Public Health Nutrition: 18(18), 3326–3336 doi:10.1017/S1368980015000324

Socio-economic differences in predictors of frequent dairy food consumption among Australian adolescents: a longitudinal study

Lena D Stephens*, Sarah A McNaughton, David Crawford and Kylie Ball
Centre for Physical Activity and Nutrition Research, Deakin University, 221 Burwood Highway, Burwood, VIC 3125, Australia

Submitted 4 August 2014: Final revision received 15 December 2014: Accepted 7 January 2015: First published online 23 February 2015

Abstract

Objective: Sufficient dairy food consumption during adolescence is necessary for preventing disease. While socio-economically disadvantaged adolescents tend to consume few dairy foods, some eat quantities more in line with dietary recommendations despite socio-economic challenges. Socio-economic variations in factors supportive of adolescents' frequent dairy consumption remain unexplored. The present study aimed to identify cross-sectional and longitudinal associations between intrapersonal, social and environmental factors and adolescents' frequent dairy consumption at baseline and two years later across socio-economic strata, and to examine whether socio-economic position moderated observed effects.

Design: Online surveys completed at baseline (2004–2005) and follow-up (2006–2007) included a thirty-eight-item FFQ and questions based on social ecological models examining intrapersonal, social and environmental dietary influences.

Setting: Thirty-seven secondary schools in Victoria, Australia.

Subjects: Australian adolescents (n 1201) aged 12–15 years, drawn from a sub-sample of 3264 adolescents (response rate = 33 %).

Results: While frequent breakfast consumption was cross-sectionally associated with frequent dairy consumption among all adolescents, additional associated factors differed by socio-economic position. Baseline dairy consumption longitudinally predicted consumption at follow-up. No further factors predicted frequent consumption among disadvantaged adolescents, while four additional factors were predictive among advantaged adolescents. Socio-economic position moderated two predictors; infrequently eating dinner alone and never purchasing from school vending machines predicted frequent consumption among advantaged adolescents.

Conclusions: Nutrition promotion initiatives aimed at improving adolescents' dairy consumption should employ multifactorial approaches informed by social ecological models and address socio-economic differences in influences on eating behaviours; e.g. selected intrapersonal factors among all adolescents and social factors (e.g. mealtime rules) among advantaged adolescents.

Keywords
Adolescents
Nutrition
Behaviour
Socio-economic position

Recent reviews have demonstrated a key role for sufficient dairy food consumption in preventing diseases in adulthood, including dyslipidaemia, insulin resistance, high blood pressure, obesity[1], CVD[1,2] and osteoporosis[3]. Among adolescents, frequent dairy consumption has been shown to be associated with lower adiposity among boys and girls, and decreased CVD risk among girls[4]. Dairy food consumption is also necessary for bone accretion in adolescence[3]. Despite the importance of adequate dairy food consumption for good health during adolescence and beyond, adolescents generally consume low levels of dairy foods[5,6] and these levels decline further as adolescents age[7,8]. Adolescents experiencing socio-economic disadvantage, e.g. those from families with low levels of parental education, low income or residing in socio-economically disadvantaged neighbourhoods, are particularly prone to inadequate dairy food consumption[9,10].

Although socio-economically disadvantaged adolescents' diets tend to be poorer than those of more advantaged adolescents, some disadvantaged adolescents are able to meet dietary recommendations[11,12]. Those disadvantaged adolescents managing to consume a healthy diet, despite the odds of less healthy eating behaviours associated with socio-economic disadvantage, can be considered to be displaying a form of 'resilience'[13]. Employing a resilience approach to investigate dietary determinants provides an innovative

*Corresponding author: Email l.stephens@deakin.edu.au

pathway for identifying potential intervention targets that can be applied in nutrition promotion initiatives aimed at improving dietary intakes among other adolescents experiencing socio-economic disadvantage.

Social ecological models have been employed to provide a useful theoretical framework to further understand the range of intrapersonal, social and environmental determinants of adolescent dietary behaviour[14–20]. Examples of intrapersonal factors associated with adolescent diet include self-efficacy, perceived importance of health behaviours, taste preferences, food-related behaviours such as frequencies of meals and fast-food consumption, and barriers to healthy eating including expense, limited time and inconvenience[14]. Interactions with family and friends[15–17], parenting style, role modelling of healthy eating behaviours, perceived social norms and cultural factors are social determinants that have been found to be associated with healthy eating[17]. Several environmental factors also influence adolescent eating behaviour, including availability, accessibility and affordability of foods at home, school and in the local neighbourhood around adolescents' homes and schools[18–20].

We have previously identified a range of factors associated with more 'resilient' (frequent) intakes of vegetables and fruit in a cross-sectional study of socio-economically disadvantaged adolescents in Melbourne, Australia[12]. Also identified were longitudinal predictors of frequent fruit and vegetable consumption[21] and less frequent consumption of high-energy foods and beverages[22].

To date, few studies have investigated factors associated with dairy food consumption among adolescents from all levels of socio-economic position (SEP), all of which were conducted in the USA[23–25]. Factors identified included increased taste preferences for milk[24], decreased soft drink and fast-food consumption[23,24], regular breakfast consumption[24], positive attitude towards health[24] and greater self-efficacy for healthy eating[24]. Social correlates of dairy food consumption included frequent parental dairy food consumption[23,25] and greater social support for healthy eating[24]; and environmental factors included increased milk availability at mealtimes[23–25].

It has been suggested that interventions may unintentionally result in widening socio-economic disparities in diet[26,27]. For example, while a reduced-pricing intervention resulted in improved nutritional quality of foods purchased by disadvantaged adult women (who chose greater quantities of less healthy foods at baseline compared with more advantaged women), overall improvements after the intervention were significantly lower among disadvantaged women than more advantaged women[26]. As nutrition promotion interventions aimed at improving diet among adolescents from all SEP levels have not reported findings stratified by SEP, it is difficult to ascertain the effectiveness of such interventions among disadvantaged adolescents in comparison to those who are more advantaged and therefore to determine if dietary interventions focused on adolescents from all SEP levels result in similar increases in socio-economic disparities in diet. However, the study conducted by Darmon *et al.*[26] highlights the need for messages and strategies aimed at improving dietary intakes to be tailored specifically for socio-economically disadvantaged groups.

Associations between a range of factors and disadvantaged adolescents' frequent consumption of dairy foods remain unexplored. Further, how these factors differ from those supportive of frequent consumption of dairy foods among more advantaged adolescents is also unknown. The present study therefore aimed to identify SEP variations in cross-sectional and longitudinal associations between intrapersonal, social and environmental factors and adolescents' frequent dairy food consumption and to determine if such associations were moderated by SEP.

Materials and methods

Participants and setting

The present study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by Deakin University's Ethics Committee, the Victorian Department of Education and Training, and the Catholic Education Office. Written informed consent was obtained from all participants.

Data for the present investigation were drawn from a sub-sample of 1201 adolescents who participated in the Youth Eating Patterns (YEP) Study. The YEP Study details have been reported elsewhere[22,28,29]. Briefly, baseline was conducted in 2004–2005 and adolescents were followed up in 2006–2007. 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 region, east of Melbourne, Australia were invited to participate in the study at baseline. Seventy schools met these criteria and of those, twenty metropolitan and seventeen non-metropolitan schools (thirty-seven in total) agreed to participate. All adolescents (n 9842) from Year 7, aged 12–13 years, and Year 9, aged 14–15 years, were invited to participate in an online survey. Parents provided written informed consent for adolescents and surveys were completed during class time by 3264 sociodemographically diverse secondary students (n 2010 in Year 7, n 1254 in Year 9; baseline response rate 33·2 %). Schools that participated at baseline in 2006 were contacted again to indicate their interest in continuing their involvement in the YEP Study. At follow-up in 2006–2007, 1938 adolescents participated (59 % response rate of adolescents who participated at baseline). Of 2735 adolescents who completed the baseline YEP survey, 1584 (58 %) went on to complete the follow-up survey (low SEP n 708, mid/high SEP n 876).

https://doi.org/10.1017/S1368980015000324 Published online by Cambridge University Press

Previous dietary research has found maternal education to be an appropriate indicator of SEP among adolescents[14,17,24,30]. Maternal highest level of education (parental report) was used to define SEP as follows: 'low', mother completed ≤ Year 10 of secondary school; 'mid/high', mother completed Year 12 secondary school, a technical or trade school certificate/apprenticeship and/or a university or tertiary qualification.

Data for the present investigation were drawn from adolescents who had complete data (*n* 1201) for all measures included (sociodemographics, predictor variables, and frequencies of dairy food intake at baseline and follow-up). Among 1584 adolescents participating at baseline and follow-up, those with complete data (*n* 1201; low SEP *n* 521, mid/high SEP *n* 680) for all measures included in the present investigation (sociodemographic characteristics, predictor variables, frequencies of intake at baseline and at follow-up) were compared with those adolescents with incomplete data (*n* 383) across those measures, with few statistically significant ($P \leq 0{\cdot}01$) differences in these variables existing between groups. Compared with adolescents with incomplete data, those with complete data perceived greater maternal role modelling of healthy eating and greater family support for healthy eating, perceived greater availability of nutritious food at home and reported having plenty of food available at home often, were often allowed to eat what they liked, were often allowed to choose what they liked at fast-food restaurants, less often perceived the evening meal as unpleasant, had small amounts of spending money, rarely skipped breakfast, rarely ate dinner alone, rarely purchased fast food for lunch or dinner at home or dinner at a fast-food restaurant, and rarely bought food or drink from the school canteen or on the way to or from school. For the remaining twenty-three variables, no significant differences were observed between groups.

Measures

Outcome variables

Both the baseline and follow-up YEP surveys included a thirty-eight item FFQ (see online supplementary material, Supplemental Table 1). The FFQ comprised twenty-seven food items and eleven beverage items, based on dietary intake questions recommended by the Australian Food and Nutrition Monitoring and Surveillance Unit[31] and those used in the 1995 National Nutrition Survey[32]. FFQ items were based on food and beverages most commonly consumed by adolescents[32]. Frequency of consumption of each food item in the previous month was assessed by adolescents' responses to a seven-point scale (scored 1–7). The FFQ did not include portion size; therefore calculation of serving size was not possible. Responses were converted to represent equivalent daily frequencies for dairy foods at baseline and at follow-up, as follows: 'not in the last month', i.e. consumed zero times per day (scored 0·00); '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 commonly used with FFQ[33] and such a methodology has been employed in past research to rank adolescents according to dietary intakes[34,35].

The 'dairy food' group comprised cheese, yoghurt and milk (including flavoured milk and milk on cereal). 'Frequent consumption' among socio-economically disadvantaged adolescents was defined as consuming dairy foods ≥ 1·5 times/d. While it would have been preferable to define frequent dairy food consumption on the basis of achieving the recommendations of ≥3 servings/d outlined in the Australian Guide to Healthy Eating[36], this was not possible as too few participants met recommendations (e.g. only 17 % of disadvantaged adolescents at baseline), resulting in sample sizes too small to permit meaningful statistical analyses. Using a lower cut-point (i.e. ≥1·5 times/d) that is below dietary recommendations to indicate frequent dairy food consumption is reasonable given that socio-economically disadvantaged adolescents struggle to meet dietary recommendations for dairy foods[5,24,37]. The Australian Guide to Healthy Eating was recently updated and replaced with the Australian Dietary Guidelines[38]. The previous recommendations of the Australian Guide to Healthy Eating were used in the present investigation as they represent recommendations in place at the time the YEP Study was conducted.

Predictor variables

Social ecological models[39,40] formed the theoretical framework upon which survey items were developed to examine intrapersonal, social and environmental factors hypothesised to influence adolescent eating behaviours. The measures used in the baseline survey are summarised in the online supplementary material, Supplemental Table 2 and have been published previously[22]. Categorical-response items were summed to create a scale measuring a particular construct, e.g. five items measuring home availability of high-energy foods were summed to give a composite score. Cronbach's α coefficients were calculated for all summed scales used and ranged from 0·71 to 0·84, showing respectable internal reliability[41] (Supplemental Table 2).

Covariates

As sociodemographic characteristics (sex, age and region of residence) have been shown to be associated with adolescent diet[14,42], these variables were assessed at baseline and treated as covariates.

Statistical analyses

Except where indicated, all analyses were stratified by SEP. Sociodemographic characteristics of participants and the proportions of adolescents who frequently consumed dairy food at baseline and at follow-up were determined

using descriptive statistics. Pearson's χ^2 tests of significance were used to examine differences in sociodemographic characteristics and dairy food consumption.

Associations between each sociodemographic characteristic (sex, age and region of residence) and frequent consumption at each time point were identified in bivariate logistic regression analyses and only those sociodemographic characteristics significantly ($P \leq 0{\cdot}01$) associated with the dietary outcome were adjusted for in further bivariate and multivariate analyses. All models were adjusted for covariates, where applicable, and for longitudinal analyses models included adjustment for baseline consumption. The YEP Study involved recruitment of adolescents via schools, therefore potential clustering effects by school were adjusted for in all models using the 'cluster' command in Stata to generate robust standard errors. To decrease the likelihood of a Type 1 error (due to the relatively large sample size and large number of tests conducted), a more stringent criterion of $P \leq 0{\cdot}01$ (rather than $P \leq 0{\cdot}05$) was applied for determining statistical significance when assessing associations of predictors with the outcome.

For cross-sectional analyses, bivariate logistic regression analyses were used to examine associations between baseline predictor variables and frequent consumption of dairy food at baseline. For longitudinal analyses, bivariate logistic regression analyses were used to identify baseline predictors of frequent dairy food consumption at follow-up. Statistically significant ($P \leq 0{\cdot}01$) factors identified in bivariate analyses were entered into multivariate logistic regression analyses. Co-linearity was determined by calculating the variance inflation factor and tolerance value of each predictor included in multivariate models. Predictor variables with variance inflation factor $\geq 10{\cdot}0$ and tolerance $\leq 0{\cdot}1$ were then excluded from final multivariate analyses[43]. The following factors were excluded from multivariate logistic regression models: attitude towards health, self-efficacy for increasing fruit intake, self-efficacy for decreasing intake of high-energy food, maternal role modelling, family support for healthy eating and home availability of nutritious food.

Moderator effects were examined if a baseline predictor variable was found to be associated with frequent dairy consumption cross-sectionally or longitudinally. Using data from all adolescents (n 1201), bivariate logistic regressions were conducted including the outcome (frequent dairy food consumption) and the predictor variable, and the interaction between the independent variable and SEP[44]. If a significant moderator effect was observed ($P \leq 0{\cdot}05$), the sample was then stratified by SEP and bivariate logistic regression models were performed to explore associations between the outcome and predictor variable among low SEP and mid/high SEP adolescents independently. Statistical analyses were conducted using the Stata statistical software package version 12 (2011).

Results

The adolescents participating in the present investigation were sociodemographically diverse (Table 1). A significantly greater proportion of adolescents in Year 9 were of mid/high SEP ($P = 0{\cdot}011$). Among low SEP adolescents at baseline, 46 % (95 % CI 42, 51 %) frequently consumed dairy food (≥1·5 times/d), increasing to 51 % (95 % CI 47, 56 %) at follow-up. Just over half (51 %; 95 % CI 47, 55 %) of mid/high SEP adolescents frequently consumed dairy food at baseline, which increased to 60 % (95 % CI 56, 64 %) at follow-up.

When intakes of individual dairy foods were examined, of the three dairy foods examined, milk was the most commonly consumed at baseline, irrespective of adolescents' SEP or resilience status (results not shown). At follow-up, cheese was most commonly consumed. At both time points, yoghurt was more frequently consumed by resilient

Table 1 Sociodemographic characteristics of Australian adolescents and proportions frequently consuming dairy food at baseline (2004–2005) and follow-up (2006–2007) stratified by SEP (n 1201)

	Low SEP		Mid/High SEP		Total sample		
Sociodemographic characteristic	*n*	%	*n*	%	*n*	%	*P*
Total sample†	521	43	680	57	1201	100	–
Sex							
Boys	225	43	292	43	517	43	
Girls	296	57	388	57	684	57	0·932
Age group							
Year 7	355	68	415	61	770	64	
Year 9	166	32	265	39	431	36	0·011*
Region of residence							
Metropolitan	363	70	503	74	866	72	
Non-metropolitan	158	30	177	26	335	28	0·100
Frequent dairy food consumption (≥1·5 times/d)							
Baseline	240	46	348	51	588	49	0·079
Follow-up	267	51	408	60	675	56	0·002**

SEP, socio-economic position.
*$P < 0{\cdot}05$, **$P < 0{\cdot}01$.
†No statistical tests were performed.

https://doi.org/10.1017/S1368980015000324 Published online by Cambridge University Press

Table 2 Cross-sectional associations between intrapersonal, social and environmental factors, and odds ratios and 95 % confidence intervals, of frequent dairy food consumption at baseline (2004–2005), among low SEP (*n* 521) and mid/high SEP (*n* 680) Australian adolescents identified in multivariate logistic regression analysis

	Frequent intake (%)	Less frequent intake (%)	OR	95 % CI	*P*
Low SEP adolescents					
Frequent dairy food consumption at baseline†,‡					
n	240	281			
Sociodemographic characteristics					
Sex					
Boys	48	39	1·00	Ref.	
Girls	52	61	0·68	0·54, 0·87	0·002**
Intrapersonal factors					
Skipped meals frequency					
Skipped breakfast					
Every day/most days	13	22	1·00	Ref.	
Once/twice per week	10	15	1·27	0·59, 2·74	0·540
Once/twice per month	16	16	1·76	1·07, 2·89	0·027
Not in last month	61	47	2·20	1·30, 3·73	0·003**
Mid/high SEP adolescents					
Frequent dairy food consumption at baseline†					
n	348	332			
Intrapersonal factors					
Skipped meals frequency					
Skipped breakfast					
Every day/Most days	9	26	1·00	Ref.	
Once/twice a week	10	12	2·93	1·30, 6·57	0·009
Once/twice a month	15	17	2·89	1·63, 5·12	<0·001***
Not in last month	66	45	4·58	2·70, 7·77	<0·001***
Friends' support for healthy eating					
Mean	8·97	8·45	1·09	1·04, 1·14	0·001**
SD	0·14	0·14			
Social factors					
Family mealtime rules					
Expected to have good manners					
Never	5	4	1·00	Ref.	
Sometimes	12	21	0·26	0·13, 0·51	<0·001***
Usually	25	28	0·32	0·16, 0·65	0·001**
Always	58	47	0·36	0·18, 0·71	0·003**
Expected to eat all foods served even if disliked					
Never	20	29	1·00	Ref.	
Sometimes	31	34	0·90	0·58, 1·40	0·635
Usually	29	25	0·87	0·55, 1·37	0·538
Always	20	12	2·58	1·54, 4·30	<0·001***

SEP, socio-economic position; Ref., referent category.
**$P < 0·01$, ***$P < 0·001$.
†Frequent intake defined as consuming dairy food ≥ 1·5 times/d at baseline.
‡Model adjusted for covariate 'sex'.

adolescents from both SEP levels than non-resilient adolescents. Frequency of milk consumption decreased over time, particularly among resilient disadvantaged adolescents.

Results of bivariate analyses stratified by SEP predicting dairy food intakes cross-sectionally and longitudinally are summarised in Supplemental Tables 3 and 4, respectively (see online supplementary material). Statistically significant ($P \leq 0·01$) covariates and predictor variables (excluding those displaying co-linearity) were entered into multivariate logistic regression models. Findings are summarised below.

Cross-sectional associations between predictor variables and frequent dairy food consumption in multivariate analyses

Disadvantaged girls had 32 % lower odds of frequently consuming dairy food when compared with disadvantaged boys. Adolescents who had not skipped breakfast in the month preceding the baseline survey had more than two times greater odds of frequently consuming dairy compared with those who skipped breakfast every day or on most days (Table 2).

Advantaged adolescents who had not skipped breakfast in the month preceding the baseline survey had more than four times greater odds of frequently consuming dairy compared with those who skipped breakfast every day or on most days. Each unit increase on the 'friends' support for healthy eating' scale was associated with a 9 % increase in the odds of frequently consuming dairy food, i.e. advantaged adolescents who reported greater levels of support from their friends to eat healthily had greater odds of frequently consuming dairy compared with those who had lower levels of support. Adolescents who were frequently (sometimes,

https://doi.org/10.1017/S1368980015000324 Published online by Cambridge University Press

Table 3 Longitudinal predictors, and odds ratios and 95 % confidence intervals, of frequent dairy food consumption at follow-up (2006–2007) among low SEP (*n* 521) and mid/high SEP (*n* 680) Australian adolescents identified in multivariate logistic regression analysis

	Frequent intake (%)	Less frequent intake (%)	OR	95 % CI	*P*
Low SEP adolescents					
Frequent dairy food consumption at baseline†,‡					
n	267	254			
Dietary factors					
Baseline dairy food consumption frequency					
Infrequent intake at baseline	45	63	1·00	Ref.	
Frequent intake at baseline	55	37	2·16	1·60, 2·93	<0·001***
Mid/high SEP adolescents					
Frequent dairy food consumption at baseline†,‡					
n	408	272			
Dietary factors					
Baseline dairy food consumption frequency					
Infrequent intake at baseline	38	64	1·00	Ref.	
Frequent intake at baseline	62	36	3·10	2·09, 4·59	<0·001***
Intrapersonal factors					
Meals eaten alone					
Ate breakfast alone					
Every day	18	24	1·00	Ref.	
Most days	33	28	1·68	1·14, 2·47	0·008**
Once/twice per week	12	12	1·38	0·82, 2·30	0·224
Once/twice per month	12	12	1·49	0·89, 2·50	0·129
Not in last month	25	24	1·47	1·05, 2·06	0·025*
Ate dinner alone					
Every day/most days/once/twice per week	13	24	1·00	Ref.	
Once/twice a month	22	16	2·58	1·56, 4·26	<0·001***
Not in last month	65	60	1·77	1·22, 2·58	0·003**
Eating behaviours at school					
Bought food/drink from school vending machines					
Every day/most days/sometimes	10	19	1·00	Ref.	
Hardly ever	10	18	1·02	0·59, 1·75	0·948
Never/no vending machine	80	63	2·32	1·36, 3·96	0·002**
Social factors					
Family mealtime rules					
Allowed to buy whatever is liked at fast-food places					
Always	12	18	1·00	Ref.	
Usually	24	25	1·38	0·82, 2·30	0·226
Sometimes/never	64	57	1·57	1·18, 2·09	0·002**

SEP, socio-economic position; Ref., referent category.
*$P<0·05$, **$P<0·01$, ***$P<0·001$.
†Frequent intake defined as consuming dairy food ≥1·5 times/d at follow-up.
‡Model adjusted for baseline dairy food consumption frequency.

usually or always) expected to have good manners had approximately two-thirds lower odds of frequently consuming dairy foods compared with adolescents who never had to follow this mealtime rule. Conversely, adolescents who were always expected to eat all foods served even if disliked had more than two-and-a-half times greater odds of frequently consuming dairy foods compared with adolescents who never followed this rule (Table 2).

Longitudinal predictors of frequent dairy food consumption in multivariate analyses

Disadvantaged adolescents who frequently consumed dairy foods at baseline had more than two times greater odds of consuming dairy frequently at follow-up compared with those who were infrequent consumers at baseline; this was the only factor that remained predictive of disadvantaged adolescents' frequent dairy consumption at follow-up (Table 3).

Advantaged adolescents who frequently consumed dairy foods at baseline had three times greater odds of being frequent consumers at follow-up. Adolescents who had not eaten breakfast alone in the past month or on most days had 47 % and 68 % greater odds of frequent dairy food consumption, respectively, when compared with adolescents who ate breakfast alone daily. Similarly, adolescents who rarely consumed dinner alone (once/twice per month, not in the last month) had 77 % greater odds or more of frequently consuming dairy foods than those who ate dinner alone more often. Finally, advantaged adolescents who were sometimes/never allowed to buy whatever they liked at fast-food places had 57 % greater odds of being frequent dairy consumers compared with those who were always allowed to purchase what they liked (Table 3).

Moderator effects of socio-economic position

Of all associations between predictor variables and frequent dairy food consumption examined in multivariate

https://doi.org/10.1017/S1368980015000324 Published online by Cambridge University Press

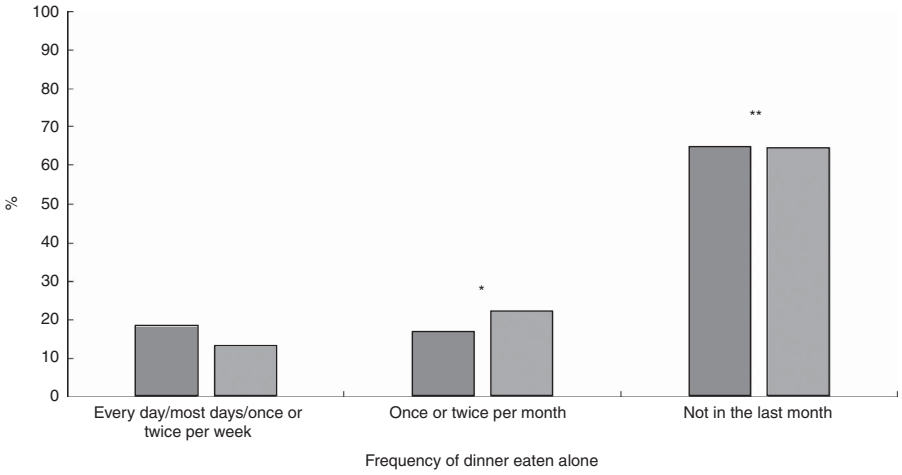

Fig. 1 Associations between the frequency of dinner eaten alone and frequent dairy consumption at follow-up among disadvantaged (■) and advantaged (□) Australian adolescents, 2006–2007. *$P < 0{\cdot}05$, **$P < 0{\cdot}01$

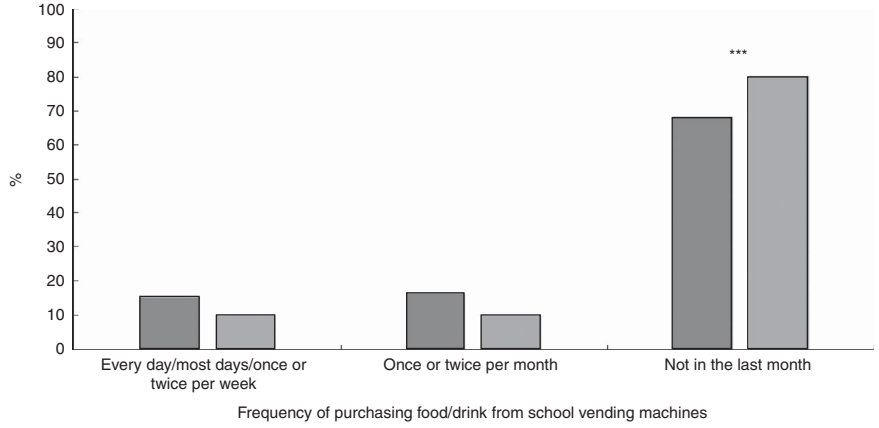

Fig. 2 Associations between the frequency of purchasing food/drink from school vending machines and frequent dairy consumption at follow-up among disadvantaged (■) and advantaged (□) Australian adolescents, 2006–2007. ***$P < 0{\cdot}001$

logistic regressions, only two were significantly ($P \leq 0{\cdot}05$) moderated by SEP. Advantaged adolescents who infrequently ate dinner alone (once/twice per month, not in the past month) had 96 % or greater odds of frequently consuming dairy food at follow-up compared with disadvantaged adolescents who ate dinner alone more often (Fig. 1). Advantaged adolescents who never made food or drink purchases from school vending machines had four times greater odds of being frequent dairy consumers at follow-up compared with low SEP adolescents who made such purchases more often (Fig. 2).

Discussion

The present investigation showed that a sizeable proportion of socio-economically advantaged and disadvantaged adolescents consumed dairy foods at least 1·5 times daily at baseline and over the 2-year follow-up period of the YEP Study. The study also identified cross-sectional and longitudinal associations between selected intrapersonal and environmental influences and frequent dairy food consumption, a small number of which appeared to be moderated by SEP.

More adolescents in the present investigation frequently consumed dairy foods at follow-up than at baseline. This finding was unexpected. Two separate analyses of Project EAT (Eating Among Teens) longitudinal data showed that as US adolescents from all SEP levels aged, mean intakes of dairy foods decreased by approximately 0·5 daily servings[7] and intakes of milk and other milk beverages also decreased[45]. In contrast, the trend towards increased dairy food consumption in the present investigation may be due to contrasting dietary trends in Australia compared with the USA during the YEP study period. For example, core food consumption has begun to improve among Australian adolescents[46], while secular analysis between 1999 and 2004 showed dairy food consumption worsened over time in the USA[45].

Regular breakfast consumption was cross-sectionally associated with frequent dairy food intake at baseline

https://doi.org/10.1017/S1368980015000324 Published online by Cambridge University Press

among adolescents from all SEP levels. Previous research has shown that regular breakfast consumers have improved dietary intakes, e.g. consuming more milk than breakfast skippers[24]. These findings suggest that promoting regular consumption of a nutritious breakfast among all adolescents irrespective of SEP may improve dairy food consumption.

Rarely purchasing food or drink from school vending machines at baseline predicted frequent dairy consumption at follow-up among more advantaged adolescents. Longitudinal research in the USA shows that high-energy beverages, such as those supplied in vending machines, tend to supplant milk and fruit juice consumption as adolescents mature[47]. Also, compared with US adolescents who made no vending machine purchases, adolescents' consumption of high-energy beverages increased by 0·21 servings daily among those who made purchases one to three times weekly and 0·71 servings daily among those purchasing from vending machines four times or more times weekly[48]. It should be noted that many adolescents who consumed more favourable diets reported having access to vending machines at school, yet managed to avoid purchasing food or drink from them. It may be possible that avoiding purchasing drinks from vending machines is mediated by some other unmeasured factor, e.g. adolescents who had a more favourable diet may prefer the taste of milk over the high-energy beverages available in vending machines. SEP moderated the association between frequency of vending machine purchases and frequent dairy consumption; i.e. advantaged adolescents who never made food or drink purchases from school vending machines were more likely to be frequent dairy food consumers at follow-up compared with low SEP adolescents who made such purchases more often. Schools, particularly those whose students are socio-economically disadvantaged, could be encouraged to remove vending machines from their campuses, or at least ensure that healthy milk-based beverages that are appealing to adolescents are supplied in such machines.

Infrequently eating breakfast and dinner alone also predicted frequent dairy intakes among advantaged adolescents, supportive of past research that demonstrates adolescent participation in a higher frequency of family meals with parental presence is associated with increased intake of calcium-rich foods including milk, yoghurt and cheese[49]. In 2011, Hammons and Fiese conducted meta-analyses that showed adolescents who participated in at least three family meals weekly were more likely to have healthier dietary and eating patterns than those who participated in fewer family meals[50]. Frequency of consuming dinner as a predictor of frequent dairy food intake was moderated by SEP. Advantaged adolescents who infrequently ate dinner alone frequently consumed dairy foods at follow-up compared with disadvantaged adolescents who ate dinner alone more often. To support increased dairy food consumption nutrition promotion initiatives could encourage families to regularly participate in meals together, particularly among those families experiencing socio-economic disadvantage.

Greater perceived support from friends to eat healthily was associated with frequent dairy food consumption among advantaged adolescents. Similar findings were reported in 2009 by Larson and colleagues[7], who showed that peer support for healthy eating predicted greater intakes of calcium-rich foods among US adolescents participating in Project EAT. The mechanisms through which adolescents in the present investigation gain support for healthy eating from their friends remain unclear; however, dietary intakes could be improved by encouraging adolescents to support one another in eating more healthfully.

In the present investigation, advantaged adolescents who reported greater adherence to family mealtime rules (with the exception of being expected to have good manners) had greater odds of consuming dairy foods frequently. These findings are supported by previous research that found a lack of family rules was associated with higher intakes of high-energy beverages[51]. Interventions aimed at improving adolescent consumption of dairy foods could incorporate strategies to assist parents in implementing family mealtime rules to support their adolescents to eat healthily.

Frequent dairy food consumption at baseline predicted frequent intake of dairy food at follow-up. Past research shows that while the quality of adolescents' diets declines as they age[7,8,25], health behaviours, such as food choice, tend to show tracking (i.e. the stability of diet over time)[52]. Baseline dairy food intake was predictive of dairy food intake at follow-up among US adolescents from all SEP levels[25]. Collectively these findings suggest that if frequent dairy food consumption can be supported and achieved during early adolescence, it may be more likely to be sustained over time.

The present findings suggest that selected intrapersonal factors may be beneficial targets for nutrition promotion initiatives aiming to improve dairy food consumption among socio-economically disadvantaged adolescents, with additional social factors supportive of frequent dairy food consumption among more advantaged adolescents. Few associations between predictors and frequent dairy consumption were moderated by SEP. While no past research exploring SEP as a moderator of associations between predictor variables and dairy consumption among adolescents has been reported, Lien *et al.*[53] similarly found no moderation by SEP when associations between predictor variables and fruit and vegetable consumption among adolescents was examined.

Predictors of dairy food intake have been identified in previous longitudinal research among adolescents from all SEP levels, e.g. parental intake of dairy food and being served milk at dinner at baseline each predicted adolescents' dairy food intake at follow-up[25]. In the present investigation, relatively few predictors of frequent dairy

food consumption were identified, suggesting that a number of other influences on dairy food consumption were not captured in the measures investigated. Other predictors, such as those investigated by Arcan and colleagues[25] (e.g. serving milk with dinner, parental intake of dairy foods), could be examined in future.

Strengths and limitations

Limitations of the present investigation should be acknowledged. FFQ were included in the YEP Study to gather information regarding dietary intakes rather than the use of food diaries or repeated 24 h recall methodologies, which pose substantial practical and economic burdens in large samples. While food diaries and repeated recalls have been shown to be more accurate in gathering dietary intake data, past research using FFQ has shown that this methodology is appropriate for ranking participants according to their dietary intakes and examining associations with predictors[54]. While the FFQ was relatively short, it was designed based on FFQ previously used among Australian adults[31]. While the FFQ did not include measures of portion size, frequency of consumption is a major determinant of intake[55]. FFQ have been used previously in adolescents[37,56,57]. However, previous FFQ developed for use in adolescent populations have included flavoured milk along with plain milk to calculate total milk consumption to reflect the eating habits of adolescents (e.g. the Youth/Adolescent Questionnaire developed by Rockett *et al.* in 1995[58]), hence providing a more accurate measure of dairy consumption. It should be noted that flavoured milk was not measured separately from plain milk consumption or from milk on cereal, and therefore could not be treated as a sweetened beverage in the present investigation. The dairy food items included in the present investigation did not distinguish between low-fat and full-fat foods. However, in a review of evidence to inform the revision of the Australian Dietary Guidelines, the body of research demonstrated increased intakes of dairy foods (of varying fat content) protected against disease[59].

The YEP Study had a relatively modest response rate; however, participants were sociodemographically diverse. As participants with complete data tended to have more favourable dietary habits than non-completers some bias may exist. Finally, as analyses could not be stratified by sex due to sample size constraints, sex differences in predictors of frequent consumption could not be determined, but models were adjusted for sex.

There are several strengths of the present investigation. Data were drawn from a large sample of socio-demographically diverse adolescents and as the YEP sample incorporated two age cohorts, adolescents across a wide age range were included in analyses. Social ecological theories were employed as the basis for a comprehensive model used to examine a range of factors associated with frequent consumption. Influences that support disadvantaged adolescents to eat healthily, such as those identified here, may be adopted more readily by families living in similar socio-economic contexts. Temporal associations between predictor variables and frequent consumption could be determined due to the longitudinal design. Statistical analysis considered co-linearity of predictors, covariates, baseline consumption frequency and adjusting for clustering by school. The present study is the first to identify a range of factors cross-sectionally and longitudinally associated with frequent dairy food consumption among adolescents, including those experiencing socio-economic disadvantage. Such factors could be employed in future nutrition promotion initiatives targeting all adolescents, but in particular disadvantaged adolescents who are at greater risk of consuming a poor diet.

Conclusions

While adolescents from all SEP levels were shown to consume amounts of dairy foods more in line with dietary recommendations, a proportion of disadvantaged adolescents managed to consume amounts of dairy foods more in line with dietary recommendations. Findings from the present investigation contribute to the evidence base by identifying factors supportive of a healthy diet among adolescents, but particularly among those experiencing socio-economic disadvantage. Nutrition promotion initiatives aimed at improving adolescent dairy consumption should employ multifactorial approaches informed by social ecological models and address socio-economic differences in influences on eating behaviours. Such messages include tailoring for disadvantaged adolescents; e.g. targeting those who are younger and female, as well as intrapersonal factors including promoting regular breakfast consumption. Among advantaged adolescents, intrapersonal factors include promoting regular consumption of breakfast and social factors include increasing friends' support of healthy eating, eating meals with others and adherence to family mealtime rules.

Acknowledgements

Acknowledgements: The authors gratefully acknowledge Dr Nick Andrianopoulos and Dr Gavin Abbott for statistical analysis advice. *Financial support:* The study was funded by the Australian Research Council (ID: DP0452044) and the William Buckland Foundation. S.A.M. is supported by an Australian Research Council Future Fellowship (FT100100581). K.B. is supported by a National Health and Medical Research Council Principal Research Fellowship (ID: 1042442). The Australian Research Council and the William Buckland Foundation had no role in the design, analysis or writing of this article. *Conflict of interest:* None. *Authorship:* D.C. and K.B. designed the research; D.C. and K.B. conducted the research; L.D.S. analysed the data; L.D.S., S.A.M., D.C. and K.B. wrote the paper; L.D.S.,

S.A.M., D.C. and K.B. had primary responsibility for final content; all authors read and approved the final manuscript. *Ethics of human subject participation:* This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by Deakin University's Ethics Committee, the Victorian Department of Education and Training, and the Catholic Education Office.

Supplementary material

To view supplementary material for this article, please visit http://dx.doi.org/10.1017/S1368980015000324

References

1. Astrup A (2014) Yogurt and dairy product consumption to prevent cardiometabolic diseases: epidemiologic and experimental studies. *Am J Clin Nutr* **99**, 5 Suppl., 1235S–1242S.
2. Rice BH (2014) Dairy and cardiovascular disease: a review of recent observational research. *Curr Nutr Rep* **3**, 130–138.
3. Weaver CM (2014) How sound is the science behind the dietary recommendations for dairy? *Am J Clin Nutr* **99**, 5 Suppl., 1217S–1222S.
4. Bel-Serrat S, Mouratidou T, Jimenez-Pavon D *et al.* (2014) Is dairy consumption associated with low cardiovascular disease risk in European adolescents? Results from the HELENA Study. *Pediatric Obes* **9**, 401–410.
5. Baird DL, Syrette J, Hendrie GA *et al.* (2012) Dairy food intake of Australian children and adolescents 2–16 years of age: 2007 Australian National Children's Nutrition and Physical Activity Survey. *Public Health Nutr* **15**, 2060–2073.
6. Diethelm K, Jankovic N, Moreno LA *et al.* (2012) Food intake of European adolescents in the light of different food-based dietary guidelines: results of the HELENA (Healthy Lifestyle in Europe by Nutrition in Adolescence) Study. *Public Health Nutr* **15**, 386–398.
7. Larson NI, Neumark-Sztainer D, Harnack L *et al.* (2009) Calcium and dairy intake: longitudinal trends during the transition to young adulthood and correlates of calcium intake. *J Nutr Educ Behav* **41**, 254–260.
8. Parker CE, Vivian WJ, Oddy WH *et al.* (2012) Changes in dairy food and nutrient intakes in Australian adolescents. *Nutrients* **4**, 1794–1811.
9. Nelson M, Erens B, Bates B *et al.* (2007) *Low Income Diet and Nutrition Survey*. vol. 2: *Food Consumption, Nutrient Intake*. Norwich: TSO.
10. Powell LM & Han E (2011) The costs of food at home and away from home and consumption patterns among US adolescents. *J Adolesc Health* **48**, 20–26.
11. Di Noia J & Thompson D (2012) Processes of change for increasing fruit and vegetable consumption among economically disadvantaged African American adolescents. *Eat Behav* **13**, 58–61.
12. Stephens LD, McNaughton SA, Crawford D *et al.* (2011) Correlates of dietary resilience among socioeconomically disadvantaged adolescents. *Eur J Clin Nutr* **65**, 1219–1232.
13. Ball K, Abbott G, Cleland V *et al.* (2012) Resilience to obesity among socioeconomically disadvantaged women: the READI study. *Int J Obes (Lond)* **36**, 855–865.
14. Rasmussen M, Krolner R, Klepp KI *et al.* (2006) Determinants of fruit and vegetable consumption among children and adolescents: a review of the literature. Part I: quantitative studies. *Int J Behav Nutr Phys Act* **3**, 22.
15. Bruening M, Eisenberg M, MacLehose R *et al.* (2012) Relationship between adolescents' and their friends' eating behaviors: breakfast, fruit, vegetable, whole-grain, and dairy intake. *J Acad Nutr Diet* **112**, 1608–1613.
16. Story M, Neumark-Sztainer D & French S (2002) Individual and environmental influences on adolescent eating behaviors. *J Am Diet Assoc* **102**, 3 Suppl., S40–S51.
17. Pearson N, Biddle SJ & Gorely T (2009) Family correlates of fruit and vegetable consumption in children and adolescents: a systematic review. *Public Health Nutr* **12**, 267–283.
18. Larson N, Laska MN, Story M *et al.* (2012) Predictors of fruit and vegetable intake in young adulthood. *J Acad Nutr Diet* **112**, 1216–1222.
19. deVet E, de Wit JB, Luszczynska A *et al.* (2013) Access to excess: how do adolescents deal with unhealthy foods in their environment? *Eur J Public Health* **23**, 752–756.
20. Laska MN, Hearst MO, Forsyth A *et al.* (2010) Neighbourhood food environments: are they associated with adolescent dietary intake, food purchases and weight status? *Public Health Nutr* **13**, 1757–1763.
21. Stephens LD, McNaughton SA, Crawford D *et al.* (2014) Longitudinal predictors of frequent vegetable and fruit consumption among socio-economically disadvantaged Australian adolescents. *Appetite* **78**, 165–171.
22. Stephens LD, McNaughton SA, Crawford D *et al.* (2014) Predictors of high-energy foods and beverages: a longitudinal study among socio-economically disadvantaged adolescents. *Public Health Nutr* **17**, 324–337.
23. Hanson NI, Neumark-Sztainer D, Eisenberg ME *et al.* (2005) Associations between parental report of the home food environment and adolescent intakes of fruits, vegetables and dairy foods. *Public Health Nutr* **8**, 77–85.
24. Larson NI, Story M, Wall M *et al.* (2006) Calcium and dairy intakes of adolescents are associated with their home environment, taste preferences, personal health beliefs, and meal patterns. *J Am Diet Assoc* **106**, 1816–1824.
25. Arcan C, Neumark-Sztainer D, Hannan P *et al.* (2007) Parental eating behaviours, home food environment and adolescent intakes of fruits, vegetables and dairy foods: longitudinal findings from Project EAT. *Public Health Nutr* **10**, 1257–1265.
26. Darmon N, Lacroix A, Muller L *et al.* (2014) Food price policies improve diet quality while increasing socioeconomic inequalities in nutrition. *Int J Behav Nutr Phys Act* **11**, 66.
27. Oldroyd J, Burns C, Lucas P *et al.* (2008) The effectiveness of nutrition interventions on dietary outcomes by relative social disadvantage: a systematic review. *J Epidemiol Community Health* **62**, 573–579.
28. Pearson N, MacFarlane A, Crawford D *et al.* (2009) Family circumstance and adolescent dietary behaviours. *Appetite* **52**, 668–674.
29. Pearson N, Ball K & Crawford D (2012) Parental influences on adolescent fruit consumption: the role of adolescent self-efficacy. *Health Educ Res* **27**, 14–23.
30. Nilsen SM, Krokstad S, Holmen TL *et al.* (2010) Adolescents' health-related dietary patterns by parental socio-economic position, the Nord-Trondelag Health Study (HUNT). *Eur J Public Health* **20**, 299–305.
31. Marks GC, Webb K, Rutishauser IHE *et al.* (2001) *Monitoring Food Habits in the Australian Population Using Short Questions*. Canberra: Commonwealth of Australia.
32. McLennan W & Podger A (1998) *National Nutrition Survey Users' Guide. Catalogue* no. 4801.0. Canberra: Australian Bureau of Statistics.
33. The Cancer Council of Victoria (2009) *Dietary Questionnaire for Epidemiological Studies (DQES v2) User Information Guide 2009*. Carlton: Cancer Epidemiology Centre, Nutritional Assessment Office, Cancer Council Victoria.
34. Di Noia J & Contento IR (2009) Use of a brief food frequency questionnaire for estimating daily number of

servings of fruits and vegetables in a minority adolescent population. *J Am Diet Assoc* **109**, 1785–1789.
35. Kvaavik E, Batty GD, Ursin G *et al.* (2010) Influence of individual and combined health behaviors on total and cause-specific mortality in men and women: the United Kingdom health and lifestyle survey. *Arch Intern Med* **170**, 711–718.
36. Smith A, Kellett E & Schmerlaib Y (1998) *The Australian Guide to Healthy Eating. Publication* no. N33. Canberra: Department of Health and Family Services.
37. Zhang CX, Chen YM, Chen WQ *et al.* (2012) Food group intake among adolescents in Guangzhou city compared with the Chinese dietary guidelines. *Asia Pac J Clin Nutr* **21**, 450–456.
38. National Health and Medical Research Council, Department of Health and Ageing (2013) *Australian Dietary Guidelines Summary. Publication* no. N55a. Canberra: National Health and Medical Research Council.
39. Bronfenbrenner U (1979) *The Ecology of Human Development: Experiments by Nature and Design*. Cambridge, MA: Harvard University Press.
40. Stokols D (1996) Translating social ecological theory into guidelines for community health promotion. *Am J Health Promot* **10**, 282–298.
41. DeVellis RF (2003) *Scale Development: Theory and Applications*, 2nd ed. Thousand Oaks, CA: SAGE Publications.
42. Shi Z, Lien N, Kumar BN *et al.* (2005) Socio-demographic differences in food habits and preferences of school adolescents in Jiangsu Province, China. *Eur J Clin Nutr* **59**, 1439–1448.
43. Kutner MH, Nachtsheim CJ, Neter J *et al.* (2005) *Applied Linear Statistical Models*, 5th ed. New York: McGraw-Hill Irwin.
44. Frazier PA, Tix AP & Barron KE (2004) Testing moderator and mediator effects in counseling psychology research. *J Couns Psychol* **51**, 115–134.
45. Nelson MC, Neumark-Sztainer D, Hannan PJ *et al.* (2009) Five-year longitudinal and secular shifts in adolescent beverage intake: findings from project EAT (Eating Among Teens)-II. *J Am Diet Assoc* **109**, 308–312.
46. Rangan AM, Kwan JS, Louie JC *et al.* (2011) Changes in core food intake among Australian children between 1995 and 2007. *Eur J Clin Nutr* **65**, 1201–1210.
47. Lytle LA, Seifert S, Greenstein J *et al.* (2000) How do children's eating patterns and food choices change over time? Results from a cohort study. *Am J Health Promot* **14**, 222–228.
48. Wiecha JL, Finkelstein D, Troped PJ *et al.* (2006) School vending machine use and fast-food restaurant use are associated with sugar-sweetened beverage intake in youth. *J Am Diet Assoc* **106**, 1624–1630.
49. Neumark-Sztainer D, Hannan PJ, Story M *et al.* (2003) Family meal patterns: associations with sociodemographic characteristics and improved dietary intake among adolescents. *J Am Diet Assoc* **103**, 317–322.
50. Hammons AJ & Fiese BH (2011) Is frequency of shared family meals related to the nutritional health of children and adolescents? *Pediatrics* **127**, e1565–e1574.
51. Verzeletti C, Maes L, Santinello M *et al.* (2010) Soft drink consumption in adolescence: associations with food-related lifestyles and family rules in Belgium Flanders and the Veneto Region of Italy. *Eur J Public Health* **20**, 312–317.
52. Kelder SH, Perry CL, Klepp KI *et al.* (1994) Longitudinal tracking of adolescent smoking, physical activity, and food choice behaviors. *Am J Public Health* **84**, 1121–1126.
53. Lien N, Lytle LA & Komro KA (2002) Applying theory of planned behavior to fruit and vegetable consumption of young adolescents. *Am J Health Promot* **16**, 189–197.
54. Van den Bulck J & Eggermont S (2006) Media use as a reason for meal skipping and fast eating in secondary school children. *J Hum Nutr Diet* **19**, 91–100.
55. Noethlings U, Hoffman K, Bergmann MM *et al.* (2003) Portion size adds limited information on variance in food intake of participants in the EPIC-Potsdam Study. *J Nutr* **133**, 510–515.
56. Neumark-Sztainer D, Story M, Hannan PJ *et al.* (2002) Overweight status and eating patterns among adolescents: where do youths stand in comparison with the healthy people 2010 objectives? *Am J Public Health* **92**, 844–851.
57. Kolodziejczyk JK, Merchant G & Norman GJ (2012) Reliability and validity of child/adolescent food frequency questionnaires that assess foods and/or food groups. *J Pediatr Gastroenterol Nutr* **55**, 4–13.
58. Rockett HR, Wolf AM & Colditz GA (1995) Development and reproducibility of a food frequency questionnaire to assess diets of older children and adolescents. *J Am Diet Assoc* **95**, 336–340.
59. Department of Health and Ageing, National Health and Medical Research Council (2011) *A Review of the Evidence to Address Targeted Questions to Inform the Revision of the Australian Dietary Guidelines. Publication* no. N55b. Canberra: National Health and Medical Research Council.