

# Associations between children's diet quality and watching television during meal or snack consumption: a systematic review.

## ~~An investigation into how watching television during meal or snack consumption influences children's diet quality: a systematic review.~~

### **Abstract**

*Background* - Studies have identified an association between watching television (TV) and childhood obesity. This review adds context to existing research by examining the associations between TV viewing, whilst eating, and children's diet quality.

*Methods* – Web of Science and PubMed databases were searched from January 2000 to June 2014. Cross-sectional trials of case control or cohort studies which included baseline data measuring the associations between eating while watching TV and children's food and drink intake. Quality of selected papers was assessed.

*Results* - Thirteen studies, representing 61,674 children aged 1-18yrs, met inclusion criteria. Of six studies reporting overall food habits, all found a positive association between TV viewing and consumption of pizza, fried foods, sweets and snacks. Of eight studies looking at fruit and vegetable consumption, seven identified a negative association with eating while watching TV ( $p < 0.0001$ ). Four out of five studies identified a positive association between watching TV while eating and servings of SSBs ( $p < 0.0001$ ). Four studies identified an association between low SES and increased likelihood of eating whilst watching TV ( $p \leq 0.01$ ). Family meals did not overcome the adverse impact on diet quality of having the TV on at mealtimes.

*Conclusion* - Eating whilst watching television is associated with poorer diet quality among children, including more frequent consumption of SSBs and high-fat, high-sugar foods and fewer fruits and vegetables. Whilst these differences in consumption are small, the cumulative effect may contribute to the positive association between eating whilst watching TV and childhood obesity.

29

## 30 **Introduction**

31 The increasing global prevalence of childhood obesity and the associated impact on physical  
32 and psychological health have been well documented (WHO, 2016). The Foresight Report  
33 (Government Office for Science, 2007) highlights the complex, multifactorial nature of  
34 obesity, with its many contributing factors.

35 The sedentary lifestyle of children has been implicated in the steady rise in the obesity  
36 epidemic, (HSE, 2014) and television (TV) viewing has been positively associated with  
37 increased BMI in children (Braithwaite et al, 2013; Montoye et al, 2013). It has been  
38 commonly hypothesised that increased TV viewing replaces hours spent undertaking physical  
39 activity, thereby leading to reduced energy expenditure and subsequent weight gain (Dietz,  
40 2001). Conversely research has shown that this might not necessarily be the case, and that the  
41 increased weight associated with higher rates of TV viewing are, in fact, unrelated to physical  
42 activity or lack thereof, but due to other factors (Biddle et al, 2004).

43 Alternative ways in which TV viewing has been linked to increased weight in children is  
44 through the influence that it has on children's diet in terms of advertising energy-dense food  
45 (Andreyeve et al, 2011), promoting mindless eating during viewing, (Ogden et al, 2013) and  
46 increased snacking and 'junk food' consumption, (Boulos et al, 2012), including higher  
47 consumption of sugary drinks (Dubois et al, 2008; Carson & Janssen, 2012). The role of  
48 parents should be taken into account when considering these factors, since their influence  
49 shapes children's food habits from a young age (Francis et al, 2003; Olafsdottir et al, 2014)  
50 and parents' ability to set rules regarding limits on time spent watching TV could prove an  
51 important in influencing their child's diet quality (Anderson & Whitaker, 2010). Associations  
52 have previously been confirmed between socioeconomic status (SES) and childhood obesity  
53 (Stamatakis et al, 2010), but it is less clear how watching TV and diet quality are influenced  
54 by low SES.

55 Whilst many studies have examined associations between TV viewing and obesity in children,  
56 there is limited data investigating the associations between TV viewing and the foods and  
57 drinks which are consumed during this time. This review examines the ~~influence~~ associations  
58 between ~~of~~-watching television during meal or snack consumption and children's diet quality.  
59 Despite living in an age of multiple electronic screen devices, this review focuses on the

60 hardware television, located in the home setting, but will include commercial and non-  
61 commercial TV, videos and DVDs without differentiating between them.

## 62 **Methods**

63 *Search strategy and selection criteria:* To ensure no similar reviews had already been  
64 published, a preliminary computerised search of the Cochrane Library was conducted. One  
65 review (Wahi et al, 2011) was not specific to the effects of interventions on diet quality. A  
66 second search of Web of Science also returned one review, entitled *ObesiTV: How television*  
67 *is influencing the obesity epidemic* (Boulos et al, 2012).

68 Results from cross sectional studies dating from January 2000 to July 2014 were reviewed by  
69 performing further computerised searches of Web of Science and PubMed (MED-LINE) using  
70 the search terms ‘family or meal\*’, ‘tele\* or TV’ and ‘obesity or BMI or food choices or obese  
71 or overweight’. Filters were used to eliminate non-human studies and those that were not in the  
72 English language, as well as studies based on adults. A title screen, followed by abstract screen  
73 was performed in order to exclude non-relevant studies. The remaining studies were then read  
74 and assessed against inclusion/exclusion criteria by all three researchers. A hand-search of  
75 included studies was performed and relevant articles assessed in order to produce the final list  
76 of studies to be included. This final list was checked by two reviewers before data extraction.  
77 A PRISMA checklist was followed (Liberati et al, 2009).

78 Inclusion criteria:

- 79 1. Study participants: children  $\leq$  18years
- 80 2. Studies examining the ~~influence of~~associations between watching TV whilst  
81 eating/drinking in developed countries and ~~the resulting~~ diet quality
- 82 3. Articles in English language

83 Exclusion criteria:

- 84 1. Data based on follow up data from longitudinal studies where other variables may have  
85 influenced food and drink intake
- 86 2. Reviews, rather than original data
- 87 3. Studies including an intervention

88 The primary outcome was the ~~influence of~~association between eating during TV viewing ~~on~~  
89 and children’s food and drink consumption. The secondary outcomes were the effect of eating

90 during TV viewing on BMI and risk of overweight, role of parents, socioeconomic influences  
91 and associated physical activity levels.

## 92 *Data collection and extraction*

93 Data extraction included: authors, year, country; type of study; method of determining amount  
94 of TV viewing during food/drink consumption; method of determining dietary intake/patterns;  
95 outcomes reported; adjustment for confounding variables; key findings.

## 96 **Quality Assessment**

97 The quality of the studies was assessed by two reviewers, independently, using an amended  
98 version of the Newcastle-Ottawa Scale (Higgins & Green, 2011), in which stars were awarded  
99 for high quality characteristics, as shown in Table1. This adapted version allowed a maximum  
100 score of two for each category. Given that multiple factors can influence food intake, high  
101 scores reflect that there has been adjustment for confounding factors – particularly SES.

## 102 **Results**

103 46 studies were originally identified that measured the associations between watching  
104 television on food intake and obesity in children. 26 studies were omitted because they  
105 included an intervention, were based on longitudinal study data or were not presented in  
106 English language. Seven studies were excluded because they did not report associations  
107 between watching TV during food/drink consumption (figure 1).

108 Table 2 presents the reported associations between watching TV **during food consumption**  
109 and children's food and drink intake (13 studies).

## 110 **Quality Assessment**

111 Results from the quality assessment are summarised in Table 3. Nine out of the thirteen papers  
112 achieved a score of 5 out of a maximum possible of six.

## 113 **Study characteristics**

114 Total number of children included in the 13 studies was 61,647, all of whom were aged between  
115 1-18 years. Of these, 24,141 children were aged  $\leq 11.5$  years. The remaining 37,506 were aged  
116 11-18. Some overlap occurred due to children being surveyed according to their school year,  
117 rather than age, and different studies targeted children according to different cut-off ages. Of

118 the 24,141 children aged  $\leq 11.5$  years, 3,011 children could be considered of pre-school age ( $\leq 6$   
119 years). 5,986 children were of primary school age (6-11.5 years). The study by Lissner *et al*  
120 (2012) (not included in this figure) used data from the European funded Identification and  
121 prevention of Dietary- and lifestyle- induced health Effects In Childhood and infantS  
122 (IDEFICS) study, which was based on children aged 2-9 years.

123 The total sample comprised 35,650 girls and 35,068 boys. A further 4,966 children were  
124 included in the study by Liang *et al* (2009) which gave no details of gender. The study by Coon  
125 *et al* (2001) only interviews 91 parent-child pairs, however its results are consistent with the  
126 results of the larger studies.

127 Eight of the 13 studies in table 2 have been submitted for publication since 2009. The data  
128 were all collected after 1993 from developed countries including the USA, Canada, Australia,  
129 Spain (and Balearic Islands), Denmark, Italy, Estonia, Cyprus, Sweden, Belgium, Greece,  
130 Germany, Hungary and Portugal. Six studies are based on data collected since 2005.

131 One study reported outcomes specifically for children from families of low socioeconomic  
132 status (Fitzpatrick *et al*, 2007); only 2 studies (Matheson *et al*, 2004; Cox *et al*, 2012) did not  
133 take SES or some measure of it (e.g. parental education level or household income) into  
134 consideration when performing the statistical analysis.

### 135 **Eating Whilst Watching TV and Food and Drink Consumption**

136 **Note only significant results ( $p \leq 0.05$ ) are reported unless otherwise stated. All results are**  
137 **reported in chronological order, from pre-school to adolescence.**

138 **Diet quality:** Eight of the studies looked at aspects of diet quality. Cox *et al* (2012) found a  
139 weak positive association between TV viewing and consumption of obesogenic ( $r=0.23$ ) and  
140 fast foods ( $r=0.27$ ) in pre-school children. Children, (2-9 years), who ate while watching TV  
141 were found by Lissner *et al* (2012) to have more high fat and high sugar items in the diet in  
142 proportion to total number of foods consumed, compared to children who did not eat while  
143 watching TV.

144 Two studies used a questionnaire to score the children's diets in order to determine an overall  
145 index of diet quality. Hare-Bruun *et al* (2011) deduced scores based on tertiles of healthy  
146 eating according to consumption of foods containing fat, added sugar and liquid sugar in order  
147 to score children on total healthy food preferences ( $\Sigma$ HFP) and total healthy food habits

148 ( $\Sigma$ HFH). They found that boys aged 8-10 years who watched TV during meals every day or  
149 most days had less healthy food preferences than those who rarely watched TV during meals  
150 ( $\Sigma$ HFP: -0.84, 95%CI -1.52, -0.16). Girls aged 8-10 years who watched TV during meals 1-2  
151 times per week, however, had higher healthy food preferences than those who rarely watched  
152 TV during meals ( $\Sigma$ HFP: 0.68, 95%CI 0.06, 1.31). Regardless of their preferences, watching  
153 TV during meals most days or every day was associated with less healthy food habits in 8-10  
154 year old boys ( $\Sigma$ HFH: -2.25, 95%CI -3.11, -1.40) and girls ( $\Sigma$ HFH: -1.56, 95%CI -2.36, -0.76)  
155 and 14-16 years old boys ( $\Sigma$ HFH -2.04, 95%CI -3.12, -0.96) and girls ( $\Sigma$ HFH: -1.24, 95%CI -  
156 2.16, -0.32). The findings of Liang *et al* (2009) in 10-11 year olds were based on a food  
157 frequency questionnaire which created a scale of diet quality based on consumption of soft  
158 drinks, energy from sugar, fat and snack foods and daily servings of fruits and vegetables. A  
159 diet quality index was created as a composite measure which encompassed dietary variety,  
160 adequacy, moderation and balance. These results concur with those of Hare-Bruun *et al* (2011),  
161 in that eating supper while watching TV is negatively associated with diet quality index, which  
162 decreased from 63.08 in children who had supper in front of the TV less than once per week,  
163 to 60.12 in children who had supper in front of the TV  $\geq 5$  times per week.

164 Other studies looked at more specific aspects of the diet. Coon *et al* (2001) found that 'middle  
165 school' children who ate  $>2$  meals/snacks per day with the TV on obtained 3% more of their  
166 total daily energy from pizza, salty snacks & sodas than children who ate meals with the TV  
167 on  $\leq 2$  meals/day. Feldman *et al* (2007), identified an increased consumption of fried foods by  
168 adolescents who ate family meals with the TV on compared to those who did not (1.3 servings  
169 per day compared to 1.1 in girls and 0.54 compared to 0.49 in boys). Carson and Janssen (2012)  
170 observed an increase in junk food consumption, as defined by sweets (candy and chocolate),  
171 coke or other soft drinks containing sugar, cakes, pastries or doughnuts, potato chips or French  
172 fries, associated with more time spent eating whilst watching TV.

173 These findings were reinforced by Rey-López *et al* (2010), who ascertained that energy dense  
174 dietary intake during TV viewing, mainly in the form of snacks, including soft drinks, pastry,  
175 sandwiches and sweets, were more likely in adolescents who watched TV  $>2$ h/day. Boys  
176 consumed savoury snacks more frequently, whereas girls consumed fruit juice and coffee more  
177 frequently compared to adolescents of the same gender who watched  $\leq 2$  hours per day.

178 **Consumption of fruits and vegetables:** Of the eight studies which reported on consumption of  
179 fruits and vegetables, seven identified a negative association between eating whilst watching  
180 television and consumption of fruits and vegetables.

181 Cox *et al* found a moderate negative association between TV viewing and daily servings of  
182 vegetables ( $r = -.31$ ) in pre-school children. This was confirmed by both Dubois *et al* (2008),  
183 where eating dinner or snacks daily whilst watching TV and Fitzpatrick *et al* (2007) where the  
184 number of days the TV was on during dinner was associated with fewer servings of fruits and  
185 vegetables in this age-group. Matheson *et al* (2004), found that on weekdays 5th grade students,  
186 ate 0.39 servings of vegetables when the TV was on compared to 2.07 servings eaten by their  
187 peers with the TV off. This finding was re-inforced by Liang *et al* (2009), in their study of 5<sup>th</sup>  
188 grade students. Coon *et al* (2001), found that children who ate  $\geq 2$  meals/snacks per day with  
189 the television on consumed 16% less fruit and vegetables, which equated to 2% less of their  
190 total daily energy from fruits, vegetables and juices. Daily consumption of dinner or snacks  
191 while watching TV was found to be associated with 0.23 fewer servings of fruits and vegetables  
192 per day (Dubois et al, 2008). Feldman *et al* (2007) identified the importance of family meals,  
193 but found that, even if adolescents eat with the family, having the TV on during mealtimes was  
194 associated with a reduction in the number of daily servings of vegetables and particularly in  
195 the number of servings of dark green/yellow vegetables per day. Only Verzeletti *et al* (2010)  
196 found no association between watching TV during daily meals and fruit and vegetable intake  
197 in adolescence but this study was of low quality.

198 **Consumption of sugar-sweetened beverages (SSBs):** Four out of five studies which reported  
199 on SSB consumption found a positive association between watching television while eating  
200 and servings of SSBs.

201 Dubois *et al* (2008), found that eating while watching TV was associated with significantly  
202 increased odds of drinking soft drinks daily, which was more than double in those who ate  
203 snacks while watching TV sometimes (OR: 2.294) and more than tripled in pre-school children  
204 who ate snacks while watching TV every day (OR: 3.568). They also found significant  
205 associations between total daily eating while watching TV and consumption of soft drinks.  
206 There was a 70% (95% CI 1.2, 2.4) greater chance of daily soft drink consumption in children  
207 who ate while watching TV once a day and an 83% (95% CI 1.2, 2.7) greater chance in children  
208 who ate in front of the TV twice a day compared to pre-schoolers who ate in front of the TV  
209 less than once a day.

210 Coon *et al* (2001), identified a 15% increase in consumption of SSBs by ‘middle school’  
211 children where the television is on during  $\geq 2$  meals per day. In contrast, children of a similar  
212 age, who ate whilst watching TV on weekdays, consumed 0.07 servings of soda with the TV  
213 on compared to 0.36 with the TV off but with no adjustment for confounding factors (Matheson  
214 *et al*, 2004).

215 Older children who ate family meals with the TV were found to drink a further 0.2 servings of  
216 soft drinks than those who ate family meals without the TV on (Hare-Bruun *et al*, 2011). Rey-  
217 López *et al* (2010), found that 21% of boys and 12% of girls who watched TV for  $\leq 2$  hours  
218 drank soft drinks during television viewing, compared to 27% and 18% who watched TV for  
219  $> 2$  hours per day.

220 **Consumption of caffeine:** Only one study (Coon *et al*, 2001), looked specifically at caffeine  
221 consumption and found that children who ate  $\geq 2$  meals per day drank, on average, twice as  
222 much caffeine as those who ate  $< 2$  meals per day with the TV on. This may or may not be  
223 attributed to an increased intake of caffeine containing SSBs. Whilst Rey-López *et al* (2010),  
224 did not look at caffeine specifically, they found that 4% of adolescents who watched TV for  
225  $> 2$  hours per day consumed coffee during TV viewing, compared to 3% of those who watched  
226  $\leq 2$  hours per day. This figure, however, was only significant amongst girls.

227 **Consumption of carbohydrate and grains:** Dubois *et al* (2008) identified a slightly greater  
228 carbohydrate consumption by pre-school children who ate snacks while watching TV every  
229 day compared to those who did not (213g/day as opposed to 210g/day), whereas Feldman *et al*  
230 (2007) found that slightly fewer grains were consumed by adolescents who ate family meals  
231 whilst watching TV compared to those who ate family meals without TV (5.6 daily servings,  
232 as opposed to 5.9). This reduced number of grains in the diet of adolescents who ate family  
233 meals while watching TV may contribute to a diet with lower dietary fibre content.

234 **Consumption of protein:** Three studies considered protein consumption. Pre-school children  
235 who ate snacks while watching TV every day consumed less energy from protein compared to  
236 those who did not (14.4% v. 15.1%) (Dubois *et al*, 2008). This result is in contrast to the  
237 observation that 2% more energy from protein and 14% more meat was consumed by ‘middle  
238 school’ children who frequently ate meals with TV on (Coon *et al*, 2001). Whilst eating meals  
239 in front of the TV leads to increased protein consumption with greater meat consumption in  
240 ‘middle school’ children (Coon *et al*, 2001), adolescents who ate snacks while watching TV  
241 obtained less of their daily energy intake from protein (Feldman *et al*, 2007).



242 ***Vitamins and minerals:*** Two studies examined vitamin and mineral intake. Coon *et al* (2001)  
243 found no association between TV watching at mealtimes and vitamin or mineral intake whilst  
244 Feldman *et al* (2007) found that older children who ate family meals whilst watching ate fewer  
245 calcium rich foods than children who ate family meals without TV. Although only the two  
246 studies report on micronutrients, the results suggest that micronutrient levels may reflect the  
247 lower diet quality of children who eat while watching TV.

248

249 ***Secondary outcomes: effects of eating whilst watching TV on BMI and obesity risk.*** Six  
250 studies reported on BMI. Four studies identified a significant positive association between  
251 eating while watching TV and children's BMI. Cox *et al* (2012) identified a moderate positive  
252 association between TV viewing and energy intake while viewing (0.61 on weekdays, and 0.50  
253 at weekends) as well as a weak positive correlation between pre-school children's BMI z-scores  
254 and energy intake whilst viewing (0.21 on weekdays and 0.22 at weekends). Dubois *et al*  
255 (2008) found that pre-schoolers who ate dinner or snacks while watching TV at least once per  
256 day had a higher BMI (mean BMI 15.9) than children who ate dinner or snacks while watching  
257 TV less than once a day (mean BMI 15.7). Both Lissner *et al* (2012) and Liang *et al* (2009)  
258 identified positive associations between eating while watching TV and overweight. Lissner *et*  
259 *al* calculated an odds ratio for being overweight of 1.28 in 2-9year olds who regularly ate food  
260 while watching TV (95%CI 1.16, 1.42). This ratio was greater in girls (OR 1.35, 95%CI 1.17,  
261 1.55) than in boys (OR 1.20, 95%CI 1.04, 1.40). Liang *et al* found that 41.7% of 5<sup>th</sup> grade  
262 children who ate supper in front of the TV  $\geq 5$  times per week were overweight, compared to  
263 30.6% of children who ate supper in front of the TV less than once per week. Only one study  
264 found that TV snacking was negatively associated with BMI. For every 1 unit increase in the  
265 television snacking scale, BMI z-scores decreased by 0.03 in this group of adolescents but BMI  
266 did increase with increased time spent watching TV (Carson & Janssen, 2012).

267 Whilst Del Mar Bibiloni *et al* (2009) did report a positive association between adolescent BMI  
268 and distraction at mealtimes, the findings were not significantly different.

269 ***Secondary outcomes: role of parents.*** Fitzpatrick *et al* (2007) found that the number of days  
270 that meals were eaten as a family was positively associated with servings of fruits and  
271 vegetables but that this does not overcome the adverse effects of having the TV on at  
272 mealtimes.

273 Adolescents who ate family meals whilst watching TV were noted to consume fewer vegetables  
274 including dark green/yellow vegetables, grains and calcium-rich foods and more soft drinks

275 than children who ate family meals without the TV on. Girls who ate family meals with the  
276 TV on also ate more fried foods than girls who did not.

277 **Secondary outcomes: influence of socioeconomic status.** Likelihood of eating while watching  
278 TV was found by Dubois *et al* (2008) to fall with increasing SES, with a significantly greater  
279 proportion of pre-school children from low SES eating meals and snacks in front of the TV  
280 than children of parents with greater occupational prestige, education level and financial  
281 situation. Of the children in quintile 1 (considered low SES), 19.8% ate their dinner (evening  
282 meal) in front of the TV every day, whereas only 5.2% of children from quintile 5 (considered  
283 high SES) ate dinner while watching TV on a daily basis. This difference was greater still  
284 when considering snacking, with 32% of children in quintile 1 eating snack foods in front of  
285 the TV every day, compared to 6.5% in quintile 5. Both breakfast and lunch followed the same  
286 trend, with likelihood of eating in front of the TV every day decreasing throughout the quintiles.  
287 Coon *et al* (2001) found that children were more likely to have the TV on if their parents had  
288 lower incomes. Single parent families and less educated mothers were also more likely to have  
289 the TV on at mealtimes. They also found that the more knowledgeable parents were about  
290 nutrition, the less likely it was that the television would be on at mealtimes.

291 Parental education was found by del Mar Bibiloni *et al* (2009) to be a risk factor for obesity  
292 with an odds ratio of 3.47 for adolescent boys of parents with low educational level, compared  
293 to those of parents with high educational level (95% CI 1.58, 7.62). For girls, the odds ratio  
294 was 3.29 (95% CI 1.38, 7.89). Rey-Lopez *et al* (2010) also found that a low level of maternal  
295 education was associated with higher consumption of energy-dense drinks during TV viewing,  
296 however this result was only apparent among adolescent girls, with an odds ratio of 3.22 (95%  
297 CI 1.81, 5.72) compared to girls whose parents achieved the highest level of education. The  
298 effect of family affluence also affected girls' consumption of energy-dense drinks during TV  
299 viewing, with children from families of low affluence more likely to consume energy-dense  
300 drinks than those from families of high affluence (OR 2.03, 95% CI 1.19, 3.47).

301 **Secondary outcomes: screen time and physical activity levels.** Just the one study, Cox *et al*  
302 (2012) identified weak but significant positive associations between both weekday and  
303 weekend TV viewing and number of minutes spent in sedentary activities in this pre-school  
304 population ( $r=0.20$  and  $0.22$  respectively,  $p=0.05$ ).

305

306 **Discussion**

307 This review has concentrated on the influences of watching TV, including commercial and  
308 non-commercial TV, videos and DVDs, without differentiating between them. Previous  
309 studies have found that energy intake is greater during TV watching than during use of  
310 computers or video games for homework or leisure (Lyons et al, 2013; Marsh et al, 2014).

311 The primary outcomes of this review are the associations observed between eating, either meals  
312 or snacks, whilst watching TV and children's diet quality and the secondary outcomes consider  
313 BMI, the role of parents, socioeconomic influences and physical activity levels. Whilst  
314 previous reviews have considered the effectiveness of reducing screen time in children and the  
315 influence of TV on obesity (Boulos et al, 2012), none have looked at how eating whilst viewing  
316 TV ~~influences~~ affects children's diet quality. For the discussion, and to support the conclusions,  
317 only results from the studies with a high quality rating ( $\geq 5$ ), and where there have been  
318 adjustments made for some measure of SES, will be considered. Related observations are used  
319 to add context to the findings.

### 320 **Diet Quality.**

321 There are many aspects that contribute to diets of poorer quality, including eating patterns,  
322 increased consumption of foods and beverages perceived to be bad for health, such as those  
323 high in fat and sugar, often referred to as junk food, as well as decreased consumption of foods  
324 perceived to be good for health, such as vegetables and fruits.

325 This review found evidence that eating whilst watching TV on most or every day does lead to  
326 a reduced quality of the diet consumed and that there is an association between watching TV  
327 during meals or snacks and a greater intake of energy dense high fat, high sugar foods including  
328 pizza, fried foods, savoury snacks, junk foods and sweet foods.

329 Based on the quality and size of the studies, the data presented on unhealthy food habits appears  
330 to confirm that, even from as young as 2 years, children who eat whilst watching TV are more  
331 likely to consume high-fat, high-sugar foods.

332 The benefits of fruits and vegetables in the diet are well documented (Slavin & Lloyd, 2012)  
333 and exposure at an early age is important to prevent selective eating in later years (Coulthard  
334 et al, 2014). However this review strongly suggests that there is a negative association between  
335 eating whilst watching TV and the consumption of fruits and vegetables (Coon et al, 2001;  
336 Feldman et al, 2007; Dubois et al, 2012). Children, of all ages, are clearly not choosing fruits  
337 as regular snack items to consume whilst watching TV. These findings are consistent with other  
338 reports which have found total TV viewing time to be negatively associated with fruit and  
339 vegetable consumption (Ramos et al, 2013). Based on these findings the authors suggest that

340 the family food environment should include a fruit bowl or vegetable platter, full of attractive  
341 and varied fruits and vegetables, sited near to the TV.

342 The findings comparing carbohydrate and protein intakes suggest that television ‘snackers’  
343 could represent a distinct population compared to those children who tend to eat meals in front  
344 of the TV, since many snacks are carbohydrate based compared to meals, which normally  
345 comprise a protein portion such as meat but the age of the child may influence the results.

346 Previous research has focussed on the effects of TV on consumption of SSBs (Olafsdottir et al,  
347 2014) and it was hypothesised that this review would support the existing evidence base that  
348 eating and drinking during TV increases consumption of SSBs, including sodas, fruit juices  
349 and caffeine containing SSBs. Indeed the results are consistent with existing studies and the  
350 findings add strength to the previously established association between screen time and SSBs  
351 by confirming a link between drinking SSBs, including fruit juice, during TV use and increased  
352 amount and/or frequency of consumption (Coon et al, 2001; Feldman et al, 2007; Dubois et al,  
353 2008; Ray-Lopez et al, 2010). Given that the consumption of SSBs in the USA has increased  
354 from 222 to 458kcal/day over the past 3 decades (Duffey & Popkin, 2007), interventions which  
355 aim to reduce the consumption of SSBs whilst watching TV are important.

356

357 Overall a positive correlation was seen between children’s BMI z-scores and energy intake  
358 whilst viewing with the exception of some teenagers who may fill up on TV snacks with a  
359 lower energy content and then eat less at mealtimes. Whilst a secondary outcome, the general  
360 association between eating while watching TV and increased BMI adds context to the primary  
361 findings regarding children’s diet quality. The size and quality of these studies adds to the  
362 previous evidence base linking TV with obesity.

363

364 The data reported confirms the important role of parents and the relevance of setting limits  
365 (Anderson & Whitaker, 2010), since increased energy intake and unhealthy eating/drinking  
366 habits are associated with increased screen time and eating whilst watching the TV. Parents  
367 are a strong influence on children’s food choices in their early years of life and it is known that  
368 girls are more likely to snack, including whilst watching TV, and to have increased screen  
369 viewing time if they come from overweight families (Falbe et al, 2013). Parents are responsible  
370 for setting a precedent for their children and are therefore influential in influencing screen-  
371 viewing habits and dietary choices. It appears that eating together as a family on a regular basis  
372 is associated with lower BMI and healthier food choices in children (Hammons & Fiese, 2011)

373 but that, whilst family meals are important, they do not counteract the effects of watching  
374 television whilst eating.

375 More children, of all age-groups, from lower socioeconomic backgrounds consume snacks,  
376 energy dense drinks and meals whilst watching TV compared to children from families with a  
377 higher level of income or educational attainment. This review implicates SES and measures of  
378 it as a major factor in children's TV eating and drinking habits. These secondary findings are  
379 supported by previous studies on the subject (Rollins et al, 2010; Currie et al, 2012),  
380 highlighting the need for educational programmes aimed at parents, especially those with low  
381 socioeconomic backgrounds.

382 Previous studies have found that, whilst TV is associated with increased BMI, typically in a  
383 dose response manner, this relationship is not dependent upon physical activity (Laurson et al,  
384 2008; Brown et al, 2011; Stamatakis et al, 2013). This review adds limited supporting evidence  
385 that the effects are not due to an increase in sedentary time replacing that which would  
386 otherwise be spent being physically active, but to changes in diet quality.

### 387 **Strengths and Limitations**

388 All data is cross sectional. Intervention trials would be necessary to confirm causality rather  
389 than the associations reported. However the data is representative of the western world and  
390 collected from a wide range of developed, westernised countries. Some of the large sample  
391 sizes may have influenced the levels of significance reported although the high quality studies  
392 made adjustments for key confounders.

393 Whilst much research has been done to confirm that this association exists, this review is, to  
394 our knowledge, the first to collate evidence on the impact of eating while watching television  
395 on children's diet quality, which clearly has an impact on weight status as well as health. We  
396 acknowledge that studies showing no association may not have been published. In order to  
397 further our understanding of this complex relationship between screen time and diet quality,  
398 future research should include interventions which provide information about the possible  
399 underlying factors. For example is there an element of convenience and eating food from  
400 packets rather than a plate or is it due to distraction and mindless eating which affects diet  
401 quality if a child eats or drinks whilst watching TV. Such research would provide follow up  
402 data to determine whether watching TV whilst eating as a child necessarily impacts on BMI  
403 and health in the long term and into adulthood.

404 Given the ever increasing number of 'screens' being used by children, further research is  
405 required to determine the impact of different types of screen time, whilst eating, on diet quality.

406 Whilst the size of some of the associations may seem to be small it is increasingly becoming  
407 recognised that the cumulative effect of small dietary changes may lead to significant  
408 nutritional improvements (Paineau et al, 2010) and a report prepared for a Joint Task Force  
409 including the American Society for Nutrition proposes that a small changes approach may help  
410 to address the obesity epidemic (Hill, 2009).

411 All dietary intake methodologies, for example the use of food frequency questionnaires or  
412 dietary recall, have their limitations which may lead to either incomplete or inaccurate  
413 reporting. Whilst the quality assessment did look for the use of validated tools, the limitations  
414 in the accuracy of dietary intake data may still be present even in high quality studies.

415

416 Overall this review suggests that for children, from pre-school age onwards, eating whilst  
417 watching TV reduces diet quality with more high-fat, high-sugar foods and fewer fruits and  
418 vegetables and increased consumption of sugar sweetened beverages. Whilst these differences  
419 in consumption tend to be small, the accumulative effect may be enough to cause the positive  
420 association between eating during TV use and prevalence of childhood obesity. It is  
421 recommended that parents are targeted in any intervention, since their influence is vital in  
422 setting and enforcing limits on screen time, particularly whilst eating, and encouraging family  
423 meals without the TV on. Given that children from lower socioeconomic backgrounds are  
424 more likely to eat whilst watching TV, a focus on supporting these families to make changes  
425 is required in order to reverse the greater trends seen in obesity levels in children from families  
426 of low SES.

427

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## 584 **Figure Legends**

585 Figure 1. Flow diagram showing data base search results.

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