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Assessing healthy diet affordability in a cohort with major depressive disorders

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Although, the cost of food is commonly described as a barrier to consuming a healthy diet, the evidence for this viewpoint has been inconsistent to date. The purpose of this study was to assess whether a healthy diet is affordable for a sample population with major depressive disorder and current unhealthy eating patterns, enrolled in supporting the modification of lifestyle in lowered emotional states (SMILES) trial. The first 20 participants of the SMILES trial were invited to complete a 7-day food diary at baseline. A cost analysis of a modified Mediterranean diet (recommended for trial participants) and 7-day food diaries of participants enrolled in the randomized controlled trial was conducted. Trial participants spent an estimated mean of $138 per week on food and beverages for personal consumption, whereas the total food and beverage costs per person per week for the recommended modified Mediterranean diet was estimated at $112, both based on mid-range product cost. The modified Mediterranean diet at $1.54 per mega-joules (MJ) was cheaper per energy unit than the cost of the current dietary intake of the SMILES participants included in this study at a mean of $2.35 per MJ. These study findings suggest that the adoption of a healthy modified Mediterranean diet does not cost more than a poor quality diet. Thus, failure to comply with healthy diets is unlikely to reflect affordability. Public health messages should incorporate the finding that healthy eating is not associated with increased costs and in fact may well involve savings to the household budget. Practical strategies and techniques for selecting healthy nutritious foods on a budget could support the achievement of desired dietary goals for preventing and managing chronic disease.

Key words: Depression, cost analysis, food cost, healthy diet, Mediterranean diet.

INTRODUCTION

Chronic diseases, such as coronary heart disease, stroke, type 2 diabetes and depression, are the leading causes of death and disability worldwide (World Health Organization (WHO, 2014a,b); representing 63% of all deaths (WHO, 2014). Nutrition is a major modifiable determinant of chronic disease, with scientific evidence increasingly supporting the view that diets (healthy or poor) have profound effects on health throughout life

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(Joint WHO/FAO Expert Consultation on Diet, 2002). Importantly, diet quality may influence not only present health, but may predict whether or not an individual will develop certain chronic diseases later in life (Joint WHO/FAO Expert Consultation on Diet, 2002). This is also pertinent in the context of mental health, where healthy diet has recently been identified as a protective factor in depressive illness (Lai et al., 2013). Depression is highly prevalent and a leading cause of disability globally (Psaltopoulou et al., 2013).

In recognition of this established evidence-base, advice to adopt a 'healthy diet' is included in clinical practice guidelines for the management of overweight and obesity (Dietitians Association of Australia (DAA), 2005), type 2 diabetes mellitus (Ajala et al., 2013; Dieticians Association of Austrialia (DAA), 2006) and stroke (National Stroke Foundation, 2010). However, despite the degree of evidence available, adherence to dietary advice is typically poor (Ball et al., 2003). One of the proposed reasons is the perception that healthy food is more expensive than unhealthy food (Goulet et al., 2008; Ryden et al., 2008; Turrell and Kavanagh, 2005; Vlismas et al., 2010). For persons from socioeconomically disadvantaged backgrounds, who already allocate a higher proportion of their disposable income to food (Drewnowski and Specter, 2004; Palermo et al., 2008), cost is argued to be of particular importance given the higher prevalence of chronic disease in those with low socioeconomic status (Joint WHO/FAO Expert Consultation on Diet) (Glover et al., 2004; Rao et al., 2013; Vlismas et al., 2010). Although, the cost of food is commonly described as a barrier to consuming a healthy diet (Kettings et al., 2009; Lopez et al., 2009; Rao et al., 2013; Ryden et al., 2008; Turrell et al., 2005) the evidence for this viewpoint has been inconsistent to date. Some studies have found that a healthy diet is associated with increased costs (Bernstein et al., 2010; Lopez et al., 2009; Rao et al., 2013) while others have reported that it is not more expensive to eat healthily (Goulet et al., 2008; Ryden et al., 2008).

It is likely that the literature to date lacks clarity because of varying methods employed, not all of which are designed to answer the question; "are food costs a barrier to healthy eating"? Specifically, studies do not accurately measure current dietary intake and the associated expenditure at an individual level, based on analysis of a poor quality and better quality diet scenario. Additionally, studies differ with regards to methods of dietary assessment, the definition of what constitutes a 'healthy diet' and the approach to costing the diet.

Dietary assessment

Some studies compare the cost of individual food items rather than whole diets (overall diet patterns), for example lean cuts of meat versus high fat sausages. Descriptions of a healthy diet can also vary and have been defined by adherence to a Mediterranean style diet (Lopez et al., 2009) or scores on the Healthy Eating Index (Bernstein et al., 2010) while other studies define diet quality based on the intake of select macro- and micronutrients (Aggarwal et al., 2011). This heterogeneity in what characterises a healthy diet poses a number of challenges when interpreting and comparing results. Moreover, studies that use participant reported eating patterns as the basis of analyses may introduce further uncertainty, as common dietary assessment tools fail to gather information of sufficient detail to determine true dietary intake. For example, the commonly employed food frequency questionnaires (FFQs) are limited by the food lists they contain, and attempt to assess usual intake over prolonged periods and across different seasons. FFQs typically lack specific detail regarding serving sizes, such that this information is often based on standardised portion sizes of specific foods published in National dietary guidelines (Vlismas et al., 2010), which does not account for individual variation (Rangan et al., 2009). Other studies use self-reported 24 h recall (Aaron et al., 2013) or dietary histories in a face-to-face interview (Turrell and Kavanagh, 2005), which are prone to recall bias and poor reliability at the individual level (Thomas B, 2002). Few studies use 7-day diet records (Rao et al., 2013), commonly referred to as the 'gold standard' dietary assessment tool (Hoidrup et al., 2002).

Assessing food costs

The methods for estimating food costs in published studies tend to be described in only general terms, for example using national food prices or a food purchasing index (example, food-cost data from the US Department of Agriculture or a purchasing index based on 16 grocery items) (Bernstein et al., 2010; Turrell and Kavanagh, 2005). Such methods are faced with limitations given the wide diversity in food prices for designated food items which vary with packing size (bulk purchasing), branding, type of outlet, season etc. Furthermore, measures of affordability are commonly based on National data of disposable income or average household spending (example, the proportion of household income required to be spent on healthy food) (Palermo et al., 2008; Vlismas et al., 2010; Ward et al., 2012; Wong et al., 2011). Thus, these studies fail to accurately examine food affordability from the consumers' perspective.

This study seeks to address a number of these methodological limitations. Our aim was to assess whether a healthy diet is affordable for a sample population with major depressive disorder (MDD) and current unhealthy eating patterns. The research tasks were to:

1. Calculate the cost of the current poor quality diets consumed by a sample of individuals with MDD enrolled

in the Supporting the Modification of lifestyle in Lowered Emotional States (SMILES) trial (O'Neil et al., 2013).
2. Estimate the cost of an alternative healthy Modified Mediterranean diet recommended for trial participants and
3. Compare the cost of the current poor quality diet with the healthy modified Mediterranean diet to assess affordability.

To our knowledge this is the first published cost analysis of foods consumed by individuals with MDD based on the gold standard 7-day food diary. It is also the first study to explore, for a sample of persons with a major chronic disease and poor diet quality, whether food cost is a plausible explanation for poor food choices, based on costs of their current diet pattern and the cost of an alternative healthy diet. These study findings are likely to be generalizable to other population groups considering that almost half (45%) of all Australians will experience a mental disorder at some point in their lifetime (Australian Bureau of Statistics (ABS), 2009). Moreover, the poor quality diets consumed by study participants are likely reflective of dietary habits of the general Australian population - most of whom fail to meet National Dietary Guidelines (Australian Bureau of Statistics (ABS), 2010).

METHODOLOGY

Subjects and dietary assessment

Participants comprised individuals enrolled in a randomized, controlled trial of dietary improvement as a treatment strategy in major depression, the SMILES study (O'Neil et al., 2013). Because 7-day food diaries were collected as part of this RCT, it provided a unique opportunity to assess the cost of current poor quality diets in a chronic disease cohort, and whether food cost was an issue in promoting better food choices. Participants were recruited across two intervention sites, Geelong and Melbourne (Victoria, Australia). Eligibility criteria required study participants to currently have "poor" dietary quality assessed using a dietary screening tool (DST) (Bailey et al., 2009), modified for the Australian population. Participants with a score of 68 or less on the DST were eligible for inclusion (O'Neil et al., 2013).

Broadly defined, these individuals had a poor (low) intake of dietary fibre, lean proteins, and fruit and vegetables, and a high intake of sweets, processed meats and salty snacks (Bailey et al., 2009). Depression status was assessed using the Diagnostic and Statistical Manual of Mental Disorders 4 (DSM-IV-TR) diagnostic criteria for major depressive disorder, single episode or recurrent. Depression severity was assessed using the Montgomery-Asberg Depression Rating Scale (MADRS); participants required a score of 18 or above (moderate to severe depression) to be eligible. Further details have been published previously (O'Neil et al., 2013).

The first 20 participants to complete a 7-day food diary (Garrow et al., 2002) at the baseline assessment (before randomization and group allocation), conducted between November, 2012 and April, 2013, were included in this study. Food diaries were self-reported written records of actual intake of foods and beverages. Participants were encouraged to record their intake at the time of consumption to minimise error. At the baseline assessment, with the participant present, a research assistant (RA) examined the completed food diaries in detail to check for missing data or potential errors. Portion sizes were checked using food models and household measures. In situations where portion size information could not be accurately obtained from the participant (example, poor recall) a number of reputable published resources were utilised to assign a 'typical' portion size (Borushek, 2012; National Health and Medical Research Council (NHMRC), 2013; Rangan et al., 2009; Xyris Software (Australia) Pty Ltd, 2012). Food diaries were analysed using AUSNUT 2007 database in Foodworks 7.0.8923 (Xyris Software (Australia) Pty Ltd, 2012) to determine average daily energy intake, expressed as MJ.

Weight and height measurements (using a stadiometer) were collected by a RA to allow for calculation of body mass index (BMI) (kg/m^2). BMI was used to calculate estimated energy requirements (EER) to assess likely accuracy of dietary reporting. Under and over-reporting were measured using the Goldberg cut-off method (Black, 2000) to provide an indicator of the likely validity of the food diary information. Under and over reporting was based on the relationship between energy intake (EI) and EER. EI was calculated based on reported intake from 7-day food diaries, and the Schofield equations (Stewart, 2009) were used to calculate EER. Under-reporters were defined as EI:EER < 0.76, acceptable reporter defined as EI:EER 0.76 to 1.24, over-reporter defined as EI:EER >1.24 (Black, 2000). Under and over-reporters were not excluded from the analysis but their impact on findings was explored.

Healthy alternative - modified Mediterranean diet

To assess healthy diet affordability, the food costs of the current poor quality diets consumed by study participants at baseline were compared to the modified Mediterranean diet recommended to individuals enrolled in the SMILES trial. The modified Mediterranean diet, developed specifically for the SMILES trial, includes recommended serves of each of the following food groups: to achieve the macronutrient profile detailed in Table 1:

1. Non-refined cereals
2. Vegetables
3. Pulses (example, lentils and chickpeas)
4. Nuts
5. Fruit
6. Red meat, chicken, eggs and fish
7. Dairy
8. Olive oil
9. Wine
10. Sweets

Further details have been published previously (O'Neil et al., 2013).

COSTING METHODOLOGIES

Overview

Three research assistants (RAs) (LN, SD, JP) and one accredited practicing dietitian (RSO) completed the cost analyses of the modified Mediterranean diet and of the 7-day food diaries, reflecting advice on the costing method by a health economist Leonie Segal (LS). Costing of the modified Mediterranean diet occurred between January and February, 2013, and the food diaries were costed between April and July, 2013.

Participant diets at baseline (poor quality diet)

Using the 7-day food diaries, a purchase cost was applied to every food and fluid item recorded in the diaries. Total estimated weekly cost of the participant's diet was simply equal to the sum of the daily costs for all seven days ($ / week). Current dietary patterns and their associated costs were taken as the best indicator of the available food budget.

Table 1. Nutrient profile of the modified Mediterranean diet.

Nutrient profile	Average/Day	Percentage of energy contribution
Energy	9.9 MJ*	-
Protein	104.3 g	18
Total fat	103.6 g	39
Saturated fat	23.3 g	9
Monounsaturated fat	53.6 g	20
Polyunsaturated fat	19.7 g	7
Carbohydrate	220.5 g	37

*Energy with alcohol (110 ml red wine /day @ 450 kJ) = 10.4 MJ.

Modified Mediterranean diet (healthy diet)

The total cost of the modified Mediterranean diet was calculated by assigning a price (medium, low, high) to each food item. These costs were then multiplied by the weekly consumption frequency of servings of that food group. Total cost of the diet was equal to the sum of all food types in $ / week. The healthy diet cost analysis was based on a modelled meal plan, and we did not conduct a diet cost comparison based on actual diet patterns or actual food purchases. Finally, the total weekly cost of the modified Mediterranean diet was compared to the total cost of the participant's 7-day food diaries.

Participant food diaries

The woolworths on-line website (www2.woolworthsonline.com.au) was used to establish participant food expenditure. Woolworths is one of two largest supermarket chains in Australia, which are competitively (similarly) priced and together account for roughly 80% of all grocery sales (National Association of Retail Grocers of Australia (NARGA), 2010). The site was accessed between April, 2013 and July, 2013. Where a participant reported consuming a specific brand or product (example, Kellogg's Nutri-Grain or Rev milk) the quoted price for that product was used. Otherwise a medium cost product was selected, which was crosschecked by two RAs. For each food item such as 'white bread' or 'canned tuna' all items in that category were identified and a product in the mid-price range was selected. This process was independently conducted by LN, SD, JP, RSO and any discrepancies resolved in discussion with RSO. The mid-cost item was commonly priced at 30 to 60% above the low cost item and 20 to 50% below the high cost item. Where seasonal fruits consumed were no longer available at time of costing (example, berries, cherries and mangoes) current data on the average price of fruit was obtained (Department of Primary Industries et al., 2014). The Victorian Healthy Food Basket (Palermo and Wilson, 2007) was used to guide the selection of product volumes/pack size. For products with a short shelf life (example, eggs and milk) smaller purchase volumes were used. Whereas, products with a longer shelf life (example, olive oil and rice) larger purchase volumes were used. Otherwise a mid-range product volume/pack size was assumed to be purchased. A sensitivity analysis was conducted around the food cost estimate. In all scenarios, the same pricing assumption (low, medium or high) was applied to both the poor quality and healthy diet.

Mixed meals

A mixed meal is a meal comprising a variety of food groups example, lasagne or stir-fry. Mixed meals prepared at home were broken down into their individual components and costed as per methods above. Additionally, if the location of meal consumption was not specified, it was assumed to have been prepared at home. Mixed meals specified as purchased outside of the home were costed using the menu price list from the specified eating venue. If the eating venue was not specified Urbanspoon (www.urbanspoon.com) was used to identify cafés or restaurants located in Collingwood or Melbourne (the main intervention site). Restaurants of the specified cuisine with a $ (cheap eats) symbol were selected or moderately priced restaurants ($$ symbol) were chosen if 'cheap eats' restaurants lacked the relevant information. Menus needed to be available on-line.

Missing data

If any days were incomplete, a food cost was entered based on the average cost of the other recorded days. When foods did not incur a direct cost to the participant (example, food supplied at a work function or party), an average meal value was allocated based on the respective participant's food diary.

Healthy alternative - Modified Mediterranean diet

Product selection and data sources

As described earlier, Woolworths online (www2.woolworthsonline.com.au) was used to ascertain cost of food items. If a product was not available on this website, Coles on-line (http://shop.coles.com.au) was utilised. As previously noted medium priced items were selected for the primary analysis. Sale prices were not used. Low and high cost items were also recorded to generate a high and low cost alternative in sensitivity analysis. A wide range of information was gathered to account for the variation in food costs due to factors such as branding, whether fresh or frozen, organic or mass produced, product size (whether purchased in bulk) and outlet type (example, supermarket or local store). Similar product volumes / pack size were selected across the three cost categories in an effort to limit further cost variation associated with bulk purchases.

Food cost per person per week

Once purchase costs were established, these figures were converted to a cost per person per week based on the daily / weekly consumption frequency of servings of that food group. Portion sizes (and frequency of servings) were based on the modified Mediterranean diet guidelines (O'Neil et al., 2013). The mid-point was used where a range in portion sizes were specified (for example; 65 to 100 g cooked meat was converted to 82.5 g per day).

Table 2. Example of costing calculations for modified Mediterranean diet.

Food item	Purchase cost			Daily intake	Intake per week	Cost per week		
	High	Medium	Low			High	Medium	Low
Bread, wholegrain	Burgen (700 g, 1 loaf) $5.29	Mighty soft (700 g, loaf) $3.19	Homebrand (650 g, 1 loaf) $1.50	2 slices (50 g)	14 slices (350 g)	Burgen $2.64	Mighty soft $1.59	Homebrand $0.81
Red meat	Beef Steak, Porterhouse (1kg) $24.07	Lamb, midloin chops (1kg) $16.99	Beef Mince (1kg) $7.96	1 serve≡ 82.5 g	3 to 4 serves ≡ 248 – 330 g	Beef steak, Porterhouse $5.97 – 7.94	Lamb, midloin chops $4.21 – 5.61	Beef Mince $1.97 – 2.63

Table 2 shows an example of the costing calculations.

Sensitivity analysis

For the sensitivity analysis an assumption was made that participant spending patterns and behaviours would not change when substituting unhealthy foods for healthy foods. For example individuals who habitually purchase home-brand products would continue to purchase these generic products. Thus, the sensitivity analysis compared low cost products of trial participants with low cost products of the modified Mediterranean diet, and high cost products of trial participants with high cost products of the modified Mediterranean diet. The sensitivity analysis was limited to varying unit food costs; as the parameter subject to greatest uncertainty. A low and high cost alternative was specified to selected food groups; taken as – and + 33% of the middle value and applied to both the poor quality and modified Mediterranean diet. A small number of food items for which prices have little variability such as milk were not adjusted. As only 45% (9/20) of study participants consumed alcohol according to the 7-day food diaries, an adjusted figure was applied to the modified Mediterranean diet to reflect an average alcohol intake across the group (45% of $15.19).

Cost per energy unit ($ / MJ)

Due to potential differences in EI (according to 7-day food diaries), and the energy contribution of the modified Mediterranean diet, there was a need to adjust the dietary intake and cost to equivalent energy levels. The daily cost per energy unit ($ / MJ) for: the 7-day food diaries was equal to the daily food expenditure ($) divided by average daily EI for each participant; the modified Mediterranean diet was equal to the average daily food costs ($) divided by the total energy contribution (10.4MJ) for medium cost products.

RESULTS

Sample characteristics

Characteristics at baseline of adults enrolled in the SMILES trial are displayed in Table 3. The sample was 65% female, 35% of participants were overweight (BMI ≥ 25 kg/m^2 <30 kg/m^2) and 45% obese (BMI ≥30 kg/m^2). Using the MADRS as a measure of depression status, 80% of participants had moderate depression and 20% had severe depression. Ninety percent of the participants had completed at least secondary school. Compared to Australian population figures, 70% of 25 to 64 year olds have at least upper secondary education (Australian Bureau of Statistics (ABS), 2010b). With regards to diet quality, scores on the DST ranged from 26 to 61. All participant diets were well below the eligibility cut off score for a poor quality diet of 68 or less.

Participant 7 day food diary costs

All 20 participants completed a food diary. There were seven missing days across the group which was mainly attributed to one participant recording their intake for four days only. Based on the 7-day food diaries and costing method described above, participants spent a mean $138 per week on food and beverages for personal consumption (Table 4). Expenditure varied widely from $53 to $239 per week. Yet, expenditure was evenly distributed across the range, with the median at $130, only slightly below the mean. The mean cost per megajoule was $2.35 (R:1.20 to 4.59). The calculations are available on request to the lead author. Participants spent on average almost one third (32.7%) of their total food expenditure on extras for example, alcohol, deep fried food and chocolate (see supplementary material with *extras* defined). Only four individuals (20%) spent less than 25% of their total food expenditure on extras. These four participants purchased meals outside the home as frequently as the other participants, however the meals selected were more nutritious, and were thus not classified (or costed) as an extra for example, Asian stir-fry or vegetarian curry.

Table 3. Characteristics at baseline of adults enrolled in the SMILES trial.

Characteristic		Total N = 20
Age (years)	Mean±*SD*	40.25±11.35
	Range	*22 to 63*
Gender	Male, n *(%)*	7 (35%)
Weight (kg)	Mean±*SD*	85.06±18.35
	Range	64.0 to 136.7
Body Mass Index	Mean ± *SD*	29.11±5.10
	Range	*21 to 41*
BMI		
Obese (≥30 kg/m^2)	N (%)	9 (45%)
Overweight (≥25 kg/m^2 <30 kg/m$^{2)}$	-	7 (35%)
Healthy weight (<25 kg/m^2)	-	4 (20%)
MADRS		
Moderate (≥18 and < 31)	Mean±*SD*	25.45±5.36
Severe (≥31) Müller et al. (2003)	Range	19 to 37
	N (%)	16 (80%), 4 (20%)
DST	Mean±*SD*	49.55±10.6
	Range	26 to 61
Highest educational attainment; n (%)	Primary school	2 (10)
	Secondary School	5 (25)
	Apprenticeship/trade	3 (15)
	Bachelor degree	6 (30)
	Postgraduate degree/certificate	4 (20)
	Doctoral degree	0 (0)
Living arrangement; n (%)	Single	9 (45)
	Married / de facto	7 (35)
	Living with friends or family	4 (20)
	Widow/widower	0 (0)
Children; n (%)	Yes	9 (45)

SD = standard deviation, BMI= Body mass index.

Modified Mediterranean diet costs

The total food costs per person per week for the modified Mediterranean diet was estimated at $105 (excluding red wine) or $120 including red wine, based on mid-range product cost. Based on adjusted alcohol intake, the total food cost per person per week for the modified Mediterranean diet was estimated at $112. The highest share of food cost was for vegetables (22.5%) followed bydairy (15.7%), fruit (14%) and meat (14%) (Table 5). The mean cost per MJ was $1.54. The modified Mediterranean diet classified extras as red wine, dark chocolate, lollies and dairy dessert. At the medium cost bracket, extras contributed 14.4% of the total food expenditure.

Comparing cost of 7-day food diaries to modified Mediterranean diet

Total cost

The mean food expenditure of SMILES participants at $138 per week was higher than the estimated cost of the modified Mediterranean diet of $112 per person per week with both cost estimates based on medium product prices. For 60% of participants, their current estimated weekly expenditure on food was at least equal to (or greater than) the cost of the recommended Mediterranean diet. This compares to the average household expenditure of $204 (Australian Bureau of Statistics (ABS, 2011) per week for food and non-

Table 4. Participant expenditure, cost per MJ and cost of extras as a percentage of total expenditure (April – July 2013 prices).

Participant #	Average daily expenditure (total diary days completed) ($)	7-day expenditure ($)	Cost per MJ ($)	Cost of extras as a percentage of total expenditure (%)
1	11.25 (6)	78.73	1.92	34.21
2	16.72 (7)	117.02	1.43	31.03
3	27.25 (9)	190.73	3.50	39.83
4	15.12 (6)	105.82	1.98	31.08
5	33.69 (6)	235.80	3.62	36.77
6	32.00 (7)	224.02	4.59	33.61
7	22.67 (6)	158.71	2.83	22.49
8	7.59 (7)	53.16	1.66	47.52
9	24.43 (7)	170.98	3.66	8.25
10	17.38 (7)	121.69	1.55	41.24
11	19.82 (7)	138.77	2.41	35.27
12	20.49 (7)	143.40	2.41	33.40
13	12.30 (4)	86.07	1.52	27.82
14	14.23 (7)	99.62	1.74	32.41
15	12.32 (7)	86.26	1.59	51.98
16	11.40 (7)	79.81	1.20	7.44
17	25.53 (7)	178.70	2.39	35.25
18	10.75 (7)	75.25	1.40	44.33
19	34.22 (7)	239.57	3.21	20.08
20	25.67 (7)	179.68	2.36	39.73
Mean (±SD)	$19.74 (±8.14)	$138.19 (±56.95)	$2.35 (±0.94)	32.69% (± 11.38)
Range	$7.59 – 34.22	$53.16 – 239.57	$1.20 – 4.59	7.44 – 51.98%

alcoholic beverages in Australia in 2009 to 2010, or an estimated $215 in 2012 (adjusting for the food price component of the Consumer Price Index (Australian Bureau of Statistics (ABS), 2014). With a mean household size of 2.6 persons (Australian Bureau ofStatistics (ABS), 2010a), this suggests a food cost per adult of $107.50 per week (adjusting for lower food costs for children).

Energy intake and cost per energy unit

To allow for further comparisons of weekly food costs for participants with current poor quality diets and weekly costs of the modified Mediterranean diet of the cost data above was adjusted to account for over and under-reporting as well as differences in energy contribution of the diets. According to the 7–day food diaries, participants consumed 4.58 to 11.71MJ per day, however, one quarter of participants were considered under (n = 4) or over reporters (n = 1) using the Goldberg cut-off (Black, 2000). Five participants had EER's that exceeded the energy contribution of 10.4 MJ of the modified Mediterranean diet. For these participants, relative to EERs the modified Mediterranean diet was inadequate in energy by 0.21 to 2.31MJ. The modified Mediterranean diet at $1.54 per MJ was cheaper per energy unit than the cost of the current dietary intake of SMILES participants at a mean $2.35 per MJ, with both diets costed at medium priced product options.

Spending patterns

For medium cost products of the modified Mediterranean diet, extras made up 14% of the total food expenditure. In comparison, all but two SMILES participants spent 20% or more of their total food costs on extras with the mean extras spending just over double (32%) of the Modified Mediterranean diet.

Sensitivity analysis

Sensitivity analysis modified Mediterranean diet

The total low and high cost food estimates per person per week for the modified Mediterranean diet were $75 and $150 per week, respectively. There was a large cost

Table 5. Modified Mediterranean diet -Total food costs for each food group (weekly intake).

Food group	High ($)	Medium ($)	Low ($)	Cost difference percentage (medium to high)	Cost difference (medium to low)
Cereals	12.99	8.67	5.50	49.8	57.6
Vegetables	38.74	27.03	14.15	43.3	91.0
Nuts	7.80	6.96	5.15	12.1	35.1
Pulses	2.68	1.35	0.67	98.5	101.5
Fruit	23.09	16.83	11.35	37.2	48.3
Meat, chicken, eggs, fish	22.65	16.91	10.20	33.9	65.8
Dairy	26.30	18.78	13.94	40.0	34.7
Olive oil	7.49	6.31	5.22	18.7	20.9
Sweets	2.17	2.07	1.49	4.8	38.9
Total ($) (without red wine)	143.90	104.91	67.67	-	-
Total ($) (including red wine*)	159.10	120.10	82.86	-	-
Total ($) (including adjusted red wine intake**)	150.74	111.75	74.51	-	-

*Cost for red wine of $15.19 was based on average consumption in 2007 (Ross et al., 2010).** Adjusted red wine intake (45% of $15.19) = $6.84
^Cost per energy unit = $1.54 (average daily consumption of $15.96 divided by 10.4 MJ).

variation between high and low cost products; percentage differences ranged from 43.5 to 301.8%, relative to low cost products. Food costs were affected by many factors including branding, freshness, seasonality, cuts of meat and whether or not the product was organic. For example; home brand products were less expensive than their branded counterparts, frozen or tinned vegetables and fish were cheaper than fresh options, selecting fruit and vegetables in season was more cost effective and beef mince was less expensive than porterhouse steak.

Sensitivity analysis participant 7-day food diaries

The values for the sensitivity analysis of participant food diaries was driven by the cost estimates from the modified Mediterranean diet where a low and high cost alternative was taken as – and + 33% of the middle value. Thus, mean spending for trial participants increased to $183 per person per week for high cost products and reduced to $92 for low cost products.

Sensitivity analysis comparing modified Mediterranean diet to participant food diaries

When comparing the low cost products of the modified Mediterranean diet to the low cost products of the poor quality diet the modified Mediterranean diet was found to be considerably cheaper; $75 versus $92, respectively. Additionally, the modified Mediterranean diet was substantially cheaper than the poor quality diet when high cost products were costed; $150 versus $183, respectively.

DISCUSSION

The results of this cost analysis suggest that a healthy Mediterranean-style diet can be affordable for individuals with MDD whose habitual diet is of a poor quality. These findings suggest that individuals are adopting poor quality diets for reasons other than food costs. For this population with MDD, it is pertinent that emotional distress and especially symptoms such as depression and fatigue are known to generate cravings for sugary or high fat foods, such as ice-cream, chocolate bars and fast-food. Consumption of these foods, results in a temporary mood improvement, but eventually the negative mood state returns and the cycle starts again (Christensen and Brooks, 2006; Meyer et al., 2013; Mikolajczyk et al., 2009; Oliver and Wardle, 1999). Furthermore, depressive symptoms may decrease an individual's motivation to engage in healthy dietary habits, and thus may lead to poor dietary choices (Anton and Miller, 2005). Consistent with these theories, the mean spending on "*extras"* by SMILES participants was just over double that of the modified Mediterranean diet. Common extras amongst trial participants included deep-fried food, pastries and chips; cakes, chocolate and sweet biscuits; alcohol; soft drink and meals eaten outside the home example, pizza and fast-food items.

Results of this study also suggest that individuals could achieve a healthy diet at even lower cost than our mid-priced scenario, by purchasing cheaper product items from the Mediterranean diet such as pulses, canned fish, frozen or tinned vegetables and purchasing less alcohol, soft drinks, sweets and meals eaten outside the home. Other strategies that could be employed to achieve a nutritionally balanced diet at lower cost include; selecting home brand products rather than branded counterparts; purchasing fruit and vegetables in season; selecting cheaper cuts of meat and including pulses as an alternative protein source, and purchasing foods in bulk.

This study is unique in assessing food affordability by comparing actual dietary intake data of individuals with current poor quality diets with the estimated food costs of

an alternative healthy diet. Moreover, dietary information was obtained from self-reported intake using 7-day food diaries, the gold standard measure (Hoidrup et al., 2002) and dietary data were examined for accuracy of reporting. These food diaries include detailed information about food choices not available from a FFQ. Total cost per energy unit was calculated offering an alternative basis of comparison, and likely under and over-reporting of food consumption was also assessed. All four individuals identified as under-reporters spent less than the mean cost of the modified Mediterranean diet. They represented 50% of those for whom the Mediterranean diet appeared to be more expensive. These reporting inaccuracies are common and imply that food expenditure for these participants were almost certainly greater than reported. Studies have indicated that reported energy intake ranges from 20 to 37% less than measured energy expenditure (Trabulsi et al., 2001). When comparing the total daily cost per MJ, thereby eliminating the differences in energy intake of SMILES participants and the energy contribution of the modified Mediterranean diet, the Mediterranean diet was cheaper for 80% of the participants.

Whilst depression is a condition associated with appetite changes, the poor quality diets of study participants are likely reflective of dietary habits of the general population most of whom fail to meet National Dietary Guidelines (Australian Bureau of Statistics (ABS), 2009). Possible generalizability of the study results to other individuals with MDD, and poor quality diet is uncertain in view of the small sample size. However, given the 7-day food diary technique employed, 133 person days of diet information was captured. As the 7-day food diaries lacked detailed product information, food expenditure was calculated based on medium cost products (incorporating a sensitivity analysis) using prices from the two supermarket chains that make up the dominant share of the national grocery market and incorporated 'reasonable' assumptions on purchase volumes. These limitations could be addressed in future studies by obtaining shopping receipts, or requesting individuals record location of purchase (example, farmers' market, supermarket) as well as reporting product brand and purchase volume. In applying the same approach to the costing of the poor quality diet and the recommended Mediterranean diet, the possible error in the comparison was minimised.

Conclusion

Food costs are a commonly reported barrier to healthy eating, yet this study demonstrates that a healthy diet does not have to cost more than a poor quality diet, which is common in people with MDD as well as the wider community. If food cost is not a major hurdle to healthy eating this clearly focuses attention on other barriers to healthy eating. For example, individuals with depression typically have reduced motivation to engage in healthy dietary habits (Anton and Miller, 2005), a reduced desire to cook and prepare meals (Darnton-Hill, 1992); and depleted energy for activities such as grocery shopping, meal preparation, and clean-up (Anekwe and Rahkovsky, 2013; Ryden et al., 2008). Individuals may also find the challenge of learning new recipes or developing cooking skills overwhelming (Anekwe and Rahkovsky, 2013; Ryden et al., 2008).

Given that fatigue is a prominent symptom of MDD, the extra effort involved is a disincentive to healthy food preparation. Cooking skill is positively associated with consumption of fruit and vegetables and negatively associated with consumption of convenience foods(Anekwe and Rahkovsky, 2013). As such, providing education and nutritional counselling on preparing nutritious convenient meal ideas on a budget could form part of an integrated care package for people with clinical depression, which may in turn translate into improved dietary patterns and better health outcomes (O'Neil et al., 2013; Opie et al., 2014). Further, it's a common perception that healthy foods are more expensive than less healthy foods and this perception, real or hypothetical, may prevent individuals from choosing healthy foods. Many clinicians have accepted this view point, potentially based on the conflicting evidence available, which may influence their recommendations to patients' regarding food choices. Hence, it is imperative that clinicians are provided with the correct information on this matter when supporting their patients to adopt a healthier diet.

These study findings suggest that the adoption of a healthy modified Mediterranean diet does not cost more (and may cost less) than a poor quality diet. Thus, food cost is not a barrier to healthy eating. This is an important public health message that should be promoted at an individual and population level to encourage improvements in dietary habits. It is desirable that public health messages and nutrition consults incorporate practical strategies for selecting healthy nutritious foods on a budget as well as simple and convenient ways for including these foods in the diet. Addressing these barriers to healthy eating will help improve wellbeing, and achieve desired dietary goals for preventing and managing chronic disease.

Conflict of Interest

The authors have not declared any conflict of interest.

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