecting the cheapest price, this may not represent the product most often chosen and some consumers may not purchase generic labels. Generic labels differ across chains so the same brand cannot be priced at different chains. There is a risk that changes in price over time may be influenced more by the number and extent of items on discount, rather than true changes over time.

For the pairs approach, it would be useful to collect both the price of the branded item and the cheapest item to provide direction on an appropriate policy action. If the healthier item of the same brand is more expensive then pressure could be placed on the manufacturer to provide this at the same price. If the healthier item is more expensive than the less healthy item of a different brand (likely to be a generic label), pressure could be placed on the manufacturer or retailer to provide a generic healthier version of the item.

Table 87: Decisions required for collection of prices

Issue	Decision	Rationale
Source of price data, type and selection of retail outlets	If price data is already available, use this if possible. Otherwise select the most common types of retail outlets, most common chains and locations.	The retail environment of each country varies so it is not possible to stipulate a selection protocol. The price collection will depend on resources.
Decide on the type of price to be collected	Collect the cheapest price, if available and feasible to select. Include compatible generic labels and the discount price.	Cost is a major influence on purchases so the cheapest price will represent the price collected by many consumers. If the most popular brand is priced this would require additional information to identify the brand. Generic labels are common in many countries. Discount prices are the actual price paid by the consumer.

7.4 Contribution of this research

An unhealthy diet is the major burden of disease globally and as cost is one of the major determinants of food choices, it is imperative that changes in the cost of healthier and less healthy foods is monitored. There was no comprehensive system for routinely assessing and monitoring the costs of foods, meals or diets. For the first time, a comprehensive assessment and monitoring framework has been developed, validated and tested within a country to answer the critical question of whether healthy eating is more expensive than less healthy eating. The application of these methods across countries and over time provides a robust platform for answering the critical policy question about the costs of healthy eating.

Numerous studies report the results of comparing the cost of healthier and less healthy foods using a range of principles and steps, though often the methodology lacks detail. The limitations of these studies were considered. As the pairs approach is commonly used, the methods described were built on, and principles developed for the selection of pairs. The categorisation of foods as healthier and less healthy is often specific to the study or complex to use. Two simple classification systems that are suitable to use across multiple countries were identified. The price metric to use was explored and critiqued in numerous studies. As the literature and this research showed, the price metric used alters the results. It became clear that the price of healthier and less healthy foods could only be monitored over time, and that price per 100g is the appropriate metric.

There are few published papers reporting on the cost of common takeaways compared with their healthier home-cooked counterparts, particularly accounting for the cost of time. The literature indicates that convenience and cost are major factors when choosing between home-cooked and takeaway meals. Some researchers indicated the need to explore this further. This research tested a novel method to compare the cost of popular takeaways with their healthier home-cooked counterparts, including the cost of time, in a systematic way that allows for a test of significance of the cost. While comparing and monitoring the cost of meals provides evidence for advocacy for fiscal policies, an unexpected outcome found when disseminating the results was the potential to challenge the perception that takeaway foods are cheaper and quicker to purchase than home-cooked meals.

Numerous studies report the results of the affordability of a healthy diet with some countries routinely monitoring affordability over time. Few studies compare a healthy diet to the cost of the current diet and none monitor these over time. This research considered the methodological challenges in doing this, and developed and tested a feasible method that can be used by multiple countries with a range of information sources. Through the identification and testing of scenarios, this research highlights the limitation of having the cost of one healthy and one current diet, due to the impact on the relative price difference when the type of price collected, or the composition of the diet is altered. Concepts have been advanced, particularly around including options for energy adjustment based on current and healthy body weights that can utilise self-reported physical activity data. For NZ, the inclusion or exclusion of takeaways in the diets, the use of generic labels when determining the price of an item, and the principle selected to determine the energy requirement of the diets considerably change the cost, and therefore the price differential between the healthy and current diets.

7.5 Recommendations for INFORMAS food price monitoring

The INFORMAS food pricing methods have been developed to allow for the same steps, based on the same principles, to be followed that are flexible to the needs of a country. It is recommended that countries conduct the diet approach if possible. As it is likely that more countries will have the information sources and capacity to undertake the foods approach, all participating countries should conduct the foods approach to allow cross-country comparisons between more countries. The meals approach can be implemented if there are sufficient resources and if the consumption of takeaways is of particular interest. If the diet approach is not undertaken, the meals approach adds context to the foods approach on the way foods are combined. The INFORMAS protocol provides options for data sources and methods where applicable, to allow flexibility for the differing food environments and data sources in countries The strengths and limitations of each approach outlines some alternative data sources and methods if those recommended in the INFORMAS protocol are not available. There are some data sources that are essential, for example, the diet approach cannot be implemented without information on the current diet which is usually obtained from a national nutrition survey.

For the foods approach, the relative change in price is monitored over time, not the absolute price difference between food groups classified as healthier/less healthy or by degree of processing. The pair's component is an additional option to measure the price differential between each item of the pair.

The diet approach enables scenarios to be conducted, such as changes in GST, to simulate the effect on the cost of the diet with a tax or subsidy. Costs can be compared when the diet composition is altered, for example including or excluding takeaways and alcohol, or assessing the effect of the type of price, for example the inclusion of the discount price. Expert knowledge or focus groups can be used, particularly if survey data is limited, to identify commonly consumed foods, meals and dietary patterns.

The meals and diet approaches can be cross-sectional studies, as well as monitoring over time. The diet approach only provides point estimates. Ideally, the variation in cost of possible healthy and current diets that can be created would be calculated, so the full degree of overlap of healthy with current diets could be assessed with statistical analyses performed to test if there is a significant difference between diets. The research from this PhD has already led to the development of a novel computer programme (DietCost) to generate the costs for a large number of potential healthy and current diets, thus giving thousands of point estimates to a distribution for healthy and current diets. It is recommended that the use of this programme for INFORMAS be explored. The same information required on commonly consumed foods, food group and nutrient targets to develop one healthy diet and one current diet, is required for DietCost.

Some countries participating in INFORMAS may use data from the FPI so will not be able to control the type of price used. It is recommended to collect the cheapest price but if unit prices are not displayed this could be time-consuming to calculate. Some flexibility is required to allow a country to use the price that is simplest to collect.

A country can build on the methodology for the foods, meals and diet approaches to answer specific research questions. The cost of foods and diets could be analysed by location or deprivation. Separate diets could be developed for specific population groups, such as ethnic groups.

INFORMAS should implement the food prices module in other countries to test the feasibility of the methodology in a different food environment, and collect the prices of foods, meals and diets in New Zealand in the future to test the feasibility of monitoring prices over time. Following this research, the protocol will be finalised and made available to other countries.

8 CONCLUSION

This research has provided a comprehensive, detailed, validated platform of methods to answer the important question of 'how the cost of healthier and less healthy foods, meals and diets can be compared and measured over time, and between countries'. This will contribute to the strength of the INFORMAS approach of using a standardised methodology to measure price differentials that can be compared over time and between countries. Having three approaches allows a country to monitor prices according to the available information and capacity. Each approach has enough flexibility to allow for the different nature of the data sources available, and the nature of the food environment across countries, while following the same steps and cost comparisons. Though the initial development work can be time-consuming, once the commonly consumed foods have been identified and the meals and diets developed, price monitoring can be conducted regularly without requiring too much time. As each approach has now been comprehensively tested in New Zealand, countries can utilise the methodology and under INFORMAS, cross-country comparisons of the relative price differential can be undertaken.

Monitoring the price of foods and affordability of diets provides evidence to inform economic and fiscal policies, such as taxation and subsidies to alter the price of foods, or by either increasing income or reducing other essential household costs to alter affordability. As demonstrated in this study, having information on the prices of the current and healthy diets is invaluable to demonstrate the impact taxes and subsidies will have on diets, rather than food prices alone, as it captures the amount people consume. In NZ, removing GST from healthy foods has the potential to move people to healthier diets, as the healthy diet becomes relatively cheaper than the current diet.

The evidence provided from the foods, meals and diets approaches can be used in social marketing to challenge perceptions about the price of healthier foods, meals and diets. Having actual price data can be utilised in nutrition education when providing advice on choosing healthier foods, meals and diets.

The identification of commonly consumed foods, meals and dietary patterns requires detailed data sources, particularly to identify dietary patterns. The collection of the prices on a regular basis and analysis of cost and affordability is straightforward, though the time commitment depends on the size of the shopping list and the number of retail outlets selected.

The INFORMAS foods approach requires limited resources for collection. Sufficient information is required on the selected foods to categorise according to healthiness. The relative change in price is monitored over time, not the absolute price difference, between food groups classified as healthier/less healthy or by degree of processing. The choice of price metric results in differing interpretations of the price difference. Price per 100g is considered most appropriate as it is simple to calculate and useful for comparing two similar foods or groups of foods. A direct cross-sectional comparison between healthier and less healthy foods can only be made for the pairs approach as each healthier item is matched to its less healthy counterpart. This provides specific information about the price differential between similar foods that differ in key nutrient(s).

The INFORMAS meals approach is can be conducted if there are additional resources and capacity available for data collection. The steps in the meals approach are comprehensive with a range of home-cooked recipes and combinations selected which allows a statistical difference between meal types to be calculated. Arbitrary decisions were made when developing the methodology to define the healthier home-cooked meals criteria, the estimation of the time component and the cost of time. This approach is time-consuming to implement and requires additional information to identify popular takeaway meals. Prices need to be collected from both takeaway outlets and retail stores, and some meals need to be prepared or purchased to assess the time component. This approach is useful to build on the foods approach when there is a lack of information to undertake the diet approach. Implementing the meals approach highlighted the difficulty in estimating the value of time when costing the preparation and waiting time. Further research is required to investigate the value people place on their time in relation to food preparation.

The INFORMAS diet approach is the desirable data set to be collected within limits of resources, capacity and feasibility. This is the most useful approach as the cost of diets considers what people are actually eating for the current diet, or are recommended to be eating for the healthy diet. This approach requires additional information: a food consumption survey to identify current eating patterns and nutrient intake, food-based dietary guidelines and nutrient reference values to identify the healthy diet, household income data to calculate affordability. The initial work to develop the diets is time-consuming depending on the nature of the data sources, degree of disaggregation and the way the data is categorised. The diet approach allows for scenarios to be modelled for different price types and diet composition. The main limitation of the diet approach is that a cost of only one healthy and one current diet are estimated. Ideally, the variation in cost of the healthy and current diets that could be created with the commonly consumed foods meeting the food group and nutrient targets would be measured, which is an area for further research.

In New Zealand, food prices increased over the past ten years. Healthier foods and less healthy foods, and minimally processed, processed and ultra-processed foods all increased in price at a similar rate. The price of the healthier items of a pair tends to be more expensive or the same price as the less healthy item. Healthier home-made and home-assembled meals are less expensive than their takeaway counterparts. When the cost of time is included, the home-assembled meals are the cheapest option and half of the home-made meals are at least as expensive as the takeaway meals. This research questions whether takeaways are better value than home-cooked meals. The healthy and current NZ diets are the same price, however if some aspect of the price (exclusion of generic labels or exclusion of discount prices) or diet (inclusion or exclusion of takeaways or alcohol) or the energy requirement changes, the cost of the diets and the relative cost differential between the diets changed.

The food prices methodology can be implemented in different countries over time to monitor changes in the impact of changing prices on populations. There is currently no routine monitoring of the cost of healthier compared to less healthy foods, meals or diets. This methodology offers a standardised approach which can be implemented in a range of countries enabling comparisons over time, and between countries.

APPENDICES

Appendix One: Excerpts from draft INFORMAS food prices protocol

A: Identify commonly consumed foods and takeaway meals

1. Identify sources of commonly consumed foods. Recent survey data is most useful as it provides consumption data. Use as many sources as required to identify commonly consumed foods.

    a. National Nutrition Survey - the usefulness of survey data depends on how food items are named and grouped. Some nutrition surveys ask for the source of the food consumed so it may be possible to identify foods purchased at fast food and takeaway outlets.
    b. Household Expenditure Survey, Consumer Price Index, Food Price Index
    c. Market research data
    d. Other market baskets
    e. Consultation with experts

2. Foods and meals should be culturally acceptable, commonly eaten and widely available.

3. Identify commonly consumed foods within each food group: fruits, vegetables, grains, meat and alternatives, milk and alternatives, fats and oils, grains and baked goods; savoury snack foods; sugary foods; processed meat and alternatives; sweetened beverages; takeaways and ready meals; fats and oils (predominately saturated); alcohol.

4. The level at which the food is identified will differ depending on the source. For example, grains – breakfast cereals –muesli – Sanitarium toasted muesli - Berry Blast. The more detail available the better. If possible, use data relating to the frequency or amount of consumption as well.

5. For the pairs and food group components, the item selected must be purchasable as a single item, rather than prepared at home with added ingredients. For example, potato, not roast potato in added fat.

6. For the meals component, identify meals frequently purchased from fast food or takeaway outlets, rather than restaurants and cafes. Identify 2-6 commonly consumed meals.

7. If there is a lack of data, consult with local nutrition experts. Discuss commonly consumed foods for each food group, including snacks, takeaway items and beverages.

8. Identify seasonal foods at the time of price collection.

9. Check that the commonly consumed foods can be matched to a food in the food composition tables of the country, or that Nutrition Information Panel information is available. The tables or the nutrient analysis programme should provide data for the foods in grams (or mls) and typical serving sizes to aid in construction of menus. For example, 1 slice bread = 26g, 1 cup cornflakes = 30g.

10. The number of foods and meals selected will depend on the diversity of foods consumed in a country.

Information required for each food item:

For each food item collect:

1. Standard serving size identified through one of the following:
   a. reference serving sizes with multipliers (number of servings) in food-based dietary guidelines,
   b. serving size in food composition database,
   c. Nutrition Information Panel (size may vary between similar products depending on source so decide serving size relevant)

2. Nutrient information – energy, saturated fat, sodium, sugar, fibre. For meals - also protein and carbohydrate. For meals use food composition data, or industry information.

3. Edible portion –account for yield factors (e.g. rice, pasta) or loss factors (e.g. meat, fish) for cooked food. More information on yield factors in the section on compiling a shopping list. Account for inedible parts such as fruit skin or core, chicken bone or skin. Food composition tables usually report edible portion.

4. Tax or subsidy component – for example import, excise, value-added, goods and services taxes.

B: Food approach

Pairs

1. Choose key commonly consumed foods that have a similar *healthier* and *less healthy* item. For some items and some food groups (fruits, vegetables, eggs) there may be no or few similar items.
2. Define a relevant policy action regarding the price differential between the foods.
3. The items should contrast in the relevant nutrient(s): saturated fat, salt, added sugar, fibre. The healthier item should be recommended by food-based dietary guidelines.
4. Each item of the pair should be based on the same main ingredient.
5. Choose items that a consumer would realistically choose between for a similar end-use/purpose - meal or snack or ingredient.
6. The item should be readily available.
7. Each item of the pair should be a similar serving size by weight or volume.

Healthier and less healthy food groups

1. Assign the commonly consumed foods into food groups and categorise as healthier or less healthy according to the WHO Europe nutrient profile model.

Degree of processing

1. Categorise the commonly consumed foods according to the degree of processing. Include takeaway foods but not alcohol.
    a. Natural or minimally processed foods
    b. Processed culinary ingredients
    c. Processed products
    d. Ultra-processed products

C: Meals approach

1. Identify common serving sizes for the popular takeaway meals.
    a. Use survey data if available, market research data or local knowledge.
    b. Use a fast food menu or advertising to identify a meal that would be appropriate for the reference household of 2 adults and 2 children (aged 7, 14).
    c. The meal needs to be purchasable in the size priced, for example, whole not half pizza. Do not include beverages.
    d. The meal will contain two or more food groups.

2. Identify the minimum wage.

3. The home-made and home-assembled meals should meet the following criteria per 4 people:
    a. <24g saturated fat
    b. <3600mg sodium
    c. Minimum 20g protein
    d. 600g vegetables
    e. Use core foods with at least two of the core food groups, preferably three.
    f. Have a starch, protein and vegetable component.
    g. Maximum raw weight: 125g red meat, 150g skinless poultry, 150g fish.

4. Construct a home-made meal with similar components to the takeaway meal. Use popular recipe books and websites.

    Composition of meal:
    a. Use common ingredients that are 'acceptable' to eat.
    b. Preparation should take a reasonable time and use common kitchen equipment.
    c. Match key components in takeaway meal to home-made meal.
    d. Specify the key components and cooking methods required for each home-made meal based on ingredients in takeaway meal and meal guidelines.

e. Select meals that will increase the likelihood of meeting the nutrient criteria.
f. Match the type and form of the meat/fish/poultry component to the takeaway meal. The serving size for the home-made meal should be similar to that recommended in food-based dietary guidelines and to the size in the popular recipes. This may be slightly smaller than the takeaway meal.
g. The cooking methods between the healthy and takeaway meals may differ, for example, deep-fried compared to roast chicken.
h. Home-made meals may have more vegetables than a takeaway meal. Use seasonal vegetables.
i. Use ingredients low in sodium. A small amount of unsaturated fats or oils, sauces or condiments can be added for flavour or for cooking. Do not add salt.

Process:
j. Identify any exclusions of ingredients that make it difficult to meet the nutrient criteria.
k. Standardise common components, review recipes for unusual ingredients, modify cooking methods and ingredients if required to meet nutrient criteria. Replace saturated fats with unsaturated fats where possible.
l. Standardise the meat component across recipes of the same meal as this may be the most expensive.
m. Aim for 600g vegetables for 4 servings, if appropriate for the type of meal.
n. Adjust the ingredient amounts in the home-made meal to match the weight.
o. Determine the size of the home-made meal from typical amounts in recipes and takeaway meals. Scale to 4 servings if required.
p. Test some of the combinations to record the time to prepare and cook the meal. Calculate the hands-on preparation time. Note any changes of weight from raw to cooked, particularly meat and grains.
q. Estimate the time required to prepare the meal from a range of recipes. Do not include the cooking time. If the time is not provided, have several people prepare the meal and average the preparation time.

5. Construct a similar home-assembled meal consisting of partially prepared ingredients purchased at a store.

Composition:
a. The items will need assembling and may need cooking, unlike a ready-to-eat meal that only requires heating. Examples of ingredients are pasta, pasta sauce, stir-fry sauce, prepared vegetables (coleslaw, oven chips), grated cheese, pizza base.
b. Match the 'meat/fish/chicken or alternative' component. The serving size for the home-assembled meal should be similar to that recommended in food-based dietary guidelines and to the size in the popular recipes. This may be smaller than the takeaway meal.
c. The cooking methods between the meals may differ, for example, deep-fried compared to rotisserie chicken.

d. Home-assembled meals should be a similar weight to the takeaway and home-made meals. Adjust the amounts in the home-assembled meal to match the weight, part of a package may be used.
e. A small amount of unsaturated fats or oils, sauces or condiments can be added for flavour or for cooking if not already a meal component. Do not add salt.

Process:

f. Select a range of brands for each meal item if there is a difference due to ingredients, nutrient content, serving size or price.
g. Compile the nutrient composition of potential ingredients.
h. Select items so the meal will closely meet the meal criteria, though it is difficult to meet the maximum sodium level. Note if a sauce is high in sugar as there is no maximum level for sugar. Set a maximum sodium and saturated fat level for some items to increase the likelihood of the meal meeting the maximum sodium level.
i. Assess if the items are widely available
j. The ingredients should be priced in the package size required, for example a frozen pizza base, a jar of stir-fry sauce, or scaled if only part of a package is required. Use the package size as the serving size when close to the amount required in the meal, for example, for 600g coleslaw a package of 500g can be used.
k. Test some of the combinations to record the time to prepare and cook the meal by the same researcher in the same home kitchen. Calculate the hands-on preparation time. Do not include unsupervised cooking time. Note any changes of weight from raw to cooked, particularly meat and grains.

6. Nutrient Analysis
   a. Analyse the nutrient composition of the meals using a nutrient analysis programme.
   b. If the takeaway and convenience items chosen are not in the food composition database use nutrient data supplied by the food industry or the Nutrient Information Panel.
   c. Allow for yield and loss factors of ingredients. Calculate the weight of the meal.

7. Ingredients
   a. List all ingredients and the time in a spread-sheet.
   b. Compile a list of ingredients and record the edible weight to calculate the amount to purchase.
   c. Choose the cheapest product fit for the purpose.

D: Diet approach

Reference household

The reference household is the same for each country.

Four-person household: girl 7 years, boy 14 years, woman 45 years, man 45 years.

Healthy diet nutrient targets

1. A national nutrition survey is used to estimate the height of the adults and the corresponding weight for a BMI of 23. FAO/WHO/UNU 2004 recommendations for energy requirements[436] are used to estimate the energy requirement for moderate physical activity for children, and for a PAL of 1.70 for adults. For children, the CDC growth charts are used for weight[435] and height is from a national survey.

1. Population nutrient intake goals. The diet should meet the nutrient reference values of the country for: energy, fat (% energy), carbohydrate (% energy), protein (grams, % energy), saturated fat (% energy), fibre (g), sodium (mg). If the country does not have its own nutrient reference values, the diet should meet the WHO population nutrient intake targets listed below[319], or those of a similar country.

Nutrient/Food	**Goal**
Total fat	15-30%
Saturated fatty acids	<10%
Total carbohydrate	55-75 %
Free sugars	<10% or preferably 5%
Protein	10-15%
Sodium	<5 g salt per day (1 tsp salt, <2g sodium)
Fruits and vegetables	≥ 400g per day
Total dietary fibre	>25g per day (or fibre density >11.1 g/4184 kJ)

2. Vitamin and mineral intake goals. Select micronutrients of importance. The healthy diet should meet, or be close to meeting (within 5%), the nutrient reference values of the country, or the WHO/FAO vitamin and mineral intake goals[322] according to the health needs of the individual country.

Current diet nutrient targets

1. Identify a representative survey of the population of adults and children, ideally a survey conducted within the previous 10 years. If national survey data is not available, use a regional nutrition survey if it is representative of the population. Alternatively, use nutrition survey data from a neighbouring country if eating patterns are similar.

2. Document the average weight and height and nutrient intake for the relevant age/sex group of each member of the reference household. Nutrients: fat (g, % energy), carbohydrate (g, % energy), protein (g, % energy), saturated fat (g, % energy), fibre (g), alcohol (g, % energy), sodium (mg), sugar (g).

3. Calculate the energy requirements of the reference household using the body weight simulator[434]. Enter the mean weight and height of each member of the reference household reported or measured in a national health or nutrition survey. Measured weight is preferable, if available.

Estimate the PAL of the population from the percentage of the population meeting physical activity guidelines.

Healthy diet: Dietary patterns

1. The healthy diet will be guided by the food-based dietary guidelines of the country.
2. The following principles can be used as an alternative or in conjunction with the country's own guidelines.
    a. Diet based on a variety of foods, mainly from plants.
    b. Breads, grains, pasta, rice, starchy vegetables and roots are about half the dietary energy.
    c. Two-thirds of grains are whole-grain.
    d. 400g vegetables and fruits per day (edible portion) (do not include starchy roots and tubers).
    e. No foods high in added salt, sugar or saturated fat.
    f. Mainly reduced-fat / low-fat milk products, or alternative sources of calcium if milk products not commonly consumed (fish with bones, seaweed, dark-green leafy vegetables, wholegrain cereals, soy milk, tofu, nuts, seeds).
    g. Small servings of a range of foods from the meat, poultry, seafood, eggs, legumes, nuts and seeds group.
    h. A small amount of added unsaturated fats and oils.
3. The healthy diet will consist of the amount of each food sub-group (serving size x number of servings) recommended per week for each member of the reference household.

Current diet: Identify current patterns

Use nutrition survey data to identify the following, if possible:

- The proportion of less healthy (energy dense, nutrient poor) foods consumed.
- The grams of food consumed for the core food groups, for example, 143g fruit consumed per day by an adult male.

If the survey data does not provide data for these, identify other potential sources of information on dietary patterns:

- Food frequency data.
- Dietary habits questionnaire, for example, reported servings of fruit per day, how often wholemeal bread is consumed.
- Sources of energy from food groups.

Healthy diet: Menu

1. Use the following to construct a two-week menu plan for each member of the reference household:
    a. Commonly consumed foods
    b. Dietary guidelines
    c. Recommended number of servings per week

   d. Nutrient reference values
2. Choose commonly consumed foods that are also core foods.
3. The menu will have no energy-dense, nutrient-poor foods. Add healthy fats and oils for cooking and dressings. Healthy convenience foods can be used if common.
4. Tea and coffee are not included.
5. Construct a diet without alcohol. If alcohol is commonly consumed, a scenario of a menu with alcohol could also be analysed.

Current diet: Menu

1. Use the following, when available, to construct a 2-week menu plan for each member of the reference household:
   a. commonly consumed foods
   b. % of energy-dense, nutrient-poor foods consumed
   c. number of servings per week currently consumed for each food group
   d. % whole-grain and refined grains consumed
   e. proportion of low and full-fat dairy products consumed
   f. whether fat is trimmed from meat and skin removed from poultry
   g. types of vegetables consumed
   h. common types of fats and oils used
2. Include alcohol in the menus of adults if alcohol is commonly consumed. A scenario of a menu without alcohol could also be analysed.
3. Tea and coffee are not included, though drinking chocolate and other powdered beverages that provide energy may be included.

Both menus

1. Follow common eating patterns, for example, breakfast, lunch, dinner, snacks.
2. Use realistic combinations of the food groups usually represented in a meal, for example dinner has meat or an alternative, a grain or starchy vegetable, and vegetables.
3. Select foods that are culturally acceptable, available, accessible and affordable.
4. Select seasonal foods at the time of price collection.
5. Use similar foods for each member of the reference household, as long as they are commonly consumed, so the overall household shopping basket is realistic. Household members often share the same main meal but may differ in snack choices.
6. Select meals that can be prepared by most households using common cooking equipment. Include cooking fats and sauces but not small amounts of herbs and spices.

Guidance for menu construction

Construct one household menu for the current menu then adapt the amounts and types of foods for the individual.

For the healthy menu

1. Construct a new menu or,

2. Change the current menu, compare recommended grams or serving sizes from each food group to identify where to increase or reduce foods.

Analyse nutrient profile of menus

1. Analyse the nutrient profile of the menu using a food analysis programme with a food composition database for the relevant country, or a database from a country with similar foods. Check that the data is complete for the relevant nutrients for each food in the menu.
2. Enter edible portion.
3. Analyse the two-week menu plan for each member of the reference household. Adjust to meet the nutrient intakes, energy requirements and recommended servings from food groups while following dietary principles.

Convert to a shopping list.

Use the excel worksheet to calculate the following.

1. Combine the individual menu plans to construct a menu plan for the household.
    a. Use the list of commonly consumed foods with information about serving size, volume, edible portion, proportion of food group etc.
    b. List the amount of each food item required.

2. Convert to edible portion
    a. Use the yield factors for your country, or the following: Bognar(373,374), USDA(374), UK(375).
    b. Rice and pasta: convert to dry weight.
    c. Meat and alternatives: convert to raw weight, account for wastage (skin, bone etc).
    d. Cooked weight/yield factor = amount to purchase, for example, 120/0.7 = 171g.
    e. Food composition tables should provide edible portion.
    f. Note the drained weight of canned foods.

3. Identify the amount to price. For packaged items, price the most common package size or if not known, the medium package size. For fruit and vegetables price the package size or price per kilogram.

Food Affordability

OECD countries:
The OECD reports median disposable household income in national currency. All income data are equivalised by the square root of household size. Use the reported household income for your country from http://stats.oecd.org/Index.aspx?DataSetCode=IDD.

Other countries:
1. Use the most recent household income survey.
2. Check the following:
    a. Is mean or median income reported?

b. Is income gross or disposable (after tax)?
c. Is income capita, per household? Is the household size stated?
d. Is the household income equivalised for household size?
e. Is the definition of household income similar to the OECD definition?

3. Calculate household income for the reference household or use the reported income:
    a. Median income.
    b. Disposable (less tax and current transfers) income. If disposable household income is not available, the Inland Revenue Department may have an online calculator that could be used to estimate the median household tax rate to then calculate the median disposable household income.
    c. Own country's currency.
    d. If data is provided per capita, equivalise to the reference household by multiplying by the OECD adjustment (the square root of household size which is 2 for a household of 4).
4. Measure affordability by calculating the percentage of weekly household income required to purchase each diet.

Appendix Two: Rationale for selection of commonly consumed foods in NZ

Rationale for inclusion of commonly consumed foods identified in the HES and NZANS

Key:

Selection of items differ between methods.

Inclusion marginal, decision to include.

Inclusion marginal, decision to not include.

Fruit HES: Include all categories if purchased by >20% households, include individual fruit if >13%	
Apples, fresh	
Bananas, fresh	
Grapes, fresh	
Kiwifruit, fresh	
Mandarins, fresh	
Nectarines, fresh	
Oranges, fresh	
Peaches, canned	Canned fruit high consumption NZANS. Selected peaches to represent.
Pears, fresh	
Sultanas, dried	Raisins/sultanas highest purchased dried fruit but only by 5.3% households in HES. Dried fruit consumed by less people compared to other fruit. Selected sultanas as in FPI.
Berries	Low expenditure. Moderate consumption NZANS. Seasonal and wide price variation.
Canned pineapple	Purchased by 9.6% households, canned fruit represented by peaches. Low consumption NZANS.
Fresh pineapple	Purchased by 4.3% households. Low consumption NZANS.
Vegetables HES Include all categories with >20% households purchasing, include individual vegetable if >10%.	
Avocados, fresh	
Broccoli, fresh	
Cabbage, fresh	
Capsicums, fresh	
Carrots, fresh	
Cauliflower, fresh	
Courgettes, fresh	Highly purchased HES. Moderate consumption NZANS.

Cucumber, fresh	
Lettuce, fresh	
Kumara, fresh	
Mixed vegetables, frozen	Frozen vegetables highly purchased HES but type not stated.
Mushrooms, fresh	
Onions, fresh	
Peas, frozen	Frozen vegetables highly purchased HES but type not stated.
Potatoes, fresh	
Potato fries, frozen	Potato products had a high consumption NZANS so selected potato fries to represent. Provides a convenience product.
Pumpkin, fresh	Consumption of individual gourds not provided HES. Selected pumpkin to represent category. Moderate consumption NZANS
Silverbeet, fresh	Not purchased by many households. Moderate consumption NZANS. Represents other green leafy vegetables (spinach etc).
Tomatoes, fresh	
Tomatoes, canned	
Corn (child)	Separated into fresh, canned, frozen in HES, purchased by >10% households for each. Difficult to separate canned, frozen and fresh in NZANS. Corn common in children's FFQ.
Taro	Not a separate item. Low consumption NZANS
Celery, fresh	Purchased by <10% households. Moderate frequency NZANS
Green beans	Purchased by <10% households for fresh and frozen combined. Fresh and frozen not separated NZANS, already 2 frozen vegetables.
Grains HES Purchased by >10% households	
Bread, white	
Bread, wheatmeal	
Bread, wholegrain	
Pita bread	Purchased by 9.4% households HES. Category of flat bread, tortillas, roti etc had a high frequency so selected pita bread to represent category.
Cake, fruit	Type not specified HES. Cake high consumption NZANS. Fruit cake slightly higher frequency than other cakes.
Biscuits, plain gingernut	Type not specified HES. Plain biscuits high consumption NZANS. Difficult to select most common.

Biscuits, Tim Tam	Type not specified HES Chocolate biscuits high consumption NZANS. Difficult to select most common.
Biscuits, crackers Shapes	Type not specified HES. Crackers high frequency, especially high fat. Shapes most common.
Muffins	No separate category HES. Category of muffins, scones and pikelets high consumption NZANS. Similar for muffin and scone, not stated if home-made or purchased.
Cornflakes	
Muesli, toasted	
Wheat biscuits	
Rolled oats	
Rice bubbles (child)	High frequency children's FFQ so added for child.
Pasta dried	
Quick noodles, 2 minutes	Noodles not further defined in HES, purchased by 5.3% households. Consumption high NZANS.
Rice, long grain, white	
Spaghetti, canned	
Bread rolls	Consumption low for rolls in NZANS.
Meat, poultry, seafood, eggs, legumes, nuts	
Eggs	
Beef, corned silverside	High expenditure for beef in HES so require several cuts. Beef for grilling, frying, minced most popular followed by corned, cut not provided. Difficult to select cuts of meat from NZANS as wide range. Selected range of common cuts: stewing, grilling, mince.
Beef steak, blade	
Beef steak, rump	
Beef, mince, stewed	
Chicken breast fresh	
Whole cooked chicken (supermarket)	Most common form of whole chicken in NZANS, include so a convenience food.
Lamb shoulder chops	Lamb purchased by fewer households in HES compared to beef so only 1 cut. Difficult to select cuts as wide range in NZANS.
Pork leg roast	Pork purchased by fewer households compared to beef so only 1 cut. Pork for grilling, frying most popular, cut not provided. Difficult to select cuts as wide range in NZANS.
Bacon, middle rashers	
Ham, sliced or shaved	
Sausages	
Luncheon sausage (child)	Not purchased by many households HES. High frequency children's FFQ.

Fish fillets, fresh	Only 2 types of fish named in HES, tarakihi most popular. Difficult to select type as wide range in NZANS.
Tuna, canned	
Fish fillets, frozen	Frozen fish fillets purchased by 6% households. Crumbed hoki common in NZANS but not specified whether home-made or purchased crumbed. Added so a convenience food.
Baked beans regular	
Peanuts, plain	Type of nut not specified HES. One of most common nuts NZANS.
Almonds, plain	Type of nut not specified HES. One of most common nuts NZANS.
Chicken nuggets	Not common NZANS.
Mussels	Not common NZANS.
Fish fingers, fish cakes	Not common NZANS.
Dairy	Selected foods with high number of households purchasing item within category
Cheese, Colby	Type not defined HES. Colby slightly more frequent than tasty NZANS.
Cheese, Edam	
Milk, trim	Type not defined HES. Trim milk selected to represent lower-fat milks.
Milk, standard	
Yoghurt, full-fat flavoured	Type not specified.
Cream	Purchased by 21% households. Not common NZANS.
Processed cheese slices	Purchased by 10.7% households. Not common NZANS.
Cheese, Camembert	Not common NZANS.
Fats & Oils	
Butter	
Margarine, canola, regular fat	Similar consumption for different types NZANS so selected canola regular fat to represent.
Olive oil	
Canola oil	
Snacks	
Chocolate, dairy milk	Selected as proxy for other chocolate items.
Sweets - soft	
Ice cream, plain	
Muesli bar	
Potato crisps	
Ice blocks	Not purchased by many households.
Sauces, dressings, spreads, sugars	

Jam	Purchased by more households than honey. Honey also common in NZANS, selected jam to represent sweet spreads.
Peanut butter	
Vegetable soup, canned	Similar number of households purchased canned and dried soup in HES. Soup high consumption NZANS, similar for home-made, canned, dried. Vegetable soup most common flavour.
White sugar	
Mayonnaise, regular	
Tomato sauce	
Pasta sauce	Individual items not specified in HES but high number households purchased items in category of meal additives. Moderate consumption NZANS but higher than other sauces, used to represent category.
Soy sauce	Purchased by low number households HES. Low amount consumed NZANS.
Takeaways	
Meat pie	
Hot chips	
Battered fish	
Pizza	
Burger	
Filled roll and sandwiches	Common in NZANS but many home-made and individual ingredients represented.
Alcohol	
Wine, medium white	Type not stated HES. Similar consumption NZANS red and white wine so selected medium white to represent category.
Beer, draught	Type not stated HES. Similar consumption lager, draught and bitter so selected draught to represent category.
Beverages	Wide range of beverages common so selected categories to represent.
Milo, powder	Drinking chocolate purchased by moderate number of households. Milo high number of consumers NZANS.
Cola	Highly purchased item HES. Cola flavoured drinks to represent soft drinks as most common type NZANS.
Diet cola	Diet drinks not separated in HES. Diet cola to represent soft drinks as most common type NZANS.
Fruit drink orange	Selected orange to represent fruit drinks as most common type NZANS.
Orange juice	Type of juice not stated HES. Selected orange to represent fruit drinks as most common type NZANS.
Drink Powder	Category of drink concentrate/powder high expenditure HES. Difficult to judge consumption as mix of powdered drink and diluted form in NZANS.

Bottled water	Purchased by moderate number of households HES but expenditure low compared to other drinks. Low frequency NZANS compared to other drinks. Added for pairs' comparison.
Energy drinks	Not purchased by many households HES. Low frequency NZANS.

Rationale for addition of healthy foods

Item	**Explanation**
Lentils canned in spring-water	Legumes not a common food (except baked beans) but required legumes for healthy diet. Lentils selected to represent category.
Hummus	High number of households purchased dips HES but type not stated. Adds another legume to healthy diet. In FPI.
Wholegrain crackers	Lack of snacks for healthy diet. Crackers are commonly consumed. Lack of information to identify common wholegrain crackers so selected a product placed at eye-level or popular brand with a high Health Star Rating (4.5)
Lamb, loin chop	Lamb shoulder chop identified as common but high in fat so selected a leaner chop.
Cottage cheese	Selected to provide more variety for lunches and snacks. In FPI.

Appendix Three: Meals used in the exploratory work to guide development of the meals approach

Table 88: Meal description

	Home-made meal	**Home-assembled meal**	**Takeaway meal**
Fish and chips	Fish fillets crumbed (120g per serve) Potato wedges – home-made Pre-prepared coleslaw, mayonnaise	Crumbed frozen fish fillets (120g per serve) Oven fries Pre-prepared coleslaw, mayonnaise	4 battered fish fillets (146g per serve) 2 scoops chips
Pizza	Scone dough Sauce of tomato paste & tin tomatoes Toppings: cheese, onion, ham, mushroom, tomato, capsicum	Frozen pizza reheated	16 slices Domino’s classic supreme deep-crust pizza
Burger & chips	Burger bun Meat patty: mince (70g per serve), egg, breadcrumbs, onion Filling: lettuce, tomato, grated carrot, tomato sauce, slice cheese Potato wedges – home-made	Burger bun Meat patty: pre-prepared Filling: lettuce, tomato, grated carrot, tomato sauce, slice cheese Oven fries	4 Big Macs 4 medium fries
Chicken and vegetables	Roast chicken (130g per serve) Roast potatoes Boiled carrots Frozen peas	Rotisserie chicken (125g per serve) Fresh bakery bread Pre-prepared coleslaw, mayonnaise	KFC family pack 8 pieces chicken (164g per person) 1 large fries 1 large potato & gravy 1 large coleslaw

Table 89: Nutrients per serving

	Home-made meal	Home-assembled meal	Takeaway meal
Fish and chips			
Weight (g)	1570	1440	1244
Energy (kJ)	2112	2555	3380
Fat (g)	29	26	47
Saturated fat (g)	5	3.6	23
Sodium (mg)	372	648	772
Number servings vegetables	3	3	0*
Pizza			
Weight (g)	1410	1350	1280
Energy (kJ)	2074	2872	4061
Fat (g)	19	22	20
Saturated fat (g)	8.3	11	9
Sodium (mg)	754	2059	1820
Number servings vegetables	2.3	0.5*	0.5*
Burger and chips			
Weight (g)	1400	1400	1412
Energy (kJ)	2064	2248	4376
Fat (g)	18	29	53
Saturated fat (g)	5	11	13
Sodium (mg)	488	1334	1546
Number servings vegetables	2.5	2.5	0.5*
Chicken and vegetables			
Weight (g)	1720	1650	1654
Energy (kJ)	1805	2875	2639
Fat (g)	17	15	37
Saturated fat (g)	4	3	9
Sodium (mg)	127	1418	1117
Number servings vegetables	4	1.5	2.5

NB Vegetables includes mashed potatoes and home-made wedges but not deep-fried potato chips. Serving sizes for vegetables: 75g non-starchy, 135g starchy.

* An estimate of the vegetables in toppings/fillings

Table 90: Cost of meals with and without time

Meal (4 servings)	Home-made meal	Home-assembled meal	Takeaway meal
Fish and chips			
Cost without time	$13.23	$16.13	$22.80
Cost with time	$18.15	$17.36	$22.80
Preparation time (minutes)	20	5	0
Pizza			
Cost without time	$9.36	$20.39	$22.30
Cost with time	$14.28	$20.88	$22.30
Preparation time (minutes)	20	2	0
Burger and chips			
Cost without time	$9.95	$14.12	$34.80
Cost with time	$16.10	$17.81	$34.80
Preparation time (minutes)	25	15	0
Chicken and vegetables			
Cost without time	$10.95	$17.08	$27.90
Cost with time	$14.64	$18.31	$27.90
Preparation time (minutes)	15	5	0

Table 91: Criteria met by different meals for classification systems

	Food & Beverage Classification			**Canadian Heart & Stroke Foundation**			**Traffic Lights**			**NZ Heart Foundation**			**Pick the Tick**		
	E	SF	Na	F	SF	Na	F	SF	Na	SF	Na	E	SF	Na	Veg
Fish and chips															
HM	✓	✓	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
HA	✓	✓	✓		✓	✓		✓	✓	✓			✓	✓	✓
TA			✓			✓			✓					✓	
Pizza															
HM	✓	✓	✓	✓	✓	✓			✓			✓		✓	✓
HA	✓	✓													
TA		✓	✓	✓											
Burger & chips															
HM	✓	✓	✓	✓	✓	✓		✓	✓		✓	✓	✓	✓	✓
HA	✓		✓						✓					✓	✓
TA		✓	✓												
Chicken meal															

HM	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
HA	✓	✓	✓	✓	✓			✓		✓			✓		✓
TA	✓	✓	✓						✓						✓

E = energy, SF = saturated fat, F = fat, Na = sodium

HM = home-made meal, HA = home-assembled meal, TA = takeaway meal

Appendix Four: Example of recipes for meals approach using fish and chips

(13 identified, 3 recipes deleted as similar to others)

Recipe	Summary ingredients, cooking method	Original recipe	Modified recipe
1 Nacho-crumbed Fish Countdown online	egg corn chips pan-fry	500g Basa fillets cut into 3cm wide strips 2 eggs, lightly beaten with 1T water 100g corn chips, crushed oil for frying	500g fish fillets 1 egg, lightly beaten with ½T water 125g corn chips 2T canola oil
2 Fish and Chips Healthy Food Guide Dec 2008	egg, fresh breadcrumbs bake	4 white fish steaks (about 170g each) 2 eggs, lightly beaten 2T reduced-fat spread, melted 1T oil 1½C breadcrumbs lemon pepper seasoning	500g fish fillets 2 eggs, lightly beaten 2T reduced-fat spread, melted 1T oil 1½C fresh breadcrumbs black pepper
3 Nadia's Fish n' chips	flour, egg, dry breadcrumbs pan-fry	4 fillets (120-150g each) fish ⅓C flour black pepper 1 egg, beaten ¾C breadcrumbs 2T canola oil	500g fish fillets ⅓C flour 1 egg, beaten ¾C dry breadcrumbs 2T canola oil black pepper
4 Crumbed fish Food Truck	sautéed fresh breadcrumbs, Dijon mustard bake	4 x 100g fillets snapper 3T olive oil ½ loaf wholemeal bread, processed into breadcrumbs pinch each salt and white pepper 2t Dijon mustard	500g fish fillets 2T canola oil 3 toast slices wholemeal bread, processed into breadcrumbs (90-100g) 3t Dijon mustard black pepper
5 Oven-baked Fish and Chips Alison Holst	seasoned flour, egg bake	4 fish fillets (150g each) ½C self-raising flour ½t salt ½t sugar ½t cumin ½t oreganum ½t paprika	500g fish fillets ½C self-raising flour ½t ground cumin ½t oreganum ½t paprika 2T canola oil 1 egg, beaten

		2-3T oil 1 or 2 eggs, beaten	
6 Pan-fried fish Edmonds	flour, egg, fresh breadcrumbs pan-fry	4 fillets firm white fish ½C plain flour 1t grated lemon rind salt pepper 1 egg 2T water 2½C soft breadcrumbs 2T butter 2T oil lemon slices	500g fish fillets ½C standard plain flour 1t grated lemon rind 1 egg 2T water 1½C soft breadcrumbs (approx 3 slices) 2T canola oil
7 Basic pan-fried fish fillets Alison Holst	flour pan-fry	150g fish fillets milk (optional) ¼C plain flour ½t salt 2-3t olive oil 2-3t butter	500g fish fillets ½C flour 2T canola oil
8 Oven-fried fish Alison Holst	milk, dry breadcrumbs bake	600g boneless, skinless fish fillets ¼C milk ½t garlic salt or plain salt ½C dry breadcrumbs 2T butter, melted 2T oil	500g fish fillets ¼C milk ½C dry breadcrumbs 2T canola oil
9 Fast fried fish Alison Holst	seasoned egg, self-raising flour pan-fry	4 skinless, boneless fish fillets about ½C self-raising flour 1 egg ½t salt black pepper	500g fish fillets ½C self-raising flour 1 egg black pepper 2T canola oil
Potatoes		Combination of recipes	800g potatoes (620g cooked) 2T canola oil

Excluded recipes

Source	**Rationale for exclusion**
New World	Similar ingredients to other recipes
Healthy Food Guide August 2012	Similar ingredients to other recipes
Heart Foundation Healthy living	Similar ingredients to other recipes

Appendix Five: Menus developed for diet approach

Healthy Menu: Adult male one week example

	Breakfast	g	Lunch	g	Dinner	g	Snacks	g	Drinks	Fats & Oils	g
Monday	Wheat biscuits	65	Bread multigrain	120	Beef mince	100	Grapes	120	Water	Margarine	35
	Yoghurt natural	100	Cucumber	50	Tomatoes canned	75	Almonds	30			
	Milk trim	180	Tuna	120	Frozen mix vegetables	75	Bread wholemeal	65			
	Kiwifruit	120			Cauliflower	75	Avocado	50			
					Silverbeet	75	Cottage cheese	40			
					Spaghetti wholemeal	300	Orange	120			
Tuesday	Porridge	250	Bread multigrain	125	Beef rump steak	100	Mandarin	120	Water	Olive oil	35
	Milk trim	180	Egg	110	Kumara	300	Yoghurt flavoured	200			
	Peaches canned	120	Tomatoes	50	Peas green frozen	100	Raisins	50			
			Cucumber	50	Potato boiled	100	Peanut butter	50			
			Pasta	300			Cracker wholegrain	40			
Wednesday	Wheat biscuits	75	Bread multigrain	140	Chicken rotisserie	120	Apple	120	Water	Olive oil	35
	Yoghurt natural	100	Avocado	50	Potato boiled	300	Cheese Edam	80			
	Milk trim	180	Lettuce	25	Carrot	75	Bread wholemeal	75			
	Banana	120	Tomatoes	25	Broccoli	100	Orange	120			
							Peanuts	20			
							Cracker wholegrain	60			
Thursday	Porridge	300	Pita bread white	250	Chicken breast	120	Nectarine	120	Water	Canola oil	35
	Milk trim	180	Hummus	50	Courgette	25	Yoghurt natural	200			

	Breakfast	g	Lunch	g	Dinner	g	Snacks	g	Drinks	Fats & Oils	g
	Pear	120	Cucumber	30	Cabbage	50	Cheese Edam	80			
			Lettuce	30	Capsicum green	50	Cracker wholegrain	40			
					Rice white	300	Mandarin	80			
Friday	Muesli	110	Rice brown	350	Potato boiled	300	Cheese Edam	50	Water	Canola oil	35
	Yoghurt natural	100	Almonds	30	Fish fresh	140	Cracker wholegrain	40			
	Milk trim	180	Cucumber	30	Peas green frozen	100	Orange	120			
	Banana	120	Capsicum	75	Pumpkin	75	Bread multigrain	140			
			Mushrooms	75	Broccoli	50	Peanut butter	30			
			Egg	55			Apple	120			
Saturday	Wheat biscuits	75	Bread multigrain	100	Lamb chop	120	Orange	120	Water	Margarine	30
	Yoghurt natural	150	Baked beans	250	Pasta	300	Bread wholemeal	70			
	Milk trim	160			Carrot	50	Hummus	70			
	Apple	120			Cabbage	50	Banana	60			
					Courgette	50	Almonds	30			
Sunday	Bread multigrain	125	Bread multigrain	185	Lentils	150	Apple	120	Water	Margarine	35
	Egg	110	Pumpkin soup	150	Rice brown	300	Milk trim	100			
			Cheese Edam	80	Tomatoes canned	100	Hummus	70			
			Banana	120	Onion	50	Kiwifruit	60			
					Mushrooms	50	Cottage cheese	50			
					Carrot	50	Cracker wholegrain	40			
							Peanuts	40			

Current Menu: Adult male one week example

Adult Male	Breakfast	g	Lunch	g	Dinner	g	Snacks	g	Beverages	g	Other	g
Monday	Wheat biscuits	40	Bread white	150	Potato boiled	250	Apple	130	Water		Butter	30
	Milk whole	130	Lettuce	70	Peas green frozen	75	Gingernut	20	Diet coke	300	White sugar	10
	Milk trim	60	Tomato	70	Carrot	75	Yoghurt flavoured	200				
	Peaches canned	60	Corned beef	50	Chicken rotisserie	220	Instant noodles	300				
			Mayonnaise	50								
Tuesday	Cornflakes	40	Soup, vegetable	250	Potato boiled	250	Pear	130	Water		Butter	30
	Milk whole	130	Bread white	140	Silverbeet	75	Gingernut	20	Milo	25	White sugar	10
	Milk trim	60	Tomato	30	Frozen vegetables	75	Blueberry muffin	80				
	Peaches canned	60	Ham	90	Sausage beef	250						
					Tomato sauce	30						
Wednesday	Wheat biscuits	40	Bread white	170	Chicken drumstick	220	Nectarine	70	Water		Margarine	30
	Milk whole	130	Spaghetti canned	300	Kumara baked	200	Tim Tam	40	Milo	25	White sugar	10
	Milk trim	60	Cheese Colby	60	Pumpkin baked	75	Peanuts salted	50	Juice	300		
	Banana	60			Broccoli	75			Beer	600		
					Frozen vegetables	75						

Thursday	Porridge	200	Fresh fish	200	Pork leg roast	150	Apple	130	Water		Margarine	30
	Milk whole	130	Cucumber	35	Potato boiled	150	Crackers	30	Milo	25	White sugar	10
	Milk trim	60	Lettuce	35	Broccoli	75	Cheese Colby	80	Beer	500		
	Banana	60	Rice white	350	Cabbage	75	Chocolate bar	70				
					Kumara baked	50	Bread multigrain	140				
							Almonds	30				
Friday	Porridge	200	Pie mince	250	Rice white	250	Peanut butter	40	Water		Margarine	30
	Milk whole	130			Beef blade steak	200	Mandarin	65	Fruit drink	250	White sugar	10
	Milk trim	60			Courgette	75	Fruit cake	50	Beer	500		
	Banana	60			Cauliflower	75	Bread multigrain	140				
Saturday	Bread wheatmeal	140	Bread multigrain	140	Fish battered	150	Grapes	80	Water		Canola oil	30
	Milk whole	130	Egg	110	Chips	250	Blueberry muffin	100	Coca cola	500	White sugar	10
	Milk trim	60	Avocado	20			Muesli bar	70	Wine	320		
	Jam	50					Kiwi fruit	60				
Sunday	Egg	110	Pizza	150	Pasta	350	Raisins	15	Water		Olive oil	30
	Milk whole	130			Mince	200	Potato crisps	80	Beer	600	White sugar	10
	Milk trim	60			Tomatoes canned	75	Ice cream	120	Coca cola	400		
	Bread white	150			Onion	70						
					Mushrooms	75						
					Capsicum green	75						
					Pasta sauce	60						

Appendix Six: Amount of food in household diets per fortnight

Current diet

Food	**Household**		**7-year old girl**	**14-year old boy**	**Adult woman**	**Adult man**
	Edible amount (g)	Amount to purchase (g)	Edible amount (g)	Edible amount (g)	Edible amount (g)	Edible amount (g)
Fruit						
Apple	1520	1727	490	380	260	390
Banana	1910	3131	480	470	470	490
Grapes	760	792	240	120	240	160
Kiwifruit	900	1200	270	240	270	120
Mandarin	800	1111	375	130	165	130
Nectarine	600	652	250	70	140	140
Orange	1170	1828	520	260	260	130
Peaches canned	660	1100	0	180	240	240
Pear	710	807	230	130	220	130
Sultanas	105	105	0	20	50	35
Vegetables						
Avocado	135	193	20	25	50	40
Broccoli	1015	1450	225	265	225	300
Cabbage	600	800	150	150	150	150
Capsicum green	360	409	0	110	100	150
Carrot	755	868	255	125	225	150
Cauliflower	550	1019	150	100	150	150
Corn	180	180	180	0	0	0
Courgette	400	444	0	100	150	150
Cucumber	200	206	0	30	105	65
Frozen mix vegetables	1040	1040	225	215	300	300
Kumara	1150	1322	150	400	350	250
Lettuce	685	856	120	100	255	210
Mushrooms	410	410	0	110	150	150
Onion	420	494	0	80	200	140

Food	Household		7-year old girl	14-year old boy	Adult woman	Adult man
Oven baked fries	1220	1220	270	550	200	200
Peas green frozen	950	950	300	200	225	225
Potato	3880	4311	480	1150	1050	1200
Pumpkin	550	764	150	100	150	150
Silverbeet	550	663	150	100	150	150
Tomato	730	730	120	150	255	205
Tomatoes canned	495	825	70	125	150	150
Dairy						
Cheese Colby	750	750	230	180	200	140
Cheese Edam	300	300	100	120	40	40
Milk trim	3610	3610	940	700	1120	850
Milk whole	6630	6630	1010	2680	1120	1820
Yoghurt flavoured	1650	1650	700	300	300	350
Yoghurt natural low fat	150	150	0	0	150	0
Grains						
Bread multigrain	1880	1880	250	700	370	560
Bread wholemeal	960	960	150	200	190	420
Bread white	4120	4120	830	1470	700	1120
Pita bread white	680	680	0	200	280	200
Muesli	330	330	0	60	190	80
Pasta	3270	1363	420	1050	750	1050
Rolled oats	1700	294	400	0	900	400
Rice white	2930	1221	270	1050	560	1050
Rice bubbles	120	120	120	0	0	0
Spaghetti canned	920	920	150	250	220	300
Wheat biscuits	1045	1045	315	350	220	160
Cornflakes	760	760	215	285	180	80
Meat and alternatives						
Almonds	120	120	0	20	50	50
Beef mince	1130	1329	130	300	300	400
Beef blade steak	560	789	60	150	150	200
Beef rump steak	570	803	70	150	150	200
Chicken breast	660	880	70	150	220	220

Food	Household		7-year old girl	14-year old boy	Adult woman	Adult man
Chicken drumstick	630	1313	60	200	150	220
Chicken rotisserie	1220	1848	120	360	300	440
Corned silverside	310	508	0	110	100	100
Eggs	945	1112	120	220	165	440
Fish frozen fillets	365	384	30	60	75	200
Fresh fish	365	429	30	60	75	200
Lamb chop	520	867	70	150	150	150
Pork leg roast	560	848	60	200	150	150
Tuna canned	360	493	0	100	180	80
Peanut butter salt	285	285	65	70	70	80
Baked beans	1020	1020	100	400	220	300
Fats and Oils						
Margarine	490	490	45	175	120	150
Canola oil	165	165	20	45	40	60
Olive oil	170	170	20	50	40	60
Butter	435	435	40	120	125	150
Discretionary items						
Instant noodles	2350	522	200	1150	200	800
Biscuit, Tim Tam	360	360	80	70	120	90
Muffin	480	480	0	80	120	280
Crackers, Shapes	410	410	150	120	80	60
Fruit cake	325	325	0	70	85	170
Biscuit, ginger-nut	490	490	150	150	60	130
Bacon	170	221	0	80	0	90
Ham	380	380	90	100	60	130
Luncheon	70	70	70	0	0	0
Salted peanuts	230	230	0	90	60	80
Sausage beef	1390	1782	170	420	300	500
Chocolate bar	520	520	80	180	120	140
Ice cream	970	970	240	390	100	240
Lollies, jelly beans	80	80	0	80	0	0
Muesli bar	310	310	90	150	0	70
Potato crisps	830	830	190	360	120	160

Food	Household		7-year old girl	14-year old boy	Adult woman	Adult man
Jam	270	270	70	70	30	100
Mayonnaise	270	270	0	90	80	100
Pasta sauce	470	470	80	130	140	120
Soup, vegetable canned	1250	625	0	250	500	500
Tomato sauce	235	235	55	80	40	60
White sugar	515	515	80	160	135	140
Takeaways						
Big Mac	840	840	0	390	150	300
Chips	1040	1040	150	520	120	250
Fish battered	620	620	120	200	150	150
Pie mince	1230	1230	100	730	150	250
Pizza Hawaiian	1240	1240		890	200	150
Beverages						
Cola	6900	6900	1250	3100	800	1750
Diet cola	950	950	0	0	350	600
Fruit drink	2235	2235	560	580	525	570
Milo	420	420	120	100	75	125
Orange juice	2450	2450	450	850	650	500
Powdered drink	25	25	0	0	0	25
Beer	5290	5290	0	0	490	4800
Wine	1870	1870	0	0	1450	420

Healthy diet

Food	Household		7-year old girl	14-year old boy	Adult woman	Adult man
	Edible amount (g)	Amount to purchase (g)	Edible amount (g)	Edible amount (g)	Edible amount (g)	Edible amount (g)
Fruit						
Apple	3380	3841	740	720	960	960
Banana	3450	5656	690	960	960	840
Grapes	920	958	200	240	240	240
Kiwifruit	1530	2040	280	500	390	360

Food	Household		7-year old girl	14-year old boy	Adult woman	Adult man
Mandarin	1480	2056	240	600	240	400
Nectarine	960	1043	240	240	240	240
Orange	3360	5250	720	960	720	960
Peaches canned	960	1600	0	240	480	240
Pear	970	1102	130	240	360	240
Sultanas	320	320	60	80	80	100
Vegetables						
Avocado	700	1000	100	200	200	200
Broccoli	1330	1900	300	390	200	440
Cabbage	900	1200	200	300	200	200
Capsicum green	780	886	0	300	230	250
Carrot	2290	2632	610	680	650	350
Cauliflower	420	778	70	100	100	150
Corn	150	150	150	0	0	0
Courgette	400	444	0	100	150	150
Cucumber	740	762	0	240	180	320
Frozen mix vegetables	600	600	250	100	100	150
Kumara	1700	1954	200	500	400	600
Lettuce	530	663	180	120	120	110
Mushrooms	800	800	0	300	250	250
Onion	410	482	60	150	100	100
Peas green frozen	1290	1290	300	340	250	400
Potato	4300	4778	600	1300	1000	1400
Pumpkin	1600	2222	150	150	150	150
Silverbeet	500	602	150	100	100	150
Tomato	520	520	60	160	150	150
Tomatoes canned	1030	1717	120	400	160	350
Dairy						
Cheese Edam	2000	2000	360	640	420	580
Cottage cheese	310	310	0	0	130	180
Milk trim	10940	10940	2800	3820	2000	2320
Yoghurt flavoured	1600	1600	500	400	300	400
Yoghurt natural low fat	5340	5340	740	1700	1600	1300

Food	Household		7-year old girl	14-year old boy	Adult woman	Adult man
Grains						
Bread multigrain	6060	6060	800	1650	1740	1870
Bread wholemeal	1800	1800	500	460	420	420
Bread white	830	830	0	830	0	0
Pita bread white	1800	1800	400	500	400	500
Crackers, wholegrain	1460	1460	310	360	350	440
Muesli	620	620	0	200	200	220
Pasta	3600	1500	400	1400	600	1200
Pasta wholemeal	2100	875	300	700	500	600
Rolled oats	4440	928	1200	940	1200	1100
Rice brown	4540	1892	800	1400	1040	1300
Rice white	2300	958	400	700	600	600
Spaghetti canned	600	600	0	600	0	0
Wheat biscuits	1690	1690	480	420	360	430
Cornflakes	150	150	0	150	0	0
Meat and alternatives						
Almonds	530	530	60	150	140	180
Beef mince	820	965	160	300	160	200
Beef rump steak	820	1155	160	300	160	200
Chicken breast	880	1173	160	320	160	240
Chicken rotisserie	860	1303	160	300	160	240
Egg	1690	1988	260	660	220	550
Fish frozen fillets	390	411	70	130	70	120
Fresh fish	530	624	70	170	130	160
Lamb chop	460	767	80	160	100	120
Pork leg roast	460	697	80	160	100	120
Tuna canned	820	1123	120	300	160	240
Peanut butter no salt, or sugar	550	550	70	280	40	160
Peanuts plain	420	420	60	150	90	120
Lentils, canned	1200	2000	200	400	300	300
Hummus	1160	1160	120	420	240	380
Baked beans	1900	1900	300	800	300	500

Food	Household		7-year old girl	14-year old boy	Adult woman	Adult man
Fats and Oils						
Margarine	660	660	90	220	150	200
Canola oil	440	440	50	150	100	140
Olive oil	450	450	60	150	100	140

Appendix Seven: Diet scenario with fewer foods priced

Standard Diet	Healthy diet with fewer foods	Current diet with fewer foods
Fruit		
Apple	Apple	Apple
Nectarine		
Pear		
Banana	Banana	Banana
Grapes		
Sultanas		
Peaches canned	Peaches canned	
Kiwifruit	Kiwifruit	Orange
Mandarin	Orange	
Orange		
Vegetables		
Broccoli	Broccoli	Broccoli
Cauliflower		
Silverbeet	Silverbeet	
Cabbage	Cabbage	Cabbage
Courgette		
Carrot	Carrot	Carrot
Mushrooms	Mushrooms	
Frozen mix vegetables	Frozen mix vegetables	Frozen mix vegetables
Corn		
Peas green frozen		
Lettuce	Lettuce	Lettuce
Cucumber		
Onion	Onion	Onion
Capsicum green		
Potato	Potato	Potato
Pumpkin	Pumpkin	
Kumara	Kumara	
Oven baked fries		
Tomato	Tomato	Tomato
Avocado		

Standard Diet	Healthy diet with fewer foods	Current diet with fewer foods
Tomatoes canned	Tomatoes canned	Tomatoes canned
Dairy		
Cheese Colby		Cheese Colby
Cheese Edam	Cheese Edam	
Cottage cheese	Cottage cheese	
Milk trim	Milk trim	Milk whole
Milk whole		
Yoghurt flavoured		Yoghurt flavoured
Yoghurt natural low fat	Yoghurt natural low fat	
Grains		
Bread multigrain	Bread multigrain	Bread multigrain
Bread wheatmeal		
Bread white		Bread white
Pita bread white		
Pasta	Pasta wholemeal	Pasta
Pasta wholemeal		
Rice brown	Rice brown	
Rice white		Rice white
Wheat biscuits	Wheat biscuits	Wheat biscuits
Muesli toasted		
Cornflakes		Cornflakes
Rice bubbles		
Rolled oats	Rolled oats	Rolled oats
Meat and alternatives		
Almonds	Almonds	Almonds
Peanuts plain		
Beef mince	Beef mince	Beef mince
Beef rump steak		
Lamb chop		
Pork leg roast		
Beef blade steak		
Corned silverside		
Chicken breast	Chicken breast	Chicken breast
Chicken rotisserie		

Standard Diet	Healthy diet with fewer foods	Current diet with fewer foods
Chicken drumstick		
Egg	Egg	Egg
Fish frozen fillets	Fresh fish	Fresh fish
Fresh fish		
Tuna canned	Tuna canned	Tuna canned
Peanut butter no salt, or sugar	Peanut butter no salt, or sugar	
Lentils, canned	Lentils, canned	
Hummus	Hummus	
Baked beans	Baked beans	Baked beans
Spaghetti canned		
Fats and Oils		
Margarine	Margarine	Margarine
Canola oil	Olive oil	Olive oil
Olive oil		
Butter		

<table>
<tr><th>Discretionary items</th><th>Current diet</th></tr>
<tr><td>Instant noodles</td><td>Instant noodles</td></tr>
<tr><td>Biscuit Tim Tam</td><td rowspan="2">Biscuit Tim Tam</td></tr>
<tr><td>Ginger-nuts</td></tr>
<tr><td>Blueberry muffin</td><td rowspan="2">Blueberry muffin</td></tr>
<tr><td>Fruit cake</td></tr>
<tr><td>Crackers Shapes</td><td>Crackers Shapes</td></tr>
<tr><td>Bacon</td><td rowspan="3">Ham</td></tr>
<tr><td>Ham</td></tr>
<tr><td>Luncheon</td></tr>
<tr><td>Sausage beef</td><td>Sausage beef</td></tr>
<tr><td>Salted peanuts</td><td>Salted peanuts</td></tr>
<tr><td>Chocolate bar</td><td rowspan="2">Chocolate bar</td></tr>
<tr><td>Lollies - jelly beans</td></tr>
<tr><td>Ice cream</td><td>Ice cream</td></tr>
<tr><td>Muesli bar</td><td>Muesli bar</td></tr>
<tr><td>Potato crisps</td><td>Potato crisps</td></tr>
<tr><td>Peanut butter with salt</td><td>Peanut butter with salt</td></tr>
<tr><td>Jam</td><td>Jam</td></tr>
<tr><td>Mayonnaise</td><td>Mayonnaise</td></tr>
<tr><td>Pasta sauce</td><td>Pasta sauce</td></tr>
<tr><td>Soup, vegetable canned</td><td>(removed)</td></tr>
<tr><td>Tomato sauce</td><td>Tomato sauce</td></tr>
<tr><td>White sugar</td><td>White sugar</td></tr>
<tr><td>Takeaways</td><td>Takeaways</td></tr>
<tr><td>Big Mac</td><td rowspan="2">Big Mac</td></tr>
<tr><td>Fish battered</td></tr>
<tr><td>Chips</td><td rowspan="2">Chips</td></tr>
<tr><td>Pizza Hawaiian</td></tr>
<tr><td>Pie mince</td><td>Pie mince</td></tr>
<tr><td>Beverages</td><td>Beverages</td></tr>
<tr><td>Coca cola</td><td rowspan="2">Coca cola</td></tr>
<tr><td>Diet coke</td></tr>
<tr><td>Milo</td><td>Milo</td></tr>
<tr><td>Orange juice</td><td>Orange juice</td></tr>
</table>

Fruit drink	
Powdered drink	
Beer	Beer
Wine	Wine

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