

The affordability of a healthy and sustainable diet: An Australian case study.

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Abstract

BACKGROUND/AIMS : EAT– Lancet Commission’s Planetary Health Diet proposed a diet that integrates nutrition and sustainability considerations, however its affordability is unknown in many country-specific contexts, including Australia. The aim of this study is to develop a healthy and sustainable food basket modelled on the Planetary Health Diet to determine the affordability of the Planetary Health Diet basket across various socio-economic groups, and compare this affordability with a food basket modelled on the typical current diet, in an Australian setting.

METHODS : An Australian-specific Planetary Health Diet basket was developed for a reference household (2 adults and 2 children) modelled on the Planetary Health Diet reference diet, and compared to a previously-developed Typical Australian Diet basket. The cost of each food basket was determined by online supermarket shopping surveys in low, medium and high socio-economic areas in each Australian state. Basket affordability was determined for the reference household by comparing the basket cost to disposable income in each socio-economic group in each state. Mann-Whitney U tests then determined if there were significant differences between the median costs and the median affordability of both baskets.

RESULTS : The Planetary Health Diet basket was shown to be less expensive and more affordable than the Typical Australian Diet basket nationally, in all metropolitan areas, in all socio-economic groups across Australia (median cost: Planetary Health Diet=AUD\$188.21, Typical Australian Diet=AUD\$224.36; median affordability: Planetary Health Diet=13%, Typical Australian Diet=16%; $p < 0.05$).

CONCLUSIONS : This study showed the Planetary Health Diet to be more affordable than the Typical Australian Diet for metropolitan-dwelling Australians.

IMPLICATIONS : These results can help to inform public health and food policy aimed at achieving a healthy and sustainable future for all Australians, including reductions in overweight/obesity rates and increased food security.

2. Introduction

Global diets and food systems,¹ and the populations relying on them, are experiencing major challenges in terms of both health and sustainability which are predicted to worsen – models project that if global eating patterns do not change away from the current diets characterised by excess energy, processed-meat and refined sugar consumption (particularly in high income countries) and towards dietary patterns that are more rich in plant-based foods, half of the adult population and one-third of the total population (including children) will be overweight or have obesity by 2030.² Current global food systems jeopardise climatic balance and ecosystem adaptability, as well as contribute to an estimated 11 million preventable adult deaths per year.³ In order for the projected 2050 global population of 10 billion people² to have sufficient food to meet nutritional needs within the limits of the planet’s resources, the ways in which food systems operate must change, including which food is consumed and by whom.²⁻⁵ Recently released research has proposed a global diet which, if widely adopted, is predicted to help to alleviate these issues of malnutrition and unsustainability.³

2.1 The inherent link between food systems and climate change

Food insecurity⁶ is being exacerbated by climate change, with temperature changes, droughts and/or floods affecting food crops and consequently food accessibility in regions worldwide, including Australia.⁶⁻¹⁰ Increased carbon dioxide in the atmosphere also contributes to a reduction in the nutrient content of food,¹¹⁻¹³ which could have widespread health implications for the global population, in particular those who are already struggling to consume enough quality food to meet their nutritional needs.^{6,13}

The extent to which climate change will affect future food security remains uncertain,^{7,8} however, what is known is that while climate change affects food systems (e.g. in regard to the food able to be produced and the nutritional quality of this food), food systems also affect climate change (e.g. meat from ruminant animals contributing methane to greenhouse gas emissions),^{3,14} due to their mutually dependent relationship.^{8,14-17} Indeed, food production accounts for $\approx 30\%$ of greenhouse gas emissions, $\approx 70\%$ of water use, and $\approx 40\%$ of land use globally.³ It is the largest cause of environmental damage and has the greatest effect on human and planetary health, but is also an area that we have a degree of control over to bring about positive change.^{3,18} In the EAT– Lancet Commission report,³ Willett et al. describe a Great Food Transformation that is predicted to result in healthier diets from sustainable food systems, for the benefit of the entire population and the planet. The need to transition to a more healthy and sustainable diet is echoed by organisations such as the Food and Agriculture Organization of the United Nations^{4,6,19} and the Food Climate Research Network (FCRN).^{20,21} The EAT– Lancet Commission report provides evidence that the most effective way to lessen the environmental impact of our food systems is to change our diet to a more sustainable one, such as the Planetary Health Diet (PHD) discussed further below.^{3,22}

2.2 The Planetary Health Diet – both healthy and sustainable

A healthy and sustainable diet has been defined elsewhere but essentially is considered to be a diet that has low environmental impact while contributing to food security and meeting the health and nutritional needs of current and future generations.^{3,4,18,20,23-31} The Australian Dietary

Guidelines (ADG), which have been criticised as having a reductionist approach to diet, consider nutrients first and foremost, not sustainability.³²⁻³⁴ It also places importance on animal-based proteins, so may not be the diet to propose as optimal especially given the demands on the food system of the consumption of the amount of meat recommended in the ADG. Australians generally consume a diet that is neither healthy nor environmentally sustainable,^{35,36} though to date few countries have adopted environmental sustainability as a focus in their dietary recommendations. In contrast, Sweden and Brazil are examples of countries who have already incorporated sustainability into their dietary guidelines by including recommendations such as a predominantly plant-based diet based on seasonal and local foods, reducing food waste, and reducing consumption of red and processed meat, ultra-processed foods, and sugar-sweetened beverages.^{19,37,38}

The EAT–*Lancet* Commission's report³ was the first to comprehensively integrate the nutritional needs of individuals with planetary sustainability principles into a single set of global dietary recommendations. The PHD reference diet³⁹ is an example of a diet that is both healthy and sustainable. This reference diet forms the framework of the PHD recommendations and can be customised to regional cultural preferences.³ The PHD reference diet was analysed as being nutrient-sufficient, and modelling showed that the intake of most nutrients increased after adoption of this diet compared with current consumption patterns, with the exception of vitamin B12 which needs fortification or supplementation,³ consistent with the current general consensus on mostly plant-based diets.^{18,23,25,40} The EAT–*Lancet* Commission report stated that a global shift in dietary behaviours to align with the PHD could prevent around 19-23% of deaths per year (around 11 million deaths prevented) by way of improved human health,³ however under subsequent further analysis it appears that these prevented deaths may be purely the result of the changes in energy consumption associated with the PHD.⁴¹

2.3 Affordability as a factor affecting food choices

For the PHD to be widely adopted, it needs to be acceptable to consumers. While there are several factors that affect consumer food choices, such as accessibility, availability, health concerns and food preferences,^{2,42} this review considered the role of affordability as a key factor that may influence the uptake of the PHD.⁴³ Cost is generally a major determinant of food choices,⁴⁴⁻⁵² and, although health and sustainability are desired outcomes of consumer choices, affordability often takes priority, particularly for lower-income consumers.^{44,45,53-55} Therefore, it is necessary to understand the cost and affordability of a healthy and sustainable diet, such as the PHD, for a range of socioeconomic groups.

2.4 Is a healthy and sustainable diet affordable for Australians?

Presently, information about the affordability of healthy and sustainable diets is scant. Only one study appeared to exist on the affordability of a healthy *and* sustainable food basket across various socio-economic groups in an Australian context,⁴⁶ but this was not undertaken nationally and the basket did not include the sustainability principles incorporated in the PHD. Studies also exist that have been undertaken in small regions in Australia such as specific metropolitan areas,^{46,56,57} but not nationally, meaning results cannot be applied to all areas in all states, and national comparisons between different areas in different states is not possible. To our knowledge, a healthy and sustainable food basket based on the PHD has not been created and analysed for affordability nationally across various socio-economic groups in Australia, however since the present study was completed, other research on the affordability of the PHD throughout the world has since been published.⁵⁸ This is essential for measuring the affordability, and therefore the feasibility, of a healthy and sustainable diet for all Australians. Globally, two studies from United Kingdom have determined the cost of a healthy and sustainable diet and compared it to the typical diet consumed in that country.^{59,60}

The aims of this study were to: (a) Determine the affordability of the PHD food basket for low, middle and high socio-economic groups in metropolitan Australia; (b) Determine if the PHD food basket is more or less affordable than the Typical Australian Diet (TAD) food basket for low, middle and high socio-economic groups in metropolitan Australia.

3 Method

3.1 Study design

This cross-sectional study developed food baskets for a reference family of four, then used food basket surveys at Coles supermarket⁶¹ (which together with Woolworths supermarket accounts for around 80% of the total grocery spend in Australia)⁶² representing the PHD and the TAD baskets, to cost the baskets in metropolitan postcodes that vary in socio-economic status, for each Australian state/territory. Metropolitan areas were chosen due to the majority of Australians (71%) dwelling in these areas.⁶³ The baskets were then analysed using existing secondary data from the Australian Bureau of Statistics (ABS)⁶⁴ on area level (dis)advantage and median incomes of those areas to determine affordability.

3.2 Data collection

The reference household represents a common Australian household structure to establish the quantity of food items needed in a food basket.⁶⁵ In this study, a family of two adults (19–60 years) and two children (boy 15 years, girl 4 years) was chosen to allow for comparison to other food basket

studies using the same reference household.^{35,46,56} Additionally, the 2016 census reported that the 'typical Australian' (i.e. 38 years old, born in Australia of English ancestry) lives as a married couple with two children, making this household structure a sensible and representative choice.⁶⁶

To compare across various socio-economic groups, data from the ABS Socio-Economic Indexes for Areas – Relative Socio-economic Advantage and Disadvantage (SEIFA-IRSAD) was used.⁶⁷ To cover a wide range of socio-economic groups, one survey area from SEIFA-IRSAD quintile 1 (most disadvantaged), quintile 3 (no real (dis)advantage) and quintile 5 (most advantaged) from each state/territory was selected. Within each quintile in each state/territory, survey areas were defined by postcodes. Postcodes chosen were the median-ranked postcode in each state/territory (Australian Capital Territory was included in New South Wales), and non-metropolitan postcodes were excluded.

The resulting list of survey areas was composed of one postcode in each of three SEIFA-IRSAD quintiles in each of the state/territory capital city metropolitan areas in Australia (Darwin, Sydney, Melbourne, Brisbane, Adelaide, Perth and Hobart).

A variety of food items from each category listed in the PHD reference diet³⁹ were selected, informed by the options proposed by Friel, Barosh and Lawrence as being both healthy and sustainable.⁶⁸ The items selected enabled sufficient consumption for the reference household for 7 days, were commonly known brands/varieties, widely available in Australian supermarkets, and allowed for dietary variety over 7 days. The basket contents were analysed using FoodWorks v9⁶⁹ software to ensure that the amount and energy intake in each category matched the PHD reference diet³⁹ as closely as possible.

The PHD reference diet³⁹ recommended an intake of 1323.8 g of food per adult per day, providing energy of 10472 kJ. As the reference household used in this study comprises two adults and two children, the basket contents were increased to reflect this. The estimated energy requirements of the 15 year old boy is 12600 kJ and of the 4 year old girl is 6100 kJ, determined using Nutrient Reference Values⁷⁰ using a physical activity level of 1.8 (moderate). Therefore, the total estimated energy requirements of the two children is 18700 kJ, which is 89% of the combined intake of the two adults (20944 kJ). Hence, the PHD basket was developed using the daily per-adult quantities in the reference diet,³⁹ then multiplying by two to arrive at the basket contents for both adults, then multiplying by 1.89 to increase the basket contents by 89% to include the children's needs, and then multiplying by seven to arrive at the final weekly basket amount.

For comparison to the usual diet consumed by Australians, the TAD basket previously developed by Friel, Barosh and Lawrence³⁶ was used. This pre-established food basket was based on actual consumption habits over 7 days for a reference household of two adults (19–60 years) and two children (boy 15 years, girl 4 years) as determined by national nutrition survey data.^{35,36} The household structure used for the TAD basket was the same as for the PHD basket, allowing for clear comparison. Following construction of the two baskets, each was costed to determine affordability.

Costing was determined using online shopping pricing data from Coles supermarkets⁶¹ to build a hypothetical order of the basket contents to determine the cost of the food items. As Coles Online uses the same pricing for online sales as the store from which the order will be delivered from or collected⁶¹ (confirmed via Coles Customer Care phone call, 21 May 2019), using this online pricing gives an accurate representation of prices as if the basket was purchased in store at one of the 21 postcodes selected. The survey was conducted 14th -15th August 2019.

The cheapest item available for each food item in the food basket was selected, including generic brands and temporarily out of stock items (which were assumed to be otherwise available). The item of the same size/quantity as the food basket item was selected. If there was no item of the same size, a larger size was selected and only the cost of the food basket portion was calculated and included in the basket cost on a unit-cost basis. Only non-sale prices were used.

The collection store entered into the Coles Online website was the same postcode as each survey area to capture the prices from the Coles store that residents of that postcode would likely frequent. In the event there was no Coles store in the survey area postcode, the closest store in a nearby postcode was used. The same food basket contents were used for each survey area and only the collection store changed, to determine the price of the same food basket items in each survey area. If the same item was not available in a particular store, the closest matching item was chosen. If there was no closest matching item available, the price of the item in the nearest survey area was used.

To determine the affordability of the PHD and TAD baskets, income data was required. The median family income in the postcode survey areas was determined using ABS Census data.⁷¹ Family income data was used, as only family members are included and this calculation does not include non-family households such as group or lone households.⁷² As the Census median family income data is the total income before tax, an estimate of tax paid and therefore resulting disposable income was performed using an online calculator from the Australian Taxation Office.⁷³

3.3 Affordability of Planetary Health Diet and Typical Australian Diet baskets across socio-economic groups

Affordability of both baskets was calculated and compared for each socio-economic group in the survey areas using the formula $Affordability = Cost \div Income \times 100$, rounded to the nearest whole percent.

3.4 Statistical analysis

Data were analysed using SPSS v23.0,⁷⁴ checked for errors, and outliers were included as the 5% trimmed mean values were very similar to the mean values. Tests of normality showed the data was non-parametric, therefore a Mann-Whitney U test was used to determine if there was a significant difference between the median costs of both baskets, and the median affordability of both baskets, using $p < 0.05$ for statistical significance. Assumptions for the Mann-Whitney U test were met for both tests.

Further, mean cost and affordability were determined for each food basket in each SEIFA-IRSAD quintile in each metropolitan area.

4 Results

4.1 A healthy and sustainable food basket for Australians

Table 1 - Planetary Health Diet basket

Total weekly amount for 2 adults and 2 children*

Basket item	Amount
<u>Whole grains</u>	
Rice, brown, uncooked	1323 g
Bread, mixed grain & seeds, wholemeal, extra grainy, other seeds, fresh	185 g
Rolled oats, uncooked, plain, unfortified	1191 g
Pasta, wholemeal, dry	1191 g
Barley, uncooked	1058 g
Quinoa, uncooked	1191 g
<u>Tubers or starchy vegetables</u>	
Potato, plain, other, other, unpeeled, raw	1323 g
<u>Vegetables - dark green</u>	
Broccoli, fresh, raw	556 g
Kale, raw	476 g
Baby spinach, raw	318 g
Cabbage, savoy, raw	397 g
Lettuce, cos	212 g
Capsicum, green, fresh, raw	212 g
Zucchini, green, fresh, unpeeled, raw	265 g
Cucumber, common, unpeeled	212 g
<u>Vegetables - red and orange</u>	
Capsicum, red, fresh, raw	265 g
Carrot, regular, fresh, unpeeled, raw	582 g
Pumpkin, butternut, fresh, raw	529 g
Sweet potato, orange, plain, unpeeled, fresh, raw	132 g
Tomato, common, raw	1138 g
<u>Vegetables - other</u>	
Mushroom, fresh, common, fresh	1879 g
Onion, mature, brown, raw	714 g
Garlic, fresh, raw	53 g
<u>Fruits</u>	
Banana, fresh, cavendish	1323 g
Apple, fresh, pink lady, unpeeled	1323 g
Kiwifruit, green (hayward), unpeeled	794 g
Mandarin, fresh	1191 g
Strawberries, fresh	529 g
Avocado, raw	132 g
<u>Dairy foods</u>	
Milk, cow, ready to drink, regular fat, regular	6422 mL
<u>Protein sources - animal</u>	
Beef, diced, untrimmed, raw	185 g
Pork, diced, raw	185 g
Chicken, breast, with skin, raw	767 g
Fish, salmon, raw, Atlantic	741 g
Eggs, chicken, whole, raw, regular	344 g
<u>Protein sources - plant</u>	
Lentils, red, dried	926 g
Beans, red kidney, dried, uncooked	132 g
Beans, cannellini, dried	132 g
Peas, split, uncooked	265 g
Tofu, firm	132 g
Nuts, peanut, raw, unsalted	1058 g
<u>Tree nuts</u>	
Nuts, almonds, raw, with skin	53 g
Nuts, cashews, raw	265 g
Seeds, sunflower	344 g
<u>Added fats</u>	
Oil, coconut**	196 mL
Oil, olive, extra virgin	1151 mL
Lard	132 g
<u>Added sweeteners</u>	
Sugar, raw, regular	820 g

* Based on the average weekly intake of a household of four: adult male (aged 19-60 years), adult female (aged 19-60 years), boy aged 15 years and girl aged 4 years.

** Replaces palm oil as a more popular and readily available saturated fat in Australia.

Table 1 shows the food basket developed, modelled on the PHD. This PHD basket matched the PHD reference diet³⁹ in regards to the quantity of food and energy intake.

4.2 Cost and affordability of the Planetary Health Diet and Typical Australian Diet baskets for low, middle and high socio-economic groups in metropolitan Australia

Table 2 - Family disposable income, basket costs, and affordability per week per postcode per metropolitan area quintile

State	Metro-politan area	SEIFA-IRSAD quintile	Postcode	Family disposable income	Coles store	PHD [^] basket cost	PHD [^] afford-ability as % of income	TAD ^{^^} basket cost	TAD ^{^^} afford-ability as % of income
NT	Darwin	Q1	0822	\$800	Coolalinga 0839*	\$192.58	24%	\$221.68	28%
		Q3	0812	\$1,806	Northlakes, Marrara	\$192.58	11%	\$221.68	12%
		Q5	0820	\$2,104	Darwin CBD 0800*	\$192.58	9%	\$221.68	11%
NSW/ACT	Sydney	Q1	2195	\$1,004	Roselands 2196*	\$182.31	18%	\$225.89	22%
		Q3	2750	\$1,528	Penrith	\$182.31	12%	\$225.89	15%
		Q5	2022	\$2,116	Bondi Junction	\$182.31	9%	\$225.89	11%
VIC	Melbourne	Q1	3022	\$1,224	Derrimut Village 3030*	\$185.58	15%	\$220.43	18%
		Q3	3173	\$1,416	Keysborough	\$185.58	13%	\$220.43	16%
		Q5	3183	\$1,822	Prahran 3181*	\$185.58	10%	\$220.43	12%
QLD	Brisbane	Q1	4205	\$1,142	Waterford 4133*	\$196.60	17%	\$224.66	20%
		Q3	4127	\$1,404	Springwood	\$196.60	14%	\$224.66	16%
		Q5	4130	\$1,728	Loganholme 4129*	\$196.60	11%	\$224.66	13%
SA	Adelaide	Q1	5115	\$1,212	Munno Para	\$187.19	15%	\$221.61	18%
		Q3	5118	\$1,422	Gawler	\$187.19	13%	\$221.61	16%
		Q5	5157	\$1,616	Blackwood 5051*	\$187.19	12%	\$221.61	14%
WA	Perth	Q1	6064	\$1,280	Alexander Heights	\$191.93	15%	\$234.01	18%
		Q3	6057	\$1,570	High Wycombe	\$191.93	12%	\$234.01	15%
		Q5	6152	\$1,794	Karawara	\$191.93	11%	\$234.01	13%
TAS	Hobart	Q1	7030	\$1,138	Bridgewater	\$188.21	17%	\$224.36	20%
		Q3	7026	\$1,294	Sorell 7172*	\$188.21	15%	\$224.36	17%
		Q5	7052	\$1,512	Kingston 7150*	\$188.21	12%	\$224.36	15%

*No Coles store in the selected postcode, survey taken from nearest store.
[^] Planetary Health Diet; ^{^^} Typical Australian Diet

Table 2 details PHD and TAD basket costs and affordability. While the cost of each basket was the same across all SEIFA-IRSAD quintiles for each metropolitan area (i.e. Coles did not vary their prices as postcodes were changed, within areas), the family disposable income varied, meaning the proportion needed to purchase each basket was greater in the lower socio-economic areas (SEIFA-IRSAD quintile 1), and lesser in the higher socio-economic areas (SEIFA-IRSAD quintile 5). At the time of the survey, the cost of the PHD basket was highest in Brisbane metropolitan area (\$196.60) and lowest in Sydney metropolitan area (\$182.31), with affordability highest in SEIFA-IRSAD quintile 5 of Darwin and Sydney metropolitan areas (9% of disposable income) and lowest in SEIFA-IRSAD quintile 1 of Darwin metropolitan area (24% of disposable income). The PHD basket required a much higher proportion of income in Darwin metropolitan area SEIFA-IRSAD quintile 1 than in other survey areas, and was a statistical outlier in the data set. A comparison of the cost and affordability of PHD and TAD baskets is discussed further below. As a national average, the lowest SEIFA-IRSAD quintile required 17% of family disposable income to purchase the PHD basket compared to the highest SEIFA-IRSAD quintile at 11%. Affordability for the PHD basket was highest in Darwin and Hobart metropolitan areas (15%), and lowest in Sydney, Melbourne, Adelaide and Perth metropolitan areas (13%).

4.3 Comparison of cost and affordability of the Planetary Health Diet and Typical Australian Diet baskets

As shown in Table 2 above, the cost of the TAD was highest in Perth metropolitan area (\$234.01) and lowest in Melbourne metropolitan area (\$220.43), with affordability highest in SEIFA-IRSAD quintile 5 of Darwin and Sydney metropolitan areas (11% of disposable income) and lowest in SEIFA-IRSAD quintile 1 of Darwin metropolitan area (28% of disposable income). The TAD basket cost of \$234.01 was a statistical outlier for all areas in WA. Additionally, the TAD basket required a higher proportion of income (28%) in Darwin metropolitan area SEIFA-IRSAD quintile 1 than in other areas, and was also a statistical outlier.

Figure 1 shows mean and median costs of the PHD and TAD baskets nationally, demonstrating that the PHD costs less than the TAD (median is provided due to statistical test used). A Mann-Whitney U Test⁷⁴ on median costs of both baskets revealed that the PHD basket was significantly less expensive ($Md=188.21$, $n=21$) than the TAD basket ($Md=224.36$, $n=21$), $U=0.000$, $z=-5.559$, $p<0.001$, $r=-0.86$.

Figure 2 demonstrates the PHD is more affordable than the TAD (median is also provided due to statistical test used). A Mann-Whitney U Test⁷⁴ on the median affordability of both baskets revealed that the PHD basket ($Md=13$, $n=21$) was significantly more affordable than the TAD basket ($Md=16$, $n=21$), $U=128.00$, $z=-2.340$, $p=0.019$, $r=-0.36$.

Figure 3 shows the comparison between affordability of PHD and TAD baskets across SEIFA-IRSAD quintiles, showing that the PHD basket was more affordable (i.e. required less disposable income) than the TAD basket in all quintiles nationally.

The PHD basket was less expensive than the TAD basket in all metropolitan areas across Australia, with the biggest gap in the Sydney metropolitan area supermarkets where the PHD basket was over \$43 less expensive than the TAD basket. Consequently, the PHD basket was more affordable than the TAD basket in all state metropolitan areas.

5 Discussion

The novel PHD basket for Australians was found to be both less expensive and more affordable than the TAD basket nationally, in all metropolitan areas, and across all SEIFA-IRSAD quintiles. This research suggests that healthy and sustainable diets such as the PHD are highly feasible in the Australian context, in terms of the basket contents being available and purchased in large-scale retail outlets in urban settings and with culturally appropriate adaptations for Australian consumers.

Results indicated that an average of \$AUD189.20 (\approx \$USD120) per week was required to consume a diet consistent with the PHD, compared to an average of \$AUD224.66 (\approx \$USD145) for the TAD. If adopted over a one year period, the PHD would result in savings of \$AUD1843.92 (\approx \$USD1200) to the household food budget for a family of two adults and two children. This study also found SEIFA-IRSAD quintile 1 households are required to dedicate an average of 17% of their income to a healthy and sustainable diet, compared to 21% of their income required for a typical diet, indicating that the PHD would be more affordable for metropolitan-dwelling Australians than what is typically being consumed currently regardless of socio-economic (dis)advantage.

The national mean food basket affordability results from this study were consistent with ABS data showing Australians spend approximately 17% of their disposable income on food and non-alcoholic beverages^{75,76} – in other words, the results of this study's surveys fell into the expected range. All SEIFA-IRSAD quintiles in all metropolitan areas were within the acceptable range of food affordability (not more than 30% of disposable income),^{65,77-80} however the Darwin SEIFA-IRSAD quintile 1 survey area was nearing the domain of potential food stress for both the PHD and TAD baskets,^{46,65,78} with the baskets costing 24% and 28% of disposable income respectively.

Results of the present study are in contrast to a similar Australian study by Barosh et al. which found that a healthy and sustainable diet is more expensive than the TAD.⁴⁶ However, the disparity in results could be explained by differing methods – the surveys for the present study were conducted only in major supermarkets (Coles and Woolworths together account for around 80% of the total grocery spend in Australia),⁶² whereas Barosh et al. surveyed food price data from a variety of retail outlets including small corner stores, which the authors indicated are more expensive than supermarkets.⁴⁶ In addition, the Barosh et al. healthy and sustainable basket was composed of different items to the PHD basket, and included more meat which would inevitably increase the cost of the basket, especially from smaller retail outlets.⁴⁶ Further, the Barosh et al. food basket surveys were conducted in 2011, and food costs may have changed since that time. Two studies from United Kingdom also showed that a healthy and sustainable diet cost the same or less than the typical current United Kingdom diet, consistent with the present study's findings even though different methods were used (one study collected food costs of mid-range items from supermarkets,⁶⁰ and one study collected food costs from all retail sources from consumer's actual purchases).⁵⁹

A 2013 global review on food prices and affordability showed that for some consumers price is more of a purchasing determinant than taste, and that consumers generally purchase more food when prices fall and less food when prices rise.⁴⁹ Although the affordability of the PHD has now been demonstrated, it remains unclear if, and to what extent, the cost of fluctuating food prices could affect consumer adoption of this diet, particularly lower-income consumers who are more price sensitive than higher-income consumers.⁵¹ This could become more of an issue in the future as it is predicted that food prices will rise due to issues associated with climate change, which will affect affordability and therefore accessibility of food for many people.^{2,9}

The results of the present study suggests that a diet modelled on the PHD reference diet is feasible in regards to the cost, amounts and availability of food for a range of Australians. This PHD basket was designed to accommodate Australian food preferences and considered item availability in Australia.⁶⁸ The only item alteration was coconut oil replacing palm oil, as palm oil is neither readily accessible nor popular in Australian cuisine. Kangaroo meat was considered for inclusion due to its relatively low environmental footprint,^{9,68,81} however as this meat is not farmed but hunted on a quota system which varies between states and is dependent on the wild kangaroo population size, the supply of kangaroo meat may not be large enough or consistent enough to meet demand if the PHD is widely adopted.⁸² Compared to the TAD, the total amount of meat was reduced, but most important was the reduction of ruminant meat – from 1168 g (TAD) down to 185 g (PHD). As ruminants are a large contributor to greenhouse gasses due to their methane output, this contributes greatly to the lower environmental footprint of the PHD.^{3,14}

As the present results demonstrate, the PHD was less expensive and more affordable than the current TAD across socioeconomic groups. However, that does not mean that the PHD will be widely adopted. As the PHD contains more fresh produce and no pre-prepared foods, it requires more preparation time and manual cooking than the TAD. This could be an issue for those who do not like or know how to cook, or those who are time-poor (e.g. full-time workers, single parents) and may make acceptance and compliance more difficult. The inclusion of more fresh produce also means that the basket as a whole is more perishable, hence households may need to shop more regularly than for the TAD – this could reduce feasibility of adopting the PHD for time-poor families, those who need to travel long distances to get to food retail outlets, and those who rely on public transport for travel.

While this study has endeavoured to be as accurate as possible, it is not without limitations. The PHD basket contents do not consider medical dietary restrictions such as gluten-free diets for coeliacs, although this is also true for other existing food baskets.^{46,56,57,59,60,83-87} The TAD basket, while developed from surveys of actual consumption, may not be representative of an individual's consumption, and was based on the 1995 National Nutrition Survey³⁵ – in future, TAD baskets should be informed by the more recent 2011-13 National Nutrition and Physical Activity Survey. In addition, the present survey only used one supermarket chain so may not be representative of the cost of items purchased elsewhere, e.g. corner stores, farmers markets or grown at home. The survey also does not consider that consumers' food choices may be influenced by sale prices, which could alter both the contents and the cost of the baskets.⁴⁴⁻⁵⁵ Despite these limitations, this study still provides a worthwhile and novel contribution to the literature regarding healthy and sustainable food baskets, and the affordability of these food baskets in Australia.

5.1 Strengths and contributions to literature

To our knowledge, this study is the first time that a food basket has been developed that is modelled on the PHD, contributing to current literature on both development and use of food baskets, and healthy and sustainable diets for different population groups. Additionally, to our knowledge, this study is the first time that a PHD basket has been costed for affordability in Australia, and that food baskets in general have been costed for affordability nationally across various socio-economic groups. This cost and affordability analysis of the PHD basket fills a gap left by the EAT-*Lancet* Commission, which did not address the diet's economic viability for consumers.³ Further research is needed to ascertain the feasibility of the PHD diet in rural and remote areas of Australia, as well as general consumer acceptance of the PHD diet.

5.2 Implications

This study has shown that the PHD is an affordable, and therefore financially feasible, diet for metropolitan-dwelling Australians regardless of socio-economic status or location. These results can help to inform public health and food policy aimed at achieving a healthy and sustainable future for all Australians. This can lead to a reduction in overweight/obesity rates and subsequent non-communicable diseases, and increased food security in the face of predicted population increases and environmental uncertainty due to global climate change effects. These results add to the available evidence used to promote food and nutrition literacy for Australians, and consumers may transition their dietary behaviour towards the PHD if not to be healthier and more environmentally friendly, then perhaps for financial benefits. However, given the likely increased time and cooking skill required to adopt the PHD, this would need to be considered in parallel.

5.3 Conclusion

This study showed that a diet modelled on the latest proposal for a healthy and sustainable diet, the PHD, is achievable within Australian cultural food preferences, cheaper when shopping at major retail outlets, and more affordable than the current Australian diet.

6 Declarations

Ethics approval and consent to participate: Not applicable.

Consent for publication: Not applicable.

Availability of data and materials: To be confirmed.

Competing interests: The authors declare that they have no competing interests.

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Authors' contributions: TG lead the writing of the manuscript and collected and analysed the data. TG, CGR and RL conceptualised and designed the study. CGR and RL assisted with the data analysis and interpretation and edited the manuscript. All authors read and approved the final manuscript.

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Figures

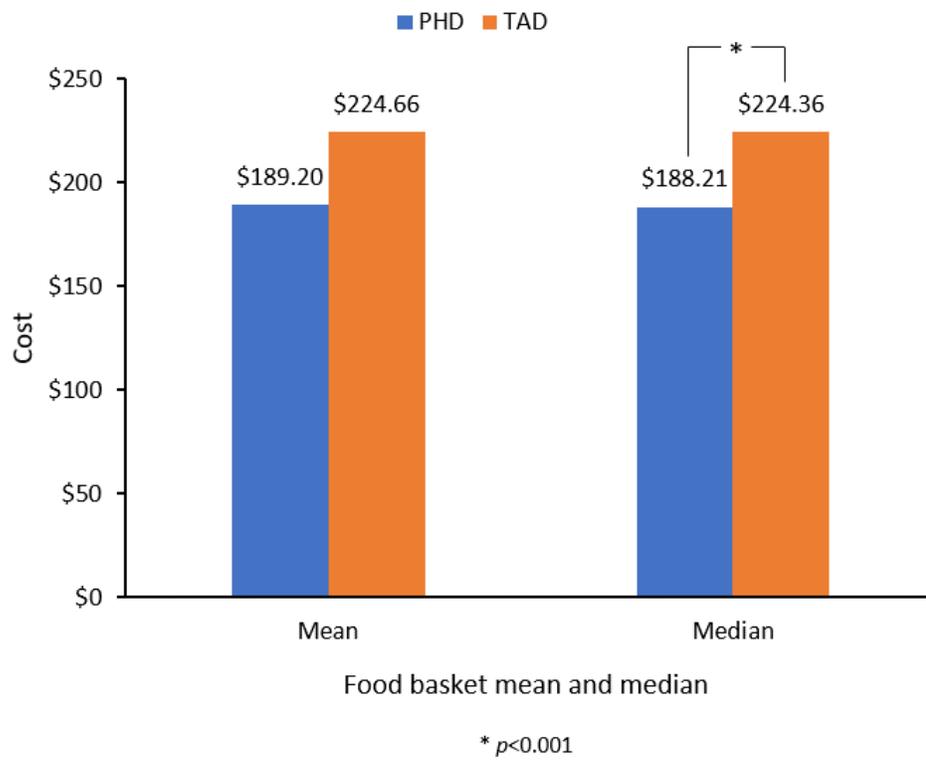


Figure 1

National mean and median food basket cost

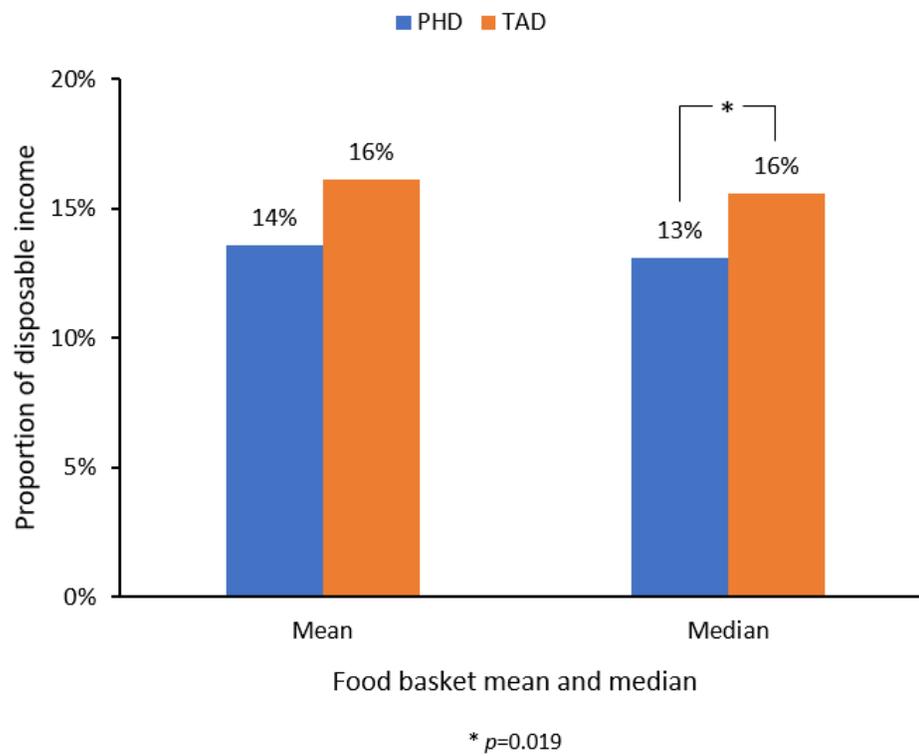


Figure 2

National mean food basket affordability as proportion of disposable income

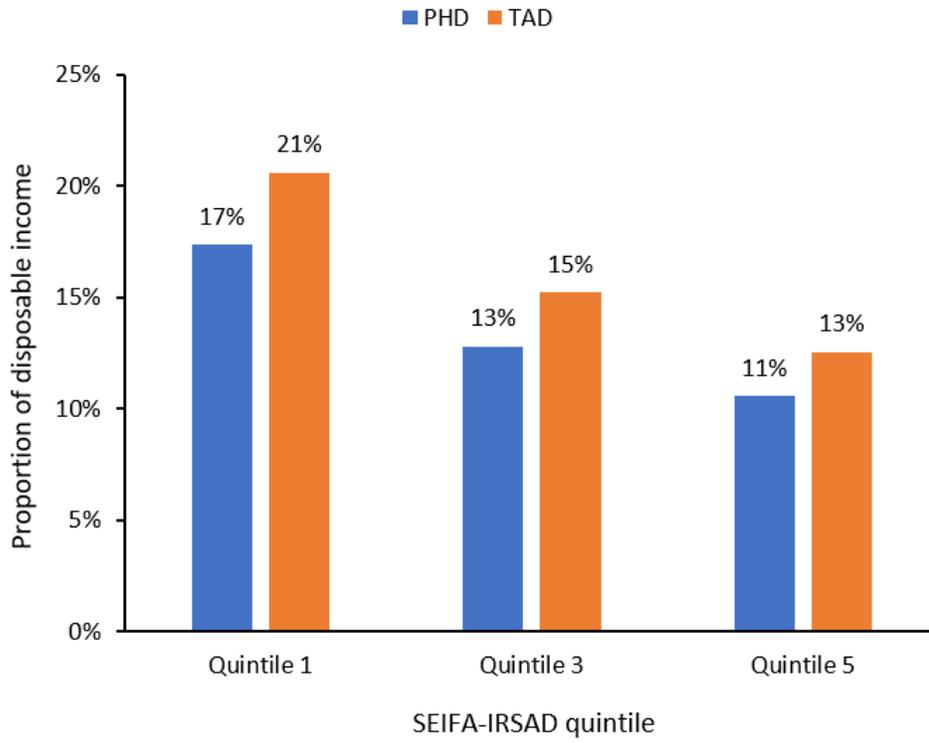


Figure 3

National mean food basket affordability by SEIFA-IRSAD quintile