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.

Introduction

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

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

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

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

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

Methods

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

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

Inclusion criteria:

1. Study participants: children ≤ 18years
2. Studies examining the ~~influence of~~associations between watching TV whilst eating/drinking in developed countries and ~~the resulting~~ diet quality
3. Articles in English language

Exclusion criteria:

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

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

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

Data collection and extraction

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

Quality Assessment

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

Results

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

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

Quality Assessment

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

Study characteristics

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

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

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

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

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

Eating Whilst Watching TV and Food and Drink Consumption

Note only significant results (p≤0.05) are reported unless otherwise stated. All results are reported in chronological order, from pre-school to adolescence.

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

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

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

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

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

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

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

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

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

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

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

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

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

Consumption of protein: Three studies considered protein consumption. Pre-school children who ate snacks while watching TV every day consumed less energy from protein compared to those who did not (14.4% v. 15.1%) (Dubois et al, 2008). This result is in contrast to the observation that 2% more energy from protein and14% more meat was consumed by 'middle school 'children who frequently ate meals with TV on (Coon et al, 2001). Whilst eating meals in front of the TV leads to increased protein consumption with greater meat consumption in 'middle school' children (Coon et al, 2001), adolescents who ate snacks while watching TV obtained less of their daily energy intake from protein (Feldman et al, 2007).

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

Secondary outcomes: effects of eating whilst watching TV on BMI and obesity risk. Six studies reported on BMI. Four studies identified a significant positive association between eating while watching TV and children's BMI. Cox *et al* (2012) identified a moderate positive association between TV viewing and energy intake while viewing (0.61 on weekdays, and 0.50 at weekends) as well as a weak positive correlation between pre-school children's BMI z-scores and energy intake whilst viewing (0.21 on weekdays and 0.22 at weekends). Dubois *et al* (2008) found that pre-schoolers who ate dinner or snacks while watching TV at least once per day had a higher BMI (mean BMI 15.9) than children who ate dinner or snacks while watching TV less than once a day (mean BMI 15.7). Both Lissner e*t al* (2012) and Liang *et al* (2009) identified positive associations between eating while watching TV and overweight. Lissner *et al* calculated an odds ratio for being overweight of 1.28 in 2-9year olds who regularly ate food while watching TV (95%CI 1.16, 1.42). This ratio was greater in girls (OR 1.35, 95%CI 1.17, 1.55) than in boys (OR 1.20, 95%CI 1.04, 1.40). Liang *et al* found that 41.7% of 5th grade children who ate supper in front of the TV ≥5 times per week were overweight, compared to 30.6% of children who ate supper in front of the TV less than once per week. Only one study found that TV snacking was negatively associated with BMI. For every 1 unit increase in the television snacking scale, BMI z-scores decreased by 0.03 in this group of adolescents but BMI did increase with increased time spent watching TV (Carson & Janssen, 2012).

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

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

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

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

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

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

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

Discussion

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

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

Diet Quality.

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

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

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

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

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

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

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

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

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

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

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

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

Strengths and Limitations

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

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

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

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

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

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

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Figure Legends

Figure 1. Flow diagram showing data base search results.