Does watching TV contribute to increased body weight and obesity in children?

A report prepared by the Scientific Committee of the Agencies for Nutrition Action
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1.1 Background

Considerable attention is currently being paid to childhood obesity in New Zealand by both the scientific and the media communities, particularly in light of the recent National Children's Nutrition Survey, which reported that almost one in three New Zealand children aged 5-14 years is overweight or obese. Identifying environmental influences that impact on body weight in children is critical for developing appropriate preventive strategies. One potential environmental factor is the amount of television (TV) watched by children. During the week one-quarter of New Zealand children watch two or more hours of TV each weekday, with higher numbers (40%) watching two or more hours each weekend day.

1.2 Aims

The aims of this report are to evaluate the scientific literature with respect to the following questions:

- Is TV watching associated with increased body weight and obesity in children?
- Is time spent watching other types of screens (besides TV), such as computer games, associated with increased body weight and obesity in children?
- If TV watching is associated with obesity in children, what mechanisms may explain the relationship?

1.3 Methods

Databases of scientific publications and relevant websites were searched for papers published from January 1999 to June 2005, an arbitrary starting point to make the analyses manageable. Only English-language references and human studies were included in the review. The reference lists from papers selected in the literature search were used to identify earlier publications, and recent publications up to December 2005 were also identified. Considerable attention was paid to study design, with intervention studies and longitudinal studies with appropriate sample sizes and adjustment for confounders considered "stronger" evidence than smaller studies or cross-sectional studies. A meta-analysis was not undertaken because the studies were not comparable (Appendix L).

1.4 Studies investigating TV watching and obesity

A total of 66 analyses of data on the association between TV watching and obesity (excluding repeat publications of the same data) were identified. Thirty-two of 42 cross-sectional studies, one of two case-control studies, 10 of 15 cohort studies, and four of seven intervention studies reported a positive association between TV watching and obesity. In total 47 studies reported a positive association, 19 studies reported no association, and no studies reported an inverse association between TV watching and obesity. If no association between watching TV and obesity existed, we would have expected to find several studies in the latter category. Among the studies reporting a positive association is the National Children's Nutrition Survey. Data from the studies reviewed fulfil the most important of the Bradford-Hill criteria used to decide whether there is a cause and effect relationship between watching TV and obesity in children. In particular, a dose-response association was reported in 28 studies indicating that each extra hour of TV watching increases the risk of obesity.

1.5 Studies investigating non-TV screen watching and obesity

Ten studies that had examined whether watching other types of screens (besides TV), such as computer games, was associated with body weight and obesity were identified. Six studies (five cross-sectional, one cohort) reported significant positive associations, and four studies (all cross-sectional) did not find an association. No studies reported a significant inverse association. More research is required to determine if non-TV screen watching is associated with obesity in children.

1.6 Possible mechanisms by which TV watching might contribute to body weight in children

Only two studies that had evaluated the effect of TV watching on resting metabolic rate (RMR) were identified. TV watching decreased RMR in one study and had no effect on RMR in the other.

Findings from studies that examined the association between TV watching and physical activity were inconsistent. Of the 34 studies identified, two reported a positive association, 16 found no association, 15 concluded there was an inverse association, and one had mixed results.

Information from 25 studies on TV watching and dietary intake was more consistent; 19 of these studies reported small but significant associations between TV watching and a less nutritious intake (higher consumption of energy-dense snack foods and/or lower intake of nutrient-rich foods such as fruit and vegetables). Four studies reported no association between dietary intake and TV watching, one study concluded that TV watching was associated with a more nutritious intake and one study did not report appropriate statistics. The national Children's Nutrition Survey is among the studies that reported an association between TV watching and a less nutritious dietary intake.

1.7 Summary and conclusions

- Data from multiple sources show that, on average, New Zealand children are watching more than two hours of TV each day.
- Almost half of year 5 to 10 students in New Zealand report having their own TV. Data from the US and Greece suggest that the presence of a TV in children's bedrooms adds significantly to the total amount of TV viewed each day.
- Few restrictions on advertising to children currently exist in New Zealand; those that do exist refer to the number of advertisements allowed during designated children's TV time rather than addressing nutritional issues.
- Only 4 of the top 60 programmes viewed by 5 to 13-year-old children in 2005 screened during designated children's viewing hours.
- Approximately three out of every four TV food advertisements in New Zealand are for foods counter to improved nutrition.

Conclusion*: New Zealand children are watching large amounts of TV; most of this viewing is occurring outside the hours designated as children's programming times and exposes children to considerable amounts of food advertising.*

- Six out of ten studies reported a positive association between non-TV screen watching and obesity, and more research is required to determine if non-TV screen watching is a risk factor for obesity.

- Thirty-two of forty-two (76%) cross-sectional studies, one of two (50%) case-control studies, 10 of 15 (67%) cohort studies and four of seven (57%) intervention studies reported a positive association between watching TV and body weight (or obesity) in children (71% of studies in total).
- A dose-response association was reported in 28 studies indicating that each extra hour of TV watching increases the risk of obesity.
- Relative risks (or odds ratios) of obesity associated with watching TV are about 2 or higher when children in the highest TV watching category are compared with those in the lowest.

***Conclusion**: There is considerable evidence that watching TV contributes to increased body weight and obesity in children.*

- Watching TV is not associated with a reduction in the resting metabolic rate.
- Although studies do not provide consistent support for the "displacement hypothesis", that watching TV replaces more active pursuits, much of the evidence is cross-sectional and is not based on objective measures of activity.
- Data have been more consistent in demonstrating an adverse effect of TV on dietary intake in children; 19 of 25 studies reported that increased TV viewing was associated with a less nutritious diet (usually expressed as a higher intake of energy-dense foods and/or lower intake of fruit and vegetables).

***Conclusion**: An adverse effect on dietary intake provides the strongest evidence to date explaining the relationship between TV watching and body weight in children.*

- A number of international reports have identified marketing as a probable cause of childhood obesity.

1.8 Recommendations

- On the basis of New Zealand data, children and their families should reduce their TV viewing to one hour per day or less.
- Parents should ensure that alternative entertainment options are available and promoted including creative play, games, reading, playing outside and sports.
- Parents should monitor the TV programmes their child(ren) view.
- Health professionals should spend time educating parents and young people about the impact of TV on their diet and weight and suggest strategies to limit the amount of TV viewed.
- Health professionals and other interested parties should publicise the impact of TV on diet and weight, and advocate for the legislative and organisational recommendations contained in this set of recommendations.
- Schools, parents and community organisations should form partnerships to provide after school or evening activities for students to provide alternatives to TV viewing.
- Schools should include curriculum lessons that target reductions in TV use by students and their families. The Ministry of Education should support schools to implement appropriate curriculum initiatives.
- Research is required to determine the most effective interventions for limiting TV viewing in children.
- The government should legislate against the marketing of high fat, high sugar or energy-dense foods and beverages via TV and its characters.

1.9 Strategies to reduce TV viewing:

- Move the TV set(s) to less prominent locations in the home.
- Remove the TV set from your child's bedroom.
- Place clear limits on how much TV can be viewed.
- Designate certain days of the week to be TV-free.
- Plan an appropriate amount of TV programmes you and the family want to watch at the start of the week and don't watch any others.

2 Background

The widespread prevalence of obesity in children[1], the rapidity of recent increases in the rates of obesity[2-4] and concern that these rates are not declining[5] forecast major health problems as these children reach adulthood. The prevention of obesity in children is of utmost importance given the health consequences of obesity during growth[6] and the intractable nature of obesity in adults[7]. Considerable attention is currently being paid to this issue in New Zealand by both the scientific and the lay communities, particularly in light of the recent National Children's Nutrition Survey (2002), which reported that almost one in three New Zealand children aged 5-14 years is overweight or obese[8], and the recent substantial increases in prevalence observed in 11-12 year old Hawkes Bay children[9].

Recognising environmental influences that impact on body-weight change in children is critical for developing appropriate preventive strategies[10,11]. One such environmental influence may be the amount of TV watched by children; more specifically, the proportion of children watching TV, the number of hours being watched, and the content of the programmes and advertisements broadcast. Interest in the effects of TV is not a new phenomenon; in the late 1970s advocacy groups were concerned 'that TV was creating a generation of fat children with decaying teeth who are intellectually passive, prone to violence and profoundly materialistic'[12]. These ongoing concerns, together with the health statistics reported above, provide a compelling justification for exploring the relationship between TV watching and childhood obesity.

2.1 Aim of report

The aims of the current report are to evaluate the scientific literature with information that addresses the following questions:

- Is TV watching associated with increased body weight and obesity in children?
- Is time spent watching other types of screens (besides TV), such as computer games, associated with increased body weight and obesity in children?
- If TV watching is associated with obesity in children, *how* might it contribute to obesity? Does it decrease the metabolic rate? Does it replace more active pursuits? Does it encourage eating, particularly of less nutritious foods?

Before addressing these questions, we review information on the patterns of TV watching by children in New Zealand.

3 Children Watching TV In New Zealand

3.1 Homes with TVs

The number of homes in New Zealand that have more than one TV set has risen significantly, from just 6% in 1983 to 64% in 2004, with 97% of all homes having at least one TV set[13].

3.2 Hours of TV watched

3.2.1 All age groups

Across all age groups there has been a steady increase over time in the amount of TV watched per day in New Zealand. This has increased from an average of 2 hours 41 minutes in 1992 to 2 hours 53 minutes per day in 2004[13]. Statistics New Zealand's Time Use survey in 1999 reported that TV watching is New Zealand's most popular

Table 1. Mean (standard deviation) television viewing hours in NZ children over time[1]

Age (years)	Boys	Girls
5*	1.9 (1.2)	1.9 (1.4)
7*	1.9 (1.0)	1.7 (0.9)
9*	2.2 (1.0)	2.0 (1.0)
11*	2.6 (1.2)	2.4 (1.1)
13#	3.9 (1.6)	3.5 (1.5)
15#	3.6 (1.8)	3.2 (1.7)
5-15*	2.4 (0.9)	2.2 (0.9)

* weekday average
# daily average of weekdays and weekends

Table 2. Percent of New Zealand children aged 5-14 years watching two or more hours of television per day (2002 National Children's Nutrition Survey)[8]

Age (years)	Percent watching TV ≥ 2 hours per day			
	Boys		Girls	
	Week day	Weekend day	Week day	Weekend day
5-6	18	36	18	30
7-10	27	39	24	36
11-14	31	48	35	45
Total	**27**	**42**	**27**	**39**

leisure time activity. It showed that on average, people watched a total of 2 hours and 47 minutes per day (167 minutes); of these, 119 minutes of viewing occurred as a primary activity and a further 48 minutes a day occurred as a simultaneous activity, undertaken when viewers were also engaged in some other task. The demographic groups found to have spent the greatest amount of time watching TV were the youngest and oldest age groups[14].

3.2.2 Children and young people

New Zealand is fortunate to have multiple sources of data that report TV viewing hours. Interestingly, similar results are apparent from each source, from which it is clear that as a nation, our children watch a lot of TV. New Zealand TV Broadcasting Council data[13] derived from ACNielsen PeopleMeter surveys recorded that in 2005, 5-13 year old children spent an average of 2 hours and 7 minutes watching TV every day, with 40% of children watching more than 2 hours every day, and 5% watching more than 4 hours.

Slightly higher figures were reported in the longitudinal Dunedin Multidisciplinary Health and Development Study[15], which showed that boys watched an average of 2 hours 25 minutes, while girls watched 2 hours 15 minutes. These estimates are based on several data collection points while children were aged 5–15 years (Table 1). Data were collected for weekday viewing only when the children were aged 5-11 years, but weekend data were also collected at 13 and 15 years. Sixty-one percent of the study participants watched TV for an average of more than two hours per weekday when aged 5-15 years. Few children (5.7% of boys and 7.9% of girls) watched less than one hour per day. As Table 1 highlights, considerable increases in viewing hours were observed as both boys and girls grew older.

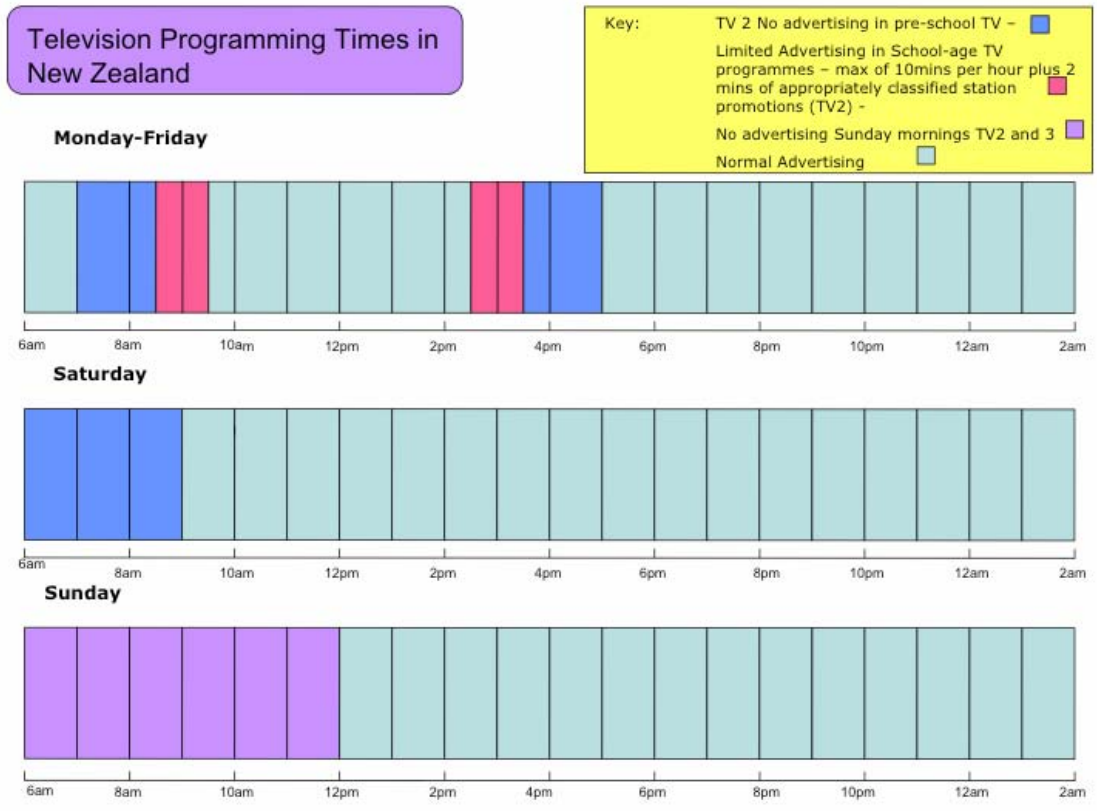
The National Children's Nutrition Survey (2002)[8] reported that 27% of New Zealand children watched more than 10 hours during the week (5% watched more than four hours per day), and 40% watched more than four hours per weekend (7% watched eight hours or more) (Table 2). This study also examined computer or video games, and found that approximately six out of ten New Zealand children did not play these games during the weekend or week; the proportion playing more than 10 hours per week was less than 2% for all ages and genders.

The nationwide New Zealand online CensusAtSchool survey of more than 30,000 year 5 to 10 students at 726 schools (voluntary participation) reported that 74% of respondents watched more than one hour of TV per day while 43% watched more than two hours per day. In addition, 39% spent more than one hour or more at a computer or game console and 18% spent two hours or more. Three-quarters of the children surveyed said they had access to the internet at home and 48% said they had their own TV[16]. This latter point is important given that children with TVs in their bedroom watched significantly more TV overall than children who did not have a TV in their bedroom[17-19]. Based on the reported research, children with a TV in their bedroom watch up to 40 additional minutes of TV per day when compared to those who do not have a TV in their bedroom[18].

3.2.3 United States of America

In comparison, information from the USA which is widely acknowledged as the heaviest TV watching country in the world, shows that up to a quarter of American

Figure 1


Television Programming Times in New Zealand
Key:
TV 2 No advertising in pre-school TV –
Limited Advertising in School-age TV programmes – max of 10mins per hour plus 2 mins of appropriately classified station promotions (TV2) -
No advertising Sunday mornings TV2 and 3
Normal Advertising
Monday-Friday
6am 8am 10am 12pm 2pm 4pm 6pm 8pm 10pm 12am 2am
Saturday
6am 8am 10am 12pm 2pm 4pm 6pm 8pm 10pm 12am 2am
Sunday
6am 8am 10am 12pm 2pm 4pm 6pm 8pm 10pm 12am 2am

children aged 8–16 years watch more than 4 hours of TV each day[7]. In the USA, children spend 10 times as much time watching TV (average of 2.5 hours per day) than they spend participating in vigorous physical activity[20]. However, while a higher proportion of children in the USA are very heavy viewers (over four hours per day), the average number of hours children in both countries spend watching TV is similar. American TV viewing is rising as the number of TVs per household increases and as channel proliferation continues (the average US home can access over 100 channels). A descriptor of TV watching used in the United States is 'constant TV households', where the TV is on in the morning, afternoon and evening and at meal times. Data do not exist in New Zealand for such a phenomenon and it would be useful to have such information.

3.3 How children watch TV

Children are often alone when they watch TV and so adult interpretations are often not brought to bear on TV messages[21]. Despite multiple TVs in the home, direct observations of US families watching TV show that viewing is often shared with other family members, typically siblings rather than parents, and there is very little active mediation by parents. Also, most co-viewing is not driven by a desire to make TV an educational experience, but by issues such as programme preferences[22].

3.4 What influences children's TV viewing patterns

A number of factors influence how much TV is watched by a child. US-based research shows that social status is a key factor: less educated parents watch more TV themselves, and the more TV a parent watches, the more TV their children watch[22]. TV watching levels are higher in children from one-parent families than among children from two-parent families and/or where the mother is unemployed[22]. In the USA, pre-school children from households where the mother was either obese or had depressive symptoms watched significantly more TV than children from other households[23]. There are also known associations with ethnicity, for example in US studies, TV watching is highest among African-Americans, next highest in Hispanics and lowest in Whites[24]. In New Zealand increased child and adolescent TV viewing (age 5–15 years) is associated with lower childhood socioeconomic status, smoking by parents and higher parental body mass[15].

3.5 TV viewing hours designated for children in New Zealand

In New Zealand the Broadcasting Standards Authority has designated "school age children's programming" as 7.00–8.35 am and 3.30–5.00 pm Monday to Friday and Saturday 6.00–9.00 am on free-to-air TV. Pre-school programming is from 8.35–9.35 am and 2.30–3.30 pm Monday to Friday[25] (See Figure 1). However TV viewing data from the ACNielsen PeopleMeter showed that of the top 60 programmes watched by children aged 5–13 years between March and August 2005, only four were screened in designated children's time slots[26]. Further, peak viewing time for children aged 5–13 is from 6.30–9.00 pm in weekends and from 6.30–8.45 pm on weekdays, and significant numbers of children watch TV until 10.00 pm on weeknights and 10.30 pm on weekends[13]. Despite the Broadcasting Standards Authority's programming designations, People Meter data reveals that children's actual TV viewing hours are very similar to adult TV viewing hours.

Advertising levels in school-aged children's programming designations (5- to 13-year-olds) are reduced to a maximum of 10 minutes per hour (from the normal 12.5 minutes), plus two minutes of appropriately classified station promotions[25]. Figure 1 shows the designated programming times for children during which limited restrictions on advertising occur, and for pre-school children during which no advertising is currently allowed.

3.6 TV advertising content

The content of the advertisements broadcast on TV in New Zealand has been analysed in two surveys carried out in 1997 and 2005[27,28]. Both analysed how often and what type of TV food advertisements were shown during viewing hours designated for children. Although the total number of advertisements per hour decreased significantly from 1997 to 2005, the number of food advertisements per hour increased over this time (8.0 to 12.8), resulting in a substantial increase in the *proportion* of food advertisements over time (29% in 1997 to 42% in 2005). To put this into context with other countries, a report of 13 OECD countries revealed levels of food advertising in 1996 were similar to the levels now apparent in New Zealand: USA (11 per hour), the UK (10 per hour) and Australia (12 per hour)[29]. As well as the advertising, Wilson et al[28] also considered food imagery and wording in promotions for TV programmes and in non-food advertisements, which amounted to another 2.3 occurrences per hour.

The 1997 New Zealand survey also considered the theoretical outcome if a child consumed the advertised diet. This analysis revealed that the diet would be too high in fat, saturated fat, protein, free sugars and sodium, and would contain sub-optimal intakes of fibre and numerous micro-nutrients. These patterns were considered to generally reflect the dietary patterns associated with an increased risk of obesity and dental caries in children[27].

New Zealand has a higher proportion of TV advertisements for food that is "high in fat and/or sugar" (80% for TV3 and 69%for TV2) than Australia (54%). Both New Zealand surveys found a high proportion of advertising that was 'counter to improved nutrition', 87.5% in 1997 decreasing to 70.4% in 2005[27,28]. While many would consider this percentage drop a positive sign, it must be balanced against the knowledge that the total number of food advertisements per hour increased from 8 to 12.8. Thus the absolute number of advertisements 'counter to improved nutrition' increased by approximately two per hour between 1997 and 2005.

Regarding advertising regulations, New Zealand has a similar self-regulatory environment to other countries overseen by the Advertising Standards Authority (ASA). The membership of the ASA is made up solely of media and advertising industry representatives and they ask members to voluntarily adhere to a code of conduct. Any complaints about breaches to the code are judged by members of the Advertising Standards Complaints Board members (selected with industry and public input and containing industry and public representatives). Therefore the industry that creates the advertisements also set the rules by which they are judged, and has a role in selecting the jury that assesses any breaches.

In summary, large numbers of New Zealand children are watching more than two hours of TV each day and currently there are few restrictions on TV advertising to

Table 3. Summary of studies reporting data on the association between watching TV and obesity in children*

Study Design	Appendix	Direction of Association			Total
		Positive	None	Negative	
Cross-sectional n (Reference number)	A-C	31 (17-19, 24, 30-51, 58, 59, 73-79)	10 (52-54, 57, 83, 84, 134-137)	0	41
Case control n (Reference number)	D	1 (55)	1 (56)	0	2
Cohort n (Reference number)	E	9 (30, 44, 51, 54, 59, 60, 62-64)	5 (19, 41, 57, 58, 65)	0	14
Intervention n (Reference number)	F	4 (66, 67, 69, 70)	3 (68, 71, 72)	0	7
Total		47	19	0	66

* Repeat publications from the same cross-sectional samples are counted only once: [31] & [32]; [24], [33] & [34]; [35] & [36]. Cross-sectional and cohort data from the same sample are counted separately.

children in New Zealand. Moreover, these restrictions refer to designated children's viewing times, yet data show that the majority of programmes viewed by children are outside of these particular time slots. Finally, TV advertising is self regulated and inappropriate advertisements are judged by a Board containing industry representatives.

4 Is Watching TV Associated With Obesity In Children?

Since the first report in 1985 by Dietz and Gortmaker[30], who described a positive association between time spent watching TV and the prevalence of obesity in children, data on TV and obesity from over 60 studies of children have been published in the scientific literature up to the end of 2005. All major study designs have been reported, including cross-sectional (Appendices A to C), case control (Appendix D), cohort (Appendix E) and intervention (Appendix F). The findings from all studies are summarised in Table 3.

4.1 Cross-sectional studies (Appendices A to C)

Forty-two cross-sectional studies were identified, of which 11 also reported follow-up cohort data (see Appendix E). Because of their large number, they have been separated into:

- *US* studies reporting a *positive* association between watching TV and obesity (Appendix A)
- *non-US* studies reporting a *positive* association between watching TV and obesity (Appendix B)
- studies reporting *no* association between watching TV and obesity (Appendix C).

No cross-sectional studies that reported a negative association between watching TV and obesity in children were identified.

Sixteen US studies reported a positive association between watching TV and obesity (Appendix A). Some national studies have been reported more than once - specifically, the National Heart, Lung, and Blood Institute (NHLBI) Growth and Health Study[31,32], the Third National Health and Nutrition Examination Survey (NHANES III)[24,33,34], and the 1999 Youth Risk Behavior Survey[35,36].

Sixteen studies from outside the US also reported positive associations between watching TV and obesity (Appendix B). These include studies in Canada[37,38], central America[39], Europe[17,40-45], Asia[46-48] and Australasia[49-51]. Three of these, from Thailand[47], New Zealand[50] and Great Britain[44], enrolled nationally representative samples. The New Zealand study is discussed in more detail in section 4.6.

Ten studies failed to find any association between watching TV and obesity (Appendix C). All of these studies have been carried out in the US, with only one using a nationally representative sample[52].

Variation in sample size is one factor that differs between studies finding a positive association and those finding no relationship. Eighteen of 32 (56%, counting separate publications from the same sample only once) studies reporting positive associations had sample sizes greater than 1000 children, compared with 3 of 11 (27%) among those studies reporting no association. Large sample sizes increase the ability to detect

associations between variables and lessen the possibility of a Type-II error (or false-negative result). It is possible that the latter error occurred in some of the small studies in Appendix C (eg. [53,54]).

4.2 Case-Control studies (Appendix D)

Only two case control studies were identified, with one reporting a positive association between watching TV and obesity in children with non-overweight parents[55], while the other reported no association[56]. The finding from the latter study is likely to be due to a Type II error (ie. a false-negative result) because of its very small sample size – only 18 cases and 18 controls. No case-control studies reporting a negative association between watching TV and obesity were identified.

4.3 Cohort studies (Appendix E)

Cohort studies provide better-quality evidence than cross-sectional or case-control studies, because they collect information on exposure (ie. watching TV) at baseline and follow-up the study sample to determine whether exposure predicts the future onset of obesity (usually over the next few years). Fifteen cohort studies were identified, 11 of which also reported data from their baseline cross-sectional samples[19,30,41,44,51,54,57-61] (Appendices A to C).

Ten cohort studies reported a positive association between watching TV at baseline and the subsequent development of obesity[30,44,51,54,59-64]; while the other five reported no association[19,41,57,58,65]. No cohort studies that reported a negative association between watching TV and obesity were identified.

Variations in sample size, in length of follow-up, and in use of statistical methods that increase statistical power may contribute to the inconsistent findings reported. For example, both cohort studies with small sample sizes that reported positive associations[54,63] used statistical methods that included measurements at all time points, such as mixed-model methods or path analysis, so that statistical power was increased. By contrast, the studies by Maffeis et al[41] and Saelens et al[19] did not use these methods and failed to detect an association between watching TV and obesity. However, the study by Robinson et al[57], which also failed to detect an association, appears to have included all data points in the analysis. Of the other studies that failed to detect an association, both of which had large sample sizes, one[65] reported that watching videogames increased subsequent risk of obesity; while the other[58] only followed up children for one year.

4.4 Intervention studies (Appendix F)

Intervention studies provide the strongest evidence that a risk factor (eg. watching TV) causes an outcome (eg. obesity). They directly answer the question: does reducing the amount of TV watching result in decreased levels of obesity? Seven intervention studies provided information that could be used to address this question; of these, four showed a positive effect of the TV intervention on reducing body weight or obesity.

Three of these studies were community intervention studies where the intervention occurred at the school or pre-school level, rather than at the individual level[66-68]. The study by Gortmaker *et al*[66] included multiple interventions against obesity, but used multivariate statistical methods to separate out different behaviour changes. This

study showed that decreased TV watching was the only behaviour associated with decreased obesity in girls in the intervention schools. Robinson[67] targeted reducing TV watching using a variety of strategies and reported that students in the intervention school both decreased the time spent watching TV and also had a smaller age-related increase in BMI compared with students in the control school during the follow-up period.

Dennison *et al*[68] concluded that seven one-hour group sessions at intervention pre-school centres were associated with significant declines in TV watching among intervention children at nine months follow-up, but mean BMI remained unchanged between intervention and control children. It is likely that the sample size (43 intervention and 34 control children) was too small to detect changes in BMI over the nine-month follow-up period. Alternatively, the low levels of TV watching in pre-school compared with older children (about two hours/day compared with more than three hours/day[66,67]) may be too low to show a benefit on body mass index (BMI) from further reductions in TV watching.

In the remaining studies, randomisation took place at the individual level. Two studies[69,70], one of which used the child as her own control[69], showed restricting access by making watching TV contingent on riding a stationary bicycle, which activated the TV set, resulted both in declines in watching TV and also in weight and percent body fat. A study of African-American girls, which combined after school dance classes at community halls with an intervention in the home to reduce TV watching showed reductions in TV viewing among the intervention group. However, the sample size was small (n=61) and was not powered to detect significant differences in BMI[57]. A further study[71] compared reinforcing reductions in sedentary behaviour (eg. praising children when they achieved goals for reduced TV watching) to re-engineering the home environment to reduce sedentary behaviours (eg. having a family rule that homework had to be completed before any TV could be watched). This study reported that both measures resulted in similar decreases in BMI. However, the children substituting sedentary behaviour (eg. watching TV) with physical activity had lower BMI z-scores at follow-up compared with children who did not replace sedentary behaviours with physical activity[71].

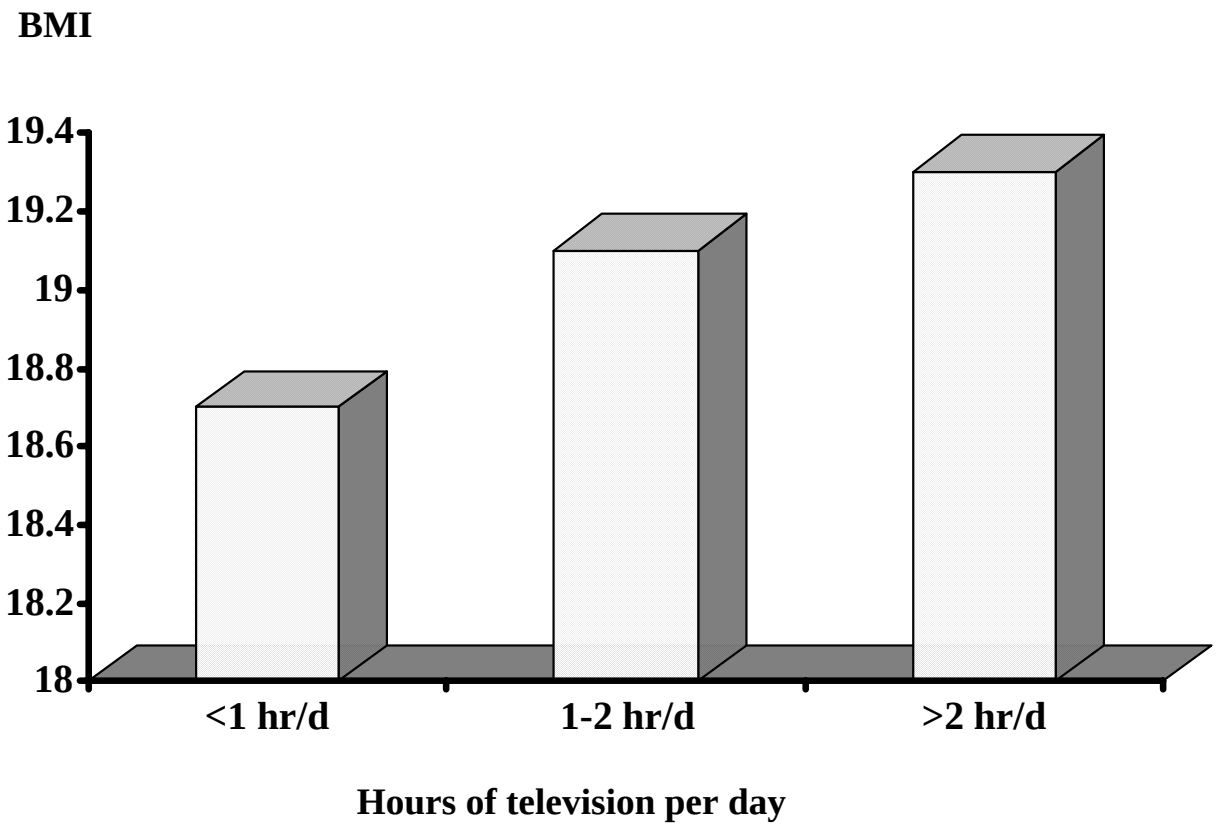
None of the intervention studies examined found that decreasing TV viewing resulted in increased obesity levels.

4.5 Summary

The results of the above studies are summarised in Table 3. Repeat publications from the same sample are only counted once, except for cross-sectional and cohort data from the same sample which are counted separately because they have two sources of data (ie. at baseline for cross-sectional analyses and at follow-up for cohort analyses). A total of 66 analyses were identified, of which 47 reported a positive association between TV watching and obesity, 19 reported no association, and no studies reported an inverse association.

The scientific literature reported above fulfils the most important of the Bradford-Hill criteria used to decide whether there is a cause and effect relationship, in this case between watching TV and obesity in children.

Figure 2. Mean body mass index (BMI) in New Zealand children aged 5-14 years by television viewing (adjusted for age, sex, ethnicity and NZDep).



- *Reversibility*: most of the intervention studies (four of seven in Appendix F) show that reducing the time watching TV results in decreased measures of body weight or obesity. The two studies that did not show an effect of the intervention on BMI had small sample sizes with limited power[68,72] in contrast with the other studies which had larger sample sizes[66,67] or very intensive interventions[69,70].
- *Temporality*: the majority of cohort studies (10 of 15) have shown that baseline measures of TV watching predict subsequent outcome measures of obesity (Appendix E).
- *Consistency*: Table 3 summarises the results of all studies in this report investigating the relationship between TV and increased body weight or obesity in children. More than 70% of the studies reported a positive association between watching TV and obesity. The remainder failed to detect an association, often because of small sample sizes used. Importantly, no study reported an inverse association between watching TV and obesity. Logically, if no association between watching TV and obesity existed, there should have been several studies in the latter category. Because the data could not be presented in a funnel plot (which graphs the size of the study sample against the strength of the association between TV watching and obesity) due to the heterogeneity of statistical methods used, we cannot exclude the possibility of publication bias. However, we believe this is unlikely, and that overall, the weight of evidence from these studies, which were carried out using a range of designs in many countries of the world, supports a positive association between watching TV and obesity in children.
- *Strength of association*: relative risks (or odds ratios) of obesity associated with watching TV are about 2 or higher when children in the highest TV watching category are compared with those in the lowest (eg.[33,34,39,55,73]). Several studies that dichotomised participants above and below a single cut-point for watching TV, reported relative risks or odds ratios of about 1.5 (eg.[35,36,49,58]). However, by using a single cut-point, the latter studies have under-estimated the full range of the true effect from watching TV on obesity risk. Thus, it is reasonable to conclude that there is a moderately strong association between watching TV and obesity in children.
- *Dose response*: many studies (n=28) reported evidence of a dose-response association between the amount of TV watching (often in hours per day) and prevalence or level of obesity. These include US cross-sectional studies[18,19,24,30-33,35,59,73-79]; non-US cross-sectional studies[39-41,43,46]; one case-control study[55]; and most cohort studies that reported a significant positive association between watching TV and obesity[30,51,54,59,61-64].
- *Biological plausibility*: mechanisms exist that explain how watching TV increases obesity risk. These are discussed in section 6.

4.6 The New Zealand evidence

The limited New Zealand evidence is in agreement with the majority of international studies which report positive associations between TV watching and obesity. The main information comes from the 2002 National Children's Nutrition Survey, which is a representative sample of New Zealand children aged 5-14 years[8]. Further analyses of the data collected in this cross-sectional survey show that mean BMI varies significantly ($p<0.01$) with amount of TV watching. Compared with children watching less than one hour per day, children watching one to two hours of TV per day are 0.4 kg/m^2 higher and children watching more than two hours per day are 0.6 kg/m^2 higher, adjusted for age, sex and ethnicity[50] (Figure 1). The real, unmeasured

Table 4. Summary of studies reporting data on the association between non-TV screen watching and obesity in children

	Direction of relationship			
Study design	**Positive**	**None**	**Negative**	**Total**
Cross-sectional n (Reference number)	5 (43, 52, 79, 82, 83)	4 (39, 49, 58, 84)	0	9
Cohort n (Reference number)	1 (65)			1
Total	6	4	0	10

association between TV watching and BMI is likely to be stronger than this because of the attenuation (or weakening) of the association caused by non-differential measurement error arising from measures of TV watching and BMI made at a single point in time[80].

Other important New Zealand data come from the Dunedin longitudinal birth cohort[15,81]. TV viewing was related to BMI in both cross-sectional and longitudinal analyses at each age (5, 7, 9, 11, 13 and 15 years) even after adjusting for gender, parental BMI and socio-economic status (SES). Further analyses[15] from this cohort demonstrate that the effect of TV viewing in childhood may be long-lasting; TV watching in childhood (5-11 years) and adolescence (13-15 years) was positively associated with BMI at age 26 years, and with other adult health factors. This study[15] found that watching TV more than two hours per day in childhood and adolescence explained 17% of overweight, 15% of raised serum cholesterol, 17% of smoking and 15% of poor fitness at age 26 years. These findings are consistent with those observed in a national British study where childhood TV watching predicted BMI in adulthood[44].

5 Is Time Spent Watching Other Types Of Screens (Besides TV), Such As Computer Games, Associated With Obesity In Children?

Ten studies that had examined whether the watching of other types of screens (besides TV) was associated with body weight or obesity in children were identified (Table 4 and Appendix G). Six studies (five cross-sectional, one cohort) reported significant positive associations between non-TV screen watching and obesity, and four studies (all cross-sectional) did not find an association. None of the studies examined reported a significant inverse association.

The definition of non-TV screen viewing varied between studies. Four of the six studies reporting a positive association defined non-TV screen viewing as playing with games – (computer, video or electronic[43,65,82,83]) while the other two reported use of computers aside from homework[79] or included non-game computer use[52]. Of the studies that found no association between non-TV screen watching and obesity, all included non-game use in their definition of non-TV screen use, such as watching videos[39] or using a computer [49,58,84].

It is possible that playing with screen games, rather than using a computer for other tasks (eg. homework) is a risk factor for obesity, although further research is required before a definite conclusion can be drawn. Furthermore, the time spent playing screen games is much less than the time spent watching TV[39,43,49,52,58,79,83], and it maybe difficult to observe an effect of playing screen games that is independent of TV watching. However, a number of studies have reported an association between time spent playing screen games and obesity after controlling for watching TV[43,52,65]. Given the paucity of studies (n=10), more research is required to determine if non-TV screen watching is associated with obesity.

6 How might TV watching contribute to obesity?

Several mechanisms that may explain the link between greater TV watching and overweight in children have been proposed[20,85]. These include suggestions that

Table 5. Summary of studies reporting data on the association between watching TV and physical activity in children

Study Design	Direction of Association				Total
	Positive	None	Negative	Mixed	
Cross-sectional n (Reference number)	1 [100]	14 [24, 38-40, 42, 48, 75, 79, 98, 136, 140-143]	15 [33, 35, 36, 53, 56, 57, 91-97, 138, 139]	1 [99]	31
Case-control n (Reference number)					0
Cohort n (Reference number)	1 [101]	1 [57]	1 [15]		3
Intervention n (Reference number)		2 [66, 67]			2
Total	2	17	16	1	36

*[24] and [33] from same sample (NHANES III), [35] and [36] from same sample (YRBS 1999), [96] and [139] from same sample

- basal metabolic rate is lower watching TV compared with other sedentary activities
- that TV simply replaces more active pursuits
- that TV encourages eating, particularly consumption of less nutritious foods and beverages.

6.1 Does watching TV result in a lowering of the resting metabolic rate?

If watching TV reduces energy expenditure when compared with other sedentary activities, it offers a plausible explanation for the increased incidence of obesity, given the volume of TV watching in Western countries. Klesges et al[86] compared the metabolic rate of 15 obese and 16 normal-weight children at rest with the rate observed while the children were watching TV and reported that TV viewing had a profound lowering effect on resting metabolic rate (RMR): a difference of 211kcal when extrapolated over a day (although it is not clear from this paper how the final estimate was obtained). On the basis of this study, the metabolic rate hypothesis received widespread attention.

A further study[87] also compared RMR in 27 young children under three conditions; resting, reading or watching TV. An advantage of this study over the previous one was that movement and fidgeting were also assessed under each condition using manual observation and activity monitors. These authors[87] showed that RMR in children was similar under the three conditions and that a higher "resting" RMR as observed in the earlier study could be an artefact produced by children fidgeting more than they normally would during the "resting" experimental condition. Thus it appears unlikely that reductions in resting metabolic rate explain the relationship between TV viewing and obesity.

6.2 Does TV decrease participation in physical activity?

The "displacement hypothesis" - that watching TV replaces more active pursuits, and thus may increase the risk of obesity - makes intrinsic sense and has been the subject of several recent reviews[88-90]. However, it is apparent from these reviews and from the studies described in Appendices H to J that many studies have not observed a relationship between increased TV viewing and reduced levels of physical activity in children.

Fifteen studies (16 references) support the displacement hypothesis, demonstrating that watching more TV is associated with lower levels of physical activity (Table 5 and Appendix H). The definition and measurement of TV exposure and participation in activity differed considerably across the studies although all used questionnaires, except DuRant et al[53] who used minute-by-minute direct observation over two to four days. Half were completed in large (over 1000 subjects) representative samples of American[33,35,36,91], Icelandic[92] and Spanish[93] children, a large birth cohort of Japanese children[94], a New Zealand birth cohort[15] and a sample of 1700 children from throughout Chile[95].

Several of these analyses presented odds ratios for children watching two or more hours per day in relation to lower viewing levels; children classified as having a high level of viewing were up to 2.9 times more likely to be classed as inactive/low-active compared with those who watched less TV[35,36,91,93]. While these odds ratios may

appear impressive, it is apparent from studies reporting simple (or adjusted) correlations between TV and activity, that the relationship is relatively weak, with r values generally less than 0.3[15,33,53,56,57,92,95-97].

No relationship between TV viewing time and physical activity was reported in 17 studies while three studies observed a positive or mixed relationship (Appendices I to J and Table 4). Time spent participating in activities was again predominantly assessed by questionnaire, with few exceptions[42,98,99]. The one study in this group from a large representative sample (NHANES III)[24] reported no interaction between physical activity and TV viewing after adjustment for several confounders. This may seem contradictory to the finding of Crespo et al[33] who analysed the same dataset and reported small but significant inverse associations. However, neither study reported this particular analysis in any detail and only Andersen et al[24] appeared to adjust for confounders.

In contrast to the majority of reports in this area, three studies demonstrate a *positive* relationship between TV and activity in children[99-101]. Huston et al [101] analysed the type of programme watched (informative, educational, general audience) and found that time spent playing was positively related to each programme category in two year old children followed for three years whereas significant relationships were only observed for animated TV in the four-year-old cohort, suggesting that TV viewing may facilitate play among younger children, although this effect appears to diminish as children grow older. However, it is clear from Appendices H to J that age does not appear to be a factor discriminating studies reporting positive, versus negative or null findings.

Surprisingly, a comprehensive study of factors affecting TV viewing in young Australian children[99] reported that boys from homes with pay TV had a *lower* risk of being classed as low-active (measured using accelerometry) compared to boys without access to pay TV. The complexity of factors affecting TV viewing is further illustrated by this study, given that rules surrounding TV viewing were a significant risk factor for low activity in boys but a positive influence in girls[99].

Table 5 demonstrates that the majority of studies in this area are cross-sectional in nature, and thus do not provide a strong evidence base. Moreover, assessment of physical activity was almost always questionnaire based, and often only a crude estimate at that. Those studies that utilised more independent measures[42,53,98,99] typically had fewer than 200 participants with the exception of Salmon et al[99]. The only longitudinal studies in this area reported no relationship in adolescent girls[57], a negative relationship in both sexes during adolescence[15] and a positive effect in preschool children[101]. The two interventions targeting reductions in TV viewing by adolescents reported no corresponding increase in physical activity, despite large decreases in time watching TV (5.5 hours per week[67] and 0.6 hours per day[66]).

Although Robinson's[67] finding is perhaps not surprising given that increasing activity was not formally promoted, one of the main aims of the Planet Health[66] intervention was to increase participation in moderate/vigorous activity. However, work by Epstein et al[102] in overweight youngsters demonstrates that targeting reductions in sedentary behaviour is effective if sufficient physically active alternatives are easily available. The observation that children may swap a sedentary behaviour such as TV

Table 6. Summary of studies reporting data on the association between watching TV and dietary intake in children

Study Design	Type of diet associated with TV watching				Total
	Adverse	**None**	**Beneficial**	**Statistics not reported**	
Cross-sectional n (Reference number)	15 (33, 36, 39, 75, 79, 97, 105, 107, 111-113, 144-147)	3 (42, 110, 148)	1 (109)	1 (106)	19
Case control n (Reference number)					0
Cohort n (Reference number)	3 (63, 103, 104)	1 (54)			4
Intervention n (Reference number)	1 (67)				1
Total	19	4	1	1	24

viewing for another sedentary alternative rather than an active option strengthens the view that using a single marker of sedentary behaviour such as TV may be inappropriate[88].

Overall, it appears that increasing TV viewing will not always reduce physical activity and that many children find the time for large amounts of both activities. However, as stated above, many of the data in this area are relatively weak and the lack of a strong relationship between TV viewing and activity in children may be due in part to the known difficulties in accurately assessing physical activity behaviour. It is feasible that measurement limitations may contribute to the relatively small effect noted in a recent meta-analysis[88]. The corrected effect size between TV viewing and physical activity was significant ($p < 0.05$), but small (–0.129). These authors also highlighted that the relationship may be restricted to more vigorous forms of activity, but it is also likely that the relationship with vigorous activity is apparent because more intense activity is less variable and thus, easier to measure[88]. A more detailed understanding of the influences on all types of sedentary activity is necessary to develop effective intervention strategies targeting active lifestyles[89].

6.3 Is TV watching associated with food or nutrient intake?

We found 25 studies in the literature that had directly examined whether TV watching is related to food intake (Table 6 and Appendix K). The studies differed greatly in size, method of dietary assessment and nutrient/food(s) of focus but all investigated measures of actual intake in relation to the amount of TV viewed. Most were cross-sectional, with a few exceptions[54,63,103,104]. However, several cross-sectional studies have been undertaken in large and/or representative samples of children from the US[33,36,79], Spain[105], Greece[106] and New Zealand[107]. Moreover, appropriate adjustment for potential confounding variables was undertaken in all of these analyses except one[106].

Two studies have reported higher energy intakes in children watching large amounts of TV[33,79]. A moderately strong correlation between energy intake and hours of TV was observed in US girls aged 8-16 years ($r = 0.43$, $p < 0.05$), but not in boys ($r = 0.26$, $p < 0.05$). At the extreme ends of the distribution, girls watching five or more hours of TV each day (8% of the sample) had an energy intake 720kJ higher than those watching one hour or less (31% of the sample), even after adjusting for age, BMI, ethnicity, family income and weekly bouts of physical activity[33]. Utter et al[79] found higher energy intakes in both boys and girls watching more TV; boys in the top tertile of TV viewing consumed 344kcal more than boys in the lowest tertile, with corresponding values of 200kcal in girls.

Other analyses in US children[36] demonstrate that high TV viewing increases the risk of a low fruit and vegetable intake (by 35%), although sub-analyses showed this relationship was restricted to White adolescents. Factor analysis in a representative sample of Spanish children and young adults[105] identified five main components of dietary patterns including “Snacky”, “Healthy”, “Protein-rich”, “Meat-rich” and “Ludicrous”. Children aged 2-13 years who watched more than two hours TV per day were more likely to follow the “Snacky” pattern, characterised by more frequent and higher consumption of bakery products, sweets, salted snacks and soft drinks and less likely to follow the “Healthy” pattern (more fruit, vegetables and fish).

In the New Zealand study, hours of TV viewing were used as a proxy for TV advertising to assess relationships between TV viewing and intake of the most commonly advertised foods and beverages[107]. Children aged 5-10 years who watched two or more hours of TV each day were less likely to eat appropriate amounts of fruit and vegetables. These children were more likely to eat or drink soft drinks, fruit drinks, potato crisps, biscuits, hamburgers, French fries or fried chicken more often, even after adjusting for age, sex, ethnicity and socio-economic status. The remaining representative study used a sample of Greek children[106], but no adjustment was made for confounders and appropriate statistics were not reported.

Four longitudinal studies (19 months to seven years) have also investigated whether TV watching directly influences food intake in children. The largest study involved 548 children from the control schools in Planet Health, an obesity prevention initiative[103]. Cross-sectional analyses at baseline showed that fruit and vegetable intake was lower by 0.16 serves per day for each hour of TV viewed. For each additional hour of TV viewed at follow-up, mean serves decreased by a further 0.14 serves per day, after adjustment for a multitude of variables. Two studies examined the intake of energy dense "snack" foods such as baked goods, soft drinks and salted snacks[63,104]. TV and snack food consumption was positively related either as contribution to energy or in terms of frequency of consumption; snack foods contributed almost 2% more kJ to the diet (or 0.13 of a serve) of 8-12 year old girls per hour of TV viewed [104].

Other work[63] has demonstrated that girls who watch more TV also snack more frequently, particularly on high-fat snack foods, which predicts BMI increases from five to nine years of age. The remaining cohort study was relatively small (n=106) but followed participants for seven years and included a more comprehensive assessment of dietary intake with 3-12 days of diet records each year[54]. No clear differences in energy or nutrient intake were observed with exposure to TV at baseline.

Many of the cross-sectional studies were undertaken in very small samples (less than 100 participants)[42,97,108-110], and used food frequency questionnaires or single use 24-hour recalls to assess intake[42,97,109,110] which is inappropriate given the sample size. The remaining cross-sectional studies[39,111-113] involved larger numbers of children (461-1775) but none appear to have adjusted for confounding variables and analyses were often limited[39,111-113]. Marquis et al[113] investigated the frequency of intake of 36 foods in relation to how often children ate in front of the TV. Weak positive associations were observed with the consumption of several energy-dense foods (significant r values ranging from 0.15 to 0.22), including French fries, salty snacks and sweets and negative associations (r values -0.12 to -0.23) with the intake of more nutrient-dense foods such as vegetables, whole-wheat bread, fruit and yoghurt.

It is apparent that the majority of studies have reported that increasing exposure to TV is associated with a less nutritious diet, usually expressed as higher consumption of energy-dense snack foods and/or lower intake of nutrient-rich foods such as fruit and vegetables. Direct comparisons are difficult given the multitude of foods assessed and the different types of analyses undertaken. However, the weight of the stronger evidence provided by the representative or large cross-sectional studies (n=6) and the longitudinal data (n=4) shows that 9 of these 10 studies report a direct relationship

between food intake and TV viewing in children. Thus there is consistency in the data reported, although the relationships are somewhat weak.

Basically, obesity results from an energy intake greater than the individual's requirement. Although it is important to assess potential relationships between types of foods and TV, if TV is related to body weight through an effect on food intake, assessing energy intake in relation to TV exposure is warranted. Unfortunately only three studies have done this[33,54,79]; one found no relationship[54], one found strong relationships in both sexes[79], whereas the other[33] observed a moderately strong relationship in girls only.

7 Marketing And Obesity In Children

It was not within the scope of this report to review the broader influence of marketing on obesity; however, numerous other reviews provide a useful context for this work. A recent ecological analysis on the extent of advertising during children's TV in relation to the prevalence of overweight in several European countries, Australia and the US[114] reported a significant positive association between the number of advertisements per hour for energy-dense, micronutrient-poor foods and the national prevalence of overweight in children ($r = 0.81$, $p < 0.005$), whereas a weaker association was observed with advertisements for healthier foods ($r = -0.56$, $P < 0.10$).

While this ecological analysis did not adjust for confounding factors, it provides a unique international analysis on the potential obesogenic effect of food advertising[114]. A global study on marketing food to children showed that there are six marketing techniques that are widely used by companies to visibly promote food to children[115]; (i) TV advertising, (ii) in-school marketing (eg sponsorship of children's books), (iii) sponsorship of events or activities (eg McDonalds sponsorship of daily best player awards at children's sport), (IV) product placement (eg brand licensing), (v) internet marketing (eg interactive games) and (vi) sales promotions that encourage purchase at the point of sale (eg up-sizing).

7.1 Does advertising affect food preferences and behaviours in children?

According to the World Health Organization, the heavy marketing of energy-dense foods and fast-food outlets is a probable cause of obesity[116]. In the most comprehensive systematic review of evidence, prepared for the British Food Standards Agency, the authors concluded that food advertising can influence children's food preferences, their purchase behaviours and what they eat[117]. The report showed that there was:

- reasonably strong evidence that food promotion influences children's food preferences for high-fat, high-salt or high-sugar foods
- strong evidence that advertising influences purchases and requests for foods high in fat, sugar and salt (first requests start at age two and often for a brand name product)
- some evidence that food promotion increase both brand and category sales, and is not limited to brand switching.
- modest evidence that food promotion influences children's consumption
- some evidence of small but significant associations between TV viewing and diet (see section 6.3)

These findings are supported by a critical review of the evidence prepared for the British Office of Communications, which concluded that:

> *there is a modest body of fairly consistent evidence demonstrating the direct effect of food promotion (in the main, TV advertising) on children's food preferences, knowledge and behaviour. Indirect food promotion may have a greater role than direct food promotion, however this cannot be demonstrated easily, if at all, using the experimental designs required for causal claims. [However] the public will never find it credible that an industry that spends huge sums each year advertising food to children on TV does so with no actual (or intended) effect on children's food consumption*[118].

The Institute of Medicine's review[119] concluded that:

> *the effects of advertising aimed at children are unlikely to be limited to brand choice. Wider impacts include the increased consumption of energy-dense foods and beverages and greater engagement in sedentary behaviours, both of which contribute to energy imbalance and obesity. … [and] that advertising targeted to children under the age of eight is inherently unfair because it takes advantage of younger children's inability to attribute persuasive intent to advertising.'*

This is highlighted by a recent study demonstrating that pre-school children watching videos with embedded advertisements for particular foods were more likely to prefer the advertised product than a similar non-advertised option, than children watching the same video with no advertisements, even when the food was only advertised once during the 30 minute video[120].

Marketing is also specifically targeted at adults to influence their food choices and subsequently those of the whole family. TV advertising targeted specifically at adults is problematic however, because the peak viewing time children watch TV in New Zealand is between 6.00 and 9.00pm. Therefore to protect children, any consideration of advertising of foods restrictions would need to control advertising at most times during the day rather than just at so-called "children's only programming" times. This may also have a flow on benefit of helping adults to choose healthy foods.

Obviously TV viewing is not the only cause of obesity and Lobstein's[114] ecologic study highlights that up to half of obesity prevalence may be due to other factors. A recent review by the Global Alliance on the Prevention of Obesity[121], reported on research that mathematically-modelled the effectiveness of a number of different obesity prevention strategies. The research suggested that a 50% reduction in inappropriate food advertising exposure to 2-12 year old children would result in a 3.2% reduction in obesity in that age group (no other strategy exceeded a 0.5% reduction in obesity). The overall effect would likely be higher if the age group was expanded and/or a greater reduction in exposure to advertising was achieved.

The advertising and marketing industries' belief that parents and children bear sole responsibility for what and how much their children eat is a naïve and obfuscating stance[122]. It flies in the face of public health knowledge about the broad determinants of wellbeing and disease[122], and experience about how society must work in multiple

spheres to tackle public health epidemics[123,124]. For many decades, public health researchers have argued that public health epidemics are best addressed by social and environmental interventions that support healthier behaviour patterns. Applying this approach to obesity leads logically to the conclusion that restrictions on advertising and marketing would remove stimuli that reinforce and prompt eating habits that militate against long-term health. We should remove obstacles to autonomous decision making rather than impose decisions on consumers[12]. The removal of advertisements would provide a clean slate for consumers to truly make their own choices, rather than being manipulated by advertising.

7.2 Is marketing to children restricted in any way in other countries?

New Zealand is one of the few developed countries in the world that does not protect the wellbeing of children from excessive food marketing. Sweden and Norway ban marketing to children under 12, the Province of Quebec bans marketing to children under the age of 13 and Greece has banned advertisements for toys on TV between the hours of 7am and 10pm. Parts of Belgium do not allow advertising within five minutes of a children's TV programme shown on local stations and Finland bans advertisements that include children or familiar cartoon characters. The BBC, under pressure, has recently removed any connections between certain food companies and their children's programming[115].

These countries have started down the "precautionary pathway", implementing modest regulations. The WHO reports that cross-border advertising, switching to adult marketing and switching to non-TV forms of marketing have occurred in such situations. There is little published evidence on the effect of advertising bans on the diets of children (there is one small study showing a positive dietary change after a ban) because there has been little or no evaluation of such a single intervention in a complex environment[115]**.** Although industry argues that such bans are therefore ineffective a lack of evidence clearly does not equal evidence of ineffectiveness. Instead, regulation is a promising intervention as it offers a means of changing the environment in which New Zealanders live and the salience of different food options available to them. For this reason, regulation to restrict marketing activities could be a highly cost-effective option for tackling obesity.

8 Known Social And Health Impacts Of Watching TV

While there is growing interest in the influence of TV watching on obesity, there has been similar interest in the effect of TV on other significant social issues. Thus there is evidence that TV watching is associated with:

- increased aggressive behaviour or willingness to use violence[125]
- increased acceptance that violence is normal[125]
- increased fearfulness and belief the real world is as dangerous as the televised world[22]
- decreased school performance[126] because viewing time replaces study time[127]
- reduced fluency and automatic skills such as reading, particularly children with learning difficulties and other difficulties who need the practice[69]
- increased substance use, early initiation of sexual activity in children and adolescents[125]
- increased risk of type 2 diabetes and abnormal glucose metabolism in adults[128]

- increased physical activity levels the more a child attempts to look like a media personality, presenting both positive and negative implications[129].
- adverse adult health outcomes including an increased risk of being overweight[15,130-133], being unfit, having high blood cholesterol or being a smoker[15] and an increased risk of type 2 diabetes[133].

9 Conclusions and Recommendations

9.1 Summary and conclusions

- Data from multiple sources show that, on average, New Zealand children are watching more than two hours of TV each day.

- Almost half of year 5 to 10 students in New Zealand report having their own TV. Data from the US and Greece suggest that the presence of a TV in children's bedrooms adds significantly to the total amount of TV viewed each day.

- Few restrictions on advertising to children currently exist in New Zealand; those that do exist refer to the number of advertisements allowed during designated children's TV time rather than addressing nutritional issues.

- Only 4 of the top 60 programmes viewed by 5 to 13-year-old children in 2005 screened during designated children's viewing hours.

- Approximately three out of every four TV food advertisements in New Zealand are for foods counter to improved nutrition.

***Conclusion**: New Zealand children are watching large amounts of TV; most of this viewing is occurring outside the hours designated as children's programming times and exposes children to considerable amounts of food advertising.*

- Six out of ten studies reported a positive association between non-TV screen watching and obesity, and more research is required to determine if non-TV screen watching is a risk factor for obesity.

- Thirty-two of forty-two (76%) cross-sectional studies, one of two (50%) case-control studies, 10 of 15 (67%) cohort studies and four of seven (57%) intervention studies reported a positive association between watching TV and body weight (or obesity) in children (71% of studies in total).

- A dose-response association was reported in 28 studies indicating that each extra hour of TV watching increases the risk of obesity.

- Relative risks (or odds ratios) of obesity associated with watching TV are about 2 or higher when children in the highest TV watching category are compared with those in the lowest.

***Conclusion**: There is considerable evidence that watching TV contributes to increased body weight and obesity in children.*

- Watching TV is not associated with a reduction in the resting metabolic rate.

- Although studies do not provide consistent support for the "displacement hypothesis", that watching TV replaces more active pursuits, much of the evidence is cross-sectional and is not based on objective measures of activity.

- Data have been more consistent in demonstrating an adverse effect of TV on dietary intake in children; 19 of 25 studies reported that increased TV viewing was associated with a less nutritious diet (usually expressed as a higher intake of energy-dense foods and/or lower intake of fruit and vegetables).

***Conclusion**: An adverse effect on dietary intake provides the strongest evidence to date explaining the relationship between TV watching and body weight in children.*

- A number of international reports have identified marketing as a probable cause of childhood obesity.

9.2 Recommendations

- On the basis of New Zealand data, children and their families should reduce their TV viewing to one hour per day or less.

- Parents should ensure that alternative entertainment options are available and promoted including creative play, games, reading, playing outside and sports.

- Parents should monitor the TV programmes their child(ren) view.

- Health professionals should spend time educating parents and young people about the impact of TV on their diet and weight and suggest strategies to limit the amount of TV viewed.

- Health professionals and other interested parties should publicise the impact of TV on diet and weight, and advocate for the legislative and organisational recommendations contained in this set of recommendations.

- Schools, parents and community organisations should form partnerships to provide after school or evening activities for students to provide alternatives to TV viewing.

- Schools should include curriculum lessons that target reductions in TV use by students and their families. The Ministry of Education should support schools to implement appropriate curriculum initiatives.

- Research is required to determine the most effective interventions for limiting TV viewing in children.

- The government should legislate against the marketing of high fat, high sugar or energy-dense foods and beverages via TV and its characters.

9.3 Strategies to reduce TV viewing:

- Move the TV set(s) to less prominent locations in the home.
- Remove the TV set from your child's bedroom.
- Place clear limits on how much TV can be viewed.
- Designate certain days of the week to be TV-free.
- Plan an appropriate amount of TV programmes you and the family want to watch at the start of the week and don't watch any others.

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Appendix A: US Cross-sectional studies reporting a *positive association* between TV viewing and obesity in children

Author and year	Subjects	Assessment of TV viewing	Assessment of obesity	Confounders adjusted for	Main results
Dietz and Gortmaker 1985[30] (also cohort)	6965 boys and girls aged 6-11 years from representative US sample (NHES – cycle II)	Parental reports of child watching TV (hours/day)	Skinfold thickness: obesity >85th %; Super-obesity >95th %	Age, parental education and income, race, birth order	Each extra hour per day watching TV associated with 1.2% higher prevalence of obesity and 0.6% increased prevalence of super-obesity.
	6671 boys and girls aged 12-17 years from representative US sample (NHES – cycle III)	Self-reported hours watching TV per day	Skinfold thickness: obesity >85th %; Super-obesity >95th %	Age, parental education and income, race, birth order	Each extra hour per day watching TV associated with 2.2% higher prevalence of obesity and 1.2% increased prevalence of super-obesity.
Shannon et al 1991[74]	489 Caucasian boys and girls aged 11-13 years at 11 schools in Pennsylvania	Self-reported usual TV viewing time over 7 days	BMI & skinfold thickness	Prior BMI, sex, school district aid category	Amount of TV viewing time positively associated separately with BMI and triceps skinfold thickness.
Obarzanek et al 1994[31] Kimm et al 1996[32]	2379 black & white girls aged 9-10 years from 3 US states (NHLBI Growth & Health Study)	Self-reported hours watching TV and video per week	BMI & skinfold thickness	Ethnic-specific analyses, adjusting for age, dietary fat intake, parental income & education	Combined hours of TV & video watching per week associated positively with BMI & skinfold thickness separately, in each ethnic group.
Robinson and Killen 1995[75]	1912 boys and girls in 9th grade at 4 schools in California	Self-reported hours watching TV on usual school and usual weekend day. Included computer/ video games.	BMI	Sex and ethnic specific analyses	TV viewing positively associated with BMI in White boys only (r = 0.22).

Gortmaker et al 1996[73]	746 boys and girls aged 10-15 years in1990 who were children of a representative US sample of women aged 25-32 years	Average of child and parental reports of hours watching TV per day in 1990	BMI based on measured weight (73%) and height (83%) in 1990 (remainder parental-reports); obesity > 85th % for age and sex	Maternal age & income, race, academic scores	Odds of obesity 4.6 times higher in children watching TV >5 hours/day than those watching 0-2 hours/day.
Armstrong et al 1998[76]	588 boys and girls, mean age 9.3 years, 83% White, from 7 schools in California	Separate child and parental reports, 2 months apart. Included computer/video games.	BMI & skinfold thickness	Sex-specific analyses, no further adjustment	Parental reports: higher mean BMI and skinfold thickness in those watching 3 or more hours of TV per day, compared with other children. Child reports: no association between amount of TV watching and either obesity measure.
Andersen et al 1998[24]	4063 boys and girls aged 8-16 years from representative US sample (NHANES III)	Self-reported hours watching TV on day before interview	BMI & skinfold thickness	Sex-specific analyses, with adjustment of Tanner pubertal development score	Daily hours of TV watching associated positively with BMI & skinfold thickness separately, in each sex.
Crespo et al 2001[33]	4069 boys and girls aged 8-16 years from representative US sample (NHANES III)	Average of self-reported hours watching TV on day before 2 separate interviews	Obesity = BMI $\geq$ 95th percentile	Age, race, income, energy intake & physical activity (sex-specific analyses)	Odds of obesity about 2.5 times higher in children watching TV $\geq$5 hours/day than those watching $\leq$ 1 hour/day.

Dowda et al 2001[34]	2791 boys and girls aged 8-16 years from representative US sample (NHANES III) – sample restricted to those with complete information on confounders, including activity and parental weight	Self-reported hours watching TV on day before examination	Overweight = BMI $\geq$ 85th percentile for age and sex	Age, race, physical activity, participation in sports teams, parental BMI, family size, poverty index (sex-specific analyses)	Odds of obesity 1.9 times higher in girls watching TV $\geq$4 hours/day than those watching less; but odds ratio not significantly increased in boys.
Dennison et al 2002[18]	2761 boys and girls aged 1-4 years from families enrolled in supplemental food programme in New York State	Parental reports of child watching TV on weekday and weekend (hours/day)	Obesity = BMI >85th percentile for age and sex	Age, sex, parental education, ethnicity	Odds of obesity increased 6% for each extra hour/day watching TV. Odds of obesity 31% higher for children with TV set in the bedroom than those without.
Eisenmann et al 2002[35]	15,143 boys and girls, aged 14-18 years at representative sample of 144 US schools (1999 Youth Risk Behavior Survey)	Self-reported hours watching TV on an average school day	BMI self-reported; overweight $\geq$ 85th percentile	Age & ethnicity (sex-specific analyses)	Odds of overweight more than 60% higher in children watching TV more than 4 hours/day than those watching 1 hour or less.
Gordon-Larsen et al 2002[58] (also cohort)	12,759 boys and girls, aged 11-19 years in a representative US sample (National Longitudinal Study of Adolescent Health)	Self-reported hours per week watching TV or videos	BMI self-reported; overweight $\geq$ 95th percentile	Age, maternal education, family income, urban residence, smoking, region (sex-specific analyses)	Odds of overweight 49% higher in boys, and 43% higher in girls, for those watching TV more than 35 hours per week than those of the same sex who did not.

Janz et al 2002[77] (also cohort: Janz et al 2005[60])	467 boys and girls aged 4-6 years from families in the Iowa Fluoride Study	Parental reports of child watching TV (hours/day)	Body fat from DEXA scan	Age & height (sex-specific analyses)	TV viewing positively correlated with fat-mass (r = 0.15, 0.22) and percent body fat (r = 0.18, 0.21) in boys and girls, respectively.
Lowry et al 2002[36]	15,349 boys and girls, in grades 9-12 at representative sample 187 US schools (1999 Youth Risk Behavior Survey)	Self-reported hours watching TV on an average school day	BMI self-reported; overweight $\geq$ 95th percentile	Grade, gender, race/ethnicity; overweight definition includes age	Odds of overweight more than 50% higher in children watching TV more than 2 hours/day than those watching less.
Saelens et al 2002[19] (also cohort)	169 boys and girls, from 63 San Diego pre-schools, surveyed at both 6 and 12 years of age	Parental reports of hours watching TV on weekdays and weekend days	BMI z-scores from measured weight and height	Age and gender	Age 6 years: positive correlation between TV hours/day and BMI z-score (r=0.17, p<0.03). Age 12 years: mean BMI z-score higher in children watching TV > 2 hours/day (p<0.03).
Kaur et al 2003[59] (also cohort)	2223 boys and girls aged 12-17 years from representative Californian sample	Self reported hours per day watching TV	BMI% (standardized for age and sex) from self-reported weight and height	Age, sex, ethnicity	BMI percentile value increased by 0.9 for each extra hour of TV watched per day.

Utter et al 2003[79]	4480 boys and girls, mean age 14.9 years, from 31 middle- and high-schools in an urban area in the upper Midwest.	Self reported hours per day watching TV and videos	BMI from measured weight and height	Age, race & SES (sex-specific analyses)	Mean BMI was higher in students watching TV and videos $\geq$ 4 hours /day compared with $\leq$ 1 hour/day (boys 23.3 v. 22.6; girls 23.8 v. 22.8); although these differences remained significant ($p<0.05$) only in girls after also controlling for other sedentary behaviours (computer games, reading).
Levin et al 2004[78]	148 children aged 4 years, 75% African-American, from 5 low-income schools in South Carolina	Parental reports of child watching TV on typical week day and weekend days	BMI	None	Positive association between BMI quartile and hours of TV watched per day.

Appendix B: Non-US Cross-sectional studies reporting a *positive association* between TV viewing and obesity in children

Author and year	Subjects	Assessment of TV viewing	Assessment of obesity	Confounders adjusted for	Main results
Positive Assoc					
Bernard et al 1995[37]	144 boys and girls at elementary and high schools at 2 Cree communities in North Quebec	Self-reported hours of TV watching	BMI from measured weight & height; overweight > 90th percentile	None	Overweight children watched more TV than other children (14.2 vs 11.6 hours/day; p<0.01).
Anastassea-Vlachou et al 1996[17]	4876 boys and girls (age range unknown) recruited from hospital outpatients in Athens and from schools in Athens and the Greek provinces	Self-reported (with parental assistance) hours watching TV per week	Unclear whether weight was measured or self-reported; obesity = weight > 75th percentile for age and sex	None	Heavy TV viewers (>80th percentile for age) had significantly higher prevalence of obesity than other children aged 13+ years (29.9%vs 18.9%, p=0.026). No association between TV and obesity in younger age groups.
Guillaume et al 1997[40]	1028 boys and girls aged 6-12 years at schools in a rural province of Belgium	Self-reported days per week of watching TV	BMI & skinfold thickness	Sex-specific analyses adjusting for age and sports activity	TV viewing positively associated with BMI and skinfold thickness in both sexes, although only significant for BMI in boys (p < 0.05).
Katzmarzyk et al 1998[38]	784 boys and girls aged 9-18 years recruited into the Quebec Family Study	Children recorded activity patterns over 3 days	BMI and skinfold thickness	Sex- and age-specific analyses	Positive association (p < 0.05) between time watching TV and both obesity measures in boys aged 9-12 years (r = 0.17), but not in any other sex-age subgroup

Maffeis et al 1998[41] (also cohort)	112 boys and girls (mean age 8.6 years) from primary schools in Italy	Parents reported the time each day spent watching TV by their child	BMI	Age, gender, energy intake, percent energy from macro-nutrients, vigorous activity & parents' BMI	Time per day spent watching TV positively associated with having a BMI above the 50th percentile ($p = 0.001$).
Hernandez et al 1999[39]	712 boys and girls aged 9-16 years from 7 schools in Mexico	Self-reported hours watching TV on typical week day and weekend days	Obesity = BMI & skinfolds > 85th percentiles	Age, sex, physical activity, watching videos and playing videogames, mother's weight & school	Odds of obesity 1.9 times higher in children watching TV >3.1 hours/day than those watching <1 hour/day.
Grund et al 2001[42]	60 boys and 32 girls aged 5-11 years in Kiel	Parents reported the hours/day watching TV by their child	BMI & body fat (bio-impedance)	None	Children who watched TV > 1 hr/day had a higher BMI (22.0 vs 19.8) and fat mass (30.7% vs 24.5%) than children who watched less.
Guan-Sheng et al 2002[46]	9356 boys and girls aged 4-16 years from schools in 4 cities in eastern China	Child and parental reports of TV viewing time by child	Weight-for height >120%	Sex, age, domicile, income, parental education, breakfast frequency, fast food consumption, desired body size	Children watching TV more than 3 hours/day have about 40% increased prevalence of obesity compared with children watching less than 1 hour/day.
Ruangdaraganon et al 2002[47]	4197 boys and girls aged 6-12 years, nationally representative Thai sample	Parental reports of hours watching TV (including video games) on a typical day	Weight-for height > 2SD above mean	None	Odds of obesity 80% higher in children watching TV more than 3 hours/day than those watching less.

Toyran et al 2002[48]	886 boys and girls (mean age 7.95 years) from 2 Turkish primary schools	Parental reports of hours per day watching TV	BMI & skinfold thickness; obese = BMI > 95th percentile	None	Obese girls watched more TV than non-obese girls (2.9 vs 2.3 hours/day); no association between obesity and TV in boys.
Wake et al 2003[49]	2862 boys and girls aged 5-13 years from 24 schools in Victoria	Parental reports of hours TV watching on average school day and non-school day	BMI; overweight and obesity based on Cole criteria	Age, sex, maternal BMI, maternal education, family size, food intake, activity	Odds of overweight/obesity more than 50% higher in children watching TV more than10 hours/ week than those watching less.
Stettler et al 2004[43]	872 boys and girls, median age 8.0 years, from 10 primary schools in Zurich	Self-reports of TV watched on week days	Obesity based on combined definition of BMI & skinfold thickness	Age, sex, ethnicity, physical activity, use of electronic games, TV eating patterns, breakfast intake, paternal smoking, parental occupation, family size.	Each increased hour/day of watching TV associated with more than doubling in the odds ratio of obesity.
Scragg et al 2004[50]	2778 boys and girls, multi-ethnic sample of NZ children aged 5-14 years	Self and/or parental reports of hours/day watching TV	BMI from measured weight and height	Age, sex, ethnicity, socioeconomic status	Children watching TV > 2 hours per day had higher BMI than those watching < 1 hour per day (19.3 vs 18.7 kg/m^2; p = 0.005)
Burke et al 2005[51] (also cohort)	1430 boys and girls, recruited into Perth (Aust) cohort study in utero, mean age 8 years	Hours per day spent watching TV (probably from parental reports, but not specified)	BMI from measured weight and height; overweight and obesity defined by Cole criteria	Sex	Mean BMI increased by 0.185 units for each extra hour/day of TV watching.

Özdirenc et al 2005[45]	172 boys and girls aged 9-11 years at 1 rural and 1 urban school in Turkey	Parental reports of hours per week watching TV	BMI from measured weight and height	None	Significant positive correlation between BMI and amount of TV watching ($r=0.396$, $p < 0.05$).
Viner and Cole 2005[44] (also cohort)	8158 boys and girls, recruited in 1970 UK birth cohort, mean age 10 years	Parental reports of TV watching: often, sometimes, rarely or never.	BMI from measured weight; obesity defined as BMI $\geq 95^{th}$ percentile	Sex, height, physical activity at 10 years, maternal attitudes to TV , socioeconomic status, birth weight, parental BMI	BMI z-score increased by 0.06 for each extra hour per day watching TV.

Appendix C: Cross-sectional studies (both US and non-US) reporting *no association* between TV viewing and obesity in children

Author and year	Subjects	Assessment of TV viewing	Assessment of obesity	Confounders adjusted for	Main results
Tucker 1986[134]	379 boys (mean age 16.7 years) at school in the US	Self-reported hours per day of watching TV	BMI	Age, year in school, race, parental income	Mean BMI did not differ between heavy (> 4 hr/day), moderate (2-4) and light (< 2) viewers.
Wong et al 1992[135]	1081 boys and girls aged 2-20 years (mean 7.4) attending paediatric clinics in California	Parents reported hours per day their child spent watching TV and playing video games	BMI	None	Mean BMI did not vary with daily hours of TV watching.
Robinson et al 1993[57]	671 girls in grades 6-7 (mean age 12.4 years) at 4 schools in northern California	Self-reported hours per day watching TV after school	BMI and skinfold thickness	Age, race, parent education, parent fatness, physical activity, sexual maturity	No association between hours per day watching TV and either BMI or triceps skinfold thickness.
Wolf 1993[136]	552 girls in grades 5-12 at schools in a town in Massachusetts	Self-reported hours per day of watching TV	BMI (weight and height self-reported)	Age, race	No association between TV watching and prevalence of obesity ($p = 0.47$).
DuRant et al 1994[53] also cohort[61]	110 boys and girls aged 3-4 years enrolled in cohort study in Texas	Trained observers recorded child's activities on 4 days over a year	Average of BMI, girths & skinfold thickness, measured 1 year apart	Sex and ethnicity	Percent of time spent watching TV not correlated with any of the obesity measures.

McMurray et al 2000[83]	2389 boys and girls aged 10-16 years from 18 schools in North Carolina	Self-reported hours watching TV on school and non-school days	BMI (from measured weight and height) & skinfold thickness	Socioeconomic status (SES) and ethnicity (sex-specific analyses)	No association between TV watching and BMI after adjusting for SES and ethnicity.
Proctor et al 2003[54] (also cohort)	106 boys and girls mean age 4 years, 3rd and 4th generation offspring of Framingham Study participants	Parents reported the hours each day spent watching TV and video games by their child	Measurements of weight, height and skinfold thickness	None	Mean BMI and skinfold thickness did not vary between children categorised into tertiles of TV watching.
Giammattei et al 2003[84]	385 boys and girls aged 11-13 year old from 3 schools in California	Self-reported hours of watching TV on school nights	BMI & body fat (bio-impedance)	Age, sex, ethnicity, soft-drink intake	Odds ratio for obesity associated with watching TV ≥ 2hours/night increased, but not significant once adjusted for ethnicity.
Patrick et al 2004 [137]	878 boys and girls aged 11-15 years from 45 primary care providers in San Diego	Self-reports of hours watching TV on non-school days	Overweight = BMI ≥ 85% percentile	Age, ethnicity, household education, physical activity, energy intake	Overweight children watch more TV than other children in univariate analyses, but TV not associated with overweight in multivariate analyses.
Vandewater et al 2004[52]	2831 boys and girls aged 1-12 years (average 6) weighted to be nationally representative of US	Parents recorded the activities of their child watching TV in two 24-hour diaries (weekday & weekend)	Height measured by interviewer, but weight reported by parents	Age, sex, ethnicity, household education and income, other physical activities, and playing electronic games and computers	No association between time watching TV and BMI.

Appendix D: Case-control studies investigating the relationship between TV viewing and obesity in children

Author	Subjects	Assessment of obesity (selection of cases and controls)	Assessment of TV viewing	Confounders adjusted for	Main results
Locard et al 1992[55]	327 cases, 704 controls, both sexes, aged 5 years from schools in two French districts	Weight & height measured. Cases = z-score of weight for height and sex > +2. Controls randomly selected from children with z-score < +2.	Parents reported frequency of child's TV viewing (hours/day)	Children stratified by parental overweight.	Dose-response association between TV viewing and obesity in children with non-overweight parents (OR 2.1 in children watching $\geq$ 4 hr/day compared with those watching $\leq$ 1). No association between TV watching and obesity in children with overweight parents.
Calderon et al 1996[56]	36 (18 cases, 18 controls) Mexican-American girls aged 9-12 years in California	Weight & height measured. Cases > 90th percentile of weight on US growth charts. Controls 25th-75th percentile on growth charts.	Recall of physical activity over 3 days	None.	No difference in mean hours watching TV/day between cases and controls.

Appendix E: Cohort studies investigating the relationship between TV viewing and obesity in children

Author	Subjects	Baseline assessment of TV viewing	Follow-up assessment of obesity	Confounders adjusted for	Main results
Positive association					
Dietz et al 1985[30] (also X-sect)	2153 boys and girls from representative US sample (NHES – cycle II), followed up 3-4 years later when aged 12-17 years (NHES – cycle III)	Parental reports of child watching TV (hours/day)	Skinfold thickness: obesity >85th; Super-obesity >95th	Age, parental education and income, race, birth order, baseline skinfold thickness	Each extra hour per day watching TV at baseline associated with 2.0% increased prevalence of obesity and 0.9% increased prevalence of super-obesity over 3-4 year follow-up period.
Berkey et al 2000[62]	10,769 boys and girls aged 9-14 years in 50 US states who were offspring of Nurses Health Study II participants, followed up 1 year later	Self reported hours per week watching TV (including video/computer games) at baseline and follow up	Change in BMI from self-reported weight and height	Age, race, height growth, baseline BMI, puberty development, diet, physical activity, (sex-specific analyses)	Each extra hour per day watching TV between baseline and follow up associated with significantly increased BMI (about 0.04 BMI units/hour) during one year of follow up in boys and girls separately.
Francis et al 2003[63]	173 white girls aged 5 years in Pennsylvania, followed up at ages 7 and 9 years	Maternal reports of hours watching TV on school days and non-school days at age 7 years	Change in BMI (5-9 years age) from measured weight and height	Snacking frequency, fat intake from snacks, family income	Daily TV watching positively associated with change in BMI only in girls (n=101) from non-overweight families (r=0.29).
Kaur et al2003[59] (also X-sect)	2093 boys and girls aged 12-17 years	Self reported hours per day watching TV	BMI% (standardized for	Age, sex, ethnicity and baseline BMI%	Odds of becoming overweight during 3 year follow up period

	from representative Californian sample, followed up 3 years later (after excluding 130 students overweight at baseline)		age and sex) from self-reported weight and height; overweight >95th %;		more than twice as high in children watching TV more than 2 hours/day at baseline than those watching less.
Proctor et al 2003[54] (also X-sect)	106 boys and girls mean age 4 years, 3rd and 4th generation offspring of Framingham Study participants; followed for mean period of 7 years	Parents reported annually the hours each day spent watching TV and video games by their child	Annual measurements of weight, height and skinfold thickness	Age, sex, & baseline anthropometry	Positive dose-response association between mean hours of TV and video watched during year follow-up period and mean BMI ($p=0.043$) and skinfold thickness ($p=0.028$) at end of follow up; although $p>0.05$ when adjusting further for parental BMI, physical activity and nutrient intake.
Burke et al 2005[51] (also x-sect)	1430 boys and girls, recruited into Perth (Aust) cohort study in utero, mean age 6 years at initial assessment of TV watching; followed for 2 years	Hours per day spent watching TV (probably from parental reports, but not specified)	BMI from measured weight and height; overweight and obesity defined by Cole criteria	Child's sex and physical activity; and maternal obesity, smoking and education	Odds of being overweight or obese increased by about 40% for each extra hour/day of TV watching.
Jago et al 2005[61] (also x-sect: DuRant et al	Tri-ethnic cohort of 3-4 year old children (sample size not	Trained observers recorded child's activities on 4 days	BMI from measured weight and height,	Sex, ethnicity, physical activity, baseline BMI	Hours of TV watched per day significantly associated with increased BMI after 3 years

1994[53]	reported although 110 in DuRant 1994), from volunteer families in Texas, followed for 3 years	each year	measured at the end of each year		follow-up ($p<0.001$), but not in the first 2 years of follow-up, suggesting the effect of TV watching on BMI emerges only at 6-7 years of age.
Janz et al 2005[60] (also X-sect: Janz et al 2002)[77]	378 boys and girls, mean age 5.6 years, volunteers for Iowa bone development study; followed for mean period of 3 years	Parental reports of child watching TV (hours/day)	Body fat from DEXA scan	None	Children in the highest quartile of change in % body fat watched more TV than children in the lowest 3 quartiles (118 vs106 mins/day; $p<0.05$).
Reilly et al 2005[64]	7758 boys and girls, recruited into Avon (UK) cohort study in utero, mean age 3 years at initial assessment of TV watching; followed for 4 years	Parental reports of TV watching (hours/day) at age 3 years	BMI from measured weight and height; obesity defined as BMI $\geq$ 95th percentile	Sex, maternal education, energy intake at 3 yrs, intrauterine and perinatal factors, infant feeding and weaning practice, parental obesity	Children watching TV > 8 hours per day at 3 years age have 55% increased odds of being obese at 7 years compared with children watching < 4 hours per day.
Viner and Cole 2005[44] (also x-sect)	8158 boys and girls, recruited in 1970 UK birth cohort, mean age 5 years at initial assessment of TV watching; followed for 5 years	Parental reports of TV watching (hours/day) at age 5 years	BMI from measured weight and height at 10 years; obesity defined as BMI $\geq$ 95th percentile	Sex, height, physical activity at 10 years, maternal attitudes to TV , socioeconomic status, birth weight, parental BMI	Odds of obesity increased 10-12% for each extra hour per day watching TV.

No association					
Robinson et al 1993[57] (also x-sect)	279 girls in grades 6-7 (mean age 12.4 years) in control arm of intervention study at 4 schools in northern California, followed up 7, 14 and 24 months later	Self-reported hours per day watching TV after school	Change in BMI and skinfold thickness	Age, race, parent education, parent fatness, physical activity, sexual maturity	No association between hours per day watching TV at baseline and change in either BMI (p=0.82) or triceps skinfold thickness (p=0.67).
Maffeis et al 1998[41] (also x-sect)	112 boys and girls (mean age 8.6 years) from primary schools in Italy, followed up 4 years later	Parents reported the time each day spent watching TV by their child	Change in BMI	Age, gender, energy intake, percent energy from macro-nutrients, vigorous activity & parents' BMI	Time per day spent watching TV at baseline not associated with change in BMI (p>0.05).
O'Loughlin et al 2000[65]	2218 boys and girls at 16 Montreal schools, aged 9-12 followed for 1 year; of which 633 aged 9-11 were followed for 2 years	Students reported number of TV programmes watched on school days	BMI measured; excess weight gain defined as being in the highest decile for change in BMI	Age, grade, year of cohort, school, physical activity, times per week playing video games (sex-specific analyses)	TV watching not associated with excess weight gain over 1 or 2 years.
Gordon-Larsen et al 2002[58] (also x-sect)	12,759 boys and girls, aged 11-19 years, representative US sample (National Longitudinal Study of Adolescent Health), followed up for 1 year	Change self-reported hours per week watching TV or videos	BMI measured; overweight $\geq$ 95th percentile	Age, maternal education, family income, urban residence, smoking, region (sex-specific analyses)	Odds of overweight at follow up not associated with change in TV/video viewing (p>0.05).

Saelens et al 2002[19] (also x-sect)	169 boys and girls aged 6 years, from 63 San Diego pre-schools, followed up for 6 years	Parental reports of hours watching TV on weekdays and weekend days, at baseline and at follow up	Change in BMI z-scores, from measured weight and height at baseline and follow up	Age and gender	No association between baseline TV watching and BMI z-score at follow up, nor between change in TV watching and change in BMI over 6 year follow up period.

Appendix F: Intervention studies investigating the relationship between TV viewing and obesity in children

Author	Subjects	Intervention	Assessment of obesity	Confounders adjusted for	Main results
Gortmaker et al 1999[66]	1295 boys and girls (mean age 11.7 years) from 5 intervention schools and 5 control schools in Boston	Multiple interventions against obesity at the school level for 2 school years (1.75 calendar years): decreasing TV viewing and intake of high fat foods, increasing fruit and vegetable intake and physical activity	Measured weight, height & triceps skinfold thickness (TSF): obesity = both BMI & TSF $\geq$ 85th percentile for age and sex	Age, ethnicity, intervention status, baseline obesity (sex-specific analyses)	Prevalence of obesity in intervention schools, compared with controls schools, reduced among girls (odds ratio = 0.47, p=0.03) but not in boys (odd ratio = 0.85, p=0.48). Decreased TV viewing was the only intervention to explain the decreased obesity prevalence in intervention schools.
Robinson 1999[67]	192 boys and girls (mean age 8.9 years) from 1 intervention school and 1 control school in San Jose, California	Decreasing TV & videotape watching and video-game use by limiting access to TV sets and educating children in school to use TV and video-games selectively, for 1 school year (8 months)	Measured BMI (from weight, height), triceps skinfold thickness, waist & hip circumference	Age, sex and baseline anthropometry measure	Mean change in BMI, triceps skinfold thickness and waist circumference significantly lower in students at intervention school compared with control school. TV watching and video-game use (not video watching) decreased more in intervention children than control.
Jason and Brackshaw 1999[69]	N-of-1 intervention study with 11 year old girl n Chicago who was overweight	Riding a stationary bicycle for 60 minutes each day in return for watching 60 minutes	Measured weight	None	Weight decreased by 9.1 kg (20 lbs). TV viewing declined from mean 4.4 hours/day at baseline

	and watched > 4 hours of TV per day	of TV, for about 3.5 months			to mean 0.7 hours/day during follow up.
Faith et al 2001[70]	9 boys and girls (5 intervention, 4 control) aged 8-12 years with BMI > 85th percentile for age and sex	Riding a stationary cycle at 50% VO_2max to activate the TV for watching, for 10 week intervention period	BMI, body fat (DEXA or bio-impedance)	None	Percent body fat decreased in intervention group (-1.2%) compared with control group (+0.9%, p=0.06). Mean TV viewing significantly lower in intervention group.
Robinson et al 2003[72]	61 African-American girls from low-income families in San Francisco, aged 8-10 years, with BMI $\geq$ 50th percentile for age	Combination of attending after school dance classes (46% attended $\geq$ 2 / week), and reducing TV watching using electronic TV managers (which limited amount watched), a 2-week turnoff, and 'intelligent viewing"; for 12 week period.	BMI and waist circumference	Baseline anthropometry level	Significant decline in TV viewing among intervention group. However, no significant changes in mean BMI and waist circumference between intervention and control groups (p>0.05). However, study not powered to detect differences in anthropometry, since it was a pilot study to assess feasibility of the intervention to reduce TV viewing.
Dennison et al 2004[68]	77 boys and girls aged 2-5 years at 16 pre-school centres (8 intervention, 8 control) in New York State	Seven 1-hour sessions at intervention centres aiming to decrease TV watching, for 9 months	BMI, triceps skinfold thickness	Age, sex, baseline anthropometry level	Significant decline in TV viewing among intervention group. However, no significant changes in mean BMI and skinfold thickness between intervention and control groups (p>0.05)

Epstein et al 2004[71]	63 boys and girls aged 8-12 years with BMI > 85th percentile	Families of children randomised to either have reinforcement for reducing sedentary behaviour (TV, videogames, computer use) or have stimulus control by re-engineering the home environment for sedentary behaviours; for 6 month intervention period, with follow-up at 12 months.	BMI z-score based on value for 50th percentile BMI for age and sex	Age, sex, socioeconomic status	No difference ($p>0.05$) in BMI z-score for groups receiving either reinforcing reduced sedentary behaviours or stimulus control of sedentary behaviour (=intention-to-treat comparison). However, children who substituted sedentary behaviour with increased physical activity had significantly lower BMI z-score at 12 months follow-up than those who did not ($p<0.02$).

Appendix G: Cross-sectional and cohort studies investigating the relationship between watching other types of screens (besides TV) and obesity in children

Author and year	Subjects	Assessment of non-TV Screen viewing	Assessment of obesity	Confounders adjusted for	Main results
Positive association					
Cross-sectional					
Shaimai et al 1993[82]	3063 boys and girls at elementary schools in 9 Japanese cities	Parental reports of ownership and use of computer games	BMI (unclear whether weight and height measured or reported)	Sex-specific analyses	Obese boys more likely to own computer games than lean boys (90.6% v. 71.7%), and more likely to use them everyday (29.6% v. 17.8%). Similar association in girls, although not significant ($p>0.05$).
McMurray et al 2000[83]	2389 boys and girls aged 10-16 years from 18 schools in North Carolina	Self-reported hours playing video games on school and non-school days	BMI (from measured weight and height) & skinfold thickness	Socioeconomic status (SES) and ethnicity (sex-specific analyses)	Positive association between hours per day of video game play and BMI, after adjusting for ethnicity and SES in boys ($p=0.019$) but not in girls.
Utter et al 2003[79]	4480 boys and girls, mean age 14.9 years, from 31 middle- and high-schools in an urban area in the upper Midwest.	Self reported hours per day using a computer (not for homework)	BMI from measured weight and height	Age, race & SES (sex-specific analyses)	Mean BMI higher in students using a computer > 2 vs $\leq$ 0.5 hours/day in girls (24.1 vs 23.1, $p < 0.05$) controlling for race, SES, age and other sedentary behaviours (reading, TV) but not in boys (23.1 vs 23.2, $p > 0.05$).

Stettler et al 2004[43]	872 boys and girls, median age 8.0 years, from 10 primary schools in Zurich	Self-reports of hours per day playing electronic games	Obesity based on combined definition of BMI & skinfold thickness	Age, sex, ethnicity, physical activity, watching TV, TV eating patterns, breakfast consumption, paternal smoking, parental occupation, family size.	Each increased hour/day of playing electronic games associated with approximate doubling in the odds ratio of obesity (OR = 1.92).
Vandewater et al 2004[52]	2831 boys and girls aged 1-12 years (average 6) weighted to be nationally representative of US	Parents recorded the activities of their child playing electronic games on video game consoles/computers, and using computer for any other use, in 2 24-hour diaries (weekday & weekend)	Height measured by interviewer, but weight reported by parents	Age, sex, ethnicity, household education and income, other physical activities, and watching TV.	Positive curvilinear association between hours playing electronic games and BMI ($p < 0.05$); but hours using a computer not related to BMI.
Cohort					
O'Loughlin et al 2000[65]	2218 boys and girls at 16 Montreal schools, aged 9-12 followed for 1 year; of which 633 aged 9-11 were followed for 2 years	Students reported frequency each week of playing video games	BMI measured; excess weight gain defined as being in the highest decile for change in BMI	Age, grade, year of cohort, school, physical activity, hours per day watching TV (sex-specific analyses)	Odds of excess weight gain at 1 year follow-up 2.5 times higher in girls playing video games every day compared to those playing less than daily; association not significant at 2 years. Video game use not associated with excess weight gain in boys at either time.

No Association					
Cross-sectional					
Hernandez et al 1999[39]	712 boys and girls aged 9-16 years from 7 schools in Mexico	Self-reported hours watching videos and playing video games on typical week day and weekend days	Obesity = BMI & skinfolds > 85th percentile	Age, sex, physical activity, watching TV, mother's weight & school	Hours watching videos and playing video games not associated with odds of obesity ($p < 0.05$).
Gordon-Larsen et al 2002[58]	12,759 boys and girls, aged 11-19 years in a representative US sample (National Longitudinal Study of Adolescent Health)	Self-reported hours per week using a computer or playing video games	BMI self-reported; overweight $\geq$ 95th percentile	Age, maternal education, family income, urban residence, smoking, region (sex-specific analyses)	Odds of overweight similar in students using computers and/or videogames $\geq$ 4 hours per week compared with those of the same sex using them less.
Giammattei et al 2003[84]	385 boys and girls aged 11-13 years from 3 schools in California	Self-reported hours of using a computer or playing video games on school nights	BMI & body fat (bio-impedance)	None	Computer use and playing video games not associated with BMI ($p = 0.44$) or with percent body fat ($p = 0.87$).
Wake et al 2003[49]	2862 boys and girls aged 5-13 years from 24 schools in Victoria	Parental reports of hours using video games/ computer on average school day and non-school day	BMI; overweight and obesity based on Cole criteria	Age, sex, maternal BMI, maternal education, family size, food intake, activity	No association between hours per day using video games/ computer and odds of obesity and overweight.

Appendix H: Studies reporting a *negative relationship* between TV viewing and physical activity in children

Author	Subjects	Methods	Confounders adjusted for	Main results
Cross-sectional				
Robinson et al 1993[57]	671 6th- and 7th grade girls from 4 California high schools for baseline analyses and 279 girls from control cohort for longitudinal analyses	Asked how long spent watching TV after school. Physical activity assessed by creating score from two questions: how many days per week they exercised long enough to work up a sweat and how active they considered themselves relative to their peers (4 possible responses).	Age, ethnicity, sexual-maturity adjusted BMI, level of parental education, baseline sexual-maturity adjusted BMI	Weak negative cross-sectional association between TV time and physical activity (explained less than 1% of the variance, p = 0.043). See Appendix I for longitudinal analysis.
DuRant et al 1994[53]	191 children aged 3-4 years from Texas	Physical activity and TV time (minute to minute) assessed by direct observation for up to 4 days (6-12 hours/day, Children's Activity Rating Scale).	Sex, ethnicity and month	Percent of minutes watching TV to total time observed weakly negatively correlated with time in physical activity (r = -0.19 for CARS 3-5 and r = -0.27 for CARS 4-5). Physical activity lower during TV time than non-TV time both inside and outside the home.
Pate et al 1996[91]	4293 adolescents aged 12-18y from 1990 Youth Risk Behavior Survey	Low active (n=1641) those who reported <2 light (active for at least 20 mins at level which made you breathe a little more than usual) and no hard (active for at least 20 mins at level that made you breathe heavily and heart beat fast) activity sessions in past 14 days. High active (n=2652) defined as those with 6 or more	Age, sex, ethnicity, health behaviours and interactions between all variables	Ethnic differences in relation between TV watching and activity. White adolescents watching 3 or more hours of TV were twice as likely to be low active as those watching <3 hours (OR, 95% CI 1.99, 1.57-2.53) whereas African-American adolescents watching

		hard and 6 or more light days in past 14 days. Health behaviours by questionnaire.		more TV were less likely to be low-active (0.47, 0.36-0.61. No relationship in Hispanic adolescents.
Trost et al 1996[96]	365 5th-grade students from South Carolina, 73% African-American, 26% White	After school physical activity and TV time assessed by Previous Day Physical Activity Recall on 3 consecutive days. Students listed main activity undertaken every 30 mins from 3pm-11.30pm and indicated whether intensity was very light, light, medium or hard. See Pate 1997[139] for definition of moderate and vigorous activity.	Sex	Significant negative association between TV time and moderate ($p = 0.001$) or vigorous ($p = 0.001$) activity.
Calderon et al 1996[56]	36 Mexican-American girls aged 9-12y, 18 normal weight and 18 obese	Physical activity and TV minutes assessed from 3-day recall.	None	Significant negative association between TV time and minutes of physical activity ($r = -0.34$, $P = 0.04$).
Bungum and Vincent 1997[138] (abstract only)	852 US female adolescents 14-18y, mixed ethnicity	7-day recall of physical activity, 83-item questionnaire	Unclear	Viewing 2 or more hours of TV per night negatively influenced activity but data not shown in abstract.
Pate et al 1997[139]	361 fifth-grade children (median age 11y) from South Carolina (69% African-American)	See Trost 1996[96] for technique. Moderately active defined as having at least 2 30-mins blocks at an intensity of 3 METS or higher. Vigorously active defined as having 1 or more 30-min blocks at intensity of 6 METS or higher.	Age, sex, ethnicity, and their interactions, and several psychosocial and environmental variables	Those watching ≥ 3 hours TV more likely to be low-active than those watching < 3 hours whether used moderate (OR, 95% CI: 2.89, 1.68-4.96) or vigorous (2.25, 1.33-3.81) classification of activity.
Vilhjjalmsson and Thorlindsson	Representative national sample of	TV (5 point scale from do not watch TV to 4 or more hours per day) and physical	Sex, attitudes to activity, activity of	Physical activity was not correlated with TV viewing in simple analysis

1998[92]	1131 Icelandic adolescents aged 15-16 years	activity (how often and how many hours participated in sports and physical activities) assessed by questionnaire	family members, and social variables	(r = -0.055, p > 0.05) but significant negative relationship was observed once adjusted for confounding factors (Beta = -0.19, p < 0.01).
Tanasescu 2000[97]	53 prepubertal Puerto Rican children living in the US aged 7-10 years	TV on weekdays and weekends assessed by questionnaire. Physical activity assessed by 13-item questionnaire. Caregivers also asked to classify child's usual level of activity as sedentary, low, average, active or very active.	None	No correlation between weekday or weekend TV time and physical activity score but was negatively related to simple parental rating of activity (r = -0.38, p = 0.005, significant in girls only).
Lasheras et al 2001[93]	Representative sample of 1358 Spanish children aged 6-15 years	Parental report of child's level of activity (5 possible categories) and TV time (4 possible categories). Active children defined as those who participated in physical activity or sports several times per week.	None	Those watching > 3h TV/day not more likely to be inactive compared with those watching <1h (OR, 95% CI: 1.27, 0.77-2.10).
Crespo et al 2001[33]	4069 children aged 8-16y from NHANES III survey	Activity assessed by asking how many times per week they participated in activity which made them breathe hard or sweat. Height and weight by standard techniques. Asked how many hours TV was watched on previous day (asked on 2 days 1-3 weeks apart).	Unclear but appears none	Was small but significant inverse correlation between TV and PA in boys (beta = -0.06, p = 0.02) and girls (beta = -0.078, p = 0.01).
Lowry et al 2002[36]	Representative sample of 15,349 US adolescents aged 14-18 years from Youth Risk Behaviour Survey 1999	Single question regarding how many times in past week participated in moderate activity for at least 30 mins a time and vigorous activity at least 20 mins a time. Self-reported height and weight. Past week fruit and vege intake assessed using	Grade, gender, ethnicity, overweight (yes/no) and fruit/vegetable intake (< 5	Watching > 2 hours/day TV was associated with an increased risk of sedentary lifestyle: OR, 95% CI 1.20, 1.03-1.41. Further analyses by ethnicity showed that the risk was significantly increased in White

		6 questions (7 response categories). TV time assessed by single question asking how many hours of TV watched on typical school day.	serves/d or not)	adolescents (OR1.29) and decreased in Black adolescents (OR 0.82). No relationship was observed in Hispanic adolescents.
Eisenmann et al 2002[35]	Representative sample of 15,143 US adolescents aged 14-18 years from Youth Risk Behaviour Survey 1999	Asked how many times in past week participated in moderate activity for at least 30 mins a time and vigorous activity at least 20 mins a time. TV time assessed by single question asking how many hours of TV watched on typical school day.	Age, ethnicity	Girls who participated in moderate activity 3-5 days/week were more likely (OR 1.42, P<0.05) to watch ≥ 4 hours/day TV than girls who participated 6-7 days/week. OR for < 2 moderate activity sessions 1.93 (p < 0.05). Results for boys for moderate and vigorous activity < 2 days per week 57 and 54% more likely to watch more TV.
Olivares et al 2004[95]	1701 Chilean children aged 8-13 years	TV time assessed by asking children how many hours they spent watching TV on a typical school day and weekend day. Were also asked about the frequency of after school physical activities such as jogging, sports or bicycle riding.	Age and sex	Negative relation between TV time and after school physical activity reported (P<0.001) but data not shown.
Hancox 2004[15]	Almost 1000 children from a birth cohort in Dunedin, NZ assessed at 3, 5, 7, 9, 11, 13, 15 and 26 years	Parents asked how much time children spent watching TV on weekdays at ages 5-11. At 13, 15 and 21 years, participants were asked how long they spent watching TV on weekdays and weekends. Physical activity assessed at 15 years by questionnaire.	Sex	Activity was not correlated over overall childhood viewing (5-15 years) but was negatively associated with adolescent viewing (r = -0.09, p = 0.01).

Chen et al 2005[94]	7887 Japanese children aged 12-13 years from a birth cohort study	Assessed health-related quality of life in relation to lifestyle variables. Children asked how often participated in physical activity on 4-point scale (from almost never to very often). TV time assessed by asking children how much TV they watched each day typical (4 response categories from 0-2 hours to >4h).	Age, sex, BMI, social background and somatic symptoms	Longer TV time associated with poor quality of life in physical fitness.

Appendix I: Studies reporting *no relationship* between TV viewing and physical activity in children

Author	Subjects	Methods	Confounders adjusted for	Main results
Cross-sectional				
Wolf et al 1993[136]	Multiracial sample of 552 US girls in grades 5-12 from low to medium income town	Physical activity by self-reported questionnaire assessing frequency of participation in mild, moderate and strenuous exercise. Number of TV hours viewed per day (6 possible response categories).	Age and ethnicity	TV viewing not related to physical activity adjusting for age ($r = -0.15$, $p = 0.26$) or age and ethnicity ($r = -0.049$, $p = 0.40$).
Sallis et al 1993[98]	201 Mexican-American and 146 Anglo-American families with 4 year old children from San Diego	Physical activity assessed by minute-by-minute direct observation for 4 x 1-hour periods in the early evening. Coded as lying, sitting, standing, walking or very active. Parents reported typical week's TV of their child.	Sex, ethnicity and SES	TV hours per week not related to child's physical activity ($p = 0.36$).
Robinson and Killen 1995[75]	1912 9th grade students from 4 Californian high schools	Students asked to estimate number of hours (1-12 possible responses) they spent watching TV on a usual school day and usual weekend day. Also asked how many days per week they exercised long enough to work up a sweat.	Sex and ethnicity	No significant association between TV time and physical activity.
Guillaume et al 1997[40]	1028 children aged 6-12 years from a rural area in Belgium	Children asked the number of days and hours per day TV usually watched, and the duration and frequency of participation in two main sport activities during leisure-time.	Unclear but appears none for this analysis	Reported that no significant correlations between sports activities and TV watching but data not shown.

Andersen et al 1998[24]	4063 US children aged 8-16 years from nationally representative sample (NHANES III)	Children were asked how many times a week they played or exercised enough to make them sweat or breath hard and how much TV they had watched the previous day.	Age, sex, ethnicity, stage of puberty	Multivariate analyses showed no interaction between physical activity and TV time.
Katzmarzyk et al 1998[38]	784 Canadian children aged 9-18 years from Quebec Family study	TV time assessed by questionnaire (typical week). Physical activity from 3-day activity diaries (including 1 weekend day). Fitness by several measurements including muscular strength/endurance and cardiovascular endurance	Age and sex	No correlation between TV time and participation in moderate/vigorous activity or estimated energy expenditure. Some age and gender groups showed weak (r values < 0.30) correlations with some fitness variables but these were not consistent.
Hernandez et al 1999[39]	461 Mexican children aged 9-16y from a low and middle-income town	Time in moderate and vigorous activity by 15-item questionnaire. Height, weight and triceps skinfold by standard techniques. TV and video/ videogame time by 11-item questionnaire.	Unclear but appears none for this analysis	Physical activity and TV time not related but data not shown.
Lindquist et al 1999[140]	107 children (49% African-American, 51% White) aged 6.5-13 years from Alabama	Questionnaire assessed past-year physical activity (as percentiles for analysis) and past-week activity (how many days in past week participated in activity for at least 20 mins which resulted in breathing hard and sweating. PE exercise (mins/week) and participation in sports teams (yes/no) assessed. Parents reported hours/day TV.	None for simple analyses reported here.	TV viewing was not associated with any activity or fitness variable.

Grund et al 2001[42]	60 prepubertal German children aged 5-11 years	24-hour energy expenditure measured using heart rate monitoring and VO2 max testing, Resting energy expenditure (REE) by indirect calorimetry. Physical activity level = Total EE/REE. Height and weight by standard techniques	None	No differences in physical activity level were noted between children watching TV < 1hr/day and > 1hr/day
Toyran et al 2002[48]	886 Turkish children aged 7-9 years	Asked parents about the number of vigorous exercise sessions children participated in per week. Active defined as 3 or more per week. Height, weight and triceps skinfolds by standard techniques. TV time by questionnaire to parents re weekday and weekend activity.	None	Mean TV time did not differ among active and non-active children.
Sjolie and Theun 2002[141]	88 adolescents aged 14-16 years from two areas (1 rural, 1 urban) in Norway	Questionnaire asked about travel to school, hours of TV usually watched each week and frequency and duration of specific activities including heavy work, sports and activity.	None for simple analyses	No relationship between TV time and active transport to school or sports hours of physical activity.
Gray and Smith 2003[142]	155 Native American children aged 5-18 years	Physical activity and TV time by questionnaire, fitness by multiple tests, height and weight by standard techniques.	None	No correlation between amount or frequency of TV and activity level or fitness
Utter et al 2003[79]	4480 boys and girls, mean age 14.9 years, from 31 middle- and high-schools in an urban area in the upper Midwest.	Time in 3 sedentary behaviours (TV, reading, computer (non-homework) assessed on weekdays and weekends by questionnaire. Time in strenuous, moderate and mild intensity activity assessed by 3 questions.	Age, race & SES (sex-specific analyses)	No association between TV time and physical activity.
Burdette and	3141 3-year old US	Mothers asked how many hours their child	None	TV time and outdoor playing time

Whitaker 2005[143]	children from a birth study cohort	played outside and how many hours TV watched on average weekday and weekend day		not related (data not shown)
Cohort				
Robinson et al 1993[57]	279 girls from control cohort with 1 or more follow-ups at 7, 14 or 24 months	Asked how long spent watching TV after school. Physical activity assessed by creating score from 2 questions: how many days per week they exercised long enough to work up a sweat and how active they considered themselves relative to their peers (4 possible responses).	Age, ethnicity, sexual-maturity adjusted BMI, level of parental education, baseline sexual-maturity adjusted BMI	No significant relationship in longitudinal analyses.
Intervention				
Robinson 1999[67]	192 3rd and 4th grade US children (mean age 8.9 years) in reducing TV intervention	Child-recall of TV time yesterday (2 occasions) and last Saturday. Parents also estimated usual TV time on typical school day and weekend day. Physical activity assessed by children via 2 days of recall of specific out of school activities (list of 36 activities provided). Parents estimated amount of time child typically spent in organised and non-organised sport.	Age, sex and baseline values	Although intervention children significantly reduced their TV time by 5.5 hours per week (relative to controls), there was no significant corresponding increase in physical activity (moderate/vigorous) or fitness.

Gortmaker et al 1999[66]	1295 6th and 7th grade US children participating in Planet Health intervention	Physical activity by 16-item questionnaire that assesses time in moderate/vigorous activities over past month. TV assessed by 11-item questionnaire.	Baseline variables, clustering, obesity status, ethnicity	Although intervention children significantly reduced their TV time by 0.58 hours per day (relative to controls, $p < 0.01$), there was no significant corresponding increase in physical activity (adjusted difference in hours moderate/vigorous activity per day 0.36, $p = 0.43$) despite intervention having specific aim of trying to increase activity levels.

Appendix J: Studies reporting a *positive or mixed relationship* between TV viewing and physical activity in children

Author	Subjects	Methods	Confounders adjusted for	Main results
Cross-sectional				
Myers et al 1996[100]	995 children aged 9-15y from Bogalusa Heart Study, 65% White, 35% African-American	Children completed 24-hour recall of selected physical activity and sedentary activity (whether participated for at least 5 mins in 21 different activities plus TV and video time).	Sex, ethnicity and grade	Reported minutes of physical activity were significantly and positively correlated with reported minutes of selected sedentary activity for all children ($r = 0.20$, $p < 0.0001$) and correlations were significant for each age and gender group.
Salmon et al 2005[99]	878 Australian children aged 10-12y	Low active defined as lowest quartile of average counts per day from 8 days of accelerometer data. Family environment assessed by questionnaire. Usual TV/computer time assessed by questionnaire (parental-proxy).	Sex, maternal education, clustering by school and various family environment variables	In boys, odds of being low-active were higher in those from homes with rules about TV supervision (OR, 95% CI 1.9, 1.0-3.3) and lower in those with pay TV (0.6, 0.4-0.9). In girls, preference for TV (2.3, 1.2-4.5) and rules about supervision (0.6, 0.4-0.9) were significant.

Cohort				
Huston et al 1999[101]	175 2- and 4-year-old children from low-to moderate-income families in Kansas followed for 3 years: 38% African-American, 40% White and 18% Mexican-American	Parents completed 24-hour activity diaries for children 3-5 times per year. Type of activity and type of TV programme were recorded.	Age and season	Playtime (any playing that was not educational) was positively related to TV time in each TV category (informative, entertainment or general audience) for 2-year-olds but only for animated TV in 4-year-old cohort. Negative relation between social activities (category included meals, conversation and outdoor recreation) and general audience TV in younger cohort only.

Appendix K: Studies investigating the relationship between TV viewing and food intake in children

Author	Subjects	Methods	Confounders adjusted for	Main results
Adverse effect				
Cross-sectional				
Burdine et al 1984[144]	2695 12- and 13-year old Texan children	Children indicated (5-point scale) how often they ate 15 different snack foods, at home and at school.	Unknown	Amount of TV viewed significantly related to consumption of sweet and salty snacks at school and at home ($p < 0.01$).
Taras et al1989[145]	66 children aged 3-8 years	Viewing habits and child requests for food and sport items advertised on TV assessed by questionnaire	Unknown	Weekly viewing hours correlated significantly with children's caloric intake ($r = 0.34$, $p = 0.001$).
Signorelli and Lears 1992[146]	206 (sample 1) and 250 (sample 2) 4th- and 5th-grade children	Developed "poor eating index" from questionnaire asking about intake of foods such as sugared cereals, fast foods, sweet/salty snacks and sweet drinks, icecream, hamburgers, candy etc	Sex, ethnicity, reading level, parental occupation, parental education	Hours of TV viewed positively related to poor eating index in both samples.
Robinson and Killen 1995[75]	1912 9th-grade children from 4 Californian high schools	Students asked to estimate number of hours (1-12 possible responses) they spent watching TV on a usual school day and usual weekend day. Dietary fat intake assessed by 16-item qualitative fat-specific food frequency questionnaire (FFQ)	Sex and ethnicity	Significant positive relationship between dietary fat intake and total weekly hours of TV viewing ($r=0.23$ for all subjects, $r = 0.19$ for boys and $r = 0.22$ for girls, all $p < 0.0001$)
Hernandez et al 1999[39]	461 Mexican children aged 9-16 years from a low	Diet by US Youth FFQ adapted for Mexican use. Asked frequency of snacking while watching TV rated	Unclear but appears none for this analysis	Consumption of snacks while watching TV was never 17%, sometimes 63%, frequently 13% and

	and middle-income town	as never, sometimes, frequently, always		always 7%. Children who watched more TV had more snacks but prevalence of snacking while watching TV not associated with obesity (statement made but data not shown).
Muller et al 1999[111]	1497 German children aged 5-7 years	Diet by FFQ. Assessment of TV time not described in detail except to say that was by questionnaire.	None	High fast food and sweet consumption (daily/several times per week) more common in children watching 1+ hours/day than those watching < 1 hour (5.4 vs 1% for fast food and 86.5 vs 69.0%, $p < 0.001$)
Tanasescu et al 2000[97]	53 prepubertal Puerto Rican children living in the US aged 7-10 years	Diet by single 24-recall and 71-item FFQ conducted with children and caregivers. TV on weekdays and weekends assessed by questionnaire.	None for this analysis	Intake of sweets and snacks correlated with weekday (r=0.29) and weekend (r=0.30) hours but was significant in boys only.
Crespo et al 2001[33]	4069 children aged 8-16 years from NHANES III survey	Diet by single 24-hour recall. Asked how many hours TV was watched on previous day (asked on 2 days 1-3 weeks apart). PA assessed by asking how many times per week they participated in activity which made them breathe hard or sweat.	Age, BMI, ethnicity, family income, weekly bouts of physical activity	Significant correlation between hours TV watched and energy intake in girls ($r = 0.43$) but not boys ($r = 0.26$). Adjusted energy intake in girls watching 5 hours or more of TV was 8468kJ compared with mean of 7748kJ in girls watching 1 hour TV or less.
Coon et al 2001[147]	91 children in 4^{th}-6^{th} grades and their parents from convenience sample	Food intake assessed by 3 non-consecutive 24-hour recalls conducted with the children (1 face-to-face, 2 telephone). Looked at	Gender, ethnicity, age, two-parent household, family income, maternal	Children having more meals with TV on ate fewer serves of fruit and vege (including juice) each day (2.59 vs 3.4, $p < 0.01$), more serves of meats

	in Washington, US	frequency of intake of specific foods and their % contribution to energy. Asked whether TV typically on during breakfast, after-school snack and dinner: divided into 0-1 (n=50) and 2-3 (n=41) meals with TV on groups.	education/occupation, nutrition knowledge/ attitude/norms of parent, number of weeknights parent prepared easy meals	(1.98 vs 1.56, $p < 0.05$) and more pizza, snacks and soda (1.63 vs 1.04, $p < 0.01$). Same food groups also showed significant difference in % contribution to energy intake (5% less, 6% more and 5% more respectively).
Lowry et al 2002[36]	Representative sample of 15,349 US adolescents in grades 9-12	Past week fruit and vege intake assessed using 6 questions (7 response categories). TV time assessed by single question asking how many hours of TV watched on typical school day. Also asked how many times in past week participated in moderate activity for at least 30 mins a time and vigorous activity at least 20 mins a time. Self-reported height and weight.	Grade, gender, ethnicity, overweight (yes/no) and sedentary lifestyle (met current recommendations or not)	Watching > 2 hours/day TV was associated with an increased risk of having a low fruit and vegetable intake: OR, 95% CI: 1.35, 1.17-1.55). Analyses by ethnicity showed this was significant in White adolescents only and not Hispanic or Black subjects.
Utter et al 2003[79]	4480 boys and girls, mean age 14.9 years, from 31 middle- and high-schools in an urban area in the upper Midwest.	Time in 3 sedentary behaviours (TV, reading, computer (non homework) assessed on weekdays and weekends by questionnaire. Diet by validated 149-item semi-quantitative FFQ.	Age, race & SES (sex-specific analyses)	Both boys and girls with "high" TV viewing (top tertile) consumed significantly more energy than those watching "low" (bottom tertile) amounts (344 kcal more in boys 200 kcal more in girls). They also ate more fat, snacks, soft drinks, fried food and less fruit and vegetables.
Aranceta et al 2003[105]	Representative sample of 3534 Spanish children	Diet by validated FFQ and 24-hour recall. TV by questionnaire	Age, gender, parental education and occupation,	Children who watched more than 2 hours TV/day more likely to follow "Snacky" food pattern (high intake

	and young adults (2-24 years)		geographical region, urban/rural distribution, leisure-time physical activity, sports practice and overweight	bakery products, sweets, salted snacks and soft drinks) and less likely to follow "Healthy" patterns (more fruit, vegetables and fish).
Renders et al 2004[112] (abstract only)	1775 Dutch children aged 6-14 years	TV viewing on previous day and eaing habits collected by short interviews	Unknown	Children who had not eaten fruit or who had visited a snack bar the previous day more likely to have watched 2 or more hours of TV ($p < 0.01$)
Yannakoulia 2004[106]	Representative sample of 4211 Greek adolescents 11-15 years	Consumption of fruit, vegetables, sodas, sweets, chocolate, cakes/pastries, crisps, French fries, hamburgers/sausages/hotdogs, bread, milk and coffee assessed by FFQ (5 response categories). TV and computer games assessed by "How many hours a day do you watch TV" with 6 response categories	None	Consumption of sodas, crisps, cakes and pastries, sweets and chocolates tended to be higher with increasing hours of TV watched and fruit consumption was lower (although statistics comparing frequencies were not reported).
Marquis et al 2005[113]	534 10-year-old French Canadian children	Children were asked how frequently they ate in front of the TV (3 possible responses) and how frequently they ate 36 foods (3 possible responses).	None	Eating in front of the TV was positively associated with consumption of French fries ($r = 0.205$), salty snacks ($r = 0.224$), ice cream ($r = 0.203$), sweets ($r=0.210$), pastries ($r = 0.175$), sweetened cereals ($r = 0.224$), fruit beverages ($r = 0.149$)

				and soft drinks (r = 0.171) and negatively correlated with the intake of raw vegetables (r = -0.209), whole wheat bread (r = -0.232), fruit (r = -0.135), milk (r = -0.135), yoghurt (r = -0.097) and less-sweetened cereal (r = -0.119).
Utter et al 2006[107]	3275 New Zealand children aged 5-13 years from National Children's Nutrition Survey	TV time assessed by 7 day recall, with hours on Saturday, Sunday and weekdays asked separately. Diet assessed by FFQ. Weight and height by standard techniques. Physical activity by questionnaire (7-day recall).	Age, sex, ethnicity and socio-economic status	Children aged 5-10 years watching 2+ hours/day less likely to eat fruit 3+ times/day (OR, 95% CI: 0.5, 0.3-0.7) or vegetables 4+ times/day (0.6, 0.4-0.9), and more likely to drink soft drinks 5+ times/week (2.0, 1.2-4.0) and fruit drinks 1+ times/day (1.7, 1.1-2.6) and eat potato crisps 5+ times/week (1.8, 1.2-3.6), biscuits 1+ times/day (1.5, 1.0-2.2), hamburgers 1+ times/week (2.0, 1.2-3.2), french fries 1+ times/week (2.1, 1.4-3.1) or fried chicken 1+ times/week (1.8, 1.1-2.9) compared with those watching < 1h/d. Similar results were observed for adolescents aged 11-14 years (significant for soft drinks, fruit drinks, potato crisps, chocolate/sweets, hamburgers and French fries.
Cohort				
Boynton-Jarrett et al	548 US adolescents	Diet by validated FFQ. Physical	Baseline fruit/veg	Mean servings fruit and vege were

2003[103]	aged and average of 11.7 years at baseline followed for 19 months, mixed ethnicity, 48% females	activity and TV time assessed by questionnaire completed by students in class.	intake, age, sex, ethnicity, school, total energy intake, %kJ fat, family dinners, hours of strenuous activity, baseline TV viewing and change in TV viewing	4.23 at baseline and 3.9 at follow-up ($p = 0.07$). Baseline and follow-up TV time was correlated ($r = 0.51$). Baseline F&V intake decreased 0.16 serves/day with each hour TV viewed at baseline ($P = 0.006$) after multivariate adjustment and decreased further by 0.14 serves ($p = 0.025$) for every hour increase in TV viewing between baseline and follow-up.
Francis et al 2003[63]	172 non-Hispanic White girls and their parents assessed when 5, 7 and 9 years old	3 x 24-hour diet recalls including whether meal or snack and location (eg. in front of TV). Mothers reported TV viewing at 7 and 9 years by average number of hours watched on school and non-school days. Height and weight by standard techniques. Physical activity by 15-item questionnaire.	Child overweight status, snacking frequency, fat intake from energy dense foods, baseline BMI, change in BMI, parental weight status, income	Path analysis of determinants of BMI. Girls who watched more TV consumed more snacks in front of the TV. In girls from overweight families, girls who watched TV snacked more frequently and girls who snacked more frequently had higher intakes of fat from energy dense snacks, which predicted their increase in BMI from 5 to 9 years of age.
Phillips et al 2004[104]	166 mixed ethnicity girls aged 8-12 years, nonobese (triceps skinfold $\leq 85^{th}$) followed for an average of 7 years	Diet assessed annually by Willett FFQ. Energy dense snack foods were divided into 5 categories; baked goods (cookies, pies, cakes, brownies), ice cream (ice cream, sundaes, milkshakes, sherbet) candy (chocolate and non-chocolate), chips (potato chips, corn chips) and soda (not diet). TV time (including	Age, race, % kJ from protein, % kJ from fat, %kJ from carbohydrate and parental overweight	Significant relationship between hours of TV watched and snacking (both as number of snacks/day or snack foods as proportion of total kJ)

		video games) by 2 x 24-hour recalls on a hourly basis.		
No association				
Cross-sectional				
Grund et al 2001[42]	60 prepubertal German children aged 5-11 years	Diet by general FFQ, TV time by single question asking parents to report average time per day.	None	Few differences were observed between TV groups: those watching < 1 hour/day ate more museli and less noodles than those watching > 1 hour/day
Matheson et al 2004[148]	210 8-10 year-old African-American girls from 4 US field centres	Dietary intake assessed by 2 non-consecutive 24-hour recalls. Also asked whether they were watching TV or videos during each meal/snack.	Field centre and interaction between centre and TV on/off	No significant difference in energy density between foods consumed with TV on or off at any centre. Higher % energy from fat (weekdays only) with TV on in 1 centre only (36.3 vs 31.3%, $p < 0.05$).
Magnusson et al 2005 [110]	99 Swedish children aged 11-12 years	Habitual intake and meal/snack pattern quality assessed by questionnaire	None	No difference in intake of sweet drinks according to amount of TV watched.
Cohort				
Proctor et al 2003[54]	106 boys and girls, mean age 4 years, 3rd and 4th generation offspring of Framingham Study participants; followed for mean period of 7 years	Four sets of 3-day diet records at baseline and 1-2 sets of 3-day records in subsequent years. Annual TV questionnaire including TV and video games. Anthropometry by standard techniques. Physical activity by electronic motion sensor for 3-5 days (4 sets at baseline and 1-2 sets annually thereafter).	Age, sex, baseline anthropometry, energy intake, parental education, BMI at baseline, physical activity levels, % of calories from fat, mother's and father's age	No clear differences in energy or nutrient intake with TV exposure at baseline, but children who watched the most TV and had a high-fat diet (>34% of kJ) gained the most body fat (skinfolds) over time.

Beneficial effect				
Cross-sectional				
Matheson et al 2004[109]	Two samples: 64 mixed ethnicity children aged 7-10 years and 129 predominantly Mexican American children aged 9-11.5 years	Diet assessed by 3 x 24- hour recalls, 1st one face to face, others by telephone. Height and weight by standard methods. When completed diet record also asked what activity child was doing for each meal/snack	None	Soda (sample 1), fast food (sample 1), sweets/snacks (sample 2) and vegetables (both samples) contributed significantly less energy to the diet when TV was on compared to the TV off condition.
Intervention				
Robinson 1999[67]	192 3rd and 4th grade US children in reducing TV intervention	Child-recall of TV time yesterday (2 occasions) and last Saturday. Parents also estimated usual TV time on typical school day and weekend day. Assessed number of meals in front of TV (4-point scale), frequency of snacking while watching TV (3-point scale), and daily servings of high-fat foods and advertised foods (2 days of previous day food frequency recall).	Age, sex and baseline values	Intervention led to a reduction in the number of meals children ate in front of the TV ($p = 0.01$) but other variables were not significant.

Appendix L: Method

Goal of the Scientific Committee
The goal of the Scientific Committee is to provide New Zealand nutrition and physical activity practitioners with practical evidence summaries about issues of interest to Agencies for Nutrition Action (ANA) member organisations.

Topic identification
Three initial topics were proposed by the Scientific Committee, in consultation with the Chair and the Executive Officer of ANA. The proposed topics are of relevance to ANA and its member organisations, and reflect the professional expertise of members of the Scientific Committee. The proposed topics were submitted to the Board of ANA for discussion and approval, and this is the second of those topics.

Literature identification
Initial discussions by the Scientific Committee and the Executive Officer covered the potential questions and issues that should be incorporated into this report.

A precise and specific search of the literature was conducted using key words such as: child, adolescent, TV, multimedia, video games, computers, advertis(z)ing, marketing, obesity or overweight, BMI, skinfold, physical activity, exercise, food processing industry, etc. A full list of search terms is available on request. Searches were conducted using the following electronic databases and websites: (i) Medline, (ii) Cochrane Library, (iii) DARE database (includes a database of abstracts of reviews of effects, an NHS economic evaluation database and the Health Technology Assessment database), (iv) HDA evidence base, (v) Ministry of Health website, (vi) NHMRC website, (vii) NICE website, (viii) Research Findings Register and (ix) the Campbell Collaboration. All databases and websites were searched for papers published from January 1999 to June 2005, an arbitrary starting point to make the analyses manageable. Only English-language references and human studies were included.

Data handling process
Each member of the Scientific Committee then reviewed the title and abstract of each of the 353 identified references for relevance. Studies, commentaries and reviews were included if they addressed one of the review questions/topics:

- Contextual information about TV watching and obesity (eg. policy, guidelines, time trends, marketing, role models).
- Is TV watching associated with body weight/obesity in children?
- Is time spent watching other types of screens (besides TV), such as computer games, associated with obesity in children?
- How might TV watching contribute to obesity?
    (a) Is TV watching associated with inactivity?
    (b) Is TV watching associated with food or nutrient intake?
    (c) Is TV watching associated with other mechanisms causing obesity, such as decreased resting metabolic rate?
    (d) Is TV watching associated with food preferences or behaviours?
- Is changing the amount of TV watched associated with changing body weight? If so:

(a) What features of an intervention are important to prevent obesity?
(b) Who have the interventions been targeted at? eg. age, gender, ethnicity
(c) Is there cost-effectiveness data for the intervention?

- Is there New Zealand evidence?

Of the 353 articles, 68 were found to be potentially relevant by all three members of the Scientific Committee. A further 51 were identified by only one or two members of the steering group. Further discussion was held on the 51 documents and a final decision for inclusion/exclusion was made by the group (24 were included for further consideration).

Due to the extended period of this project a number of other strategies were used to identify potentially relevant papers while the work was ongoing. Consideration of papers from reference lists, specific literature searches for papers recommended by colleagues and new research released were rich sources of new information. The initial search strategy was narrow in its year-range and a number of papers were therefore not picked up. It is good practice to source literature using as many methods as possible, and this was reflected in the extra 56 papers that were included for further consideration using this mix of methods.

Assessment of papers

The initial 92 papers were each critically appraised in terms of relevance and quality by two Scientific Committee members. There was no blinding of authorship of retrieved documents. The 83 documents identified as potentially relevant throughout the process using a mix of methods, were appraised by the Scientific Committee member delegated with writing the relevant component of the paper.

A critical appraisal form based on the Scientific Advisory Committee's form used in the sugary drinks review[149] was further amended for use in this review. The original form was based on the NHMRC tools for assessing individual studies and the Health Development Agency tool for assessing reviews and systematic reviews. The appraisal form included questions relating to the type of study, populations studied, methods used, and the strengths and weaknesses of each study type. A joint decision was made about whether a document should inform the report and be placed on the literature database, or used in the report to inform discussion only, or discarded. Any disagreements were to be resolved through discussion, or, if necessary, by recourse to the third Scientific Committee member. For all papers, agreement for inclusion or exclusion was obtained.

Data were extracted into tables for ease of use, and split by type of study methodology, capturing such information as author, year, subjects, methods (and length of follow up if appropriate), method of obesity assessment, method of dietary assessment, method of physical activity assessment, confounders adjusted for, and main results.

Writing of the report

An initial draft of the report was produced by all three members, with members taking specific research questions to write. The appraisal form recorded which questions of interest each article covered, allowing the writing of the report to be easily split up in this way. Drafts of each section and subsequent amendments were circulated amongst

all members, and written and verbal comments (at teleconferences) were incorporated into subsequent drafts. The report was then sent for external review.

All authors contributed to the review process and writing of the report, and all members of the Scientific Committee have final responsibility for the report.

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