Nutrition 34 (2017) 118–123

Contents lists available at ScienceDirect

Nutrition

journal homepage: www.nutritionjrnl.com

Applied nutritional investigation

Dietary contribution of foods and beverages sold within a university campus and its effect on diet quality of young adults

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ARTICLE INFO

Article history:
Received 22 July 2016
Accepted 24 September 2016

Keywords:
Dietary contribution
University food outlets
Diet quality
Young adults
Food environment

ABSTRACT

Objective: Tertiary education institutions have been linked with excessive weight in young adults. However, few data are available on the effect of foods from the university food environment on the diet quality of young adults. The aim of this study was to describe the association of a number of foods and beverages consumed at university food outlets with the diet quality of young adults.
Methods: This was a cross-sectional survey in which the 103 university student participants, aged 19 to 24 y, contributed 5 d of dietary data. A purposely designed, validated smartphone application was used to collect the data. Diet quality was assessed by adherence to the 2013 dietary guidelines for food groups and nutrients, and the validated Healthy Eating Index for Australians (HEIFA-2013) was applied. Individual HEIFA-2013 scores were compared with the frequency of food purchase and consumption from university outlets to assess a dose–response effect of the food environment. Comparisons by tertiles of diet quality for body mass index, waist circumference, and takeaway food consumption (university and other) were computed using a one-way analysis of variance and post hoc Tukey test.
Results: There was a statistically significant difference between the number of university foods and beverages consumed in 5 d and the HEIFA-2013 scores: More on-campus purchases resulted in a poor-quality diet ($P = 0.001$). As the HEIFA-2013 tertile scores increased, there was a significant decrease in the number of university campus and other takeaway foods consumed; body mass index and waist circumference showed a decrease in trend.
Conclusions: Efforts to improve the diet quality of young adults attending university may benefit from approaches to improve the campus food environment.

Introduction

Young adults (generally defined as those aged 18–35 y [1]) have a higher intake of energy-dense, nutrient-poor foods and drinks, including sugar-sweetened soft drinks, fried potatoes, meat pies, savory pastries, pizza, crisps, and confectionery, compared with older adults, resulting in an overall poorer diet quality [2]. This age group experiences the highest rates of weight gain across the life course. This theory of weight gain during young adulthood is supported by longitudinal cohort data from both Australia [3] and the United States [4].

According to data from the AusDiab cohort of 11 247 Australian adults compared with older age groups, the youngest age group (aged 25–34 y) was found to have the greatest mean increase in body weight and waist circumference (WC) over the 12-y follow-up period; the mean increase in WC was higher among young women (+7.3 versus +5.7 cm in men) [3]. In analyses assessing changes in the prevalence of overweight by birth cohort (year of birth from 1915–1980), the risk for overweight was greatest in those born in and after the 1960s [5]. Some literature identifies the recent worsening of obesity-promoting

R.R. is on the Australian Postgraduate Award for her PhD. M.A.F. and A.R. have received funding from Australian Research Council and Meat and Livestock Australia. The authors declare that they have no conflicts of interest.
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http://dx.doi.org/10.1016/j.nut.2016.09.013
0899-9007/

environments as a driver of this increase in the risk for overweight [6,7].

Once young adults begin university, newfound independence has been shown to increase vulnerability to development of unhealthy behaviors and therefore poor-quality diets [8]. A recent meta-analysis reported a mean increase in weight of 1.36 kg (95% confidence interval, 1.15–1.57 kg) over an average period of 5 mo among first-year university/college students [9]. More than three of five students gain weight during the first year of attendance, with a mean gain of 3.38 kg (95% confidence interval, 2.85–3.92) [9]. These trends may result from barriers to healthy eating such as lack of time or choice, established taste preferences, lack of finances, or increased availability of discretionary foods [1]. Unlike in the United States, most young adult students in Australia live at home [10] and therefore there are not many Australian studies in the literature assessing the contribution of foods sold (usually discretionary) in university toward the diet quality of young adults. Discretionary foods and drinks are not necessary for a healthy diet and are high in saturated fat, added sugars, and added salt or alcohol, and low in fiber [11]. Studies have identified 19- to 24-y-olds as having the lowest levels of awareness regarding nutrition and the importance of a balanced diet, placing them in need of interventions that will provide opportunities for making healthy dietary choices [12,13].

The physical environment to which people are exposed creates barriers to or opportunities for the consumption of a healthy diet, which in turn effects diet-related health outcomes [14]. A large proportion of young adults attend tertiary education institutions in developed countries. More than half of all young adults in Australia are engaged in tertiary education settings [15]. In 2014, 2.3 million students were enrolled in the United Kingdom, with 38.2% of students aged between 19 and 24 y [16]. Among educational institutions, the often-closed nature of the food environment means that food choices may be limited to outlets located on site. consumption of fast food among young adults is related to its ready availability [17]. Therefore, it is important to develop an understanding of the university food environment and its contribution to dietary intake and effect on diet quality of young adults.

The US Alternative Healthy Eating Index demonstrated that less healthy food environments are associated with poorer quality diets [18]. We recently developed and validated the Healthy Eating Index for Australians (HEIFA-2013) to measure compliance with the dietary guidelines for Australians and therefore measure quality of individual diets [19].

The aim of this research was to examine the diet quality of young adults attending university by using the HEIFA-2013 tool and to assess the extent to which the number of university foods and beverages consumed in 5 d affects this outcome.

Materials and methods

This study was approved by the university's human research ethics committee (reference number: 2014/136) under the National Health and Medical Research Council and National Statement on Ethical Conduct in Human Research [20]. A participant information statement and consent were provided to the participants during recruitment. Participants provided written consent. Participants entered a drawing to win an iPad mini as an incentive for participation.

Study design

This cross-sectional study took place in a large urban university in Australia between February and June 2014. Students were recruited via email, posters, and flyers that contained a link to an online screener for eligibility. Eligibility criteria included men and women between the ages of 19 and 24 y and excluded students age 18 y who would be new to the university [1]. At this age range, young adults are transitioning from adolescence to independent lifestyles; this is often referred to as emerging adulthood [1].

Eligible participants also needed to be full-time, second- through fourth-year students enrolled in the Faculties of Science and Engineering (as these faculties agreed to assist the project researchers) who consumed food and beverages from a university food outlet at least twice in the 5 d working week.

Eligible participants were contacted by the researchers to schedule an appointment at a university clinic set up especially for interviewing participants. At this appointment, participants provided their informed consent to participate in the trial; completed a brief online survey; and had anthropometric measurements (body weight, height, body mass index [BMI] and WC) recorded by trained postgraduate nutrition students. The online survey comprised questions on demographic characteristics including living arrangements and cultural background (i.e., language spoken at home), which have been previously published and discussed [21].

Data collection

Anthropometric measurements were taken by researchers with height, weight, and WC measured to the nearest 0.5 cm, 0.1 kg, and 0.5 cm, respectively, according to the Centers for Disease Control and Prevention body measurement methods [22]. Participants were required to complete a consecutive 5-d weighed food record (WFR), including 3 weekdays and 2 weekend days via a digital entry food recording mobile application (e-DIA) [23]. The e-DIA app uses the Australian Food and Nutrient Database 2007, with 4225 foods and beverages at the time of data collection. Additionally, full nutritional analyses were conducted on foods and beverages ($N = 250$) from the university food supplier that were available for sale at campus food outlets. These foods and beverages were added to the database ($N = 4475$ foods). This app has previously been validated for nutrients and food groups [23,24].

Information recorded in the e-DIA WFRs included the type and amount of all food and beverages (e.g., coffees, soft drinks, water, and alcohol) consumed, as well as where the foods and beverages were purchased and consumed and the method of preparation for food prepared at home.

The researchers looked at foods and beverages eaten at home and foods and beverages eaten away from home. Foods and beverages eaten away from home included university outlet foods and beverages and any other takeaway foods and beverages (excluding university foods). Essentially, all foods and beverages purchased and consumed from university food outlets were separated from foods and beverages purchased and consumed from any other takeaway food outlets. Thus, a purchase of two foods and one beverage would be recorded as three foods in 5 d.

Instructions on accurate weighing, estimating food portions (when weighing was not possible), and entry of foods and beverages into the app were provided in conjunction with electronic kitchen scales and measuring spoons and cups. A text message was sent on each of the 5 d as a reminder to record intake. Each day the researchers checked the data entered by the participants on the previous day and contacted them if necessary to clarify any perceived discrepancies or missing data in their electronic WFRs.

Diet quality

The study used a comprehensive diet quality index, which focuses on the most recent Australian dietary guidelines. The HEIFA-2013 was used to assess diet quality based on mean values of food and nutrient intakes from an average of the 5-d WFR from the e-DIA app [19,23]. Details of the index have been published previously but are briefly described here. The index consists of the sum of 11 components and ranges from 0 to 100, with a higher score indicative of a diet more consistent with the dietary guidelines. Food components examined included fruit, vegetables (including variety), grains and cereals (including whole grains), dairy and alternatives, meat and alternatives, and discretionary foods. Other components included water and alcohol. Deleterious nutrients examined included in the scoring system were saturated fat, sodium, alcohol, and added sugars. We divided the total weight by the mean weight serving equivalent given to each food group category, as outlined in the dietary guidelines [11]. For example, consumption of 150 g of vegetables equates to two servings of vegetables (150 g/75 g [one serving]).

Using the information from the Australian Food and Nutrient Database 2007 recipe files, mixed dishes were converted into their core food equivalents (e.g., meat, vegetable, and fruit equivalent). Two or more components from one dish (e.g., fried rice, apple pie, and whiting cutlet) were assigned to food groups by separating mixed dishes into their individual ingredients. The mixed dishes were converted to their core food equivalents and contributed to that specific food group [19]. For example, in case of fried rice, the rice part of the dish was assigned to the grains group. Similarly, part of the fried rice was assigned to the vegetable group based on the weight of vegetables, and part of it was assigned to the meat and meat alternatives group. Weight contributions from each food item in

Table 1
Participant characteristics by sex (N = 103)

Participant characteristics	Men (n = 40)	%	Women (n = 63)	%
Body mass index (category (measured)				
Underweight (<18.5 kg/m^2)	1	2.5	7	11
Normal weight (18.5 to <25 kg/m^2)	30	75	48	76
Overweight or obese (≥25 kg/m^2)	8	20	8	13
Waist circumference risk category (measurement)				
Low (men ≤94 cm; women ≤80 cm)	36	90	57	90
Increased (men >94 cm; women >80 cm)	4	10	6	10
Living arrangements (online survey)				
At home with family	26	65	43	68
University housing	1	2.5	0	0
Off campus	9	22.5	10	16
Language spoken at home (online survey)				
English	30	75	46	73
Other	8	20	10	16
Number of university foods consumed (from WFR)*				
≤2 foods	10	25	19	30
3–6 foods	13	32.5	28	44
>6 foods	17	42.5	16	25
Number of other takeaway foods consumed (from WFR)*				
≤2 foods	10	25	20	32
3–4 foods	7	17.5	7	11
≥ 5 foods	23	57.5	36	57

WFR, weighed food record
* Foods include both foods and beverages. A purchase of two foods and one beverage would be recorded as three foods in 5 d.

accordance with its HEIFA-2013 classification were summed together to give a total weight for a food group.

Statistical analysis

Means and SDs were calculated for all the dietary variables analyzed. Energy cutoff points of 4000 to 20 000 kJ/d was set for under- and overreporters. Using the information on location of food preparation collected from the app, the participants were grouped into three consumption categories: those who consumed no more than two university foods and beverages, those who consumed three to six university foods and beverages, and those who consumed more than six university foods and beverages over the 5 d of WFR. The number of foods and beverages purchased from other takeaway outlets also were collated for each participant. The food groups and selected nutrients by each consumption category were calculated as least squares mean adjusted for sex and number of takeaway foods and beverages purchased outside the university campus and consumed. Analysis of covariance with Bonferroni correction was used to determine whether there are any significant differences between the means of food group servings and nutrient intakes of the three different categories of number of university foods consumed (specifically, the adjusted means). Differences in diet quality scores were not changed by age and years at university; therefore, data were pooled and a one-way analysis of variance with a post hoc Tukey test was used to determine differences in HEIFA-2013 scores by the number of times foods were consumed from university outlets to assess a dose–response effect of the food environment. HEIFA-2013 scores of the participants were assigned to tertiles, and trends in BMI, WC, number of university foods, and number of other takeaway foods consumed were assessed. BMI and WC were adjusted for sex, and the medians and trend across tertiles were analyzed using Cochrane Armitage *P*-values for trend analyses. The statistical program and procedures of SPSS for Windows version 14.0 (Chicago, IL, USA) were used for all analyses and SAS software was used (SAS Institute Inc., Cary, NC, USA.) for *P*-values for trend analyses. Significance was set a priori at $P < 0.05$.

Results

Participant characteristics

We initially invited 153 participants to complete the WFR. Of the 49 noncompleters, 20 did not respond to email invitations, 27 replied but were no longer interested, and 2 withdrew during data collection. After exclusion of the single underreporter, 40 men and 63 women were included (N = 103) in the analyses. Table 1 presents the anthropometric data and food purchase patterns for university and other takeaway foods of the participants measured and recorded in the WFRs, respectively. Twenty-eight percent of the students consumed no more than two university foods and beverages over the 5 d, 40% of the students consumed three to six university foods and beverages over the 5 d, and further 32% consumed more than six university foods

Table 2
Food group servings/d and mean* energy, nutrient intakes of young adults, by number of university foods and beverages purchased

Dietary intake	Recommended servings/d		Number of university foods/beverages consumed			*P*-values
			Mean number of servings/d (SD)			
Food groups	Men	Women	≤2 foods	3–6 foods	>6 foods	
Vegetable servings	6	5.5	3.9 (1.22)	3.8 (1.93)	3.0 (1.41)	0.05
Fruits	2	2	1.3 (1.25)	0.9 (0.7)	0.7 (0.58)	0.05
Grains	6	6	4 (1.52)	3.4 (2.19)	2.8 (1.87)	0.04
Meat	3	2.5	3 (1.15)	2.5 (0.92)	2.1 (2)	0.05
Dairy	2.5	2.5	1.7 (0.89)	1.1 (1.09)	0.85 (0.71)	0.07
Discretionary	0–3	0–2.5	2.5 (2.33)	3.1 (1.59)	5.3 (3.11)	0.03
Nutrients	Average adult requirements		Mean* intake/d (SD)			*P*-values
Energy, kJ	8700		6673 (1627)	7785 (1557)	8489 (2333)	<0.05
Protein, g	50		85.2 (34.7)	94.8 (36.5)	102.8 (41.9)	0.05
Protein†, %	–		22	21	21	
Saturated fat, g	24		26 (7.2)	29.7 (10.9)	29.8 (12.6)	0.05
Saturated fat†, %	–		14	14	13	
Total sugars, g	90		77.6 (39.8)	80.7 (32)	107 (118.4)	<0.05
Total sugars†, %	–		20	18	21	
Sodium, mg	<2300		2403 (801.2)	2527 (1243.7)	3103 (1590.5)	<0.05
Sodium‡, mg/1000 kJ	–		360	324	365	
Alcohol, g	≤20		0.05 (0.03)	2.06 (1.47)	16.24 (11.17)	<0.05
Alcohol, %	–		0.02	0.78	5.55	

* Least square mean (SD) adjusted for sex and non-university takeaway food consumption. *P*-values show difference in mean intake of food groups and nutrients (mean [SD]) across three consumption categories as determined by analysis of covariance with the correction of Bonferroni adjusted for age and number of takeaway foods consumed. Significance is set at $P = 0.05$.
† Mean intakes expressed as percentage of energy.
‡ Mean intake per 1000 kJ.

Table 3
Total HEIFA-2013 scores* as dependent variable and frequency of food consumption from university outlets as independent variable

Number of university foods/ beverages consumed	HEIFA-2013 scores†	
	Mean	SD
≤2 foods	60.8	8.1
3–6 foods	52.8	8.1
>6 foods	46.6	7.4

HEIFA, Healthy Eating Index for Australians
* HEIFA-2013 scores were adjusted for other nonuniversity takeaway foods and sex is accounted for in HEIFA-2013 scoring.
† Statistically significant difference in HEIFA-2013 scores between number of university foods consumed categories; one-way analysis of variance [F(2,100) = 25.2; $P = 0.001$].

and beverages over 5 d. Most foods and beverages from university food outlets were consumed during the early or late afternoon. The majority of participants also reported speaking English at home, and most lived at home with their family; only one participant lived in university housing. Most participants were classified within the normal weight range on the basis of BMI.

Frequency of foods and beverages consumed from university food outlets and their effect on diet quality

The mean (SD) HEIFA-2013 score for this sample of young adults was 53 (9.5). This score is half of the maximum achievable score (100), and diets were low in vegetables but high in discretionary foods. Table 2 shows food group and selected nutrient intake according to numbers of foods consumed from university outlets. There was an overall statistically significant difference in food group and nutrient intakes among the three consumption categories once their means had been adjusted for sex and takeaway food consumption ($P < 0.05$). The mean total energy intake was higher for participants who consumed more university foods ($P < 0.05$). These participants had lower intakes of vegetable, fruits, grains, and meat but higher intakes of protein, saturated fat, total sugars, and sodium than participants who consumed less university food ($P < 0.05$).

Table 3 shows the association between food consumption from university food outlets and diet quality (HEIFA-2013). There was a statistically significant difference between categories for numbers of university foods consumed as determined by one-way analysis of variance (F[2100] = 25.2; $P = 0.001$). A Tukey post hoc test revealed that young adults who consumed more than six university foods in 5 d (46.6 ± 1.3; $P < 0.01$) had a lower score than those who consumed between three and six (52.8 ± 1.3; $P < 0.01$) and those who consumed no more than two university foods over the 5-d period (60.8 ± 1.5; $P < 0.01$). There was a significant difference in HEIFA scores between those who consumed three to six university foods and those who consumed two or fewer university foods over the 5 d ($P = 0.003$). Men reported higher intakes of savory foods, such as pizza, hamburgers, and hot chips, from university food outlets, whereas the women reported higher intakes of sweets such as chocolates, ice cream, and sweet biscuits (this excluded all other takeaway foods consumed; data not shown in tables).

Table 4 shows the trends in participant characteristics across tertiles for HEIFA-2013 scores. Consumption of university and other takeaway foods decreased as HEIFA-2013 scores increased across tertiles ($P < 0.001$). The sex-adjusted BMI ($P = 0.02$) and WC ($P = 0.05$) also showed a trend of decrease across tertiles.

Discussion

The young adults in this study attained a mean HEIFA-2013 score that was half of the maximum achievable, with relatively low intakes of core foods and high intakes of discretionary (i.e., non-core foods) [11]. The results demonstrated that diet quality was generally poorer among young adults who ate more foods from the university outlets. Their diets had less fruit, vegetables, whole grain foods, and meat and more discretionary food items than those who consumed two or fewer foods from the university outlets during the 5-d measurement period. The male students consumed more foods such as hamburgers and pizza, typically higher in salt, and the female students consumed more sugary baked goods if they were frequent consumers at university food outlets.

Previous research in Australia and the United States has identified that diet quality is negatively associated with eating away from home [25–27]. Furthermore, eating away from home twice a week or more was associated with a higher prevalence of moderate abdominal obesity in young Australian men and women [25]. Young adults in a US study who ate at burger-and-fries style outlets three or more times per week had both poorer diets and increased prevalence of overweight and obesity [28,29]. These findings of poor-quality diet, increased WC, and increased body weight are consistent with the present study, albeit exclusively in university students. A previous study that used a food frequency questionnaire observed associations between consumption of foods prepared away from home and diet quality [30]. They reported that young adults who reported more frequent food preparation at home and less frequent consumption of foods prepared away from home were more likely to meet the dietary recommendations for fat, calcium, fruit, vegetables, and whole grains. Additionally, young women ate fewer foods prepared away from home, ate more whole grains, and had more healthful

Table 4
Differences in participant characteristics according to HEIFA-2013 tertile scores*

	HEIFA-2013 tertile 1	HEIFA-2013 tertile 2	HEIFA-2013 tertile 3	P_{trend}†
	Median (range)			
Median HEIFA tertile scores‡	42.6 (28–48)	52.5 (49–57)	61.7 (57–74)	<0.001
BMI	23.1 (17–40)	21.5 (17–28)	21.8 (17–35)	0.020
WC	76 (56–114)	70.3 (63–95)	73 (60–99)	0.050
Number of foods/beverages university foods consumed	7 (1–20)	5.5 (0–52)	4 (0–23)	<0.001
Number of other takeaway foods/beverages consumed	7 (0–33)	5 (0–14)	2 (0–8)	<0.001

BMI, body mass index; HEIFA, Healthy Eating Index for Australians; WC, waist circumference
* HEIFA-2013 scores were adjusted for other nonuniversity takeaway foods and sex is accounted for in HEIFA-2013 scoring. BMI and WC adjusted for sex.
† *P*-values for trend: analyzed by the Cochran-Armitage trend test using SAS.
‡ The tertile scores include ∼34 (N = 103) in each group. BMI and WC adjusted for sex.

food at home. However, as found in the present study, none of the young adults had optimal diets [30].

Studies have shown that cooking meals for oneself is linked to better-quality diets among young adults, whereas consumption of commercially prepared meals is associated with poorer-quality diets [27]. The students in the present study who consumed more foods and beverages from university outlets also more frequent consumed other takeaway foods and beverages. Thus, it might be that we have identified a group of young adults who are frequent consumers of foods and beverages prepared outside the home, whether it is on campus during work hours or off campus during weekend days or after hours.

Changing the food environment outside the university is challenging. However, in a country such as Australia, in which the vast majority of universities are public institutions reliant on government funding, there should be more opportunity to provide healthy food choices. Healthier food on campus has potential to affect the quality of diet. As noted, half the food prepared and purchased outside the home was from university outlets for students with HEIFA-2013 scores in tertile 1 and 2. Unfortunately, an audit of the university food environment in a sample of Australian tertiary institutions showed that the availability of healthy foods was less than ideal. The average score for healthiness was 72 of a possible 148 points. Sugar-sweetened beverages, chocolates, chips, and energy-dense, nutrient-poor snacks were the most common foods available [16]. The current findings, together with this audit, suggest that environmental interventions to improve the food supply in university food outlets are warranted.

A range of potential interventions to modify food environments at universities and colleges has been identified in a recent review [31,32]. These interventions include those that influence information relating to healthy foods and beverages through signage and labels at the point of purchase; availability of healthy food through changing catering practices; availability of free fruits and vegetables and controlling portion sizes of less-healthy foods; and combining nutrition promotion or information with incentives to increase purchases of healthy food, such as price reductions or making healthy foods easily accessible [31]. Future studies should support healthy choices for young people by testing these potentially useful intervention strategies to create healthy food environments at tertiary education settings. A tertiary institution affords the possibility for improving nutrition knowledge and shopping, budgeting, and cooking skills through its teaching to ensure university students have both the capability and opportunity to make better food choices and improve the quality of their diet. The other condition necessary will be their motivation to change dietary behaviors, which is dependent on individual students rather than a population approach.

Strengths and limitations

Strengths of the present study are notable, such as using a validated 5-d electronic WFR (including 2 weekend days) and sufficient duration for estimating usual nutrient intake. Interobserver and measurement errors were minimized through the use of standardized electronic procedures and training before collecting data. Participants were blind to nutrient output during data collection, making respondent entry alteration based on social desirability bias less likely. Additionally, overall diet quality was characterized using the latest Dietary Guidelines for Australians and the validated diet quality index such as HEIFA-2013.

Limitations include the cross-sectional design of the study. The direction of associations between BMI and WC and frequency of eating foods and beverages prepared at university and other takeaway foods and beverages could not be determined. Selection bias may have occurred because more health-conscious students may have volunteered to participate. As with all assessment of dietary intake measurement, errors can occur via the participants, such as in estimating portion sizes (if food could not be weighed) and respondent food selections from the app. With respect to applicability and generalizability, 66% of university students in Australia live at home with their families, as was the case for this study. The students at this university are of a higher socioeconomic status than those at some other universities in Australia, so results may not be generalized to all university populations [10].

Conclusion

The present study observed that the overall quality of diets of young adults attending university was less than ideal; those purchasing and consuming food on campus most frequently had the worst scores. Adherence to dietary guidelines by the most frequent consumer of university foods was poorest for servings of vegetable, fruits, grains, meat, dairy, sodium, and added sugars, suggesting the need for improvements in these areas. Therefore, interventions targeting changes to the food environment of tertiary education settings are warranted. Future studies examining the changes in the quality of young adult diets after university food environment interventions (e.g., point-of-purchase nutrition interventions, reducing cost, improving accessibility, and increasing availability of healthy foods) will be of interest.

Acknowledgments

The authors acknowledge the following postgraduate dietetic students who assisted in the recruitment processes and data collection: Naomi Wu, Reem Bashour, Sarah O'Connor, Valentina Giannelli, Ki Wong, Lu Gao, Lara Pasternak, Wenqian Wang, and Wei Ming Yap.

Supplementary data

Supplementary data related to this article can be found at 10.1016/j.nut.2016.09.013.

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