

Review Article

Costing 'healthy' food baskets in Australia – a systematic review of food price and affordability monitoring tools, protocols and methods

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Abstract*Objective:* To undertake a systematic review to determine similarities and differences in metrics and results between recently and/or currently used tools, protocols and methods for monitoring Australian healthy food prices and affordability.*Design:* Electronic databases of peer-reviewed literature and online grey literature were systematically searched using the PRISMA approach for articles and reports relating to healthy food and diet price assessment tools, protocols, methods and results that utilised retail pricing.*Setting:* National, state, regional and local areas of Australia from 1995 to 2015.*Subjects:* Assessment tools, protocols and methods to measure the price of 'healthy' foods and diets.*Results:* The search identified fifty-nine discrete surveys of 'healthy' food pricing incorporating six major food pricing tools (those used in multiple areas and time periods) and five minor food pricing tools (those used in a single survey area or time period). Analysis demonstrated methodological differences regarding: included foods; reference households; use of availability and/or quality measures; household income sources; store sampling methods; data collection protocols; analysis methods; and results.*Conclusions:* 'Healthy' food price assessment methods used in Australia lack comparability across all metrics and most do not fully align with a 'healthy' diet as recommended by the current Australian Dietary Guidelines. None have been applied nationally. Assessment of the price, price differential and affordability of healthy (recommended) and current (unhealthy) diets would provide more robust and meaningful data to inform health and fiscal policy in Australia. The INFORMAS 'optimal' approach provides a potential framework for development of these methods.

Keywords
 Diet price
 Diet affordability
 Food price
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 Monitoring and surveillance
 Australia
 INFORMAS

Unhealthy diet is the leading preventable risk factor contributing to the burden of disease in Australia and globally⁽¹⁾. The Australian Dietary Guidelines (ADG)⁽²⁾ provide evidence-based recommendations that aim to promote the potential benefits of healthy eating, improve community health and well-being, and reduce the risk of diet-related disease⁽²⁾. However, less than 7% of Australians consume a diet consistent with these guidelines⁽³⁾.

A range of factors affect dietary choices, including price, availability, accessibility and promotion of foods⁽⁴⁾. These factors can contribute to population food insecurity, that is

having inconsistent physical, social and economic access to sufficient, safe and nutritious food that meets dietary needs and food preferences for an active and healthy life⁽⁵⁾. Perceived low affordability has been reported as a key barrier to the purchase of 'healthy' foods, particularly in low socio-economic groups, although well-defined data in this area are lacking^(6–8). It has been suggested that food is affordable when no more than 30% of household income is required for its purchase⁽⁹⁾. Price elasticity studies have reported that consumers are more sensitive to price differences between close substitute foods (for example, white *v.* wholemeal bread) than to price changes between less

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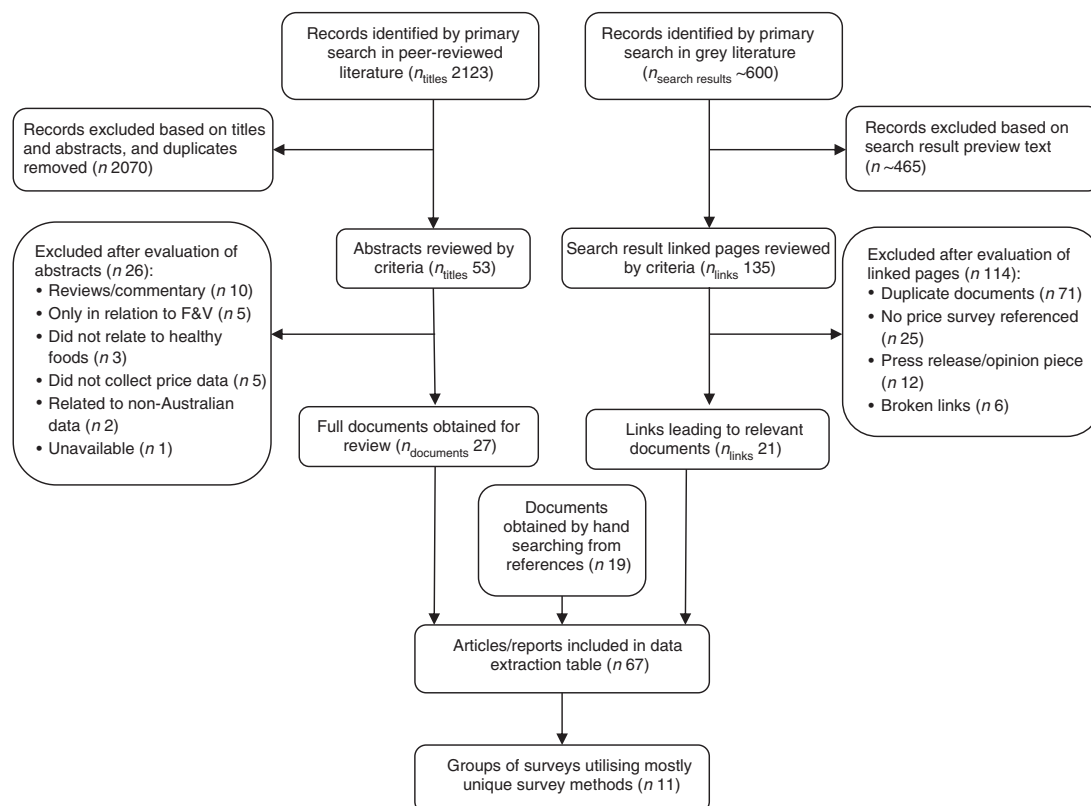


Fig. 1 PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) diagram showing the flow of studies (F&V, fruit and vegetables)

similar foods, further suggesting that cost may play a role in the choice between healthy and unhealthy diets⁽¹⁰⁾.

Different approaches have been utilised to monitor food prices in Australia, such as Consumer Price Indexes⁽⁷⁾ and supermarket price surveys^(8,11) tallying and comparing the price of highly selected individual food items. A variety of 'food basket' methods that assess the cost of diets, rather than foods, have also been developed within Australia for a variety of purposes at state, regional and community levels⁽¹¹⁾. These methods have the potential to measure the cost of a healthy diet; however, dissimilarity of metrics is a recognised barrier to the production of comparable data⁽¹²⁾ that would help pinpoint areas of high food insecurity and better inform policy and practice in relation to food pricing and affordability.

A stepwise food price and affordability monitoring framework has been developed by the International Network on Food and Obesity/non-communicable disease Research, Monitoring and Action Support (INFORMAS) network⁽⁸⁾. The framework advocates 'minimal', 'expanded' and 'optimal' monitoring approaches, including measurement indicators of affordability, stratification by region and socio-economic status (SES), and representative sampling. This approach provides potential for robust national data benchmarks and international comparisons. To assist in the development of national food price and affordability monitoring tools,

protocols and methods for use in Australia consistent with the INFORMAS framework, we conducted a systematic review to determine similarities and differences in the metrics and results between recently and/or currently used tools and protocols for monitoring Australian 'healthy' food prices and affordability.

Methods

The systematic review was conducted based on the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement⁽¹³⁾ and included peer-reviewed and grey literature published from 1995 to 2015 (Fig. 1).

Seven electronic databases were searched: Informit Health; MEDLINE, PubMed; EMBASE; CINAHL; Web of Science: Science Citation Index and Conference Proceedings Citation Index; and the Cochrane Library. Grey literature was searched using Google.com.au advanced searches, limited to the web address extensions of .gov.au, .org.au, .net.au and .com.au. The search terms used were 'health*', 'food', 'diet*', 'cost/price/afford*', 'healthy food' and 'healthy diet', with additional location limiting to Australia where necessary. Following identification of pertinent results, reference lists were reviewed and hand searching identified other known documents. Search

results for the same journal article or web links to the same report were excluded as duplicates. However, discrete journal articles and reports that related to the same collected data set were included.

The initial search results were reviewed against the inclusion criteria of relating to 'healthy' food and diet price assessment tools, protocols, methods and results using methods of retail pricing and being pertinent to Australia (at a national, state, regional or local community level). 'Healthy food price assessment' was defined as the costing or pricing of a list, or basket, of foods that represent a 'healthy' diet for one or more persons. Thus studies relating to comparative pricing of selected individual 'healthy' and 'unhealthy' foods were not included⁽¹⁴⁾. Articles and reports relating to household food expenditure methods, interventions to alter purchasing habits and dietary improvement modelling were excluded. Additionally excluded were: reviews, commentaries, press releases and opinion pieces; surveys solely relating to fruit and vegetables (F&V); and surveys where no price data were collected. Poster presentations were also excluded due to their providing insufficient information in relation to the survey methods.

Copies of three reports identified through hand searching^(15–17) and reports of the Northern Territory Market Basket (NTMB) surveys for 1998–2002 and 2013 were not publicly accessible, so were excluded from the analysis.

The systematic search identified thirty-nine reports and twenty-four journal articles which described fifty-nine discrete healthy food pricing surveys undertaken within Australia. Some of these surveys were reported in the grey literature as well as in one or more published journal articles. In addition, some journal articles described a time series of surveys.

The contents of the journal articles and reports were analysed to determine all available information relating to the basket contents (the food pricing tool), representative

households, source of household income, sampling of stores for the survey, timing of data collection, process instructions for data collection (e.g. brands or generic brands, missing item protocols), data analysis methods and reported results.

Due to the broad scope of the review, large volumes of data were identified from the reports and articles. The data were transcribed into separate tables according to the type of information listed above. Within each table, the survey data are ordered by the food pricing tool, then geographical reach and then time. Two summary tables are included in the body of this manuscript; the remaining data are included in the online supplementary material due to the large size of the data sets.

Results

Food pricing tool

Analysis of the fifty-nine discrete surveys (Table 1) identified six 'major' food pricing tools (defined as those used in multiple areas and at multiple time periods) and five 'minor' food pricing tools (defined as those used in only one survey area or at one time period). Surveys were conducted to assess food prices for different purposes at various geographic levels: statewide, regional or local. Each survey area included one or more local government areas, with one or more stores included within each local government area. All state/territory-wide surveys used a major food pricing tool by definition. The two food pricing tools developed most recently, the Revised Queensland Healthy Food Access Basket (HFAB)⁽¹⁸⁾ and the Healthy and Sustainable (H&S) basket developed by Friel *et al.*⁽¹⁹⁾, included more contemporary methodology than the other food pricing tools.

Table 2 shows that all of the food pricing tools, with the exception of the H&S basket⁽¹⁹⁾, measured the price of

Table 1 Summary of the major food pricing tools (*n* 5) and minor food pricing tools (*n* 6) used in Australia

	Food pricing tool	Abbreviation	Survey areas used (number of time periods tool used in each survey area)
Major*	Queensland Healthy Food Access Basket ⁽²⁰⁾	QLD HFAB	Statewide QLD (5); statewide NSW (3); south-west rural VIC (1); Bundaburg, QLD (1); Zillmere, QLD (1); Yarra, VIC (1)
	Western Australia Food and Cost Access Survey ⁽²⁸⁾	WA FACS	Statewide WA (2)
	Northern Territory Market Basket ⁽²⁴⁾	NTMB	Territory-wide NT (11); remote SA (1)
	Illawarra Healthy Food Basket ⁽¹¹⁾	IHFB	Illawarra, NSW (6); Dandenong, VIC (1); Adelaide, SA (1)
	Victorian Healthy Food Basket ⁽²²⁾	VHFB	Rural and regional VIC (1); local areas VIC (15); Adelaide, SA (1); statewide TAS (1); local area TAS (1)
	QLD 2014 Revised Healthy Food Access Basket ⁽¹⁸⁾	Revised QLD HFAB	Statewide QLD (1)
Minor†	Healthy and Sustainable Basket ⁽¹⁹⁾	H&S basket	Western Sydney, NSW (1)
	Sydney Food Fairness Alliance Market Basket Survey ⁽²¹⁾	SFFA	Western Sydney, NSW (1)
	Kettings Meal Plan ⁽³⁴⁾	Kettings	Melbourne, VIC (1)
	Katoomba Food Retail Price Mapping Project ⁽³³⁾	Katoomba	Katoomba, NSW (1)
	Food Supply in rural South Australia ⁽²³⁾	Meedeniya	Rural SA (1)

*Major: food pricing tools used across multiple survey areas and multiple time periods.

†Minor: food pricing tools used in one survey area or at one time period, with some minor variations.

Table 2 Contents and representative households of the food pricing tools used in Australia

Food pricing tool*	Survey area	Year	Source of data		Contents	Households (HH)		
			Reports	Journal articles		People	Rationale	Time period
QLD HFAB	QLD	2000	(20)	(72–75)	One basket of 'healthy foods' that comprise a 'healthy' diet: forty-four items + four 'unhealthy' items Core foods: 50% wholegrain, 75% fat trimmed, reduced-fat milk; Model B of Core Food Groups (1991 NHMRC RDI) Non-core foods: margarine, white sugar, canola oil; selection criteria unknown; added to adjust energy content of basket to 95% of energy requirements Other items: tobacco, cigarettes, cola drink, meat pie; selection criteria unknown; included to allow price comparisons of other commonly purchased items across ARIA categories Basket provides 70% of nutritional requirements and 95% of estimated energy for household As per QLD HFAB 2000, plus extra less nutritious foods added for cost comparison purposes: cream-filled biscuits, plain milk chocolate, ice cream, potato crisps As per QLD HFAB 2006, excluding ice cream (unclear why ice cream excluded) As per QLD HFAB 2006 As per QLD HFAB 2000, plus ten foods from list of top items purchased in supermarkets in Australia in 2000 ('unhealthy' foods for comparison to QLD HFAB and indicator of access to food in rural communities) As per QLD HFAB 2000 As per QLD HFAB 2000 (tobacco, cigarettes and meat pie not included) As per QLD HFAB 2000, some items replaced with common ethnically specific/appropriate foods with nutrient equivalence (rationale for inclusion not reported)	Adult male >19 years Adult female >19 years Older female >61 years Boy 14 years Girl 8 years Boy 4 years	Desire to consider wide range of age groups	Fortnight
		2001	(66)	(72,74,75)				
		2004	(71)	(72,74,75)				
			2006	(43)		(72,75)		
			2010	(44)		(72)		
		NSW	2006	(35)		(36)		
	2008			(36)				
	2009			(36)				
		South-west VIC	2002			(48)		
			Zillmere, QLD	2008		(39)		
	Bundaberg, QLD	2008	(40)					
	Yarra, VIC	(no date)		(31)				
WA FACS	WA	2010	(28)	(76)	List of 190 different foods, prices of 430 items collected, with at least three brands collected for each food (increases likelihood of at least one price collected per store per type of food and common practice in ABS pricing survey methodology). Includes all items of QLD HFAB, NTMB and IHFB, to allow selection of 'healthy' baskets during analysis for comparison with previous surveys Foods include: commonly purchased F&V (criteria not reported); foods preferred by Indigenous communities (criteria not reported); top five breakfast cereals & top four lunch box snacks (selected from Choice reviews, 2009, 2010); top selling market	HH1: 2 × 40-year-olds + 2 × kids aged 12 & 7 years HH2: 1 × 40-year-olds + 2 × kids aged 12 & 7 years Gender not specified	Not reported	Week

Table 2 Continued

Food pricing tool*	Survey area	Year	Source of data		Contents	Households (HH)		
			Reports	Journal articles		People	Rationale	Time period
		2013	(37)		share and commonly purchased brands in fourteen main food categories and top market share pre-prepared meals (selected from: Retail World Australasia Grocery Guide 2009; free summaries of Nielson Grocery Report 2008, Nielson Convenience Report 2008, Nielson Top Brands Report 2009); energy-dense & nutrient-poor foods, included to allow assessment of 'food pricing as a determinant of dietary habits consistent with dietary guidelines' As per WA FACS 2010. Wider range of generic products included; some changes of product name and packaging sizes; removal of fresh produce that was not available in 90% of stores in 2010			
NTMB	NT	2003–2012 annually	(24,63,77–84)		One basket of 'healthy foods' that comprise a 'healthy' diet, containing thirty food items Model C of Core Food Groups (AGHE, 1994) used to determine quantities of food to meet 70% of RDI, then basket adjusted to meet 100% nutrient requirements, 95% energy requirements Consultation with leading grocery suppliers in NT and input from nutritionists re. community observations to determine most commonly sold brands and sizes In 2007: powdered milk and cheese excluded. No note made or rationale given for exclusion of dairy foods (error in reporting?)	Female >60 years Male 35 years Female 33 years Male 13 years Girl 8 years Boy 4 years	Chosen to represent cross-section of people with important nutrient requirements	Fortnight
		2014	(62)		One basket of 'healthy foods' that comprise a 'healthy' diet, containing thirty-one food items Modified to ensure foods align with contemporary purchasing patterns. Frozen mixed veg decreased from 3.5 kg to 2.5 kg; powdered milk decreased from 7 kg to 3.6 kg; UHT milk added (25 litres). NUTTAB 2010 database and NRV used to determine quantities of foods. Nutrients selected as per those used in modelling AGHE Modifications made in consultation with Arnhem Land Progress Aboriginal Corporation (ALPA) and Outback Stores			
	Remote SA	2014	(85)	(86)	As per NTMB 2003			
IHFB	Illawarra, NSW	2000 2001 2003 2005 2007 2009		(11,64,87) (11,64,87) (11,64,87) (65,87) (65,87) (87)	One basket of 'healthy foods' that comprise a 'healthy' diet, containing fifty-seven food items (including thirteen 'extra' foods) Based on Model B of AGHE (1992). Number of servings of each food group required by adult male used as minimum number of different food types for each food group (e.g. 3–4 servings fruit = 4 different types of fruit included in basket)	Female 65 years Male 39 years Female 39 years Female 15 years Boy 5 years	Reflects age and sex characteristics of Illawarra region (determined from ABS report 1999) Includes individuals with varying nutritional needs	Week

Table 2 Continued

Food pricing tool*	Source of data		Contents		Households (HH)			
	Survey area	Year	Reports	Journal articles	Description of food pricing tool	People	Rationale	Time period
VHFB	Dandenong, VIC Adelaide, SA	2007 2005	(53)	(51)	1995 National Nutrition Survey used to select foods representative of typical eating patterns, i.e. food categories consumed by highest % of individuals, extras selected as most commonly consumed foods Product sales volumes (August 2000) from local supermarkets used to select specific foods within sub-major food groups National Heart Foundation's Pick the Tick Guidelines for Acceptability used to select healthier alternatives, except for extras and bread Foods adjusted to 100 % nutrient RDI and 95 % energy, and to comply with AGHE. Foods adjusted to reduce cost, ensure availability and acceptability. Quantities in basket calculated using edible portions of foods			
	Rural and regional VIC	2007		(22,52,88)	One basket of 'healthy foods' that comprise a 'healthy' diet, containing forty-four food items and two 'unhealthy' items Forty-one items from core food groups, three 'non core' foods, plus chocolate bar & soft drink included for cost comparison but not included in nutritional analysis Based on QLD HFAB but modified to reflect VIC family compositions, food choices, food availability and 2006 NRV EAR, AI, SDT used were recommended in NRV National Heart Foundation recommendation that sat. fat <10 % energy, P:M:S ratio of 1:2:1 80 % nutrient requirements, 95 % energy Food consumption patterns from ACNeilson Grocery Report and ABS Household Expenditure Surveys Salt-reduced items not included to mimic QLD HFAB and to be 'realistic'	HH1: male 44 years, female 44 years, female 18 years, male 8 years HH2: female 44 years, female 18 years, male 8 years HH3: female 71 years HH4: male >31 years	Selected to reflect those most affected by food insecurity and most common family types (ABS) 2004/5 National Health Survey and Centre for Health Statistics used for height/weight data to estimate requirements	Fortnight
	Mornington Peninsula & Frankston, VIC	2007 2008		(54) (54)				
	Knox, Maroondah & Yarra Ranges, VIC	2008	(55)					
	Metro. Adelaide, SA	2009		(49,89)				
	Sth Grampians & Glenelg, VIC	2009 2010	(56) (56)					
	Wellington, VIC	2010	(57)					
	8 x LGA, VIC	2010	(58)					
	Rural SA	2010		(50)				
	South Coast, VIC	2010	(90)					

Table 2 Continued

Food pricing tool*	Source of data		Contents		Households (HH)			
	Survey area	Year	Reports	Journal articles	Description of food pricing tool	People	Rationale	Time period
	South Coast, VIC	2010	(91)					
	South Coast, VIC	2010	(92)					
		2013	(92)					
	Bendigo, VIC	2012	(60)					
	Geelong, VIC	2011	(61)					
		2012	(61)					
	Port Melbourne, VIC	2014	(93)		Using 'Winter VHGB grocery list'			
	TAS	2014	(45)					
	2 × LGA in TAS	2011	(30)		'Food items modified to suit Tasmanian purchasing trends'			
Revised QLD HFAB	QLD	2014	(18)		One basket of 'healthy foods' that comprise a 'healthy' diet Thirty foods from both original and 2014 HFAB, nineteen foods new to 2014 HFAB, plus fourteen foods from original HFAB plus five unhealthy foods (soft drink, cream-filled biscuits, chocolate, potato crisps, meat pie) and two tobacco items Greater range of fresh foods, less packaged foods than previous QLD HFAB Based on recommended food groups in AGHE (2013)	HH1: 2 adults, 3 children, 1 older female HH2: 2 adults, 2 children HH3: 1 adult female, 2 children HH4: 2 older adults HH5: 1 male	Not reported	
H&S Basket	Greater Western Sydney, NSW	2011		(19,32)	One 'healthy' and 'sustainable' basket (H&S), one 'typical diet' basket, resulting in forty-eight foods priced 'Typical' basket (foods for 7 d meal plan including breakfast, lunch, dinner, snacks) Food consumption patterns of 1995 National Nutrition Survey and ABS 2003–4 household expenditure data H&S basket (adapted version of foods from typical basket): utilised health principles – minimum recommended servings from ADG (reducing overconsumption), reduced discretionary foods; utilised environmental principles derived from review of multiple sources pertaining to primary production processes, water use, GHGE and biodiversity impact	Male (19–60 years) Female (19–60 years) Boy 15 years Girl 4 years	Not reported	Week
SFFA	Western Sydney, NSW	2006	(21)		One basket of 'healthy foods' that comprise a 'healthy' diet, containing fifty-eight food items Based upon Meedeniya (see below) and South Western Sydney survey (Lowry, 2003; not available). Modifications due to cultural differences, new products & product sizes. Suits rural and urban areas. Based on servings of each food group (AGHE, 1998). Foods selected from each food group based on National Nutrition Survey 1995 Foods met most of RDI	Six people; no further details reported	Included wide range of age groups	'A long period of time'

Table 2 Continued

Food pricing tool*	Source of data		Contents		Households (HH)			
	Survey area	Year	Reports	Journal articles	Description of food pricing tool	People	Rationale	Time period
Kettings	Melbourne, VIC plus online	2007		(34)	<p>'Healthy' 7 d meal plan developed; all foods of meal plan priced and actual amounts needed for each meal/snack calculated</p> <p>To calculate cost of meal plan based on AGHE, NRV, recipes used from consumer-targeted cooking and budgeting resources (Nutrition Australia)</p> <p>Meal plan supplies breakfast, lunch, dinner, snacks & extras with 100% nutrient requirements and 95% energy requirements</p> <p>Model B of AGHE</p> <p>Excludes alcohol and takeaway foods</p>	<p>HH1: male 40 years, female 40 years, female 12 years, male 7 years</p> <p>HH2: female 40 years, female 12 years, male 7 years</p>	Based on ABS 2003 Family Characteristics Survey and 2006 Population by Age and Sex. Anthropometric data from ABS National Health Survey and NRV	Week
Katoomba Project	Katoomba, NSW	(no date)	(33)		<p>List of ~200 foods for price collection, three baskets developed (one for each type of household)</p> <p>Basket for HH1: thirty-seven items + fifteen miscellaneous items (cost considered over 1 month)</p> <p>Basket for HH2: thirty-three items + fifteen miscellaneous items (cost considered over 1 month)</p> <p>Basket for HH3: twenty-five items + thirteen miscellaneous items (cost considered over 1 month)</p> <p>Basket contents selected to meet needs as per AGHE (no further details reported)</p> <p>Foods included based on being 'best value' for that particular food within food group</p> <p>'Healthier' options included where available (low salt, low fat, high fibre)</p>	<p>HH1: male 30 years, female 28 years, child 9 years, child 4 years</p> <p>HH2: female 25 years, child 7 years, child 4 years</p> <p>HH3: male 70 years</p>	Not reported	Week
Meedeniya	Rural SA	1999	(23)		<p>One basket of 'healthy foods' that comprise a 'healthy' diet, containing fifty-one food items and six snack foods (biscuits, crisps and soft drinks, cake, chocolate, ice cream)</p> <p>Basket items based on the AGHE food groups</p> <p>Foods within each food group were based on the foods actually eaten as per National Nutrition Survey 1995</p> <p>Meet RDI for most nutrients</p>	<p>Two adults</p> <p>Boy 14 years</p> <p>Girl 8 years</p> <p>Boy 4 years</p> <p>Woman >54 years</p>	Wide range of age groups	Fortnight

LGA, local government area; NHMRC, National Health and Medical Research Council; RDI, Recommended Dietary Intake; ARIA, Accessibility/Remoteness Index of Australia; ABS, Australian Bureau of Statistics; F&V, fruit and vegetables; AGHE, Australian Guide to Healthy Eating; UHT, ultra-heat-treated; NRV, Nutrient Reference Value; EAR, Estimated Average Requirement; AI, Adequate Intake; SDT, suggested dietary target; P:M:S, polyunsaturated:monounsaturated:saturated fat; ADG, Australian Dietary Guidelines; GHGE, greenhouse gas emissions.

*See Table 1 for explanation of food pricing tool abbreviations.

a 'healthy' basket of food items developed to reflect a 'healthy' diet, which was informed by the principles of the national dietary guidelines^(11,20–24). Model B of the Core Food Groups⁽²⁵⁾ of the 1992 ADG⁽²⁶⁾ was used by all these tools except the Revised QLD HFAB⁽¹⁸⁾, which adjusted the basket contents to meet new modelling⁽²⁷⁾ developed to inform the revision of the ADG in 2013⁽²⁾.

The Western Australia Food and Cost Survey (WA FACS) food pricing tool⁽²⁸⁾ conceptually falls within the group that measured a single 'healthy' basket, although the tool included a very comprehensive list of foods for pricing that produced a database encompassing the contents of similar 'healthy' baskets, such as the QLD HFAB, to potentially enable comparison with the results of surveys using these food pricing tools.

All tools, except the H&S basket and the Revised QLD HFAB, described 'healthy' baskets that included several 'unhealthy' non-core or discretionary foods (energy-dense, nutrient-poor foods not required for health that are high in added sugar, saturated fats, salt and/or alcohol⁽²⁾), such as sugar and oil^(20,24), to adjust the energy content of the basket, and also included commonly consumed discretionary foods, such as sausages⁽²¹⁾, cake^(11,23) or chocolate⁽²³⁾. Thus most 'healthy' baskets do not constitute a diet consistent with current ADG recommendations. This was acknowledged by authors of one of the Australian food pricing tools⁽²⁰⁾, but not others.

In addition, five of the major^(11,18,20,22,28) and one of the minor⁽²³⁾ food pricing tools included a separate, arbitrary group of 'unhealthy' foods, such as soft drinks, meat pies or chocolate, to try to compare pricing with the 'healthy' basket. These items were highly selective and few in number, and were not reported as intending to constitute an 'unhealthy diet'.

In contrast to these single basket approaches, the H&S basket⁽¹⁹⁾ developed both a 'typical' basket and a 'healthy and sustainable' basket. The contents of the 'typical' basket was informed by dietary patterns observed from the 1995 Australian National Nutrition Survey⁽²⁹⁾. To create the 'healthy and sustainable' basket, many of the 'typical' basket items were substituted with foods aligning both with the ADG (2013) and selected environmental sustainability principles, such as consideration of environmental impacts of production processes (carbon footprint, water usage, biological diversity). Therefore the H&S study did not include tinned and frozen foods and excluded other foods considered healthy in the ADG, such as sweet potato, cauliflower and capsicum, due to their environmental impact compared with other vegetables.

Different research groups often adapted food pricing tools for use outside the original geographical locations for which they were developed without reporting detailed rationale. For example: the Victorian Healthy Food Basket (VHFB) is based upon the QLD HFAB, with unspecified contents varied to include 'local food choices' and to 'ensure availability'⁽²²⁾; subsequent application of the

VHFB tool in Tasmania included unspecified 'local food choices'⁽³⁰⁾; and contents of the QLD HFAB were adjusted for unspecified local cultural differences for use in inner-city Melbourne, Victoria⁽³¹⁾.

Household composition

Identification of a reference household for the survey area population is required in order to inform the quantity of foods in the basket to be costed. Six different household structures were described across the eleven food pricing tools, ranging from a household of two adults, three children and an older female, to a household of a single male. Three of the major^(11,20,24) and three of the minor^(21,23,32) food pricing tools included one household, whereas the other food pricing tools included between two and five different households.

The ages and gender of the adults and children within the reference households varied, which has implications for household nutritional requirements and food quantities. However, gender^(21,23,28,33) and ages^(21,23) of all reference household members were not consistently reported. A common rationale for selection of reference household composition was inclusion of a variety of age groups^(20,21,23) and a cross-section of people with specific nutrient requirements⁽²⁴⁾. Some food pricing tools selected reference households that were considered to reflect the usual characteristic families of the survey area^(11,22,34). No rationale was reported in relation to household composition for three of the food pricing tools^(28,32,33).

Availability

All of the food pricing tools assessed availability of all basket items. Four of the major^(18,20,24,30) and one of the minor⁽²³⁾ food pricing tools assessed availability of specific F&V. Two major food pricing tools^(20,28) also measured the availability of food items considered a 'better nutritional choice' than common items, such as wholemeal bread or reduced fat milk. (See online supplementary material, Supplemental Table 1.)

Authors suggested that availability of healthy foods should be reported, as poor availability can indicate food insecurity^(20,21,24,28). Similarly, measurement of availability of 'better nutritional choices' in remote and very remote areas was considered desirable⁽²⁰⁾.

Quality assessment

Subjective assessment of F&V quality in stores was undertaken in four major^(24,28,30,35,36) and two minor^(21,23) food pricing surveys. Only the WA FACS tool attempted to assess meat quality^(28,37).

Household income

In order to determine the level of affordability of the 'healthy' baskets, most surveys, at least once, included

estimation of reference household income. (See online supplementary material, Supplemental Table 2.) Indicative household income was calculated from Australian welfare data⁽³⁸⁾ in four food pricing surveys^(18,23,24,33). Three others included estimation of paid employment income^(19,39,40) and both methods were applied with three major^(11,22,28) and one minor⁽³⁴⁾ food pricing tools.

Calculation of the welfare income appeared to be based on the assumption that none of the adults in the households were employed. While limited information was reported, it appears that only the main fortnightly welfare payments, such as unemployment benefits and the aged pension, were usually included from published sources^(41,42). In contrast, the Revised QLD HFAB food pricing tool included all possible annual payments in addition to the main payments⁽¹⁸⁾.

Store selection

Store sample selection tended to be influenced by the survey rationale. Statewide or territory-wide surveys aimed to investigate the effect of locality and remoteness on food price and availability, regional surveys looked more at the effect on price by SES within the survey area, and local area surveys often focused on food security. Hence, the methods used for selecting participating stores varied widely, and were independent of the food pricing tool used. (See online supplementary material, Supplemental Table 3.) Further, different store sampling techniques were used in different time periods for otherwise similar surveys; for example, the QLD HFAB statewide surveys changed from convenience sampling (2000, 2001, 2004) to representative sampling in 2006 and 2010⁽⁴³⁾.

No nationally representative food price surveys have been conducted across the whole of Australia. Only statewide surveys of Queensland^(18,43,44), Western Australia^(28,37) and Tasmania⁽⁴⁵⁾ utilised representative sampling techniques. In these studies towns or stores were stratified according to the Socio-Economic Indexes for Areas (SEIFA)⁽⁴⁵⁾ or Accessibility/Remoteness Index of Australia (ARIA) classifications^(18,28,37,43,44), then locations were randomly selected within these stratifications. SEIFA ranks statistical areas of Australia by a range of socio-economic variables including household income, education, employment, occupation and housing⁽⁴⁶⁾. ARIA provides a geographical measure of remoteness based upon the access to a service centre of a defined population size⁽⁴⁷⁾. The Queensland and Western Australia surveys determined sample sizes to detect differences of 10% between remoteness categories at $P < 0.05$ and 90% power, and oversampled very remote localities. The Tasmania survey oversampled stores in the lowest SEIFA tertile.

Other statewide surveys (in New South Wales, Northern Territory and early Queensland studies) used convenience sampling; these also selected the largest store in each

included town, or district^(20,24,48), within the survey area. All of the regional surveys used convenience sampling, with occasionally some grouping based on SEIFA classifications, prior to including all stores⁽³²⁾, a store from each major supermarket chain^(21,49,50) or the largest store^(11,51) within those localities.

One regional survey in south-western Victoria⁽⁴⁸⁾ included all food outlets in towns with a population of more than 100 residents. One statewide survey in New South Wales simply selected supermarkets based on the preferences of volunteer data collectors⁽³⁶⁾ and one regional survey of rural and regional Victoria utilised convenience sampling based on the placement locations of student data collectors⁽⁵²⁾.

Local area sampling methods mainly included every supermarket within the bounds of the survey area^(30,31,33,39,40,53–59). Two local methods included one supermarket from both of two major chain stores from each locality within the local area^(21,34). Two reports of local area surveys did not provide any information regarding the criteria for store selection^(60,61).

Data collection periods occurred in all months except January. In surveys across multiple localities, data were collected within a maximum three-month window. To reduce potential effects of seasonality, time series data were usually collected in the same months. However, one survey (NTMB) deliberately altered the timing of the data collection period in one year to try to test for seasonality effects⁽⁶²⁾.

Data collection protocols

Brands

Studies noted that the use of specified common brands helped ensure both consistency of data collection in all stores on all occasions and comparability over different time periods. The most common protocols (four of the major^(11,18,20,22) and all minor food pricing tools) specified recording the price of the cheapest brand (not generic) for each food item. Generic brand prices were collected separately, or included as the cheapest brand in four major^(11,18,20,28) and three minor^(19,33,34) methods. The WA FACS protocols⁽²⁸⁾ included collection of multiple brand name prices and a generic brand price for each food item, to increase the likelihood of collecting at least one price in each store. The collection of sale prices was excluded from all but two major^(28,45) and one minor⁽³³⁾ food pricing tool. (See online supplementary material, Supplementary Table 4.)

Size

Product size protocols were reported for all major and three minor^(21,23,34) food pricing tools; a 'standard or medium size' was reported for one of these minor tools⁽³⁴⁾. Product size protocols were not reported for the remaining two minor tools^(19,33).

If the specified product size was not available, data collectors were instructed to select the next smallest size for four of the major^(11,18,20,22) and one minor⁽²³⁾ food pricing tools. Instructions to choose either a smaller or larger size were reported for two major^(24,28) and one minor⁽²¹⁾ food pricing tools. Missing item protocols were not reported for the remaining three minor food pricing tools^(19,33,34).

Data analysis protocols

To derive the cost of the 'healthy' basket, each food pricing survey determined the unit price of each food item and multiplied the unit price by the quantity required for each reference household. (See online supplementary material, Supplemental Table 5.) Analysis of the cost of 'healthy' meals was not reported in any of the food pricing surveys reviewed.

If an item was not available at a store, an average price of that item in similar locations was calculated. Similar locations were defined as stores: in the same ARIA category⁽²⁰⁾; in the same local area⁽⁵⁷⁾; of the same type⁽⁴⁰⁾; in the total sample. Details of analysis protocols for missing items were not reported for most surveys^(11,18,28,33,34).

Reporting of results of food pricing surveys

As presented above, the food pricing surveys undertaken around Australia utilised a wide variety of tools, protocols and methods; consequently, a range of non-comparable findings have been reported. Reported results included: entire basket price; cost of food groups within the basket; cost of extras or 'less healthy' foods; availability of basket items; availability and variety of F&V and/or better nutritional choices; and F&V quality scores. Those surveys that described household income also reported on affordability of the total basket and food groups. (See online supplementary material, Supplemental Table 6.)

Cross-sectional results

Depending on the purpose of each survey and its geographic reach, results were stratified by ARIA and/or SEIFA/SES classifications, or reported for districts, local government areas, census collection districts or suburbs. In general, studies stratified by ARIA reported 'healthy' diet basket prices between 20 and 60% higher in very remote areas compared with major cities. However, no association between location and basket price was found where studies stratified results by SEIFA/SES classification. On the other hand, the study using the H&S diet basket⁽³²⁾ reported that the cost difference between the 'healthy' and the 'typical' basket was greater in disadvantaged areas.

Generally it was reported that between 25 and 40% of the income of welfare-dependent family households was required to purchase the diet baskets, with a lower amount, about 18% of income, required for single older person households.

Where assessed, it was reported generally that availability and quality of F&V and availability of 'better nutritional choices' were lower in remoter locations, and that more items were missing in small supermarkets and convenience stores than major supermarkets.

Time series results

Reports of temporal changes were possible in surveys utilising the same methods in the same area over time. While annual price differences occasionally decreased (usually due to recovery of prices of fresh produce following natural disasters⁽⁶³⁾), as would be expected long-term trends showed increasing diet basket prices.

Affordability of the 'healthy' diet basket was reported over four years in Western Australia⁽²⁸⁾; over seventeen years in Northern Territory⁽²⁴⁾; over ten years in Illawarra, New South Wales⁽¹¹⁾; and over three years in a local area in Victoria⁽⁵⁴⁾. No significant trends in affordability were reported in the Northern Territory and Illawarra surveys; however, the shorter Western Australia and local Victoria surveys found affordability decreased slightly but significantly over time for welfare-dependent families.

Only in the Northern Territory⁽⁶²⁾ was improved availability and quality of F&V reported over time.

Comparison between survey areas

Few comparisons of results across different geographical areas have been reported, even where technically possible in the WA FACS survey⁽²⁸⁾. Surveys using the Illawarra Healthy Food Basket (IHFB) tool in the Illawarra region^(64,65) compared results with Queensland^(43,66); however, only proportional changes over a similar time period could be reported due to methodological differences.

Discussion

The present review identified that six major and five minor food pricing tools and a wide range of protocols have been applied on a statewide, regional and local area basis in fifty-nine surveys in Australia. The reviewed surveys measured the cost of a basket of 'healthy' foods representing 'healthy' diets and have been able to provide answers to questions relating to relative price in different locations (more expensive in rural and remote areas than in capital and regional cities), relative price in disadvantaged areas (not significantly different), relative price over time (food prices increased) and affordability over time (relatively consistent). However, without comparison with the cost and affordability of currently consumed ('unhealthy') diets⁽⁷⁾, it is challenging for these data to help inform potential policy approaches⁽⁸⁾. Measurement of the cost of a typical 'unhealthy' diet was not undertaken by any of the reviewed surveys except the H&S basket⁽³²⁾. The price and availability of some 'better nutritional

choices' or 'unhealthy' food items were included in some food pricing tools, but these measurements are insufficient to represent a 'current' or 'unhealthy' diet for comparison purposes⁽⁸⁾.

Governments have the potential to manipulate food prices to encourage consumption of 'healthy' foods via policies such as: taxation systems (tax liabilities on 'unhealthy' foods or tax exemptions of 'healthy' foods); agricultural or transport subsidies; or direct subsidies to high-risk populations such as provision of vouchers for healthy foods⁽⁸⁾. However, robust and relevant data are needed to inform policy action in relation to food pricing and taxation to improve the relative cost of healthy foods. Core to the INFORMAS stepwise food price and affordability monitoring framework⁽⁸⁾, at all levels, is measurement of the size and direction of the price differential between 'healthy' and 'less healthy' foods, meals or diets. Optimally, this approach utilises 'healthy' diets derived according to national dietary guidelines and 'less healthy' diets derived from national dietary intake data⁽⁸⁾. Use of this approach across Australia to provide a relationship between the price differential and SEIFA or ARIA stratification has the potential to provide the necessary data to inform policy.

While there were some similarities between the tools and protocols applied in the surveys, there were also many differences, even when the same food pricing tool was used in different survey areas or at a different time period. Methodological differences were found in: selection of 'healthy' basket contents; reference household composition; inclusion of availability and/or quality measures; household income sources; store sampling methods; season of data collection; and data collection protocols and analysis. As has been identified previously, it is not possible to compare results across different surveys, even when the same food pricing tool has been applied^(9,12,67).

Lack of comparability of survey results is often due to alterations in a chosen food pricing tool to accommodate local population differences. The rationale for these alterations and selection of replacement foods were not clearly reported and appeared quite subjective. Additionally, the items within the food pricing tools were selected according to various criteria to represent a 'healthy' diet and it is difficult to see how alterations for local preferences will provide additional policy-relevant data.

The review found that ten of the eleven identified food pricing tools do not fully align with the principles of the 2013 ADG⁽²⁾, as discretionary foods and/or commonly consumed unhealthy foods were included within the defined 'healthy' basket. The H&S basket food pricing tool⁽³²⁾ does align with the most recently revised ADG⁽²⁾ but specifically incorporates more exacting environmental sustainability principles, which appear to increase diet costs.

All of the food pricing tools, with the exception of the Revised QLD HFAB and the H&S basket, are based upon

outdated dietary guidelines. The Revised QLD HFAB tool is also consistent with the healthy diet tool proposed under the optimal approach of the INFORMAS food price and affordability monitoring framework⁽⁸⁾.

In contrast to the measurement of basket item availability, the availability of F&V and 'better nutritional choices', and food quality, were not consistently measured by the surveys. Other studies looking at F&V quality and availability alone were identified during the literature search; however, these have not been included as they did not represent a complete diet. A separate review of these studies may be required.

Affordability of healthy foods has been assessed inconsistently. Determination of affordability requires calculation of household income, which will vary according to composition of the household and assumptions made regarding the working status and income source of household members. The use of government welfare payments, minimum wage levels or median household income to estimate household income also requires application of arbitrary assumptions. Therefore, comparisons will be challenging until methods are standardised. However, given the well-established social gradient of health associated with dietary quality, measuring the affordability of 'healthy' diets in relation to household income would provide a useful benchmark⁽⁸⁾. When assessed, affordability of the 'healthy' baskets was just below or over the suggested 30% of household income level⁽⁹⁾. For comparison, it would also be useful to assess affordability of actual dietary intake^(8,68).

A narrative review that considered food pricing and affordability studies centred on whole diet costs conducted in New Zealand, Canada, the USA and the UK identified similar methodological concerns as described in our systematic review of the situation in Australia⁽⁸⁾.

There have been repeated calls for a nationally representative survey of the price and affordability of healthy foods in Australia since 2004, in order to highlight areas experiencing potential food insecurity due to high food prices^(6,9,12,67,69). This will require the development of standardised tools and protocols that overcome many of the challenges identified in the current review^(8,12).

Such methods, aligning with the 'optimal' INFORMAS approach, are being finalised currently⁽⁶⁹⁾. As an example of how these methods could be used to inform policy, they were used to investigate the impact of the potential extension of the 10% goods and services tax⁽⁷⁰⁾ to basic healthy foods (that are currently exempt from the goods and services tax) in Australia. The study showed that the price differential between healthy (recommended) and current (less healthy) diets would increase markedly if this policy change was implemented as proposed^(69,70). Finalisation and application of these methods has the potential to overcome many of the identified problems of the previous 'healthy' food price assessment methods undertaken in Australia.

Limitations

The present review was limited to those documents which were available from online searching. Additional food and diet pricing surveys may have been excluded if the reports were unavailable publicly. However, to our knowledge all of the major food pricing surveys, as well as many smaller, local surveys, have been located and analysed. Analysis of the food pricing survey was also limited to the reported information. In several instances details of data analysis or data collection methods were not reported.

Conclusions

Many 'healthy' food pricing surveys have been conducted in Australia. However, assessment methods vary across all metrics and most do not fully align with the recommendations of the current ADG. None have been applied nationally. Survey results are not comparable due to differences in the tools, protocols and methods and there is a need for a standardised national approach. Assessment of the price, price differential and affordability of a healthy diet (recommended) and current (unhealthy) diets would provide more robust and meaningful data to inform health and fiscal policy in Australia. The INFORMAS 'optimal' approach provides a potential framework for development of these methods.

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Supplementary material

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