

# Predictors of high-energy foods and beverages: a longitudinal study among socio-economically disadvantaged adolescents

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## Abstract

*Objective:* While socio-economically disadvantaged adolescents tend to have poor dietary intakes, some manage to eat healthily. Understanding how some disadvantaged adolescents restrict high-energy foods and beverages may inform initiatives promoting healthier diets among this population. The present investigation aimed to: (i) identify disadvantaged adolescents' high-energy food and beverage intakes; and (ii) explore cross-sectional and longitudinal associations between intrapersonal, social and environmental factors and disadvantaged adolescents' high-energy food intakes.

*Design:* Longitudinal online surveys were completed at baseline (2004–2005) and follow-up (2006–2007), each comprising a thirty-eight-item FFQ and questions examining intrapersonal, social and environmental factors.

*Setting:* Thirty-seven secondary schools in metropolitan and non-metropolitan Victoria, Australia.

*Subjects:* Of 1938 adolescents aged 12–15 years participating at both time points, 529 disadvantaged adolescents (whose mothers had low education levels) were included in the present investigation.

*Results:* At baseline and follow-up, respectively 32% and 39% of adolescents consumed high-energy foods less frequently ( $\leq 2$  high-energy food meals/week); 61% and 65% consumed high-energy beverages less frequently ( $\leq 1$  time/d). More girls than boys had less frequent high-energy food intakes, and baseline consumption frequency predicted consumption frequency at follow-up. Adolescents with less frequent consumption of high-energy foods and beverages seldom ate fast food for main meals, reported reduced availability of high-energy foods at home and were frequently served vegetables at dinner.

*Conclusions:* Nutrition promotion initiatives could help improve disadvantaged adolescents' eating behaviours by promoting adolescents and their families to replace high-energy meals with nutritious home-prepared meals and decrease home availability of high-energy foods in place of more nutritious foods.

**Keywords**  
Adolescents  
Nutrition  
Behaviour  
Socio-economic position

Good nutrition is important for preventing several diet-related diseases<sup>(1)</sup>. Since dietary habits and preferences developed in childhood and adolescence may be maintained into adulthood<sup>(2,3)</sup>, altering diet-related behaviours early in life, such as during adolescence<sup>(4,5)</sup>, is important for disease prevention. Many high-energy foods and beverages are nutrient-poor and often sources of high levels of saturated fat, sugar and salt<sup>(6)</sup>, which have been linked to overweight and obesity, dyslipidaemia, hypertension, hyperglycaemia and insulin resistance<sup>(7)</sup>. Increased intakes of high-energy foods and beverages also tend to displace consumption of more nutritious foods including fruit, vegetables and milk<sup>(8,9)</sup>, further impacting on health.

Adolescents tend to consume diets that are at odds with recommendations for health, with a high proportion consuming high-energy foods and beverages daily<sup>(10,11)</sup>.

Further, adolescents' intake of high-energy foods tends to increase as they mature, resulting in even poorer dietary quality<sup>(12–14)</sup>. Socio-economically disadvantaged adolescents are at greater risk for consuming a poorer diet than more advantaged adolescents, consuming high-energy foods and beverages more frequently<sup>(12,15)</sup>. For example, one study of adolescents from all levels of socio-economic position reported that of those who consumed high-energy foods  $\geq 3$ –4 times/week, 61% were disadvantaged, and 56% of adolescents consuming high-energy beverages  $\geq 5$ –6 times/week were disadvantaged<sup>(15)</sup>. In order to improve such eating behaviours, a better understanding of the factors influencing adolescent nutrition is required.

Although socio-economically disadvantaged adolescents are at greater risk for consuming a poor diet, some manage to consume a more favourable diet<sup>(16–18)</sup>. Understanding

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factors that enable disadvantaged adolescents to protect their dietary quality, including consuming fewer high-energy foods and beverages, can help inform nutrition promotion initiatives aiming to improve the dietary intakes of disadvantaged adolescents.

Social ecological models consider the connections between individuals and their environments, or ecologies<sup>(19,20)</sup>, across intrapersonal, social and environmental domains and provide useful frameworks for identifying factors associated with eating behaviours. Several factors have previously been shown to be associated with dietary intakes among adolescents. Self-efficacy, perceived importance of health behaviours, taste preferences, food-related behaviours (e.g. meal frequency, snacking) and barriers (e.g. cost, time, inconvenience)<sup>(21)</sup> are key intrapersonal determinants of adolescents' dietary intakes. Social factors associated with dietary intake include adolescents' interactions with family, friends and peers<sup>(22–24)</sup>. Parenting style, role modelling of eating behaviours, reinforcement, perceived norms and cultural factors may also be involved<sup>(25)</sup>. Finally, environmental influences on adolescent eating behaviour include food availability, accessibility and affordability at home, school and within the local neighbourhood<sup>(25–27)</sup>.

Several intrapersonal, social and environmental factors have previously been associated with socio-economically disadvantaged adolescents' frequent intakes of vegetables and fruit. For example, we previously reported that greater perceived importance of health and frequently being served vegetables with dinner were associated with frequent vegetable and fruit intakes<sup>(28)</sup>. Among disadvantaged boys, friends' support for healthy eating was associated with frequent vegetable consumption. Less stringent adherence to family meal-time rules, including whether the adolescent was allowed to buy whatever was liked at fast-food places among both sexes and being expected to eat all foods among boys, was associated with frequent vegetable and fruit consumption; however, the opposite was observed when girls were expected to eat all foods served<sup>(28)</sup>.

To our knowledge, predictors of less frequent consumption of high-energy foods and beverages among disadvantaged adolescents have not been examined. Therefore the aims of the present investigation were: (i) to identify disadvantaged adolescents' high-energy food and beverage intakes; and (ii) drawing on Social Ecological Theory, to explore cross-sectional and longitudinal associations between intrapersonal, social and environmental factors and disadvantaged adolescents' high-energy food and beverage intakes.

## Methods

### *Participants and setting*

The present investigation draws on a sub-sample of 529 socio-economically disadvantaged adolescents with longitudinal data from the YEP Study, an online food

habits survey conducted in thirty-seven secondary schools in metropolitan and non-metropolitan regions of Victoria, Australia. The baseline phase was conducted in 2004–2005, and adolescents were followed up in 2006–2007<sup>(14,28,29)</sup>.

At baseline, invitations to participate were open to all co-educational government and Catholic secondary schools that included Years 7–12 and had >200 enrolments located in metropolitan Melbourne and non-metropolitan Gippsland, east of Melbourne, Australia. Of seventy schools that met these criteria, twenty metropolitan and seventeen non-metropolitan schools (thirty-seven in total) agreed to participate. All students ( $n$  9842) from Year 7 (aged 12–13 years) and Year 9 (aged 14–15 years) were invited to participate. Written informed consent was received from adolescents' parents, and the survey was completed during class time by 3264 socio-demographically diverse secondary students ( $n$  2010 in Year 7,  $n$  1254 in Year 9; response rate at baseline 33.2%). Schools that participated in the baseline YEP survey were contacted again in 2006 to indicate their interest in continuing involvement in the YEP Study. Schools were sent a list of adolescents for whom parental consent had been granted at baseline and teachers invited adolescents to complete the online follow-up survey. Of 3264 adolescents who completed the baseline YEP survey in 2004–2005, 1938 completed the 2006–2007 YEP follow-up survey (59% response rate). Of 1287 socio-economically disadvantaged adolescents who completed the baseline YEP survey, 708 (55%) also completed the follow-up survey. At baseline, a survey assessing sociodemographics of the parent and their partner, including highest level of education, and additional questions about their adolescents' eating patterns was mailed out to those parents who had given informed consent for their adolescents to participate. Of parents sent a parental survey, 1622 (64% of parents who initially indicated their interest to participate; representing 50% of parents for the whole YEP adolescent sample) returned a completed survey.

In the present investigation, only data from socio-economically disadvantaged adolescents who had non-missing data for all variables of interest were included in the analyses ( $n$  529). When adolescents who had non-missing data were compared with those with missing data ( $n$  782) across the measures included in the present investigation, few statistically significant ( $P \leq 0.01$ ) differences in these variables existed between groups. When compared with adolescents who had incomplete data, adolescents with complete data rarely bought food/drink from the school canteen, rarely bought food/drink on the way to/from school, had smaller amounts of spending money, perceived greater maternal role modelling of healthy behaviours, were always expected home for dinner and had greater availability of nutritious food at home. The remaining thirty-two variables did not differ between the groups. Where differences did exist, they were relatively small in magnitude.

Socio-economic position was defined based on maternal highest level of education (self-reported at baseline): 'low', mother completed up to Year 10 of high school; 'medium', mother completed Year 12 high school and/or a technical or trade school certificate/apprenticeship; and 'high', mother completed a university or tertiary qualification. The study was approved by Deakin University's Ethics Committee, the Victorian Department of Education and Training, and the Catholic Education Office (EC 227–2003).

## Measures

### Outcome variables

The online baseline and 2-year follow-up surveys each included a thirty-eight-item FFQ, comprising twenty-seven food items and eleven beverage items, based on food intake questions recommended by the Australian Food and Nutrition Monitoring and Surveillance Unit<sup>(30)</sup> and those used in the 1995 National Nutrition Survey<sup>(31)</sup>. These food and beverage items were based on those most commonly consumed by individuals aged 12 years and older<sup>(31)</sup>. Adolescents were asked to indicate on a seven-point scale (scored 1–7) the frequency with which they had eaten each food item in the previous month. Scores representing equivalent daily frequencies for high-energy beverages were converted from monthly frequencies as follows: 'not in the last month' (scored 0.00 – i.e. consumed zero times daily), 'several times per month' (0.07), 'once a week' (0.14), 'a few times a week' (0.36), 'most days' (0.71), 'once per day' (1.00) and 'several times per day' (2.50). As the FFQ did not include portion size, calculation of serving size was not possible. Therefore each FFQ response scale was converted to weekly (high-energy food) or daily (high-energy beverages) equivalent frequencies separately at baseline and at follow-up. High-energy food monthly frequencies were converted to equivalent weekly frequencies as follows: 'not in the last month' (scored 0.0 – i.e. consumed 0 times weekly), 'several times per month' (0.50), 'once a week' (1.00), 'a few times a week' (2.00), 'most days' (4.00), 'once per day' (7.00) and 'several times per day' (14.00). Scores representing equivalent daily frequencies for high-energy beverages were converted from monthly frequencies as follows: 'not in the last month' (scored 0.00 – i.e. consumed zero times daily), 'several times per month' (0.07), 'once a week' (0.14), 'a few times a week' (0.36), 'most days' (0.71), 'once per day' (1.00) and 'several times per day' (2.50). This approach is based on the Victorian Cancer Council FFQ User Guide<sup>(32)</sup> conversion of FFQ response categories to daily equivalent frequencies, a methodology commonly used to rank individuals' dietary intakes<sup>(33,34)</sup>.

The 'high-energy food' group included 'hot chips, French fries, wedges, fried potato', 'fish or seafood (from a fish and chip shop)', 'pizza', 'pies, pastries, sausage rolls' and 'fast foods (e.g. McDonalds, KFC)'. Foods purchased at

fast-food restaurants average ~1100 kJ per 100 g<sup>(35,36)</sup>. 'High-energy beverages' included regular (i.e. not diet/low-calorie) cordial (a sweetened, flavoured, concentrated syrup mixed with water to taste), regular soft drink, energy drinks (e.g. V\*, Red Bull†) and sports drinks (e.g. Gatorade‡, Powerade§).

Among socio-economically disadvantaged adolescents, baseline and follow-up consumption frequencies were dichotomized as follows: less frequent consumption was defined as  $\leq 2$  times/week for high-energy food meals and as  $\leq 1$  time/d for high-energy beverages.

### Predictor variables

Survey items were developed to assess intrapersonal, social and environmental factors drawn from Social Ecological Theory and hypothesized to influence adolescent eating behaviours<sup>(19,20)</sup>. The YEP surveys were pilot-tested among twenty adolescents, with survey items modified slightly for clarity based on adolescents' feedback prior to being administered to the larger sample. The present investigation included a number of intrapersonal, social and environmental measures from the baseline survey (Table 1). Scales were created by summing categorical-response items measuring a particular construct. For example, three items measuring the perceived importance of health behaviours were summed to give a composite score. Cronbach's  $\alpha$  coefficients were calculated for all summed scales used in the present investigation (Table 1).

### Covariates

Past research has demonstrated that sociodemographic characteristics including sex<sup>(11,21)</sup>, age<sup>(11,21)</sup> and region of residence<sup>(10)</sup> are associated with adolescent diet. These data were gathered in the baseline survey and were considered as covariates in the present investigation.

### Statistical analyses

Statistical analyses were conducted using the Stata statistical software package version 11. Descriptive statistics were used to describe sociodemographic characteristics of participating adolescents ( $n$  529) and to examine the proportions of adolescents eating fewer high-energy foods and beverages at baseline and at follow-up. Associations between each sociodemographic characteristic (sex, age and region of residence) and less frequent intakes at each time point were identified in bivariable logistic regression analyses, and only those sociodemographic characteristics significantly ( $P \leq 0.01$ ) associated with the dietary outcome were adjusted for in further bivariable and multivariable analyses. The more stringent criterion of using a  $P$  value

\* Frucor Beverages Ltd, Auckland, New Zealand.

† Red Bull GmbH, Fuschl am See, Salzburg, Austria.

‡ Quaker Foods, a Division of Pepsico Beverages and Food, Purchase, NY, USA.

§ The Coca-Cola Company, Atlanta, GA, USA.

**Table 1** Intrapersonal, social and environmental measures from the baseline YEP adolescent survey

	Measure	Item type	Range	Cronbach's $\alpha$	Source
Intrapersonal measures					
Skipped meals frequency	Three individual items: 'Over the past month, about how often have you...?' '...skipped breakfast?' '...skipped lunch?' '...skipped dinner?'	Individual items	1–5	N/A	Original
Meals eaten alone	Two individual items: 'Over the past month, about how often have you...?' '...eaten breakfast on your own?' '...eaten dinner on your own?'	Individual items	1–5	N/A	Original
Fast food eating behaviours	Four individual items: 'Over the past month, about how often have you...?' '...eaten fast food or takeaway for breakfast?' '...bought fast food or takeaway for lunch?' '...eaten fast food or takeaway for dinner at home?' '...eaten dinner at a fast-food place (like McDonalds, Pizza Hut)?'	Individual items	1–5	N/A	Original
School eating behaviours	Four individual items examining school-time eating behaviours: 'About how often do you...?' '...buy foods or drinks from the school canteen/tuck shop?' '...leave the school grounds during school (e.g. at recess or lunchtime) to buy food or drinks?' '...buy food or drinks on the way to or from school?' 'About how often do you buy foods or drinks from vending machines at school?'	Individual items	1–5   1–6	N/A	Adapted from Cleland <i>et al.</i> <sup>(53)</sup>
Perceived importance of health behaviours	'How important are the following to you?' 'Eating healthy food' 'Limiting the amount of "junk food" you eat' 'Exercising and staying fit'	Scale	3–12	0.74	Original
Self-efficacy (for fruit or energy-dense food)	'If you wanted to, how confident (sure) are you that you could eat more fruit...?' (or '...could cut down on junk food...?') '...when you're hanging out with friends?' '...when you're at school?' '...when you're at home?'	Scale	3–12	0.84 (fruit)  0.82 (energy-dense food)	Adapted from Kremers <i>et al.</i> <sup>(54)</sup> and Neumark-Sztainer <i>et al.</i> <sup>(55)</sup>
Spending money	'In a typical week, about how much money do you have available to spend on yourself (e.g. from pocket money, a part-time job)?'	Individual item	1–6	N/A	Original

Table 1 Continued

	Measure	Item type	Range	Cronbach's $\alpha$	Source
Social measures					
Family support for healthy eating	'During the past year, about how often have your family (parents/brothers or sisters) said or done this?' '...made you feel good about the way you eat?' '...eaten healthy foods with you?' '...encouraged you not to eat "junk food" when you felt like it?' '...encouraged you to eat healthy foods?' '...encouraged you to try new foods?'	Scale	5–15	0.76	Adapted from Sallis <i>et al.</i> <sup>(56)</sup>
Friends' support for healthy eating	The same set of five questions about family support was repeated to assess support for healthy eating from friends	Scale	5–15	0.78	Adapted from Sallis <i>et al.</i> <sup>(56)</sup>
Mother's role modelling of healthy eating	'My mother...' '...eats healthy food' '...limits the amount of "junk food" she eats' '...eats vegetables most days' '...eats fruit most days'	Scale	4–12	0.71	Original
Father's role modelling of healthy eating	The same set of four questions about mother's role modelling was repeated to assess role modelling by the father	Scale	4–12	0.75	Original
Friends' role modelling of healthy eating	The same set of four questions about mother's role modelling was repeated to assess role modelling by friends	Scale	4–12	0.76	Original
Meal-time atmosphere	Two individual items: 'The evening meal is an unpleasant time for my family' 'The evening meal is a time when my family really talks and catches up with each other'	Individual items	1–4	N/A	Adapted from Fulkerson <i>et al.</i> <sup>(57)</sup>
Family meal-time rules	Eight individual items: 'I eat whatever I like at home' 'During meal times, I'm allowed to put the TV on' 'At meal times I have to follow certain rules (e.g. not talking with my mouth full)' 'I'm expected to be home for dinner unless otherwise arranged' 'I'm expected to have good manners at the dinner table (e.g. handling food politely – using my knife and fork properly)' 'I'm expected to eat all the foods served even if I don't like them' 'It's OK for me to make something else to eat if I don't like the food being served for dinner' 'I'm always allowed to buy whatever I want from fast-food places'	Individual items	1–4	N/A	Adapted from Fulkerson <i>et al.</i> <sup>(57)</sup>

Table 1 Continued

	Measure	Item type	Range	Cronbach's $\alpha$	Source
Environmental measures					
Home access to food (nutritious food or energy-dense food)	Two individual items: 'There is plenty of food at home' 'Vegetables are served at dinner'	Individual items	1–4	N/A	Adapted from Neumark-Sztainer <i>et al.</i> <sup>(55)</sup>
Home availability of food (nutritious food or high-energy food)	'About how often are the following foods available in your home?'	Scale	2–8	0.75	Adapted from Campbell <i>et al.</i> <sup>(58)</sup> and Neumark-Sztainer <i>et al.</i> <sup>(55)</sup>
	Nutritious food: 'fruit' and 'vegetables' Energy-dense food: 'cakes/doughnuts/biscuits' 'potato chips or other salty snack foods' 'chocolate or other lollies' 'soft drink' and 'sports drinks or energy drinks'	Scale	5–20	0.75	
Perception of school canteen	'How would you rate your school canteen for...?' '...buying fresh foods (e.g. fruit)?' '...buying prepared foods (e.g. sandwiches, salads)?' '...value of food (e.g. price)?' '...quality of food (e.g. freshness)?' '...speed of service (time to get served)?'	Scale	5–25	0.81	Original
Neighbourhood availability of energy-dense food	'Are there fast-food places near where you live?' Summed together with: 'Are there...' '...places to buy snacks near where you live (e.g. ice creams, lollies, soft drinks, cakes, potato crisps)?' '...fast-food places near your school?' '...places to buy snacks near your school (e.g. ice creams, lollies, soft drinks, cakes, potato crisps)?'	Scale	4–15	0.70	Original

N/A, not applicable.

of  $\leq 0.01$  (rather than  $P \leq 0.05$ ) was applied for determining statistical significance as the relatively large sample size used and large number of tests conducted in the present investigation increased the likelihood of a Type I error.

Spearman non-parametric correlation coefficients were calculated to indicate co-linearity between predictor variables. Two predictor variables were considered to be co-linear if  $P \geq 0.4$ , indicating a moderate correlation<sup>(37)</sup>. Of those two co-linear predictor variables, only the predictor variable most strongly associated with either of the two food group outcomes was included in further analyses. Therefore, due to co-linearity, the 'Self-efficacy for fruit' and 'Perceived importance of healthy behaviours' scales and the 'Expected to follow certain meal-time rules' and 'Expected to be home for dinner' items were excluded from analyses.

Bivariable logistic regression analyses were used to examine associations between baseline predictor variables and less frequent consumption of each food group outcome at baseline. Similarly, bivariable logistic regression analyses adjusted for baseline consumption frequency were used to identify baseline predictors of less frequent consumption at follow-up. The reference categories chosen for each predictor variable were selected to facilitate the simplest interpretability of results. Statistically significant ( $P \leq 0.01$ ) factors identified in bivariable analyses were then entered into multivariable logistic regression analyses, which included adjustment for baseline frequency of intake. All models were also adjusted for relevant covariates. As the YEP Study involved recruitment of a sample of adolescents clustered by school, potential clustering effects by school in regression models were adjusted for clustering by using the 'cluster' command in Stata to generate robust standard errors.

## Results

Adolescents were sociodemographically diverse (Table 2). Among socio-economically disadvantaged adolescents included in the present investigation, 32% consumed fewer high-energy foods ( $\leq 2$  high-energy meals/week) at baseline, increasing to 39% at follow-up. Sixty-one per cent of disadvantaged adolescents consumed fewer high-energy beverages ( $\leq 1$  time/d) at baseline, increasing to 65% at follow-up.

Bivariable logistic regression analyses were performed to identify statistically significant ( $P \leq 0.01$ ) covariates and predictor variables which were then entered into multivariable logistic regression models (data not shown). Multivariable logistic regression model findings from cross-sectional and longitudinal analyses are detailed below.

### **Cross-sectional associations between predictor variables and less frequent consumption of high-energy foods**

After controlling for all bivariably associated predictor variables in multivariable analysis, two intrapersonal and

**Table 2** Sociodemographic characteristics of socio-economically disadvantaged Australian adolescents and proportions consuming fewer high-energy foods and beverages at baseline and follow-up (n 529)

Sociodemographic characteristics	n	%
Total sample	529	100
Sex		
Boys	227	43
Girls	302	57
Age group		
Year 7	357	67
Year 9	172	33
Region of residence		
Metropolitan	370	70
Non-metropolitan	159	30
Baseline less frequent high-energy food intake†	171	32
Follow-up less frequent high-energy food intake†	208	39
Baseline less frequent high-energy beverage intake‡	321	61
Follow-up less frequent high-energy beverage intake‡	345	65

†Less frequent intake defined as consumption of high-energy food meals  $\leq 2$  times/week.

‡Less frequent intake defined as consumption of high-energy beverages  $\leq 1$  time/d.

one environmental predictor variables remained significantly associated with less frequent high-energy food intake ( $\leq 2$  high-energy meals/week) at baseline among socio-economically disadvantaged adolescents (Table 3). Adolescents who had consumed high-energy food for dinner at home twice or less in the month preceding the baseline survey had nearly five times greater odds of eating fewer high-energy foods than adolescents who consumed high-energy foods at home more frequently. Similarly, adolescents who had not consumed fast food for dinner at a fast-food restaurant in the past month had two times greater odds of having less frequent intakes than adolescents who ate fast-food meals in this setting more often. Each unit increase on the 'home availability of high-energy food' scale was associated with a 13% decrease in the odds of having less frequent intake, i.e. adolescents who reported less high-energy food available at home had greater odds of eating fewer high-energy foods compared with those who reported greater availability of those foods.

After controlling for all predictor variables bivariably associated with consuming fewer high-energy beverages ( $\leq 1$  time/d) at baseline including the covariate 'sex', only three factors remained statistically significant in multivariable analysis (Table 3). Disadvantaged adolescent girls had 58% greater odds of consuming fewer high-energy beverages than boys. Adolescents who reported always being served vegetables at dinner had 73% greater odds of consuming fewer high-energy beverages when compared with adolescents who were served vegetables less often. Each unit increase on the 'home availability of high-energy food' scale was associated with a 16% decrease in the odds of consuming fewer high-energy beverages.

**Table 3** Odds ratios and 95% confidence intervals of consuming fewer high-energy foods and beverages at baseline among socio-economically disadvantaged Australian adolescents identified in multivariable logistic regression analysis (*n* 529)

	Less frequent intake (%)	Frequent intake (%)	OR	95% CI	<i>P</i> value
<b>Less frequent high-energy food intake at baseline†</b>					
<i>n</i>	171	358			
<b>Intrapersonal factors</b>					
Skipped meals frequency					
Skipped lunch					
Every day/most days	7	14	1.00	Ref.	
Once/twice a week	12	15	1.69	0.68, 4.18	0.25
Once/twice a month	17	22	1.38	0.61, 3.14	0.43
Not in last month	64	49	1.89	0.77, 4.67	0.16
Fast-food eating behaviours					
Ate fast food for breakfast					
Every day/most days/once/twice a week/once/twice a month	11	24	1.00	Ref.	
Not in last month	89	76	1.46	0.72, 2.94	0.28
Ate fast food for lunch					
Every day/most days/once/twice a week/once/twice a month	36	60	1.00	Ref.	
Not in last month	64	40	1.20	0.69, 2.06	0.51
Ate fast food for dinner at home					
Every day/most days/once/twice a week	9	44	1.00	Ref.	
Once/twice a month/not in last month	91	56	4.94	2.63, 9.27	<0.001*
Ate fast food for dinner at a fast-food restaurant					
Every day/most days/once/twice a week/once/twice a month	25	52	1.00	Ref.	
Not in last month	75	48	2.09	1.23, 3.55	0.008*
School eating behaviours					
Bought food/drink from school canteen					
Every day/most days/sometimes	39	62	1.00	Ref.	
Hardly ever/never	61	38	1.53	1.08, 2.18	0.02
Left school ground to buy food/drink					
Every day/most days/ sometimes/hardly ever	8	20	1.00	Ref.	
Never	92	80	1.32	0.67, 2.58	0.41
Bought food/drink on way to/from school					
Every day/most days/sometimes/hardly ever	23	48	1.00	Ref.	
Never	77	52	1.59	1.06, 2.39	0.03
Self-efficacy for decreasing intakes of energy-dense food					
Mean	9.34	8.20	1.10	1.02, 1.18	0.02
SD	2.13	2.43			
Spending money					
\$AUD ≥30/week/\$AUD 20–29/week	12	18	1.00	Ref.	
\$AUD 10–19/week	16	21	1.28	0.52, 3.16	0.58
\$AUD 5–9/week	27	28	0.91	0.44, 1.89	0.80
\$AUD <5/week	21	20	0.94	0.38, 2.31	0.88
None	24	13	1.55	0.54, 4.48	0.41
<b>Social factors</b>					
Meal-time atmosphere					
Evening meal – unpleasant for family					
Always/usually	8	15	1.00	Ref.	
Sometimes	21	19	1.46	0.59, 3.60	0.41
Never	71	66	1.01	0.49, 2.11	0.97
Family meal-time rules					
Allowed to buy whatever is liked at fast-food places					
Always	10	20	1.00	Ref.	
Usually	26	27	1.44	0.60, 3.44	0.40
Sometimes/never	64	53	1.41	0.61, 3.26	0.41
<b>Environmental factors</b>					
Home access to food					
Vegetables served at dinner					
Never/sometimes/usually	28	46	1.00	Ref.	
Always	72	54	1.90	1.15, 3.13	0.02
Home availability of high-energy food					
Mean	10.9	12.8	0.87	0.79, 0.95	0.004*
SD	2.50	2.96			
<b>Less frequent high-energy beverage intake at baseline‡,§</b>					
<i>n</i>	321	208			
<b>Sociodemographic characteristics</b>					
Sex					
Boys	37	51	1.00	Ref.	
Girls	63	49	1.58	1.20, 2.09	0.002*

Table 3 Continued

	Less frequent intake (%)	Frequent intake (%)	OR	95% CI	P value
Intrapersonal factors					
Skipped meals frequency					
Skipped breakfast					
Every day/most days	15	23	1.00	Ref.	
Once/twice a week	11	15	1.14	0.62, 2.09	0.67
Once/twice a month	18	13	2.07	1.08, 3.97	0.03
Not in last month	56	49	1.52	0.96, 2.41	0.07
Fast-food eating behaviours					
Ate fast food for breakfast					
Every day/most days/once/twice a week/once/twice a month	15	27	1.00	Ref.	
Not in last month	85	73	1.36	0.81, 2.27	0.23
Ate fast food for dinner at home					
Every day/most days/once/twice a week	24	45	1.00	Ref.	
Once/twice a month/not in last month	76	55	1.46	0.90, 2.37	0.12
Ate fast food for dinner at a fast-food restaurant					
Every day/most days/once/twice a week/once/twice a month	36	55	1.00	Ref.	
Not in last month	64	45	1.62	0.96, 2.75	0.07
School eating behaviours					
Bought food/drink from school canteen					
Every day/most days/sometimes	47	65	1.00	Ref.	
Hardly ever/never	53	35	1.47	0.95, 2.26	0.08
Self-efficacy for decreasing intakes of energy-dense food					
Mean	8.88	8.10	1.02	0.93, 1.12	0.72
SD	2.24	2.55			
Social factors					
Family meal-time rules					
Allowed to make something else for dinner					
Always	11	17	1.00	Ref.	
Usually	18	18	1.96	0.95, 4.01	0.07
Sometimes	43	47	1.31	0.61, 2.80	0.48
Never	28	18	1.64	0.76, 3.55	0.20
Allowed to buy whatever is liked at fast-food places					
Always	13	22	1.00	Ref.	
Usually	26	28	1.14	0.71, 1.84	0.57
Sometimes/never	61	50	1.16	0.68, 1.97	0.58
Environmental factors					
Home access to food					
Vegetables served at dinner					
Never/sometimes/usually	34	49	1.00	Ref.	
Always	66	51	1.73	1.16, 2.58	0.009*
Home availability of high-energy food					
Mean	11.4	13.4	0.84	0.78, 0.91	<0.001*
SD	2.67	3.00			
Neighbourhood availability of high-energy food					
Mean	8.19	8.74	0.98	0.89, 1.07	0.59
SD	2.06	2.09			

Ref., reference category.

\* $P \leq 0.01$ .†Less frequent intake defined as consumption of high-energy food meals  $\leq 2$  times/week at baseline.‡Less frequent intake defined as consumption of high-energy beverages  $\leq 1$  time/d at baseline.

§Model adjusted for covariate 'sex'.

### Longitudinal predictors of less frequent consumption of high-energy foods

Baseline high-energy food intake frequency, sex and one intrapersonal variable remained significant predictors of less frequent high-energy food consumption at follow-up among disadvantaged adolescents (Table 4). Baseline high-energy food intake frequency strongly predicted high-energy food intake frequency at follow-up, i.e. adolescents who ate fewer high-energy foods at baseline had two times greater odds of eating fewer high-energy foods at follow-up when compared with adolescents who frequently ate high-energy foods at

baseline. Girls had 57% greater odds of eating fewer high-energy foods at follow-up when compared with boys. Adolescents who had not consumed fast food for breakfast in the month preceding the baseline survey had nearly three times greater odds of eating fewer high-energy foods at follow-up when compared with adolescents who ate fast food for breakfast more frequently.

Baseline high-energy beverage intake frequency, sex and one environmental factor predicted less frequent high-energy beverage consumption. Adolescents who consumed fewer high-energy beverages at baseline had

**Table 4** Longitudinal predictors and odds ratios and 95 % confidence intervals of consuming fewer high-energy foods and beverages at follow-up among socio-economically disadvantaged Australian adolescents identified in multivariable logistic regression analysis (n 529)

	Less frequent intake (%)	Frequent intake (%)	OR	95% CI	P value
Less frequent high-energy food intake at follow-up, ‡					
<i>n</i>	208	321			
Dietary factors					
Baseline high-energy food intake frequency					
Frequent intake at baseline	52	78	1.00	Ref.	
Less frequent intake at baseline	48	22	2.02	1.42, 2.89	<0.001*
Sociodemographic characteristics					
Sex					
Boys	35	48	1.00	Ref.	
Girls	65	52	1.57	1.19, 2.08	0.002*
Intrapersonal factors					
Fast-food eating behaviours					
Ate fast food for breakfast					
Every day/most days/once/twice a week/once/twice a month	9	27	1.00	Ref.	
Not in last month	91	73	2.80	1.52, 5.17	0.002*
Ate fast food for dinner at home					
Every day/most days/once/twice a week	21	40	1.00	Ref.	
Once/twice a month/not in last month	79	60	1.50	1.05, 2.16	0.03
School eating behaviours					
Bought food/drink from school vending machines					
Every day/most days/sometimes	9	19	1.00	Ref.	
Hardly ever	16	15	1.69	0.90, 3.19	0.10
Never/no vending machine	75	66	1.82	1.09, 3.04	0.02
Self-efficacy for decreasing intakes of energy-dense food			1.09	1.02, 1.16	0.02
Mean	9.11	8.22			
SD	2.14	2.49			
Environmental factors					
Home availability of high-energy food			0.93	0.86, 1.00	0.04
Mean	11.4	12.7			
SD	2.69	3.01			
Less frequent high-energy beverage intake at follow-up, §,					
<i>n</i>	345	184			
Dietary factors					
Baseline high-energy beverage intake frequency					
Frequent intake at baseline	27	62	1.00	Ref.	
Less frequent intake at baseline	73	38	3.15	2.19, 4.54	<0.001*
Sociodemographic characteristics					
Sex					
Boys	35	57	1.00	Ref.	
Girls	65	43	2.18	1.44, 3.29	0.001*
Intrapersonal factors					
Fast-food eating behaviours					
Ate fast food for dinner at home					
Every day/most days/once/twice a week	35	57	1.00	Ref.	
Once/twice a month/not in last month	65	43	1.44	1.02, 2.05	0.04
Environmental factors					
Home availability of high-energy food			0.88	0.83, 0.94	<0.001*
Mean	11.6	13.3			
SD	2.76	3.00			

Ref., reference category.

\**P* ≤ 0.01

†Less frequent intake defined as consumption of high-energy food meals ≤2 times/week at follow-up.

‡Model adjusted for covariate 'sex' and baseline high-energy food intake frequency.

§Less frequent intake defined as consumption of high-energy beverages ≤1 time/d at follow-up.

||Model adjusted for covariate 'sex' and baseline high-energy beverage intake frequency.

more than three times greater odds of consuming fewer high-energy beverages at follow-up. Girls had more than twice the likelihood of consuming fewer high-energy beverages at follow-up when compared with boys. For each unit increase on the 'home availability of high-energy food' scale, disadvantaged adolescents' odds of drinking fewer high-energy beverages decreased by 12%.

### Discussion

Some socio-economically disadvantaged adolescents managed to consume fewer high-energy foods and beverages. The present study identifies cross-sectional associations between intrapersonal, social and environmental factors and consumption of fewer high-energy foods and beverages;

and longitudinal determinants of adolescents' less frequent high-energy food consumption.

Past research supports the observation that some disadvantaged adolescents managed to consume fewer high-energy foods. Among disadvantaged American adolescents, 56% of boys and 58% of girls consumed fast-food meals two times or less in the week preceding the Project EAT follow-up survey<sup>(22)</sup>. These proportions are greater than observed in the present investigation, which may be explained by methodological differences between the two studies.

Proportions of disadvantaged (defined by family affluence) European adolescents who consumed high-energy beverages less than daily ranged from 50% to 94%; when parental occupation was used to define socio-economic position, proportions ranged from 47% to 91%<sup>(38)</sup>. Although the cut-off for less frequent high-energy beverage consumption ( $\leq 1$  time/d) in our study was less stringent than that used by Vereecken *et al.*<sup>(38)</sup> (less than daily), proportions of disadvantaged adolescents who drank fewer high-energy beverages (61% at baseline, 65% at follow-up) were comparable to those reported in the European study. Findings from the present investigation support the observation that a proportion of disadvantaged adolescents manage to consume high-energy foods and beverages relatively less frequently.

The observation in the present investigation that disadvantaged adolescents' consumption of high-energy foods decreased over time is unexpected, as it is at odds with findings that the quality of adolescents' diets tends to decline as they mature<sup>(12–14,39)</sup>. It could be that messages about healthy eating are leading to secular improvements in Australian adolescents' diets, as evidenced in the wider population<sup>(40,41)</sup>. For example, in 2008 fewer Australian adolescent girls consumed fast food at least once weekly (18.4%) compared with 2003 (34.6%)<sup>(40)</sup>. Secular changes in Australian adolescents' diets require further investigation, particularly consumption of high-energy foods and beverages.

The present study showed that less frequent consumption of fast-food main meals, frequently being served vegetables with dinner and reduced home availability of high-energy foods were associated with less frequent high-energy food consumption among disadvantaged adolescents. Less frequent fast-food consumption for breakfasts and dinners at home or at fast-food restaurants was associated with consumption of fewer high-energy foods at both time points. Previously, adolescents' regular fast-food meal consumption was shown to be positively associated with greater intakes of those foods<sup>(42)</sup>, resulting in poor diet<sup>(8,9,43)</sup>. Among disadvantaged adolescents, fat avoidance behaviours including eating bread, rolls or muffins without butter or margarine and replacement behaviours including ordering pasta or pizza without meat sauce or meat toppings significantly predicted low fat intakes<sup>(18)</sup>.

Lower home availability of high-energy foods predicted consumption of fewer high-energy foods and beverages. Similarly, frequently being served vegetables with dinner was associated with less frequent high-energy beverage consumption. Adolescents who consumed fewer high-energy foods may consume home-prepared meals more regularly, although this requires further investigation. Greater home availability of high-energy beverages was associated with increased consumption of such drinks<sup>(44,45)</sup>, and home availability of high-energy foods predicted US adolescent boys' and girls' higher fast-food intake<sup>(12,22)</sup> and girls' high-energy beverage intake<sup>(46)</sup>. Previously, disadvantaged adolescents were more likely to have greater home availability of high-energy beverages, while less often reporting having vegetables always served at dinner when compared with more advantaged adolescents<sup>(29)</sup>. These findings suggest that despite increasing autonomy and greater influences outside the home impacting on adolescents' eating behaviours as adolescents mature, the home environment remains important for supporting healthy eating behaviours. Health promotion initiatives could provide education and assistance for disadvantaged adolescents and their families to develop budgeting and cooking skills related to purchase and preparation of quick, easy and nutritious meals (e.g. serving vegetables with dinner) in place of high-energy foods and beverages at home.

In the present investigation, baseline frequency of high-energy food and beverage intakes strongly predicted follow-up intake frequency, reflecting tracking of less frequent high-energy food consumption throughout adolescence. Kelder *et al.* found that adolescents who measured high on a given health behaviour still ranked highly for that measure 6 years later and those who ranked low remained low<sup>(2)</sup>, a pattern that has emerged in several other related studies<sup>(47–49)</sup>. These findings suggest that while nutrition promotion messages and strategies should be employed throughout adolescence to aid disadvantaged adolescents in avoiding high-energy foods and beverages, particular emphasis on such initiatives during early adolescence is warranted.

The present findings suggest that selected intrapersonal (particularly behavioural factors) and environmental (particularly within the home) factors may be beneficial foci of nutrition promotion initiatives aiming to improve disadvantaged adolescents' diets. There also remain aspects of social factors that were not measured in the present investigation, e.g. increasing research about peer social networks. However, relatively few factors from across all domains, but particularly few environmental factors, strongly predicted disadvantaged adolescents' less frequent high-energy food consumption. Different factors were cross-sectionally and longitudinally associated with less frequent consumption of high-energy foods, suggesting that different factors may be important for promoting healthy eating among younger and older adolescents, or over the shorter *v.* longer term.

Limitations of the present study should be acknowledged. Dietary intake data were based on a self-reported thirty-eight-item FFQ and serving sizes could not be determined. However, while FFQ may provide less detailed data than food diaries or repeated recall methodologies, research has shown that this methodology presents low burden to participants, and is appropriate for ranking participants' intakes and examining associations with independent variables<sup>(50)</sup>. It is possible that some adolescents may have misunderstood the categories or descriptions of foods or beverages in the FFQ resulting in categorical bias; however, the questions and food categories have been used previously with participants of this age group in national surveys<sup>(31,51)</sup>. Also, additional types of high-energy foods and beverages consumed by adolescents may not have been represented in the FFQ resulting in an underestimation of the frequency of adolescents' consumption of such foods. While BMI is a potentially important covariate that could be associated with dietary intake, height and weight data were not gathered from participants in the YEP Study, and therefore the effects of BMI could not be accounted for in the present investigation. Correlates were only assessed at baseline to increase participant response at follow-up. Income or household economic status was not assessed in the YEP Study, and while measures of paternal education and combined parental education were collected in the YEP Study, the majority (84%) of parental socio-demographic data were provided by mothers and therefore paternal education was only available for a small number of adolescents ( $n$  263). Further, no significant associations between paternal education level and adolescent diet have been found in past research<sup>(10,21,52)</sup>.

The YEP Study response rate was not high, perhaps due to participant absenteeism on the days the surveys were conducted and the use of an active consent method, but none the less the sample was relatively socio-demographically diverse. Although there were some differences between adolescents with complete and missing data, these were generally small and existed only for six of thirty-eight variables. While some disadvantaged adolescents managed to consume fewer high-energy foods, achieving this as defined in the present study does not reflect achieving dietary recommendations. Finally, analyses could not be stratified by sex due to sample size constraints.

There are several strengths of the present investigation. Data were drawn from a large sample of socio-demographically diverse disadvantaged adolescents, and as the YEP sample incorporated two age cohorts, analyses included adolescents across a wide age range. A comprehensive model based on Social Ecological Theory was used to examine a range of factors associated with less frequent consumption. Factors supporting disadvantaged adolescents' healthy eating may be more readily adopted by families living in similar contexts.

Finally, the longitudinal design of the study allowed examination of temporally appropriate associations.

Based on our findings, health promotion programmes targeting disadvantaged adolescents and their families could focus on educating and assisting such families to develop budgeting and food preparation skills related to the preparation of quick, easy and nutritious meals at home in place of high-energy foods and beverages such as fast-food meals. Emphasis could also be placed on supporting healthy eating behaviours among boys and the suggested health promotion messages could be implemented during early adolescence.

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