

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

3

4 **Abstract**

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

8 Design: Cross-sectional.

9 Setting: Secondary schools in Victoria, Australia.

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

14 Results: School day and weekend day TV viewing were positively associated with energy-
15 dense snack consumption among adolescent boys ($\beta=0.003$, $p<0.001$) and girls ($\beta=0.03$,
16 $p<0.001$). Furthermore, TV viewing (school and weekend day) were positively associated
17 with home availability of energy-dense snack foods among adolescent boys and girls and
18 home availability of energy-dense snack foods was positively associated with energy-dense
19 snack food consumption among boys ($\beta=0.26$, $p<0.001$) and girls ($\beta=0.28$, $p<0.001$). Home
20 availability partly mediated the association between TV viewing and energy-dense snack
21 consumption.

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

27

28

29 **Introduction**

30 The prevalence of adolescent obesity has dramatically increased over the past three decades ¹,
31 and even though preliminary evidence suggests a slowing in such trends ², recent data show
32 that approximately one in five adolescents in Western countries are obese ³⁻⁵. Obesity during
33 adolescence is of particular concern due to the immediate and long-term negative health and
34 psychological effects, including an increased incidence of cardiovascular risk factors, adult
35 obesity, obesity-related comorbidities, low self-esteem and reduced health-related quality of
36 life ^{6,7}. Central in the development of adolescent obesity is eating behaviour ⁸. Several
37 studies have shown an association between consumption of energy-dense foods and excessive
38 weight in young people ^{9,10}. Despite such associations, studies have consistently shown that
39 adolescents as a group have unhealthy and sometimes erratic eating habits ^{11,12}, characterised
40 by snacking on energy-dense foods, including those high in fat, sugar and salt ¹³⁻¹⁵.

41
42 Television viewing is the most prevalent leisure-time activity among young people in Western
43 countries ¹⁶⁻¹⁸, with many adolescents far exceeding the recommendations of less than 2 hours
44 a day of television viewing. Data from the US suggests that adolescents are spending over 7.5
45 hours a day engaged in screen media with most of this devoted to TV viewing ¹⁸. Adolescents
46 who spend large amounts of time watching television are at particular risk of unhealthy eating
47 behaviours ¹⁹. For example, television viewing has been associated with increased meal
48 frequency and food intake ^{20,21}, and more specifically, is positively associated with energy-
49 intake, consumption of energy-dense foods and beverages, and negatively associated with
50 consumption of fruit, vegetables and fibre ^{19,21}. Variations in eating behaviours according to
51 television viewing are of particular concern as they could parallel other negative health
52 consequences of excessive television viewing ²², and they may represent a pathway by which
53 television viewing may lead to poorer health. However, little is known about the potential
54 mechanisms by which television viewing is associated with unhealthy eating behaviours
55 amongst adolescents.

56
57 A potential explanation for the association between television viewing and eating behaviours
58 among adolescents stems from the existing literature on the determinants of dietary
59 behaviour. There is evidence that home availability of unhealthy foods (e.g. energy-dense
60 snack foods) is associated with unhealthy eating behaviours, including lower fruit and

61 vegetable consumption²³ and higher consumption of energy-dense snack foods and drinks²⁴,
62 ²⁵. Furthermore, it is plausible that television viewing could be associated with home
63 availability of particular foods. For example, while watching television, adolescent are
64 exposed to many advertisements about food^{26,27} (television is the largest single media source
65 of messages about food²⁸), and these advertised foods are predominantly high in sugar and fat
66 ^{29,30}. Furthermore, several studies have shown that young people's television viewing is
67 associated with food preferences, requests to purchase foods and drinks advertised, parental
68 willingness to purchase these products, and the availability of these food items in the home³¹⁻
69 ³⁶. To our knowledge, however, no studies have examined whether home availability of
70 energy-dense snack foods mediates the association between television viewing and
71 consumption of energy-dense snack foods among adolescents. Understanding the mediators
72 of the associations between television viewing and consumption of energy-dense snack food
73 in adolescents is important to inform the development of nutrition promotion interventions.

74

75 This study aimed to (i) examine the associations between adolescent television viewing and
76 frequency of consumption of energy-dense snack foods; (ii) examine the association between
77 adolescent television viewing and perceived home availability of energy-dense snack foods;
78 and (iii) to examine whether associations between adolescent television viewing and energy-
79 dense snack food consumption are mediated (explained) by perceived home availability of
80 energy-dense snack foods.

81

82 **Methods**

83 *Study procedure*

84 As part of a cohort study investigating dietary habits among adolescents in Melbourne,
85 Australia, adolescents were administered self-completion questionnaires between September
86 2004 and July 2005. Study procedures were approved by the Ethics Committee of Deakin
87 University, the Victorian Department of Education and Training, and the Catholic Education
88 Office. Survey participant recruitment and study procedures have been provided in previous
89 publications^{37,38}. In brief, all co-educational state (government) and Catholic secondary
90 schools (years 7 to 12) with enrolments over 200, located in the southern metropolitan region
91 of Melbourne and the non-metropolitan region of Gippsland, to the east of Melbourne, were

92 invited to participate in the study. Of the 70 schools (47 metropolitan and 23 non-
93 metropolitan) that met these criteria, 37 schools (20 metropolitan and 17 non-metropolitan)
94 agreed to participate.

95

96 *Participants*

97 All students (n = 9,842) from year 7 (aged 12-13 years) and year 9 (aged 14-15 years) from
98 participating schools were invited to participate. Teachers distributed parental consent forms
99 via students. Parental consent was obtained for 4,502 (46%) of all eligible students. Due to
100 absence from school on the day of testing, teachers administered an online food habits survey
101 to 3,264 adolescents during class time when they had access to computers. The present
102 analyses are based on the subset of 2,984 (30%) adolescents who had non-missing data for all
103 of the variables examined in this study.

104 *Measures*

105 *Adolescent consumption of energy-dense snack foods*

106 Consistent with other large-scale studies of dietary intake and eating behaviours of
107 adolescents³⁹, food intake was assessed using a brief food frequency questionnaire (FFQ).
108 This FFQ was based on previously validated indices of food intake⁴⁰ and is described in
109 detail in previous publications^{37, 38}. Respondents indicated how frequently they had
110 consumed 37 food items during the previous month. Seven response categories ranged from
111 'never or not in the last month' to 'several times a day'. The present analyses are based on a
112 subset of three items from the FFQ: confectionery (e.g. chocolates and lollies/sweets), sweet
113 biscuits/cookies, and potato crisps/salty snacks. The frequency of consumption of the three
114 items in the past month was converted to a daily equivalent, which is an established method⁴¹
115 that has been used in other dietary studies^{39, 42}. A daily equivalent score for the three items
116 was calculated as follows: not in the last month (0.00 per day), several times per month (0.11
117 per day), once a week (0.14 per day), a few times a week (0.36 per day), on most days (0.71
118 per day), once per day (1.00 per day) and several times per day (2.50 per day). The daily
119 equivalents of the three items were then summed to create a daily estimate of energy-dense
120 snack food consumption.

121

122

123 *Adolescent television viewing*

124 Adolescents reported how much time (hours/minutes) they usually spend watching
125 television/DVDs/movies on a typical school day (Monday to Friday), which was converted to
126 minutes/day. Adolescents reported how much time (hours/minutes) they usually spent
127 watching television/DVD/movies on a typical Saturday and Sunday. The latter were
128 converted to minutes/day, summed and divided by two to create average viewing on a
129 weekend day.

130

131 *Home availability*

132 Perceived availability of different foods within the home environment was assessed with
133 items adapted from the Project EAT³⁹. Respondents were asked how frequently (ranging
134 from (1) never/rarely to (4) always) the following items were available within the home:
135 cakes or sweet biscuits; potato crisps or salty snacks; chocolate or lollies. The frequency of
136 home availability of energy-dense snack food items was summed (Cronbach's $\alpha = 0.80$).

137

138 **Statistical analysis**

139 All analyses were conducted using Stata 11 (Stata Corp, College Station TX, 2003).
140 Descriptive statistics including frequencies, means, and standard deviations were calculated
141 for all study variables according to gender and year level of adolescent participants.

142

143 Firstly, linear regression analyses were used to examine associations between adolescent
144 television viewing energy-dense snack consumption, between television viewing and
145 perceived home availability of energy-dense snack foods, and between perceived home
146 availability of energy-dense snack foods and adolescent energy-dense snack food
147 consumption. Secondly, as suggested by Cerin et al.⁴³, the mediating effects of home
148 availability on the association between television viewing and adolescent energy-dense snack
149 food consumption were assessed using the Freedman-Schatzkin test of mediation⁴⁴. The
150 Freedman-Schatzkin test is based on the difference in the unstandardised regression
151 coefficients for the association between an independent (e.g. television viewing) and
152 dependent variable (adolescent energy-dense snack consumption), unadjusted (τ) and adjusted

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

159

160 **Results**

161 Slightly more of the adolescent sample were girls (53%) and in year 7 of secondary school
162 (61%). Table I displays the means and standard deviations for the study variables for the total
163 sample and according to gender and year level. Several small but significant differences were
164 found. Boys reported higher frequency of home availability of energy-dense foods, and
165 reported watching more television on a weekend day compared to girls. Adolescents in year 9
166 reported higher frequency of home availability of energy-dense foods and reported watching
167 more television on a school day and on a weekend day compared to adolescents in year 7. All
168 further analyses were stratified by gender, adjusted for year level and accounted for potential
169 clustering by school (unit of analyses).

170 School day and weekend day television viewing were significantly associated with energy-
171 dense snack consumption (τ in Table II). Television viewing accounted for 5% (school day)
172 and 4% (weekend day) of the variance in energy-dense snack consumption among boys and
173 5% (school day and weekend day) of the variance among girls' consumption of energy-dense
174 snacks. Linear regression analyses revealed that school day and weekend day television
175 viewing were positively associated with perceived home availability of energy-dense snack
176 foods among adolescent boys and girls (Table III). Further linear regression analyses
177 revealed that perceived home availability of energy-dense snack foods was positively
178 associated with consumption of energy-dense snack foods among adolescent boys ($\beta=0.26$,
179 95% CI 0.22-0.31, $p<0.001$) and girls ($\beta=0.28$, 95% CI 0.24-0.33, $p<0.001$).

180

181 Table II shows the mediating effects of perceived home availability of energy-dense snack
182 foods on the association between school day and weekend day television viewing and

183 adolescent energy-dense snack consumption among adolescent boys and girls. When
184 perceived home availability was added to each model predicting energy-dense snack
185 consumption by television viewing (i.e. separately for school day and weekend day), the β
186 value for the association between television viewing and energy-dense snack consumption
187 was significantly decreased for both boys and girls. However, the association between
188 television viewing and energy-dense snack consumption remained significant ($p < 0.001$) in all
189 models. This suggests that perceived home availability partly mediates the association
190 between television viewing and energy-dense snack consumption. The proportion of variance
191 in energy-dense snack consumption explained by television viewing increased when
192 perceived home availability was added to each model (see Table II).

193

194 **Discussion**

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

207

208 Sedentary behaviour has become a significant issue in public health over the past decade, both
209 for adults⁴⁵ and young people⁴⁶. Operationally defined as 'sitting time' it has often been
210 assessed in respect of screen time, and especially time watching television. However, while
211 research has shown there to be consistent links between TV viewing and unhealthy weight
212 status in young people, associations are often quite small⁴⁷. This may be due to several
213 factors, including little or no association between TV viewing and moderate-to-vigorous
214 physical activity⁴⁷, except for some periods of the day, such as immediately after school⁴⁸, as

215 well the presence of co-existing behaviours such as diet. TV viewing has been shown to co-
216 exist with unhealthy eating behaviours¹⁹. It may be diet as well as time being sedentary
217 watching TV that accounts for indicators of poor health, including weight status. Our findings
218 support the view that TV viewing in young people is associated with energy-dense snack food
219 consumption. Although only 4-5% of the variance is explained by this association, this is
220 likely to be highly meaningful in term of weight status. As argued by Hill⁴⁹, ‘small changes’
221 to lifestyle may have significant health effects. This is likely to be true in the context of highly
222 frequent, repeated behaviours such as TV and snacking.

223

224 The present study showed that perceived home availability of energy-dense snacks was
225 positively associated with adolescent energy-dense snack consumption. Such findings add to
226 previous research highlighting the important role of food availability within the home^{24, 50}. It
227 has long been known from behaviour modification studies that environmental manipulation,
228 such as food visibility and availability can have potent effects on behaviour⁵¹. Simple
229 strategies, such as reductions in purchase of energy dense foods, their concealment in the
230 home, or family rules about frequency and location of their consumption may be helpful. The
231 present study also showed that television viewing was positively associated with home
232 availability of energy-dense snacks. Such findings corroborate previous research showing that
233 while young people are watching television they are exposed to numerous advertisements
234 about food (usually unhealthy)²⁶ and that this translates into young people’s food preferences,
235 requests to purchase foods and drinks advertised, parental willingness to purchase these
236 products, and the availability of these food items in the home³¹⁻³⁵. In addition, this study
237 demonstrated that the perceived availability of energy dense snack foods in the home partially
238 accounts for the association between TV viewing and energy dense snack food consumption.
239 Such findings suggest that home availability of energy-dense foods could potentially be
240 influenced by targeting reductions in television viewing, which could also result in reductions
241 in energy-dense snack food consumption. The involvement of parents and targeting the home
242 environment is likely to be particularly important in such efforts.

243

244 Alternative explanations for several of the present findings are possible. That is, adolescents
245 watching more TV may have been consuming more of all sorts of snacks, including healthy

246 snacks. It is also possible that TV viewers consumed more energy-dense snacks because they
247 had less access to fruits and vegetables in the home. To test these possibilities we conducted
248 additional analyses. In the additional analyses, we examined associations of TV viewing with
249 perceived home availability of fruit and vegetables. Results showed negative associations
250 between TV viewing and fruit and vegetable availability, but these were of very small
251 magnitude ($B=-0.002$ for boys and -0.001 for girls). Further, there were no associations
252 between TV viewing and fruit/vegetable consumption for either boys ($B<-0.001$) or girls ($B<-$
253 0.001). Therefore it appears unlikely that TV viewers are consuming more of all sorts of
254 snacks; or that the increased consumption of energy-dense snacks amongst those viewing
255 more TV is strongly attributable to lower availability of fruits and vegetables in the home.
256

257 In considering these findings it is important to acknowledge the limitations of the study. The
258 reach of the whole study was modest (46%); however this is comparable to other large scale
259 longitudinal studies. All data were collected by self-report and are subject to socially desirable
260 response bias or other misreporting. The cross-sectional study design does not permit causal
261 inferences to be drawn; potentially a third unmeasured variable could account for the
262 associations observed. Strengths of the study include the large regionally diverse sample of
263 adolescents and parents, and the use of powerful statistical mediation techniques.
264

265 **Conclusions**

266 The results of the present study suggest that television viewing has a significant role to play in
267 adolescent unhealthy eating behaviours. Future research should assess the efficacy of
268 methods to reduce adolescent energy-dense snack food consumption by targeting parents to
269 reduce home availability of energy-dense foods, and on reducing television viewing
270 behaviours of adolescents.
271

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

	Total sample (n=2984)	Gender		Year level	
		Boys (n=1390)	Girls (n=1594)	Year 7 (n=1811)	Year 9 (n=1173)
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, mean (SD) (range: 0-7.5 per day)	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, mean (SD) (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 television viewing (mins/day (SD))	134.27 (88.32)	135.54 (91.19)	133.16 (85.76)	131.65 (89.39)	138.31 (86.52)*
Weekend day television viewing (mins/day (SD))	137.65 (84.26)	146.01 (86.61)	130.36 (81.49)***	134.80 (84.99)	142.05 (82.97)*

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 II. Effects of adjustment for perceived home availability of energy-dense snack foods in the association between television viewing and adolescent energy-dense snack consumption among Australian adolescents in 2004-2005 (n=2984).

	τ (SE)	τ' (SE)	$\tau - \tau'$ (SE)	t	P -value	R^2
Adolescent boys (n=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 (n=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

τ , unstandardised regression coefficient for association between television 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 television 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 standard error, can be compared against a t -distribution with $n - 2$ degrees of freedom; SE, standard error.

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

	Home availability of ED snacks	
	Boys (n=1390)	Girls (n=1594)
School day TV viewing	$\beta=0.005$ (0.004-0.006)***	$\beta=0.004$ (0.003-0.005)***
Weekend day TV viewing	$\beta=0.005$ (0.004-0.007)***	$\beta=0.006$ (0.004-0.007)***

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