

Adolescent television viewing and unhealthy snack food consumption: the mediating role of home availability of unhealthy snack foods

Natalie Pearson^{1,2,*}, Stuart JH Biddle¹, Lauren Williams³, Anthony Worsley², David Crawford² and Kylie Ball²

¹School of Sport, Exercise & Health Sciences, Loughborough University, Loughborough, Leicestershire, LE11 3TU, UK; ²Centre for Physical Activity and Nutrition Research, School of Exercise and Nutrition Sciences, Deakin University, Burwood, Australia; ³Murdoch Children's Research Institute, Melbourne, Australia

Submitted 8 May 2012; Final revision received 14 September 2012; Accepted 29 October 2012; First published online 30 November 2012

Abstract

Objective: To examine whether home availability of energy-dense snack foods mediates the association between television (TV) viewing and energy-dense snack consumption among adolescents.

Design: Cross-sectional.

Setting: Secondary schools in Victoria, Australia.

Subjects: Adolescents (n 2984) from Years 7 and 9 of secondary school completed a web-based survey, between September 2004 and July 2005, assessing their energy-dense snack food consumption, school-day and weekend-day TV viewing and home availability of energy-dense snack foods.

Results: School-day and weekend-day TV viewing were positively associated with energy-dense snack consumption among adolescent boys ($\beta = 0.003$, $P < 0.001$) and girls ($\beta = 0.03$, $P < 0.001$). Furthermore, TV viewing (school day and weekend day) were positively associated with home availability of energy-dense snack foods among adolescent boys and girls and home availability of energy-dense snack foods was positively associated with energy-dense snack food consumption among boys ($\beta = 0.26$, $P < 0.001$) and girls ($\beta = 0.28$, $P < 0.001$). Home availability partly mediated the association between TV viewing and energy-dense snack consumption.

Conclusions: The results of the present study suggest that TV viewing has a significant role to play in adolescent unhealthy eating behaviours. Future research should assess the efficacy of methods to reduce adolescent energy-dense snack food consumption by targeting parents to reduce home availability of energy-dense foods and by reducing TV viewing behaviours of adolescents.

Keywords

Television viewing
Energy-dense snack foods
Mediation
Home availability
Adolescents

The prevalence of adolescent obesity has increased dramatically over the past three decades⁽¹⁾ and even though preliminary evidence suggests a slowing in such trends⁽²⁾, recent data show that approximately one in five adolescents in Western countries is obese^(3–5). Obesity during adolescence is of particular concern due to the immediate and long-term negative health and psychological effects, including an increased incidence of cardiovascular risk factors, adult obesity, obesity-related co-morbidities, low self-esteem and reduced health-related quality of life^(6,7). Central in the development of adolescent obesity is eating behaviour⁽⁸⁾. Several studies have shown an association between consumption of energy-dense foods and excessive weight in young people^(9,10). Despite such associations, studies have consistently shown that adolescents as a group have unhealthy and sometimes erratic eating habits^(11,12),

characterised by snacking on energy-dense foods, including those high in fat, sugar and salt^(13–15).

Television (TV) viewing is the most prevalent leisure-time activity among young people in Western countries^(16–18), with many adolescents far exceeding the recommendations of <2 h of TV viewing daily. Data from the USA suggest that adolescents are engaged in screen media for over 7.5 h/d, with most of this devoted to TV viewing⁽¹⁸⁾. Adolescents who spend large amounts of time watching TV are at particular risk of unhealthy eating behaviours⁽¹⁹⁾. For example, TV viewing has been associated with increased meal frequency and food intake^(20,21) and more specifically, it is positively associated with energy intake and consumption of energy-dense foods and beverages, and negatively associated with consumption of fruit, vegetables and fibre^(19,21). Variations in eating behaviours according to

*Corresponding author: Email n.l.pearson@lboro.ac.uk

TV viewing are of particular concern as they could parallel other negative health consequences of excessive TV viewing⁽²²⁾ and they may represent a pathway by which TV viewing may lead to poorer health. However, little is known about the potential mechanisms by which TV viewing is associated with unhealthy eating behaviours among adolescents.

A potential explanation for the association between TV viewing and eating behaviours among adolescents stems from the existing literature on the determinants of dietary behaviour. There is evidence that home availability of unhealthy foods (e.g. energy-dense snack foods) is associated with unhealthy eating behaviours, including lower fruit and vegetable consumption⁽²³⁾ and higher consumption of energy-dense snack foods and drinks^(24,25). Furthermore, it is plausible that TV viewing could be associated with home availability of particular foods. For example, while watching TV, adolescents are exposed to many advertisements about food^(26,27); TV is the largest single media source of messages about food⁽²⁸⁾ and predominantly these advertised foods are high in sugar and fat^(29,30). Furthermore, several studies have shown that young people's TV viewing is associated with food preferences, requests to purchase foods and drinks advertised, parental willingness to purchase these products and the availability of these food items in the home^(31–36). To our knowledge, however, no studies have examined whether home availability of energy-dense snack foods mediates the association between TV viewing and consumption of energy-dense snack foods among adolescents. Understanding the mediators of the associations between TV viewing and consumption of energy-dense snack food in adolescents is important to inform the development of nutrition promotion interventions.

The present study therefore aimed to examine: (i) the associations between adolescent TV viewing and frequency of consumption of energy-dense snack foods; (ii) the association between adolescent TV viewing and perceived home availability of energy-dense snack foods; and (iii) whether associations between adolescent TV viewing and energy-dense snack food consumption are mediated (explained) by perceived home availability of energy-dense snack foods.

Methods

Study procedure

As part of a cohort study investigating dietary habits among adolescents in Melbourne, Australia, adolescents were administered self-completion questionnaires between September 2004 and July 2005. Study procedures were approved by the Ethics Committee of Deakin University, the Victorian Department of Education and Training, and the Catholic Education Office. Survey participant

recruitment and study procedures have been provided in previous publications^(37,38). In brief, all co-educational state (government) and Catholic secondary schools (Years 7–12) with enrolments over 200, located in the southern metropolitan region of Melbourne and the non-metropolitan region of Gippsland, to the east of Melbourne, were invited to participate in the study. Of the seventy schools (forty-seven metropolitan and twenty-three non-metropolitan) that met these criteria, thirty-seven schools (twenty metropolitan and seventeen non-metropolitan) agreed to participate.

Participants

All students (*n* 9842) from Year 7 (aged 12–13 years) and Year 9 (aged 14–15 years) from participating schools were invited to participate. Teachers distributed parental consent forms via students. Parental consent was obtained for 4502 (46%) of all eligible students. Due to absence from school on the day of testing, teachers administered an online food habits survey to 3264 adolescents during class time when they had access to computers. The present analyses are based on the subset of 2984 (30%) adolescents who had non-missing data for all of the variables examined in the present study.

Measures

Adolescent consumption of energy-dense snack foods

Consistent with other large-scale studies of dietary intake and eating behaviours of adolescents⁽³⁹⁾, food intake was assessed using a brief FFQ. This FFQ was based on previously validated indices of food intake⁽⁴⁰⁾ and is described in detail in previous publications^(37,38). Respondents indicated how frequently they had consumed thirty-seven food items during the previous month. The seven response categories ranged from 'never or not in the last month' to 'several times a day'. The present analyses are based on a subset of three items from the FFQ: confectionery (e.g. chocolates and lollies/sweets), sweet biscuits/cookies and potato crisps/salty snacks. The frequency of consumption of the three items in the past month was converted to a daily equivalent, which is an established method⁽⁴¹⁾ that has been used in other dietary studies^(39,42). A daily equivalent score for the three items was calculated as follows: 'not in the last month' = 0.00, 'several times per month' = 0.11, 'once a week' = 0.14, 'a few times a week' = 0.36, 'on most days' = 0.71, 'once per day' = 1.00 and 'several times per day' = 2.50. The daily equivalents of the three items were then summed to create a daily estimate of energy-dense snack food consumption.

Adolescent television viewing

Adolescents reported how much time (hours/minutes) they usually spend watching TV/DVD/movies on a typical school day (Monday to Friday), which was converted to min/d. Adolescents reported how much time (hours/minutes) they usually spend watching TV/DVD/movies on

a typical Saturday and Sunday. The latter were converted to min/d, summed and divided by two to create average viewing on a weekend day.

Home availability

Perceived availability of different foods within the home environment was assessed with items adapted from Project EAT (Eating Among Teens)⁽³⁹⁾. Respondents were asked how frequently (ranging from 1 = 'never/rarely' to 4 = 'always') the following items were available within the home: cakes or sweet biscuits; potato crisps or salty snacks; chocolate or lollies. The frequency of home availability of energy-dense snack food items was summed (Cronbach's $\alpha = 0.80$).

Statistical analysis

All analyses were conducted using the statistical software package Stata 11. Descriptive statistics including frequencies, means and standard deviations were calculated for all study variables according to gender and year level of adolescent participants.

First, linear regression analyses were used to examine associations between adolescent TV viewing and energy-dense snack consumption, between TV viewing and perceived home availability of energy-dense snack foods, and between perceived home availability of energy-dense snack foods and adolescent energy-dense snack food consumption. Second, as suggested by Cerin *et al.*⁽⁴³⁾, the mediating effects of home availability on the association between TV viewing and adolescent energy-dense snack food consumption were assessed using the Freedman–Schatzkin test of mediation⁽⁴⁴⁾. The Freedman–Schatzkin test is based on the difference in the unstandardised regression coefficients for the association between an independent variable (e.g. TV viewing) and a dependent variable (adolescent energy-dense snack consumption), unadjusted (τ) and adjusted (τ')

for the proposed mediator(s). The significance of the mediating effect is computed by dividing this difference ($\tau - \tau'$) by its standard error and comparing the obtained value with a *t* distribution with $n - 2$ degrees of freedom. R^2 was used to provide an indication of the proportion of variance in energy-dense snack consumption accounted for by each model. All regression models were adjusted for year level of the adolescents and accounted for potential clustering by school (unit of analyses) using the 'cluster' command.

Results

Slightly more of the adolescent sample were girls (53%) and in Year 7 of secondary school (61%). Table 1 displays the means and standard deviations of the study variables for the total sample and according to gender and year level. Several small but significant differences were found. Boys reported higher frequency of home availability of energy-dense foods and reported watching more TV on a weekend day compared with girls. Adolescents in Year 9 reported higher frequency of home availability of energy-dense foods and reported watching more TV on a school day and on a weekend day compared with adolescents in Year 7. All further analyses were stratified by gender, adjusted for year level and accounted for potential clustering by school (unit of analyses).

School-day and weekend-day TV viewing were significantly associated with energy-dense snack consumption (τ in Table 2). TV viewing accounted for 5% (school day) and 4% (weekend day) of the variance in energy-dense snack consumption among boys and 5% (school day and weekend day) of the variance in consumption of energy-dense snacks among girls. Linear regression analyses revealed that school-day and weekend-day TV

Table 1 Description of outcome, mediating and predictor variables according to gender and year level of Australian adolescent participants in 2004–2005

	Gender									
	Total sample (<i>n</i> 2984)		Boys (<i>n</i> 1390)		Girls (<i>n</i> 1594)		Year level			
	Mean	SD	Mean	SD	Mean	SD	Year 7 (<i>n</i> 1811)		Year 9 (<i>n</i> 1173)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
School region (%)										
Metropolitan	67.2		69.2		65.5*		67.7		66.4	
Rural	32.8		30.8		34.5		32.3		33.6	
Outcome variables										
Energy-dense snacks (range: 0–7.5/d)	1.13	1.26	1.15	1.34	1.19	1.19	1.14	1.29	1.10	1.22
Potential mediating variables										
Home availability of energy-dense snacks (range: 3–12)	7.53	1.99	7.63	2.06	7.45*	1.92	7.44	1.95	7.68*	2.04
Predictor variables										
School-day TV viewing (min/d)	134.27	88.32	135.54	91.19	133.16	85.76	131.65	89.39	138.31*	86.52
Weekend-day TV viewing (min/d)	137.65	84.26	146.01	86.61	130.36***	81.49	134.80	84.99	142.05*	82.97

TV, television.

Chi-squared tests (for school region) and independent *t* tests (for all continuous variables) examining differences in means by adolescent gender and year level: * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

Table 2 Effects of adjustment for perceived home availability of energy-dense snack foods on the association between TV viewing and adolescent energy-dense snack consumption among Australian adolescents in 2004–2005 (*n* 2984)

	τ	SE	τ'	SE	$\tau - \tau'$	SE	<i>t</i>	<i>P</i> value	<i>R</i> ²
Adolescent boys (<i>n</i> 1390)									
School-day TV viewing	0.003***	0.0004	0.002***	0.0003	0.001	0.0000025	7.94	<0.0001	0.19
Weekend-day TV viewing	0.003***	0.0005	0.001***	0.0004	0.002	0.0000041	13.58	<0.0001	0.18
Adolescent girls (<i>n</i> 1594)									
School-day TV viewing	0.003***	0.0003	0.001***	0.0003	0.002	0.0000011	9.87	<0.0001	0.23
Weekend-day TV viewing	0.003***	0.0005	0.001***	0.0003	0.002	0.0000034	9.06	<0.0001	0.22

TV, television.

τ , unstandardised regression coefficient for association between TV viewing and adolescent energy-dense snack food consumption, adjusting for school year and accounting for potential clustering by school (unit of analyses) using the 'cluster' command, before adjustment for mediator; τ' , unstandardised regression coefficient for association between TV viewing and adolescent energy-dense snack food consumption, adjusting for year level and accounting for potential clustering by school (unit of analyses) using the 'cluster' command and mediator (perceived home availability of energy-dense snack foods); $\tau - \tau'$, difference between the two regression coefficients, which when divided by its SE, can be compared with a *t* distribution with *n* - 2 degrees of freedom.

Significance of the association: ****P* < 0.001.

Table 3 Associations between TV viewing and home availability of energy-dense snacks (potential mediator) among Australian adolescent boy and girls in 2004–2005

	Home availability of energy-dense snacks			
	Boys (<i>n</i> 1390)		Girls (<i>n</i> 1594)	
	β	95% CI	β	95% CI
School-day TV viewing	0.005***	0.004, 0.006	0.004***	0.003, 0.005
Weekend-day TV viewing	0.005***	0.004, 0.007	0.006***	0.004, 0.007

TV, television.

Linear regression analyses, controlling for year level and accounting for potential clustering by school (unit of analyses) using the 'cluster' command.

Significance of the association: ****P* < 0.001.

viewing were positively associated with perceived home availability of energy-dense snack foods among adolescent boys and girls (Table 3). Further linear regression analyses revealed that perceived home availability of energy-dense snack foods was positively associated with consumption of energy-dense snack foods among adolescent boys ($\beta = 0.26$; 95% CI 0.22, 0.31; *P* < 0.001) and girls ($\beta = 0.28$; 95% CI 0.24, 0.33; *P* < 0.001).

Table 2 shows the mediating effects of perceived home availability of energy-dense snack foods on the association between school-day and weekend-day TV viewing and adolescent energy-dense snack consumption among adolescent boys and girls. When perceived home availability was added to each model predicting energy-dense snack consumption by TV viewing (i.e. separately for school day and weekend day), the β value for the association between TV viewing and energy-dense snack consumption was significantly decreased for both boys and girls. However, the association between TV viewing and energy-dense snack consumption remained significant (*P* < 0.001) in all models. This suggests that perceived home availability partly mediates the association between TV viewing and energy-dense snack consumption. The proportion of variance in energy-dense snack consumption explained by TV viewing increased when perceived home availability was added to each model (see Table 2).

Discussion

Recent reviews have identified an association between TV viewing and unhealthy eating among adolescents^(19,21); however, little is known about potential mechanisms in the home environment that underpin the association between TV viewing and unhealthy eating. The present study is one of the first to examine both the direct and indirect associations between TV viewing and energy-dense snack food consumption. The results of the present study show that both school-day and weekend-day TV viewing were positively associated with home availability of energy-dense snack foods and energy-dense snack food consumption. Furthermore, associations between TV viewing and energy-dense snack food consumption were partially mediated by home availability of energy-dense snack foods. Acknowledging the cross-sectional study design, our findings give weight to the likely importance of addressing TV viewing behaviours, as well as home availability of foods, in interventions aimed at promoting healthy eating among adolescents.

Sedentary behaviour has become a significant issue in public health over the past decade, both for adults⁽⁴⁵⁾ and young people⁽⁴⁶⁾. Operationally defined as 'sitting time', sedentary behaviour has often been assessed in respect of screen time and especially time watching TV. However, while research has shown there to be consistent links between TV viewing and unhealthy weight status in

young people, associations are often quite small⁽⁴⁷⁾. This may be due to several factors, including little or no association between TV viewing and moderate-to-vigorous physical activity⁽⁴⁷⁾, except for some periods of the day, such as immediately after school⁽⁴⁸⁾, as well as the presence of coexisting behaviours such as diet. TV viewing has been shown to coexist with unhealthy eating behaviours⁽¹⁹⁾. It may be diet as well as time being sedentary watching TV that accounts for indicators of poor health, including weight status. Our findings support the view that TV viewing in young people is associated with energy-dense snack food consumption. Although only 4–5% of the variance is explained by this association, this is likely to be highly meaningful in terms of weight status. As argued by Hill⁽⁴⁹⁾, ‘small changes’ to lifestyle may have significant health effects. This is likely to be true in the context of highly frequent, repeated behaviours such as TV and snacking.

The present study showed that perceived home availability of energy-dense snacks was positively associated with adolescent energy-dense snack consumption. Such findings add to previous research highlighting the important role of food availability within the home^(24,50). It has long been known from behaviour modification studies that environmental manipulation, such as food visibility and availability, can have potent effects on behaviour⁽⁵¹⁾. Simple strategies, such as reductions in purchase of energy-dense foods, their concealment in the home or family rules about frequency and location of their consumption, may be helpful. The present study also showed that TV viewing was positively associated with home availability of energy-dense snacks. Such findings corroborate previous research showing that while young people are watching TV they are exposed to numerous advertisements about food (usually unhealthy)⁽²⁶⁾ and that this translates into young people’s food preferences, requests to purchase foods and drinks advertised, parental willingness to purchase these products and the availability of these food items in the home^(31–35). In addition, the present study demonstrated that the perceived availability of energy-dense snack foods in the home partially accounts for the association between TV viewing and energy-dense snack food consumption. Such findings suggest that home availability of energy-dense foods could potentially be influenced by targeting reductions in TV viewing, which could also result in reductions in energy-dense snack food consumption. The involvement of parents and targeting the home environment are likely to be particularly important in such efforts.

Alternative explanations for several of the present findings are possible. That is, adolescents watching more TV may have been consuming more of all sorts of snacks, including healthy snacks. It is also possible that TV viewers consumed more energy-dense snacks because they had less access to fruits and vegetables in the home.

To test these possibilities we conducted additional analyses. In the additional analyses, we examined associations of TV viewing with perceived home availability of fruit and vegetables. Results showed negative associations between TV viewing and fruit and vegetable availability, but these were of very small magnitude ($B = -0.002$ for boys and -0.001 for girls). Further, there were no associations between TV viewing and fruit/vegetable consumption for either boys ($B < -0.001$) or girls ($B < -0.001$). Therefore it appears unlikely that TV viewers are consuming more of all sorts of snacks; or that the increased consumption of energy-dense snacks among those viewing more TV is strongly attributable to lower availability of fruits and vegetables in the home.

In considering these findings it is important to acknowledge the limitations of the study. The reach of the whole study was modest (46%); however, this is comparable to other large-scale longitudinal studies. All data were collected by self-report and are subject to socially desirable response bias or other misreporting. The cross-sectional study design does not permit causal inferences to be drawn; potentially a third unmeasured variable could account for the associations observed. Strengths of the study include the large regionally diverse sample of adolescents and parents, and the use of powerful statistical mediation techniques.

Conclusions

The results of the present study suggest that TV viewing has a significant role to play in adolescent unhealthy eating behaviours. Future research should assess the efficacy of methods to reduce adolescent energy-dense snack food consumption by targeting parents to reduce home availability of energy-dense foods and by reducing TV viewing behaviours of adolescents.

Acknowledgements

Sources of funding: This work was supported by the Australia Research Council (DP0452044), the William Buckland Foundation, a National Medical Research Council Senior Research Fellowship (479513) to K.B. and a VicHealth Senior Public Health Research Fellowship to D.C. *Conflicts of interest:* There are no conflicts of interest. *Authors’ contributions:* N.P. carried out the statistical analyses and drafted the paper. S.J.H.B. and L.W. contributed to the drafting of the paper. K.B., D.C. and A.W. were involved in the design and conduct of the study and contributed to the drafting of the paper. All authors read and approved the final manuscript.

References

1. Han JC, Lawlor DA & Kimm SYS (2010) Childhood obesity. *Lancet* **375**, 1737–1748.

2. Olds T, Maher C, Zumin S *et al.* (2011) Evidence that the prevalence of childhood overweight is plateauing: data from nine countries. *Int J Pediatr Obes* **6**, 342–360.
3. Australian Bureau of Statistics (2009) *National Health Survey: Summary of Results, 2007–2008*. Canberra: ABS.
4. Ogden CL, Carroll MD, Curtin LR *et al.* (2010) Prevalence of high body mass index in US children and adolescents, 2007–2008. *JAMA* **303**, 242–249.
5. The Information Centre (2009) Statistics on obesity, physical activity and diet: England, February 2009. <http://www.ic.nhs.uk/> (accessed April 2009).
6. Tsiros MD, Coates AM, Howe PR *et al.* (2011) Obesity: the new childhood disability? *Obes Rev* **12**, 26–36.
7. Nadeau KJ, Maahs DM, Daniels SR *et al.* (2011) Childhood obesity and cardiovascular disease: links and prevention strategies. *Nat Rev Cardiol* **8**, 513–525.
8. Affenito SG, Franko DL, Striegel-Moore RH *et al.* (2012) Behavioral determinants of obesity: research findings and policy implications. *J Obes* **2012**, 150732.
9. Guyenet SJ & Schwartz MW (2012) Regulation of food intake, energy balance, and body fat mass: implications for the pathogenesis and treatment of obesity. *J Clin Endocrinol Metab* **97**, 745–755.
10. Du H & Feskens E (2010) Dietary determinants of obesity. *Acta Cardiol* **65**, 377–386.
11. Dwyer JT, Evans M, Stone EJ *et al.* (2001) Adolescents' eating patterns influence their nutrient intakes. *J Am Diet Assoc* **101**, 798–802.
12. 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.
13. Linde JA, Wall MM, Haines J *et al.* (2009) Predictors of initiation and persistence of unhealthy weight control behaviours in adolescents. *Int J Behav Nutr Phys Act* **6**, 72.
14. Australian Bureau of Statistics (2007) *2004–2005 National Health Survey: Summary of Results, Australia*. Canberra: ABS.
15. Currie C, Robert C, Morgan A *et al.* (editors) (2004) *Young People's Health in Context. Health Behaviour in School-aged Children (HBSC): International Report from the 2001/2002 Survey. Health Policy for Children and Adolescents no. 4*. Copenhagen: WHO Regional Office for Europe.
16. Office for National Statistics (2006) *The Time Use Survey, 2005. How We Spend Our Time*. London: ONS.
17. Australian Bureau of Statistics (2008) *How Australians Use Their Time, 2006*. Canberra: ABS.
18. Rideout VJ, Foehr UG & Roberts DF (2010) *Generation M²: Media in the Lives of 8- to 18-Year Olds. A Kaiser Family Foundation Study*. Menlo Park, CA: The Henry J. Kaiser Family Foundation.
19. Pearson N & Biddle SJ (2011) Sedentary behavior and dietary intake in children, adolescents, and adults: a systematic review. *Am J Prev Med* **41**, 178–188.
20. Sonnevile KR & Gortmaker SL (2008) Total energy intake, adolescent discretionary behaviors and the energy gap. *Int J Obes (Lond)* **32**, Suppl. 6, S19–S27.
21. Chaput JP, Klingenberg L, Astrup A *et al.* (2011) Modern sedentary activities promote overconsumption of food in our current obesogenic environment. *Obes Rev* **12**, e12–e20.
22. Salmon J, Tremblay MS, Marshall SJ *et al.* (2011) Health risks, correlates, and interventions to reduce sedentary behavior in young people. *Am J Prev Med* **41**, 197–206.
23. Ding D, Sallis JF, Norman GJ *et al.* (2012) Community food environment, home food environment, and fruit and vegetable intake of children and adolescents. *J Nutr Educ Behav* **44**, 634–638.
24. Ezendam NP, Evans AE, Stigler MH *et al.* (2010) Cognitive and home environmental predictors of change in sugar-sweetened beverage consumption among adolescents. *Br J Nutr* **103**, 768–774.
25. Campbell KJ, Crawford DA, Salmon J *et al.* (2007) Associations between the home food environment and obesity-promoting eating behaviors in adolescence. *Obesity (Silver Spring)* **15**, 719–730.
26. Kelly B, Chapman K, King L *et al.* (2011) Trends in food advertising to children on free-to-air television in Australia. *Aust N Z J Public Health* **35**, 131–134.
27. Powell LM, Szczypka G & Chaloupka FJ (2010) Trends in exposure to television food advertisements among children and adolescents in the United States. *Arch Pediatr Adolesc Med* **164**, 794–802.
28. Marquis M (2004) Strategies for influencing parental decisions on food purchasing. *J Consum Mark* **21**, 134–143.
29. Adams J, Tyrrell R, Adamson AJ *et al.* (2012) Effect of restrictions on television food advertising to children on exposure to advertisements for 'less healthy' foods: repeat cross-sectional study. *PLoS One* **7**, e31578.
30. British Heart Foundation (2008) *How Parents Are Being Misled. A Campaign Report on Children's Food Marketing*. London: BHF.
31. Chamberlain IJ, Wang Y & Robinson TN (2006) Does children's screen time predict requests for advertised products?: cross-sectional and prospective analyses. *Arch Pediatr Adolesc Med* **160**, 363–368.
32. Hastings G, Stead M, McDermott L *et al.* (2003) *Review of Research on the Effects of Food Promotion to Children. Final Report Prepared for the Food Standards Agency*. Glasgow: University of Strathclyde, Centre for Social Marketing.
33. Galst JP & White MA (1976) The unhealthy persuader: the reinforcing value of television and children's purchase-influencing attempts at the supermarket. *Child Dev* **47**, 1089–1096.
34. Young B & Hetherington M (1996) The literature on advertising and children's food choice. *Food Sci Nutr* **5**, 15–18.
35. Coon KA & Tucker KL (2002) Television and children's consumption patterns. A review of the literature. *Minerva Pediatr* **54**, 423–436.
36. Boyland EJ, Harrold JA, Kirkham TC *et al.* (2011) Food commercials increase preference for energy-dense foods, particularly in children who watch more television. *Pediatrics* **128**, e93–e100.
37. MacFarlane A, Crawford D, Ball K *et al.* (2007) Adolescent home food environments and socioeconomic position. *Asia Pac J Clin Nutr* **16**, 748–756.
38. Savige GS, Ball K, Worsley A *et al.* (2007) Food intake patterns among Australian adolescents. *Asia Pac J Clin Nutr* **16**, 738–747.
39. Neumark-Sztainer D, Wall M, Perry C *et al.* (2003) Correlates of fruit and vegetable intake among adolescents. Findings from project EAT. *Prev Med* **37**, 198–208.
40. Marks GC, Webb K, Rutishauser IHE *et al.* (2001) *Monitoring Food Habits in the Australian Population Using Short Questions*. Canberra: Commonwealth of Australia.
41. Willett W (1998) *Nutritional Epidemiology*. New York: Oxford University Press.
42. Mishra G, Ball K, Arbuckle J *et al.* (2002) Dietary patterns of Australian adults and their association with socioeconomic status: results from the 1995 National Nutrition Survey. *Eur J Clin Nutr* **56**, 687–693.
43. Cerin E, Taylor LM, Leslie E *et al.* (2006) Small-scale randomised controlled trials need more powerful methods of mediational analysis than the Baron–Kenny method. *J Clin Epidemiol* **59**, 457–464.
44. Freedman L & Schatzkin A (1992) Sample size for studying intermediate endpoints within intervention trials of observational studies. *Am J Epidemiol* **136**, 1148–1159.

45. Owen N, Healy GN, Matthews CE *et al.* (2010) Too much sitting: the population health science of sedentary behavior. *Exerc Sport Sci Rev* **38**, 105–113.
46. Tremblay MS, Leblanc AG, Kho ME *et al.* (2011) Systematic review of sedentary behaviour and health indicators in school-aged children and youth. *Int J Behav Nutr Phys Act* **8**, 98.
47. Marshall SJ, Biddle SJ, Gorely T *et al.* (2004) Relationships between media use, body fatness and physical activity in children and youth: a meta-analysis. *Int J Obes Relat Metab Disord* **28**, 1238–1246.
48. Atkin AJ, Gorely T, Biddle SJ *et al.* (2008) Critical hours: physical activity and sedentary behavior of adolescents after school. *Pediatr Exerc Sci* **20**, 446–456.
49. Hill JO (2006) Understanding and addressing the epidemic of obesity: an energy balance perspective. *Endocr Rev* **27**, 750–761.
50. Pearson N, Ball K & Crawford D (2011) Predictors of changes in adolescents' consumption of fruits, vegetables and energy-dense snacks. *Br J Nutr* **105**, 795–803.
51. Mahoney MJ & Mahoney K (1976) *Permanent Weight Control*. New York: Norton.