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Streamlined data-gathering techniques to estimate the price and affordability of healthy and unhealthy diets under different pricing scenarios

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Abstract

Objective: To determine the reliability of streamlined data-gathering techniques for examining the price and affordability of a healthy (recommended) and unhealthy (current) diet. We additionally estimated the price and affordability of diets across socio-economic areas and quantified the influence of different pricing scenarios.
Design: Following the Healthy Diets Australian Standardised Affordability and Pricing (ASAP) protocol, we compared a cross-sectional sample of food and beverage pricing data collected using online data and phone calls (lower-resource streamlined techniques) with data collected in-store from the same retailers.
Setting: Food and beverage prices were collected from major supermarkets, fast food and alcohol retailers in eight conveniently sampled areas in Victoria, Australia (*n* 72 stores), stratified by area-level deprivation and remoteness.
Participants: This study did not involve human participants.
Results: The biweekly price of a healthy diet was on average 21 % cheaper ($596) than an unhealthy diet ($721) for a four-person family using the streamlined techniques, which was comparable with estimates using in-store data (healthy: $594, unhealthy: $731). The diet price differential did not vary considerably across geographical areas (range: 18–23 %). Both diets were estimated to be unaffordable for families living on indicative low disposable household incomes and below the poverty line. The inclusion of generic brands notably reduced the prices of healthy and unhealthy diets (≥20 %), rendering both affordable against indicative low disposable household incomes. Inclusion of discounted prices marginally reduced diet prices (3 %).
Conclusions: Streamlined data-gathering techniques are a reliable method for regular, flexible and widespread monitoring of the price and affordability of population diets in areas where supermarkets have an online presence.

Keywords
Food price
Food affordability
Pricing policies
Nutrition policy
Obesity prevention
Online data

Food price is a key determinant of food choice and population diets[1,2], particularly for those with limited food budgets[3,4]. The perceived higher price of healthy foods, relative to unhealthy foods, has been identified as a key barrier to healthy eating[1]. However, recent evidence examining the affordability of diets challenges this idea[2,5]. In Australia and New Zealand, healthy diets have been found to be 14–23 % cheaper (for a four-person reference household) compared with unhealthy diets[2,5,6], across a few different geographical locations. Pricing policies, such as the exemption of basic healthy foods (including bread, milk, fruits and vegetables) from the Goods and Services Tax in Australia, are imperative to protect the affordability of healthy foods and diets relative to unhealthy options[2].

To inform comprehensive health- and nutrition-related pricing policies, there is widespread consensus that the price and affordability of foods and diets should be monitored over time and across a wide range of geographical locations[7–9]. Indeed, many studies in high-income countries like Australia, New Zealand, Canada and the UK attempt to do this by reporting on the price and affordability of 'market baskets' (hypothetical shopping baskets of

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commonly consumed foods) or a collection of foods and beverages representing healthy (recommended) and unhealthy (current) 'diets'[10]. The latter approach to assessing the price, price differential and affordability of healthy and unhealthy diets (as opposed to 'market baskets') has become the optimal approach in recent times[11]. This approach, referred to as The Healthy Diets Australian Standardised Affordability and Pricing (ASAP) protocol in the Australian context[11], is designed to be more comprehensive and relevant to real-world consumption and expenditure practices. That is, the ASAP protocol can be used to estimate the price of entire diets (i.e. total price expended on food and beverages according to the amounts in which they are consumed by a reference household). In contrast, approaches that only compare food prices per gram or nutritional unit (i.e. $ per kilojoule or energy, or gram of fat, sugar, etc.) have been criticised for being reductionist, with limited relevance to population consumption practices, limited calculation of diet affordability and limited analysis across different geographic areas and socio-economic groups[10,12].

Regardless of the methodological approach, all data collection concerning food and beverage pricing involves travelling to food retailers across various demographic and geographic locations. Because this data collection can be resource intensive in terms of personnel, travel and time, monitoring of the price and affordability of diets is infrequently conducted and is often limited to select geographical regions[10]. The growing availability of online food and beverage data provides a mechanism to streamline data collection by reducing time and costs, and increasing virtual reach and access to multiple locations[13]. Online prices have been used in other disciplines such as economics[13], but public health nutrition research is yet to capitalise on this resource. Scanner data (collected by retailers or a consumer panel) have also been used to streamline economic research[14,15]. Whilst such methodological advancements might be increasingly useful to public health[16], scanner methods often come with high purchasing costs and may be neither accessible nor practical to use to monitor food and beverage pricing on an ongoing basis.

Online data provide a low-cost avenue which can increase the frequency and breadth of food and beverage product information available for collection by public health researchers. For health-related food and beverage pricing research, this enables the consideration of alternative products, pricing strategies and policy targets, which are used to sway consumer purchasing in today's retail environment[17]. Price promotions (also known as temporary price discounts or multi-buy specials) and generic brands (brands that are owned by retailers; also referred to as private label or home brands) are two price lowering strategies that are used extensively to influence consumer purchasing[18–20], yet such pricing strategies are rarely accounted for in studies examining food and diet prices and their affordability. One Australian study compared the in-store prices of 443 food and beverage items in remote stores with major supermarkets prices (online) in 2013[21]. Ferguson *et al.* concluded that remote stores were generally more expensive than major supermarkets. When factoring in price promotions and generic brands, the pricing differential between remote stores and major supermarkets increased. That is, remote stores were 47 % more expensive than major supermarkets when comparing standard non-discounted prices, 60 % more expensive when including discounted/advertised prices and 106 % more expensive when including generic brands[21]. In comparison, the prices of a healthy and unhealthy diet in New Zealand, when including price-promoted and generic branded products, were only 2 % and 3 % cheaper, respectively, than when these pricing strategies were not considered[22]. Nevertheless, price promotions and generic brands represent understudied food policy pricing targets globally, and further research into how they affect the price and affordability of unhealthy compared with healthy diets is essential.

Regular and widespread geographical monitoring of the price and affordability of diets and foods will be fundamental to inform food and beverage pricing policies that have the capacity to improve population nutrition for all socio-economic groups in Australia and around the globe. The primary aims of this study were to determine the reliability of lower-resource streamlined data-gathering techniques (using online food and beverage price data supplemented with phone calls for items where prices could not be collected online) and to estimate the price, price differential and affordability of a healthy (recommended) and unhealthy (current) diet in Australia. In doing so, we additionally report on these diet pricing outcomes across different socio-economic areas in the Australian state of Victoria. Finally, we demonstrate the flexibility of our streamlined data-gathering techniques by quantifying the influence of different pricing scenarios, namely price promotions and generic brands, on the price and affordability of healthy and unhealthy diets.

Methods

Study design

A cross-sectional study was conducted using publicly available food and beverage prices. Prices were collected from each sampled retail store once online (together with phone calls) and once in-store, across eight locations in Victoria, Australia. All data were collected during one week in October 2018 to ensure consistency with the retailers' price promotion cycles.

Healthy Diets Australian Standardised Affordability and Pricing protocol

The Healthy Diets ASAP protocol consists of two diets – one healthy and one unhealthy (see Table 1). The healthy diet

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Table 1 Foods and beverages included in the Healthy Diets ASAP (Australian Standardised Affordability and Pricing) protocol*

ASAP diet	Foods and beverages
Healthy diet	• *Water* (bottled) • *Fruit:* apples, bananas, oranges • *Vegetables:* potatoes, broccoli, white cabbage, iceberg lettuce, onion, carrot, pumpkin, tomatoes, sweetcorn (canned), four bean mix (canned), diced tomatoes (canned), baked beans (canned), frozen mixed vegetables, frozen peas, salad vegetables in sandwich • *Grain (cereals):* wholegrain cereal biscuits (Weet-bix™), rolled oats, cornflakes, wholemeal bread, white bread, white rice, white pasta, dry water cracker biscuit, bread in sandwich • *Meats and alternatives:* beef mince, lamb chops, beef steak, cooked chicken, tuna (canned), eggs, peanuts (unsalted), chicken in sandwich • *Dairy and alternatives*: cheddar cheese (full fat, reduced fat), milk (full fat, reduced fat), yoghurt (full fat plain, reduced fat flavoured) • *Oils:* sunflower, olive, rapeseed (margarine)
Unhealthy diet (discretionary items in addition to healthy diet items†)	• *Beverages:* artificially sweetened soft drink, sugar-sweetened soft drink, orange juice • *Processed cereals, snacks and desserts:* muffin, sweet biscuits, savoury biscuits, confectionary, chocolate, potato crisps, muesli bar, peanuts (salted), ice cream, fruit salad (canned in juice) • *Processed meats:* beef sausages, ham • *Spreads, sauces, condiments and ingredients:* butter, tomato sauce, salad dressing, white sugar • *Convenience meals:* frozen lasagne, chicken soup (canned), fish fillet (crumbed), instant noodles, meat and vegetable casserole (canned) • *Fast food:* pizza, meat pie, hamburger, potato chips/fries • *Alcohol:* beer (full strength), white wine (sparkling), red wine, whisky

*Table adapted from the Healthy Diets ASAP protocol developed by Lee *et al.*[11].
†In addition to the discretionary items listed above, the unhealthy diet also includes all foods and beverages in the healthy diet (in suboptimal rather than recommended amounts).

was designed to reflect the Australian Dietary Guidelines[23], and the unhealthy diet represents the 'current' self-reported nutritional intakes for the Australian population from the 2012–2013 Australian Health Survey[24]. The healthy diet therefore consists of the Five Food Groups (vegetables and legumes, fruit, wholegrain cereal foods, lean meats and meat alternatives, and milk and dairy alternatives[23]), oils and water (see the forty-three foods and beverages listed in Table 1). By comparison, the unhealthy diet consists of the items listed in the healthy diet (with quantities adjusted to align with the Australian Health Survey intakes, rather than recommended dietary guidelines) and an additional unhealthy, 'discretionary' category (see the thirty-two foods and beverages listed in Table 1), fast foods and alcohol. These tools were selected as they have been piloted and developed in the Australian context, with the latest national health survey indicating that 'current' population diets have not changed notably since 2012–2013[25]. Further details about the ASAP protocol can be found elsewhere[11].

Sample

Food and beverage prices were collected from a convenience sample of Statistical Area 2s (SA2s: the preferred sampling unit as per ASAP protocol[2]; classification defined by the Australian Bureau of Statistics[26]). A convenience sample was chosen as the primary aim of this study was to determine methodological reliability rather than representation. To ensure the streamlined data-gathering techniques were reliable across areas of varying socio-economic position (SEP) and remoteness, sampled stores represented two SA2s in Melbourne (a major Australian city) for each of the first (lowest SEP), third (middle SEP) and fifth (highest SEP) Index of Relative Socio-economic Disadvantage (IRSD) quintiles[27], and two inner regional areas (herein referred to as 'regional areas') based on the Australian Statistical Geography Standard remoteness structure (n 8 SA2s in total)[28].

The four store types included in the ASAP protocol were consequently sampled in each SA2 using Google Maps™. These included supermarket retailers which sell general product lines of foods and beverages[29], fast-food retailers which sell ready-to-eat foods, alcohol retailers which sell general product lines of alcoholic beverages, and convenience stores which sell automotive fuel, selected food and beverage product lines and ready-to-eat foods[29]. Stores were deemed to be eligible for inclusion if they were within a 7-km distance from the centre of the SA2[2]. We surveyed the price of every food and beverage item specified in the ASAP protocol once across each retail store sampled (within each SA2), with corresponding item prices also collected once online for each of the specified stores.

Streamlined data-gathering techniques

Online food and beverage data were collected from retailers with a major online presence including two supermarket chains (which dominate 67 % of the grocery market share in Australia[30]), three alcohol and two fast-food

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retailers. Food and beverage price data collected online were compared with the same data collected in-store (traditional methods) during the same week. When collecting data from the different geographic locations, we changed the online location to match the sampled in-store location. Delivery charges associated with online purchasing platforms were not included in the streamlined approach. Online price data were not available for four items (5 % of all items in the ASAP protocol). These items were a cooked chicken from major supermarkets, a chicken and salad sandwich from supermarkets or convenience stores, a meat pie from an independent bakery, and hot chips from an independent fish and chips shop. The research team sourced these price data by phoning retailers directly, as this was the most practical and low-resource way to obtain this information prescribed in the ASAP protocol. If retailers declined to provide information or could not be contacted over the phone, the next most central retailer in the SA2 was sampled and phoned.

In addition to collecting the standard non-discounted price of all foods and beverages listed within the ASAP protocol, we also collected the discounted price (defined as any temporary price discount or multi-buy offer) for the specified items, where available. We further collected the prices of generic branded equivalents (brands owned by Australian retailers) for all items, where possible (accounting for different unit sizes to adjust the energy and nutritional values that underpin the traditional ASAP protocol).

Data analyses

Reliability of streamlined data-gathering techniques

The total diet prices, price differential (i.e. the difference between healthy and unhealthy diet prices, expressed as a percentage of the healthy diet price or the extent to which unhealthy diet prices exceed healthy diet prices) and affordability of healthy and unhealthy diets were calculated and compared for both the traditional and streamlined approaches (see section *Diet prices and affordability*). We additionally calculated the phone call response rate to understand the feasibility of this aspect of the streamlined data-gathering methods. Mean percentage agreements between the streamlined and traditional approaches were calculated for price (including presence of price promotions), item availability and in total. This involved summarising the number of discrepancies between the data collected using the streamlined and in-store methods for every food and beverage item in the ASAP protocol (in each of the sampled stores across all areas). Findings are summarised across retailer type and food category.

Given the small sample of SA2s and limitations associated with statistical reliability tests[31], we report reliability descriptively. However, Bland–Altman plots are presented in the Supplementary Material as a supplementary quantitative assessment of the reliability of the streamlined data-gathering techniques used in this study.

Diet prices and affordability

Pricing and affordability analyses were conducted separately according to the type of data collection method used (i.e. streamlined *v.* in-store). For each food or beverage item, the price per unit (either obtained online, through phone calls or in-store) was converted to the edible price per gram or millilitre. This price was then multiplied by the amounts consumed by a four-person reference family over 2 weeks (i.e. biweekly), which were collectively summed to derive the total healthy and unhealthy diet prices per SA2, using a standardised Healthy Diets ASAP template. To account for the two different supermarket chains with each SA2, we calculated diet prices twice – once for each chain – then averaged these two estimates to obtain a diet price relevant for each SA2. Finally, diet prices across all eight SA2s were aggregated as statewide means with standard deviations. The mean relative price differential between healthy and unhealthy diets was also calculated, along with the percentage contribution of each food category to the overall price. All estimates were derived using descriptive statistics, and all prices are in Australian dollars.

While the use of median disposable household income is recommended to measure affordability, it is not available at the SA2 level in Australia. Instead, diet affordability was estimated using three different types of income, each with a distinct purpose. First, to examine the affordability of healthy and unhealthy diets for the lowest income Australians, mean diet prices were measured against the national poverty line in Australia (weekly income of $909 for two adults with two children[32]). Second, the statewide affordability of healthy and unhealthy diets in Victoria was assessed against the indicative low disposable household income. Indicative low disposable household income is a national measure calculated to represent households receiving minimum wages and welfare payments (see the Healthy Diets ASAP protocol[11] and see online supplementary material, Supplemental Table 1 for calculation details). Finally, we also present each SA2 diet price as a percentage of gross median total household income to enable area-level affordability comparisons[33].

Based on the limited available literature and ASAP protocol, a diet affordability threshold level of 30 % of disposable household income was used[10,11]. We also assessed diet affordability when using a more sensitive threshold of 25 %, in accordance with literature indicating that food stress can begin to be experienced at this level (particularly for households of low SEP)[34].

Pricing scenarios

We repeated our analyses to estimate the mean price and affordability of the healthy and unhealthy diets described above after substituting in discount prices for price-promoted

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items and prices for corresponding generic branded items, where appropriate.

Ethics

This research was approved by the ethics committee at Deakin University (HEAG-H 164_2018).

Results

Data were collected from seventy-two retailers, including sixteen supermarkets (two major supermarkets in each of the eight SA2s; 107 items in each including generic alternatives), sixteen alcohol stores (two chains in each SA2), sixteen fast-food retailers (burger and pizza chains), eight bakeries, eight fish and chip stores, and eight convenience stores or gas service stations. All major store types (supermarkets, alcohol stores and fast-food retailers) specified within the ASAP protocol had relevant data available online for all areas sampled, except for the specified pizza chains in three areas. For these areas, prices from an alternate pizza chain or a local pizza store were obtained. Short phone calls were made to collect price data from nineteen small independent or fast-food retailers. Three of these retailers refused to participate in this study (15·8 % refusal rate). After phoning a sub-sample of thirteen supermarkets (81·3 %) and four convenience stores (50·0 %), the feasibility of obtaining prices from these retailers was limited by the complex phone communication lines (i.e. centralised calls, department transfers, store procedures and an unwillingness to participate in the study). From the sub-sample examined, the prices were found to be the same across the retail chains and so standard prices obtained in-store were used.

Agreement between traditional and streamlined data-gathering techniques

When comparing the price and availability of foods and beverages in-store with the same items collected via streamlined techniques, the mean agreement (i.e. the percentage of identical product prices sold in-store and online) was highest for the supermarket platforms (94·2 % overall), followed by fast-food (87·5 %) and alcohol retailers (64·1 %). Within the supermarket setting, there was 99·1 % agreement for price (*n* 1 discrepancy), 97·9 % agreement for the presence of price promotions (*n* 2 discrepancies) and 97·3 % for product availability (*n* 3 discrepancies) (see online supplementary material, Supplemental Tables 2a and 2b). Overall, the mean price and availability agreements did not appreciably differ by food and beverage healthiness, and price discrepancies were typically random and minor (see online supplementary material, Supplemental Tables 3a–c for detailed descriptions of discrepancies observed). Similarly, the small number of price discrepancies observed between in-store and online fast food retailers was minor whereby two items were priced five cents higher online. For alcohol retailers, online and in-store price discrepancies arose predominantly from the use of in-store, but not online, price promotions. For example, price promotions were not displayed online by one retail chain. Nonetheless, when discount prices were available online and in-store, these were of the same magnitude. Additionally, there were some differences in the type of alcohol products available online and in-store (e.g. six-pack beer price available online but not in-store and vice versa).

When calculating the diet price and price differential, we did not observe any appreciable differences between using in-store and streamlined data (Table 2). These findings are supported by our interpretations of the Bland–Altman plots presented in the Supplementary Material (see online supplementary material, Supplemental Figures 1 and 2). We therefore report on the diet price and affordability findings from the streamlined data in the following section.

Diet prices and affordability

For a reference family of four, the mean biweekly price of a healthy diet ($596) was calculated to be cheaper than that of an unhealthy diet ($721) across eight areas in Victoria. This translates to a relative price differential of 21 %. Prices varied slightly across inner city IRSD and regional areas (healthy diet price range: $582–612, unhealthy range: $694–746), although no clear pattern was observed (Table 3). For the unhealthy diet, discretionary foods and beverages made the largest contribution to overall mean diet price (58 %). For the healthy diet, meats and alternatives made the largest contribution to overall mean price (33 %), followed by grains and cereals (17 %), vegetables and legumes (17 %), fruit (15 %), milk and alternatives (14 %), and unsaturated oils and spreads (1 %). See online supplementary material, Supplemental Tables 4 and 5 provide a complete summary of the mean diet prices and standard deviations, overall and across each food group.

When using the 30 % affordability threshold, only the healthy diet was deemed to be affordable when assessed against indicative low disposable household income (26 %). When using the more sensitive affordability threshold of 25 %, both healthy and unhealthy diets were considered unaffordable against indicative low disposable household income (healthy: 26 %, unhealthy: 31 %) and the poverty line (healthy: 33 %, unhealthy: 40 %).

According to the gross total family incomes for each area in the major Australian cities stratum, the mean affordability of a healthy diet ranged from 27 % in an IRSD quintile 1 (lowest SEP) area to 12 % in an IRSD quintile 5 (highest SEP) area (Table 3). A similar socio-economic patterning was observed for the affordability of an unhealthy diet (range: 32 % in an IRSD quintile 1 area to 14 % in an IRSD quintile 5 area). Across the two areas in the regional stratum, the affordability of a healthy and unhealthy diet closely aligned with their respective IRSD quintiles (healthy: 21–27 %, unhealthy: 25–32 %).

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Table 2 Mean overall prices and price differentials for the diets and food categories consumed by a reference family of four over 2 weeks, calculated using the traditional in-store and lower-resource streamlined data-gathering techniques

	Healthy diet				Unhealthy diet				Price differential (%)	
	In-store		Streamlined		In-store		Streamlined			
	Mean price $AUD	SD	Mean price $AUD	SD	Mean price $AUD	SD	Mean price $AUD	SD	In-store	Streamlined
Overall	594·98	15·00	596·49	12·12	731·32	16·03	720·98	14·47	23	21
Water	19·20	1·60	19·20	1·60	19·20	1·60	19·20	1·60	0	0
Fruit	89·13	8·33	92·19	8·69	53·64	3·60	54·90	5·07	40	40
Vegetables and legumes	101·58	9·52	98·40	0·76	40·77	2·96	39·95	0·47	60	60
Grain (cereal) foods	99·50	0·46	99·47	0·45	41·60	0·30	41·57	0·29	58	58
Lean meats and poultry, fish, eggs, nuts and seeds	191·88	6·27	193·90	1·18	101·21	2·07	101·65	1·22	47	47
Milk, yoghurt, cheese and alternatives	85·88	2·49	85·41	2·56	41·09	3·11	40·96	3·14	52	52
Unsaturated oils and spreads	7·80	0·34	7·93	0·27	1·22	0·09	1·24	0·01	84	84
Discretionary (total)	n/a		n/a		427·15	13·47	416·06	9·36	n/a	n/a
Alcohol	n/a		n/a		90·39	8·90	77·99	12·61	n/a	n/a
Fast food	n/a		n/a		145·36	7·94	145·36	7·94	n/a	n/a
Artificially sweetened soft drinks	n/a		n/a		5·45	0·00	5·45	0·00	n/a	n/a
Soft drinks	n/a		n/a		32·84	0·00	32·84	0·00	n/a	n/a

n/a, not available.

Pricing scenarios

Price promotions

Across all stores and areas sampled over 1 week, price promotions were available online for 11 % of supermarket items and 15 % of alcohol items on average. The inclusion of discounted prices marginally lowered the price of healthy and unhealthy diets (both, 3 % decrease) (Fig. 1). The price of a healthy diet remained cheaper than the price of an unhealthy diet when accounting for price promotions. Mean diet affordability only marginally improved with price promotions compared with the traditional approach (healthy: 25 % *v.* 26 %, unhealthy: 30 % *v.* 31 % of the indicative low disposable household income).

Generic brands

Generic branded alternatives were identified for 44 % of all products surveyed at the two supermarket chains on average. The inclusion of generic branded alternatives lowered the price of a healthy diet (25 % cheaper) more than an

Table 3 Price, affordability and price differential of healthy and unhealthy diets consumed by a reference family of four over 2 weeks, stratified across socio-economic areas (*n* 8) in Victoria, Australia

	Healthy		Unhealthy		
	Price ($AUD)	% affordability	Price ($AUD)	% affordability	Price differential* (%)
Victorian mean (using indicative low disposable household income)†	596·49	26	720·98	31	21
Victorian mean (using Australian poverty line)†‡	596·49	33	720·98	40	21
IRSD Q1 – area A§	596·10	27	711·45	32	19
IRSD Q1 – area B	597·45	24	727·60	29	22
IRSD Q3 – area A	597·29	25	719·64	30	20
IRSD Q3 – area B	597·83	17	730·27	21	22
IRSD Q5 – area A	601·24	12	731·44	14	22
IRSD Q5 – area B	598·91	12	726·87	14	21
Regional – area A	588·08	21	707·21	25	20
Regional – area B	595·05	27	713·31	32	20

IRSD Q1, Q3, Q5: Index of Relative Socio-economic Disadvantage Quintiles 1 (lowest SEP), 3 (middle SEP) and 5 (highest SEP).
*The difference between healthy and unhealthy diet prices, expressed as a percentage of the healthy diet price (i.e. the % in which unhealthy diet prices are more expensive than healthy diet prices).
†Mean state diet prices (% affordability against indicative low disposable household income and poverty line).
‡The poverty line equates to 50 % of the median equivalised disposable household income in Victoria.
§Mean area diet prices (% affordability against gross total Statistical Area 2 household income).

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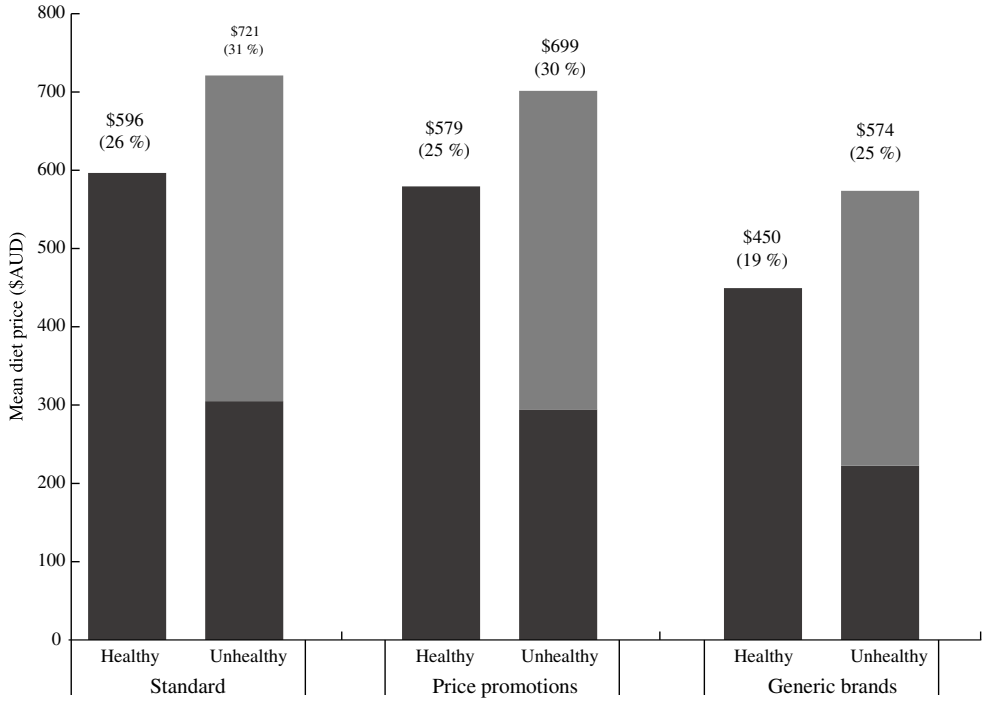

Fig. 1 Mean prices and affordability* of a Healthy and Unhealthy Diet† for a reference family of four over 2 weeks under three pricing scenarios (the traditional in-store Australian Standardised Affordability and Pricing (ASAP) protocol, price promotions and generic brands). *Percentage affordability of mean diet prices measured against indicative low disposable household income. †A healthy diet represents foods and beverages in amounts recommended for consumption by the Australian Dietary Guidelines. An unhealthy diet represents the same foods and beverages as the healthy diet but in amounts consumed by the Australian population according to the 2012–2013 Australian Healthy Survey with additional discretionary food and beverage items (contributing to 42 % of all unhealthy diet items). Additional information is provided in Table 1. ■, Discretionary; ■, Five Core Food Groups

unhealthy diet (20 % cheaper; Fig. 1). Consequently, both diets became more affordable when including generic brands compared with the traditional approach (healthy: 19 %, unhealthy: 25 % of the indicative low disposable household income). Whilst both diets were therefore considered affordable at the 25 % threshold (when assessed against indicative low disposable income), only the healthy diet was borderline affordable when assessed against the poverty line (25 % *v.* 32 % for an unhealthy diet).

Discussion

We demonstrate the feasibility and reliability of lower-resource streamlined data-gathering techniques (using online data and phone calls) to monitor the price and affordability of healthy and unhealthy diets in Australia. The availability and price of food and beverages obtained online were found to have a high agreement with those obtained in-store by major supermarkets (99 %). Consequently, the mean price and affordability of both healthy and unhealthy diets using online and in-store data produced comparable results. This streamlined approach has international relevance to public health nutrition as major supermarkets in many countries increase their online presence.

For a family of four in Victoria, the mean biweekly price of a healthy diet ($596) was found to be cheaper than that of an unhealthy diet ($721). This corresponded to 26 % (healthy diet) and 31 % (unhealthy diet) of the indicative low disposable household income in Victoria, Australia. Whilst there was some variation in the diet prices across geographical areas, differences were small with no observable pattern according to area-level disadvantage or remoteness (healthy diet price range: $582–612, unhealthy range: $694–746). The use of the discounted price when items were price-promoted reduced healthy and unhealthy diet prices by 3 %, with minimal impact on the affordability of both diets. By contrast, the inclusion of generic brand alternatives reduced healthy and unhealthy diet prices by more than 20 % and considerably improved their affordability.

Our affordability estimates (that healthy and unhealthy diets account for 26 % and 31 % of the indicative low disposable household income) are lower than those reported by a recent study. This study found that healthy and unhealthy diets accounted for 30–32 % and 37–40 % of median gross and indicative low household incomes, respectively, in one regional local government area in Victoria in 2017[5]. The different estimates are likely to be explained by geographic and socio-economic disparities in food environments and incomes. Specifically, remote areas of Victoria

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and other Australian states and territories do not have any major supermarkets with prices collected from smaller independent stores. Furthermore, the median gross household income is lower in remote areas compared with metro and regional areas included in our study[35].

Nevertheless, our finding that a healthy diet is cheaper compared with an unhealthy alternative is consistent with this rural Victorian study and more broadly with the existing literature[2,5], ultimately raising questions relating to why the public perceive food price and affordability to be leading barriers to healthy eating today[1]. It is possible that consumers interpret prices on a food-by-food basis instead of considering the collective impact of price on an entire diet. To this extent, food prices have been found to be cheaper per gram/millilitre for foods higher in energy saturated fat, sugar and salt compared with healthier foods[12]. This study also infers that healthy diets are cheaper because they do not incur the extra expenses associated with consuming discretionary foods, which are not recommended and therefore excluded from the definition of a healthy diet in this study. In particular, we show that on average, 65 % of the price differential between healthy and unhealthy diets is attributable to alcohol. Additionally, price promotions have also been found to be more frequently available for unhealthy, compared with healthy, foods and beverages in the USA and Australia[36–38] and are extensively purchased by consumers (constituting as much as 50 % of all grocery purchases in New Zealand and the UK)[18,39]. It remains unclear whether price promotions on unhealthy foods and beverages actually influence the overall relative affordability of diets or just perpetuate the perception that unhealthy foods and beverages can be purchased cheaply and offer good value[40,41]. Clarifying this idea would require investigation and experimentation beyond simply substituting in the discounted price of food and beverage items within the ASAP protocol. It will be important to investigate how price promotions influence consumer brand switching, impulse purchasing, stockpiling (i.e. when consumers buy a greater volume of products when price-promoted to avoid paying full price at a later time), fast-food pricing and purchasing, and consumption behaviours, which were beyond the scope of this study[42].

Our finding that diet price and affordability did not appreciably change when substituting in the discounted price of food and beverage items is similar to results from one other study that assessed the influence of price promotions on diet prices. This study, conducted in New Zealand, found that price promotions have little influence on overall diet prices when substituted for the everyday price of prespecified food and beverage items, reducing both healthy and unhealthy diet prices by only 2 %[22]. Noting the limitations to the consideration of price promotions in our study and the New Zealand study (discussed above), regular and longer-term monitoring should examine the impact of price promotions on diet price and affordability over time. The methods that we have tested here ultimately provide a reliable streamlined approach for future research that can feasibly address these evidence gaps.

Our study demonstrates that substitution of prespecified branded foods and beverages in the ASAP diets with generic branded alternatives has a substantial impact on diet prices and affordability, reducing the affordability of a healthy diet by 25 % and an unhealthy diet by 20 %. This is in contrast to a similar New Zealand study that examined the impact of generic brands on diet prices, finding reductions in diet prices by only 3 %[22]. These differences are likely to reflect country-specific availabilities and market shares whereby generic brands are estimated to constitute 21 % of the market share in Australia, with an increasing trend forecasted, compared with only 13 % in New Zealand[20,43]. Our findings are further supported by studies that have compared the prices of generic and branded food and beverage items (but not diets) in Australia, indicating that generic branded items were 44 % cheaper on average and that this differential was highest for core healthy foods including breads and cereals[21,44]. The relative cheapness of generic brands exemplifies the power of large supermarket chains in influencing food and beverage pricing[17]. As such, generic branded products have the potential to form important policy targets and their prices, availability and purchasing should continue to be regularly monitored.

Strengths and limitations

The streamlined methods we propose for monitoring the price and affordability of diets (and the foods they constitute) greatly circumvent the travel and time required for existing in-store data collection methods and minimise the human error associated with data entry (by cross-checking and verifying online data in real-time). These methods can therefore be used to ensure regular and geographically widespread monitoring, as well as the inclusion of a wider variety of products and pricing scenarios.

Nonetheless, our streamlined approach is ultimately limited to inner cities and inner regional areas where an online presence is available for major supermarkets (and two-thirds of Australians reside[45]). In-store data-gathering techniques remain important for rural and remote areas or countries, especially low-income countries, where grocery prices are unavailable online. Our approach also did not include data collection from local markets, small independent grocery stores (Independent Grocers Australia) or discount grocery stores (Aldi) as these stores do not have online price data. However, on average, a smaller proportion of food and beverages are purchased from such stores (Aldi: 9 %, Metcash/Independent Grocers Australia: 7 %[30]) compared with the two major Australian supermarkets (where approximately two-thirds of all grocery sales occur), suggesting that the streamlined approach is likely to be relevant to the average Australian consumer. Similarly, collecting the prices of one food item from

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convenience stores was limited when using phone calls, often hindered by retail communication procedures and disclosure practices. Although convenience stores make a small contribution to the price of healthy and unhealthy diets in this study and the smallest contribution to all grocery sales in Australian retail ($2·8 million compared with $135·0 million for supermarkets in 2018[46]), there is a need to identify novel methods that capture food and beverage pricing data across these types of settings.

Whilst the potential exists to streamline the regular monitoring of modelled diet prices (i.e. hypothetical diets), food and beverage retail prices do not reflect what populations actually expend or purchase. As such, food and beverage retail prices should be used in conjunction with purchase data[16] or more sophisticated and up-to-date estimates of population dietary patterns, where available, to investigate this.

Implications for policy and future research

Food and beverage pricing is widely recognised by international health organisations as a key policy leverage point to improve population diets[47]. With routine use, our streamlined collection of food and beverage prices can be used to more broadly understand how different factors (i.e. retailer/industry pricing strategies, food/nutrition policies, climate and weather conditions, seasonality, festive periods, etc.) affect the prices of healthy and unhealthy diets and thereby inform comprehensive pricing policies and interventions. Our methods can be further streamlined using web scraping methods and advanced computer programming (also known as web crawling technologies), to automatically calculate the price and affordability of diets over time; methods that are currently being used to enhance price statistics in economics[48]. Such automated advancements are critical to develop a low-cost monitoring system to ensure that healthy diets remain more affordable and economically attractive than unhealthy diets. This is particularly important as our findings demonstrate that healthy diets are unaffordable for some Australians.

Improving the affordability of a healthy diet can also be influenced by policies that target the broader social determinants of health. This may include polices addressing housing affordability, welfare payments and/or income redistribution, all of which are likely to affect disposable household income and the consequent affordability of foods and beverages, particularly for low-income households. These types of policies also have broader benefits for improving social inequities in health, independent of food and beverage prices.

Conclusion

Food and beverage prices are increasingly accessible online, with some exceptions identified for smaller retail and convenience stores. Additional research is required to identify low-resource methods to capture data across all food and beverage retail settings. Our streamlined approach to monitoring the price and affordability of foods and diets should be adopted in jurisdictions where reliable and detailed online food and beverage price data are available. Doing so will ensure regular and comprehensive monitoring of this fundamental determinant of population diets and health across different geographic areas around the globe.

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Supplementary material

For supplementary material accompanying this paper visit https://doi.org/10.1017/S1368980020001718

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