Environmental Determinants of Public Health in Scotland

(EDPHiS)

Obesity case study

Phase II summary report

May 2010

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Contents Page number

Executive Summary

The EDPHiS project obesity case study is a four year project designed to assess the evidence for environmental influences on overweight and obesity in children under 8y in Scotland, and to quantify the impact of actions on the influences for which the evidence is strongest. This report describes the work of the first two phases (April 2008-March 2010) which included a literature review, prioritisation of the evidence for further analysis and initial scoping of the likely impact of prioritised topics. Further work in the final phase will extend the quantification exercise using more detailed analysis and modelling of existing data, with wider consultation about the acceptability and feasibility of actions in the prioritised topics.

The case study reviewed the literature for 24 environmental 'chains' of possible environmental influences on overweight and obesity in children up to 8 years of age which were modified from chains identified at stakeholder workshops held by NHS Health Scotland in 2008. A systematic review was carried out, with a focus on higher quality evidence (intervention and longitudinal studies): cross-sectional studies and review articles were used where higher quality evidence was lacking. Some evidence was found for the majority of chains though much was from the USA and many interventions were short term or did not include overweight or obesity prevalence as an outcome.

The evidence from included studies was tabulated and the case study team and other experts in the area rated each chain in two respects: the strength of the evidence and the likely effect size on overweight or obesity. Fourteen people completed the rating exercise which identified 8 chains (later reduced to 7 due to overlap of included studies) as those with the strongest evidence for action:

- Sedentary behaviour
- Physical activity in schools and nurseries
- Breast feeding and weaning practices
- Sugar sweetened soft drinks
- Snacking behaviour
- Portion size of manufactured foods
- Fast food consumption

Using estimates of the difference in energy balance between children on the lower bound of obesity and those on the upper bound of normal weight, the scope for changes in these areas to bring about the required changes of 50-150 kcal/d difference in activity energy expenditure or food and drink energy intake were explored. The prevalence of overweight and obesity and the variation by age, sex, socio-economic status and rural/urban area of residence in Scottish children was estimated to provide a framework to assess the need for action on these areas in the different population subgroups. The prevalence of overweight was higher in boys than girls, especially among 5-9 year olds, and in those in middle and lower quintiles of socio-economic status but there was little difference between those in rural and urban areas.

Background

The Environmental Determinants of Public Health in Scotland (EDPHiS) project is a four-year project designed to evaluate the evidence on environmental determinants of health in children up to 8 years in Scotland, and to assess the likely impact of actions on the environmental determinants for which the evidence of effects are strongest. The four health outcomes for the project are accidental injuries, asthma and mental health and well-being and obesity. This report summarises the progress on the obesity case study for the first two years, which includes the literature evidence gathered, the prioritisation of environmental determinants for detailed study and preliminary work on quantification of the likely effects of public health actions to alter these determinants.

Methodology

Initial scoping of environmental influences

The EDPHiS project uses the DPSEEA (Drivers, Pressures, States, Exposures, Effects and Actions) conceptual framework proposed by WHO[1], with the modification of examining the impact of contextual factors such as rural/urban residence and socio-economic status on the exposures and effects. DPSEEA 'chains', starting with drivers and following through to health effects, were developed at stakeholder workshops on physical activity and diet in relation to cardiovascular disease in 2008. The EDPHiS obesity case study team modified the chains to include factors relevant to obesity in children up to 8 years. The 24 chains which were then used for the evidence gathering are shown in Fig. 1. Full details of the modified DPSEEA chains are given in appendix 1.

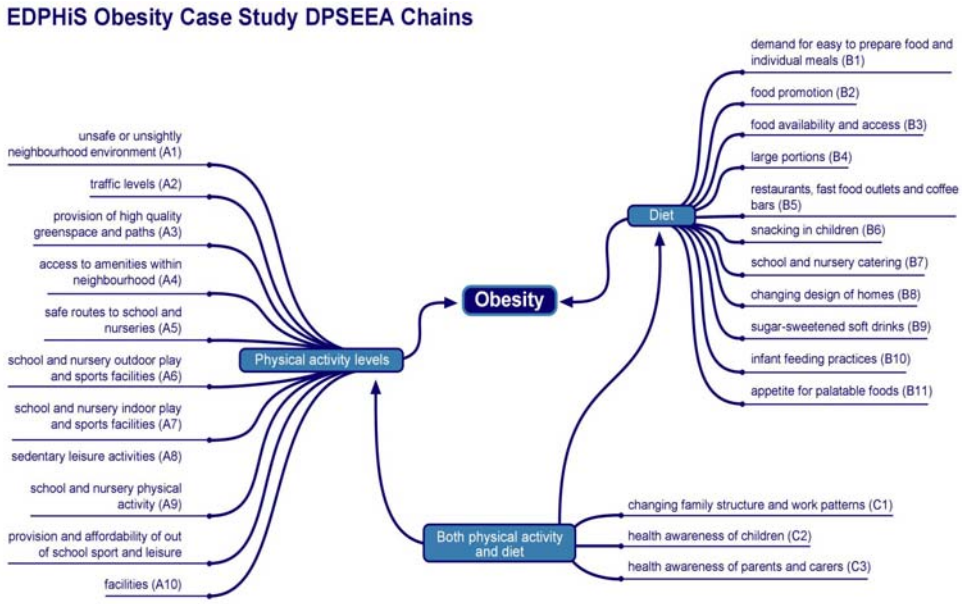

Fig 1: DPSEEA chains of environmental factors affecting physical activity and diet used in the obesity case study.

Evidence gathering

To gather evidence for the impact of each of the chains on obesity in children, a systematic literature review was carried out. The search aimed to include only intervention studies or longitudinal studies, though in some cases the latter were actually cross sectional analyses within longitudinal studies, though these were retained where it was felt they were particularly relevant to the chain. Where there was no evidence for a chain from intervention or longitudinal studies, reviews of evidence (which were often largely based on cross-sectional studies) were sought. The detailed search strategies used for physical activity and for diet are given in appendix 2.

From the titles and abstracts of articles identified by the initial search strategy, a total of 136 studies were selected (for flow diagrams see appendix 3). A bibliographic list of the studies selected is provided in appendix 4. Relevant information from each of the selected studies was extracted and the results for all studies were summarised in tabular form, as shown in appendix 5. Using methodology developed for the EDPHiS project based on Gee's approach[2], each study was classified in terms of the likelihood that any effect seen was causal and the strength of any effect on obesity.

Selection of chains for detailed analysis

The tables of the articles were sent to experts in academic institutions or government agencies who were familiar with the process of analysing evidence, who were asked to rate the evidence presented for the different chains on a scale of 0 (lowest) to 5 (highest) in two respects: the strength of the association and the likely effect size of any action on this chain. The rating form is provided in appendix 6. Fourteen experts completed the rating exercise. Using the mean values for the ratings, the chains rated as 3 or above for both strength of evidence and effect size were identified. This rating exercise follows a similar approach for stakeholder consultation on certainty of effectiveness vs. potential population impact proposed for obesity interventions by Swinburn and colleagues[3].

Estimation of prevalence of overweight and obesity.

To allow estimation of the impact of actions on the prioritised chains on overall levels of overweight and obesity, and variations in the impact on children in areas of socio-economic deprivation and in rural vs. urban areas, data was obtained from national surveys of children in Scotland. Overweight was defined as BMI $\geq$ 85th centile but < 95th centile, and obesity as BMI $\geq$95th centile of the age- and sex- specific standards from the UK 1990 reference data[4]. Overall and sex-specific prevalence of overweight and obesity for children aged 2-4 and 5-8 years was derived from the Scottish Health Survey 2008[5] (which does not give estimates for children under 2 years).

Variation in the prevalence of overweight and obesity by socio-economic status and urban vs. rural area of residence was not reported in the 2008 Scottish Health Survey due to the smaller number of participants in the first year of the new rolling programme of data collection, though this will be available as more years of data are gathered. The variation by socio-economic status was reported in

earlier national surveys, the 2003 Scottish Health Survey[6], which reported data based on measurements in 2438 children aged 2-15y in 2003, and the Survey of Sugar Intake in Children in Scotland[7], which collected data on 1619 children aged 3-17y in 2006. Estimates of the variation by socio-economic status and urban vs. rural area of residence were derived from the 2006 Sugars Survey, and imposed on the overall data from the 2008 Scottish Health Survey.

Quantification of likely impact of actions on prioritised environmental chains

Due to variations in the studies providing evidence for each of these chains (e.g. age of children, duration of intervention or follow up, measure of body fatness used) it was difficult to derive a summary estimate of the likely impact of actions on the prevalence of overweight or obesity for actions on the selected chains. As a starting point an estimate of the required action of each chain required to bring about the difference in energy intake or expenditure between a typical boy or girl on the 95th BMI centile (lower boundary of obesity) and his or her counterpart on the 85th BMI centile (upper boundary of normal weight) at various ages as calculated, using current estimates of energy requirements provided by the Department of Health[8]. The energy needed to achieve this change in BMI was then compared with estimated energy expenditure of increases in moderate activity, or in vigorous activity in school age children, and with the energy content of snack foods and drinks commonly consumed by Scottish children (appendix 7).

Results

Details of prioritised chains

The mean ratings of the 24 chains in terms of strength of the evidence and likely effect size is displayed in figure 2, with details of the individual values provided in appendix 8.

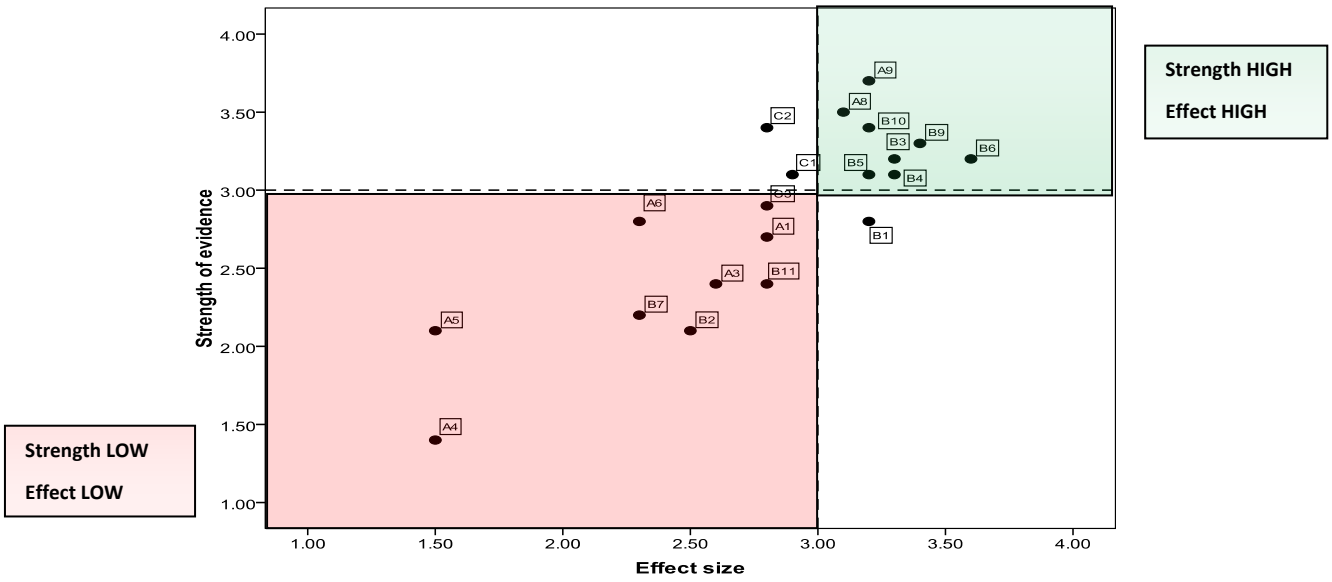

Fig 2: Cross-tabulation of strength of evidence and likely effect size for all chains.

The eight chains which had mean ratings > 3 for both strength of evidence and likely effect size were

a) Physical activity chains:

- A8: Sedentary behaviour
- A9: Physical activity in schools and nurseries

b) Diet chains:

- B10: Breast feeding
- B9: Sugar-sweetened soft drinks
- B6: High energy dense snacks
- B4: Portion size of manufactured foods
- B3: Availability of high fat, sugar and salt foods
- B5: Portion size of restaurant and cafeteria foods

On detailed review of the literature on the diet chains it was agreed that there the names of the chains did not always reflect the focus of the evidence gathered. As a result chain B10 was re-named 'breast feeding and weaning practices', chain B6 was re-named 'snacking behaviour' and chains B3 and B5 were merged to a single chain, 'fast food consumption'. Details of the studies in each of the final chains are provided below:

1. Sedentary behaviour (Chain A8: 8 studies)

All of the studies were carried out in the USA. Two longitudinal studies were based on the ECLS-K study in which TV viewing in 8,000 children assessed at school entry was found to be associated with development or persistence of overweight or obesity at ages 9-10 or 10-11y (Gable *et al*, 2007; Danner 2008). These studies suggested that for every hour of TV viewing per week was associated with a 2% increase in the odds of becoming overweight or a 3% increase in the odds of remaining overweight, and that a child watching 4 hours of TV per day would gain 0.42 kg/m^2 more in BMI by age 10-11, which would take a child of average weight to the overweight category. Another smaller study found that time spent in TV viewing at age 4 years predicted BMI and body fat gain from 4-11y (Proctor *et al*, 2003).

All the intervention studies were carried out with relatively small samples (28-198 children). A trial of a TV time manager (a device to limit the time the TV/video recorder could be used by each person in the family) with classroom-based counselling by teachers in 8-9 year old children led to beneficial effects on activity and a 0.45 kg/m^2 lower increase in BMI than the control children after 6 months (Robinson, 1999). A trial of this device in children aged 4-7 years who were on or above the 75^{th}

centile of BMI, which aimed to reduce TV viewing by 50% in the intervention group by progressive target setting with financial incentives, found a significant decrease in TV viewing and a greater reduction in energy intake at 6 months which persisted at 24 months, and a decrease in BMI or around 0.2 z-scores in the intervention group among the children in families of lower socio-economic status (Epstein *et al*, 2008). Another study in pre-school children of a 7-session programme to reduce TV viewing found that there was a decrease in TV viewing at 1 year but no significant difference in growth or adiposity between the intervention and control groups (Dennison *et al*, 2004. Two other studies suggested that activity patterns of children can be changed by interventions: a study of 7-12 y old African American children found that counselling with the TV time manager could have beneficial effects on activity patterns after 4 weeks (Ford *et al*, 2002) while a trial of a dance-based Play Station game also found beneficial effects on sedentary screen time but not on more vigorous activity after 10 weeks in children aged 7-8 years (Maloney *et al*, 2008).

2. Physical activity in schools and nurseries (Chain A9: 28 studies)

Five longitudinal studies were included: one from Scotland in which 78 children aged 3 years had detailed measurements of physical activity which were repeated at 5 years in 72 children. In the group a median of 79% of waking hours were spent in sedentary activity at 3 years and 76% at 5 years, and there was an increase in BMI z-score from 0.05 at 3 years to 0.26 at 5 years (Reilly *et al*, 2004. In the ECLS-K study there was a reduction in BMI for each hour of physical activity in schools per week only in children with BMI > 85th centile which was more marked in girls (Datar & Sturm, 2004). In the Framingham Children's Study, children aged 3-5y who were inactive were significantly more likely to have an increase in triceps skinfold thickness at 6 years than those who were active over the period of follow up (Moore *et al*, 1995). In another US study children in the highest tertile of activity from age 4-11 years had smaller gains in BMI and body fat than those in the middle and lowest tertiles throughout this the period (Moore *et al,* 2003). A study in the Czech Republic found that children decreased their activity from their pre-school to first school year, particularly during school hours (Sigmund *et al*, 2009).

Twenty three intervention studies were included of which three were in pre-school children. A study of a 30 week exercise programme in 4-5 year old children in Thailand found a marginal beneficial effect on BMI and skinfold thickness which was more evident in girls (Mo-Suwan *et al*, 1998). A randomised trial of an enhanced physical activity programme in 545 children in their pre-school year in nurseries in Glasgow found an improvement in motor skills performance at 6 months in the intervention children but no difference in BMI z-score or overall activity levels between the groups at 6 or 12 months (Reilly *et al*, 2006). A pilot study of 270 3-5 year old children in New Mexico found that daily 10 minutes of classroom activities could be used to increase activity and improve motor skills (Williams *et al*, 2009).

The remaining twenty studies assessed the impact of school-based or after school physical education on a wide range of outcomes including physical activity, BMI, subcutaneous and visceral fat, bone mineral density, motor skills and cardiovascular fitness in children from many different countries. The amount of activity varied from 10 minutes a day (Liu *et al,* 2008) to 40 minutes a day (Linden *et al*, 2006, Valdimarsson *et al*, 2006). Most included all children, regardless of initial weight status, though

some after school programmes were aimed at overweight children (Ildiko *et al*, 2007, Gutin *et al*, 1995). A majority of the studies reported beneficial effects on the outcomes measured which were mostly statistically significant. One study which followed the participants up for three years reported that the beneficial effect of an after school activity programme for 7-9 year old children on body fatness and physical fitness was lost during the summer holidays (Gutin *et al*, 2008). Only two studies reported the results in terms of prevalence of obesity: one study in French 6-8 year olds found that 6 months of an after school activity programme for 1 hour twice a week led to a decrease in the prevalence of obesity (>97th centile) of 16.3% in the intervention group compared to 9.3% in the control group (Lazaar *et al*, 2007), while a German study of primary school children given a 5 minute physical activity break each morning with enhanced opportunities for activity at other times in the school day for 4 years found no significant effect on the change in prevalence of obesity (Graf *et al,* 2008). The only UK study was a pilot study in Glasgow which found that a 10-week school based activity programme was successful in terms of attendance and enjoyment in both boys and girls in primary schools (Hughes *et al*, 2007).

3. Breast feeding and weaning practices (Chain B10: 10 studies)

A longitudinal study of Brazilian infants found that those who were predominantly breast fed were heavier up to 6 months but lighter from age 7 months than formula fed infants (Spyriedes et al, 2008). An analysis of US national data showed that breast feeding for 6-12 months was associated with reduced odds of overweight at 4 years in non-Hispanic whites but not in Hispanic or black children (Grummer-Strawn & Mei, 2004): this finding was supported by a longitudinal study of low income families in Ohio in which exclusive breast feeding for at least 16 weeks or mixed breast and formula feeding for at least 26 weeks were associated with lower risk of obesity at age 4y only in white children whose mothers had not smoked in pregnancy (Bogen *et al*, 2004). Two German studies found associations between breast feeding and later obesity: in the DONALD study body fat was higher in the first four years in those not breast fed for at least four months, particularly in those children who grew rapidly: fat intake in the second year also predicted body fat at four years (Karaolis-Danckert *et al*, 2007), in line with another longitudinal study in which exclusive breast feeding for < 6 months was associated with a 65% increased odds of elevated weight gain at 2 years (Kalies *et al*, 2005). In the PIAMA longitudinal study in Holland, children breast fed for > 16 weeks had a 29% lower odds of overweight at 8 years, even after adjustment for maternal education, maternal overweight and diet and TV viewing at age 7 years (Scholtens et al, 2008), but a Swedish study found that the association between overweight at 5 years and exclusive breast feeding for less than 4 months was no longer statistically significant when parental overweight, BMI and smoking were accounted for (Huus *et al*, 2008).

Two studies explored the influence of protein intake: one study from Italy found that children were more likely to be overweight at 5 years of age if they had a higher intake of protein at 1 year of age (Scaglioni et al, 2000), while a multicentre European trial of infant formula of high vs. low protein content found similar length but greater weight for length at 2 years of age in those fed the high protein formula (Koletzko *et al,* 2009).

A longitudinal study in Dundee investigated the association between introduction of solids before 15 weeks and later weight and body fat. Children given solids before 15 weeks had higher BMI z-scores at 7 years than those who were given solids at or after 15 weeks, particularly if they were partly or wholly formula fed, and in the whole sample body fat was 18.5% in those who had solids before 15 weeks compared to 16.5 % in those who did not. There were no differences in BMI z-score at age 7 years between breast-fed, partly breast-fed or wholly formula-fed groups (Wilson *et al,* 1998).

4. Sugar-sweetened soft drinks (Chain B9: 6 studies)

Four longitudinal or cross-sectional studies were included. A small study of US children aged 6-13 attending a summer camp found that the children with >16 oz/d of sweetened drinks had significantly higher total energy intake and a tendency to greater weight gain over the summer compared to other children (Mrdjenvic & Levitsky, 2003). Children in Finland with high sucrose intake between 13 months and 9 years had a higher BMI up to 3 years but lower BMI from 5-9 years (Ruottinen *et al*, 2008) and in a longitudinal study in Germany, no evidence was found for adverse effects of high fruit juice consumption on growth of children followed from 3-5 years (Alexy *et al*, 1999). In a retrospective longitudinal study of over 10,000 children in Missouri who had diet assessed at age 2 or 3 years and height and weight measured a year later found that the odds of becoming overweight (defined as BMI reaching the 95th centile) was 2 times higher in children who were above the 85th centile at baseline and who had 1 or more 'sweet drinks' (fruit juices, juice drinks and non-diet carbonated drinks) per day, with no difference in effect size between children having 1-2, 2-3 or more than 3 sweet drinks a day. A similar but non-significant pattern was seen in children who were below the 85th centile at baseline, but there was no evidence for an association between becoming overweight and having fruit juice (Welsh *et al,* 2005).

Two intervention studies were included: one study in primary schools in deprived areas in Germany in which schools were randomised to have drinking water fountains with provision of drinks bottles and related lessons found a reduction in overweight in intervention schools after 11 months but no significant difference in mean change in BMI z-score, suggesting a greater effect of the intervention in overweight children (Muckelbauer *et al*, 2009). The CHOPPS study of children aged 7-11y in the UK found that educational sessions and activities designed to reduce carbonated drink consumption led to a decrease in the percentage of overweight and obese children of 0.2%, compared to an increase of 7.5% in the control group after 1 year (James *et al*, 2004).

5. Snacking (Chain B3: 6 studies)

All studies for this chain were longitudinal or cross-sectional. Two studies of primary school aged children in South America found cross-sectional associations between obesity and a snacking dietary pattern (McDonald *et al*, 2008) and frequent snack consumption in commercial establishments (de Novaes *et al*, 2008). Other studies were all from the USA: national diet survey data showed that the frequency of snacking, though not the energy per snack, increased by around 30% in children aged 2-5y and those aged 6-11y from 1977-1996 (Jahns *et al*, 2001). Another study using national data from

1994-8 found no association between snacking frequency or energy content and BMI percentile in children aged 3-5 or 6-11y once implausible energy intake reports had been excluded (Huang *et al*, 2004). By contrast in a longitudinal study of girls, higher snacking frequency was associated with increase in BMI from 5-9y. This study also found that girls who watched more TV consumed more snacks in front of the TV (Francis *et al*, 2003). In an experimental study of 5-7 year old US girls, those who ate large amounts of snack foods in the absence of hunger were more likely to be overweight at both ages (Fisher & Birch, 2002).

6. Portion size of manufactured foods (chain B4: 5 studies)

For this chain there were three longitudinal or cross-sectional studies. Using national diet survey data from the US, in boys aged 6-11y a positive association between meal portion size and BMI centile was observed, though the relationship was not seen in girls of this age or in children aged 3-5 years of either sex (Huang *et al*, 2004). In children aged 1-2y and 2-5y portion size was positively associated with energy intake and body weight (McConachy *et al*, 2002; McConachy *et al*, 2004).

Two laboratory experimental studies were also included: one study found that portion size influenced the amount of food consumed by 5 year old but not 3 year old children (Rolls *et al*, 2000) though in children aged 3-5y doubling an age-appropriate portion of a main dish increased energy intake by 15% (Fisher *et al*, 2003).

7. Fast food consumption (Combined chains B3 and B5: 7 studies)

All studies for this chain were longitudinal or cross-sectional. A US study using national diet survey data for children aged 4-19y found that on the 30% of days in which food was consumed at fast food or pizza places the average energy, fat and sugar intake was significantly higher (by 126 kcal, 7g and 21g respectively) than other days (Bowman *et al*, 2004). A study of US children aged 7-17y found that mean energy, fat and carbohydrate intake at restaurants was over 50% higher than in eating occasions at home, school or other places (Zoumas-Morse *et al*, 2001). A longitudinal study of US girls found that those who ate fast food twice a week or more had a greater increase in BMI z-score over 3 years than other girls (Thompson *et al*, 2004). Children aged 6-8 years in Brazil had a higher odds of being obese if their mother reported that they ate frequently in commercial establishments, at which soft drinks, chips and French fries were commonly served (de Novaes *et al*, 2008), while children aged 5-12 in Colombia were found to be more likely to be overweight if they had hamburgers or hot dogs once a week or more (McDonald *et al,* 2008). By contrast, US children in the ECLS-K study who ate more family meals at age 5y were less likely to become overweight or remain overweight three years later (Gable *et al*. 2007). In 4-7 year old Mexican American children, those whose families reported that fast food chains were the type of restaurants they ate at most often were twice as likely to be overweight or obese than those whose parents reported eating at American (buffet-style) , Mexican or other ethnic restaurants (Duersken *et al*, 2007).

Estimates of the prevalence of overweight and obesity by age, sex, socio-economic status and rural/urban area of residence in Scotland

The Scottish Health Survey does not report overweight and obesity prevalence in children under 2 years and it was agreed by the case study team that only the age groups 2-4 years and 5-9 years would be explored since overweight and obesity in younger children is more likely to be transient while eating patterns and activity are becoming established. The overall prevalence for children over 2 years for boys and girls were taken from the Scottish Health Survey (SHS) 2008[5]. As the EDPHiS project age classification differs from the age groups reported in the survey, the prevalence for 2-4 year olds was taken as that for 2-6 year olds in the Scottish Health Survey, whereas for 5-9 year olds it was derived from the prevalence in 2-6 year olds and 7-11 year olds weighted in the ratio 2:3.

Variation in prevalence rates by socio-economic status (using quintiles of Scottish Index of Multiple Deprivation or SIMD) was not reported in the 2008 Scottish Health Survey but was reported in the Survey of Sugar Intake in Children in Scotland in 2006[7] and in the 2003 Scottish Health Survey[6]. In both cases the published figures are for children of a wider age range than the EDPHiS project: 3-17y in the Survey of Sugar Intake in Children in Scotland and 2-15y in the 2003 Scottish Health Survey. The variation by quintiles of SIMD was taken from the 2006 survey as it was the more recent, though as appendix 9 tables A9.2 and A9.3 show, the variation in overweight and obesity by socio-economic status was similar in the two surveys. The ratio of the prevalence in each SIMD quintile to the mean prevalence in all quintiles was calculated and these ratios were applied to the overall prevalence of overweight and obesity for boys and girls in the EDPHiS age groups as derived from the 2008 Scottish Health Survey. Tables 1 a) and b) show that in 2008 the prevalence of overweight was higher in boys than in girls but the prevalence of obesity was similar in boys and girls. Differences in prevalence between the 2-4y and 5-9 y age groups were limited apart from obesity in boys which increased with age. Prevalence of overweight did not differ markedly by socio-economic status but for obesity there was a tendency for prevalence to be lower in the children living in the less deprived areas.

Variation in prevalence by urban and rural areas of residence was also estimated from the Survey of Sugar Intake in Children in Scotland, again using data for children aged 3-17y. The Scottish Executive Urban Rural Classification was used to define area of residence as follows:

- Urban: Large urban areas, other urban areas and accessible small towns
- Rural: Remote small town, accessible rural and remote rural area

The ratio of the prevalence in the two subgroups to the overall prevalence was for all areas was calculated from this survey, using weighting based on the number of children measured in each area (see appendix 9, table A9.4). These ratios were applied to the overall prevalence of overweight and obesity for boys and girls in the two age groups used in tables 1a and 1b. Variation by socio-economic status was applied to these estimates as described above. Tables 2 a) and b) show that overweight was a little more common in rural than in urban areas but the differences were not marked. Tables 3a) and b) show that the prevalence of obesity was also a little higher in rural than urban areas lower in urban than in rural areas but the differences were very small.

Tables 1a and 1b: Estimation of the prevalence of overweight and obesity in Scottish children and variation by age, sex and socio-economic status

Table 1a: Estimated prevalence of overweight (BMI ≥ 85th but < 95th centile)

	Boys					Girls				
	Pre-birth	**<1**	**1-2 y**	**2-4 y**	**5-9 y**	**Pre-birth**	**<1**	**1-2 y**	**2-4 y**	**5-9 y**
All				18.1 %	19.5 %				13.1 %	12.3 %
SIMD 1[a]	*n/a*	*n/a*	*n/a*	*15.9%*	*17.2%*	*n/a*	*n/a*	*n/a*	*14.8%*	*13.9%*
SIMD 2	*n/a*	*n/a*	*n/a*	*22.6%*	*24.4%*	*n/a*	*n/a*	*n/a*	*14.0%*	*13.2%*
SIMD 3	*n/a*	*n/a*	*n/a*	*18.6%*	*20.1%*	*n/a*	*n/a*	*n/a*	*12.2%*	*11.4%*
SIMD 4	*n/a*	*n/a*	*n/a*	*17.4%*	*18.7%*	*n/a*	*n/a*	*n/a*	*12.2%*	*11.4%*
SIMD 5[b]	*n/a*	*n/a*	*n/a*	*15.9%*	*17.2%*	*n/a*	*n/a*	*n/a*	*12.2%*	*11.4%*

[a] Most deprived [b] Least deprived

Table 1b: Estimated prevalence of obesity (≥95th BMI percentile)

	Boys					Girls				
	Pre-birth	**<1**	**1-2 y**	**2-4 y**	**5-9 y**	**Pre-birth**	**<1**	**1-2 y**	**2-4 y**	**5-9 y**
All		n/a	n/a	7.8%	16.9%				13.0%	12.0%
SIMD 1[a]	*n/a*	*n/a*	*n/a*	*9.3%*	*20.1%*	*n/a*	*n/a*	*n/a*	*11.7%*	*10.8%*
SIMD 2	*n/a*	*n/a*	*n/a*	*7.3%*	*15.7%*	*n/a*	*n/a*	*n/a*	*16.4%*	*15.1%*
SIMD 3	*n/a*	*n/a*	*n/a*	*9.3%*	*20.1%*	*n/a*	*n/a*	*n/a*	*16.4%*	*15.1%*
SIMD 4	*n/a*	*n/a*	*n/a*	*7.3%*	*15.7%*	*n/a*	*n/a*	*n/a*	*12.5%*	*11.5%*
SIMD 5[b]	*n/a*	*n/a*	*n/a*	*5.9%*	*12.7%*	*n/a*	*n/a*	*n/a*	*8.7%*	*8.0%*

[a] Most deprived [b] Least deprived

Tables 2a and 2b: Estimates of the prevalence of overweight in children in urban and rural areas

Table 2a: E**stimated p**revalence of overweight (≥85th but <95th BMI percentile) in urban areas

	Boys					**Girls**				
	Pre-birth	**<1**	**1-2 y**	**2-4y**	**5-9 y**	**Pre-birth**	**<1 y**	**1-2 y**	**2-4y**	**5-9 y**
All				17.9%	19.3%				13.0%	12.2%
SIMD 1[a]	*n/a*	*n/a*	*n/a*	*15.8%*	*17.0%*	*n/a*	*n/a*	*n/a*	*14.7%*	*13.8%*
SIMD 2	*n/a*	*n/a*	*n/a*	*22.4%*	*24.1%*	*n/a*	*n/a*	*n/a*	*13.9%*	*13.1%*
SIMD 3	*n/a*	*n/a*	*n/a*	*18.4%*	*19.9%*	*n/a*	*n/a*	*n/a*	*12.1%*	*11.3%*
SIMD 4	*n/a*	*n/a*	*n/a*	*17.2%*	*18.5%*	*n/a*	*n/a*	*n/a*	*12.1%*	*11.3%*
SIMD 5[b]	*n/a*	*n/a*	*n/a*	*15.8%*	*17.0%*	*n/a*	*n/a*	*n/a*	*12.1%*	*11.3%*

[a] Most deprived [b] Least deprived

Table 2b: Estimated prevalence of overweight (≥85th but <95th BMI percentile) in rural areas

	Boys					**Girls**				
	Pre-birth	**<1**	**1-2 y**	**2-4y**	**5-9y**	**Pre-birth**	**<1 y**	**1-2 y**	**2-4y**	**5-9 y**
All				18.8%	20.3%				13.6%	12.7%
SIMD 1[a]	*n/a*	*n/a*	*n/a*	*16.5%*	*17.9%*	*n/a*	*n/a*	*n/a*	*15.4%*	*14.4%*
SIMD 2	*n/a*	*n/a*	*n/a*	*23.5%*	*23.4%*	*n/a*	*n/a*	*n/a*	*14.6%*	*13.6%*
SIMD 3	*n/a*	*n/a*	*n/a*	*19.4%*	*20.9%*	*n/a*	*n/a*	*n/a*	*12.6%*	*11.8%*
SIMD 4	*n/a*	*n/a*	*n/a*	*18.0%*	*19.5%*	*n/a*	*n/a*	*n/a*	*12.6%*	*11.8%*
SIMD 5[b]	*n/a*	*n/a*	*n/a*	*16.5%*	*17.9%*	*n/a*	*n/a*	*n/a*	*12.6%*	*11.8%*

[a] Most deprived [b] Least deprived

Tables 3a and 3b: Estimates of the prevalence of obesity in children in urban and rural areas

Table 3a: E**stimated p**revalence of obesity (≥95th BMI percentile) in urban areas

	Boys					**Girls**				
	Pre-birth	**<1**	**1-2 y**	**2-4y**	**5-9 y**	**Pre-birth**	**<1 y**	**1-2 y**	**2-4y**	**5-9 y**
All				7.7%	16.7%				12.9%	13.3%
SIMD 1[a]	*n/a*	*n/a*	*n/a*	*9.2%*	*19.9%*	*n/a*	*n/a*	*n/a*	*11.6*	*10.7%*
SIMD 2	*n/a*	*n/a*	*n/a*	*7.6%*	*15.7%*	*n/a*	*n/a*	*n/a*	*16.3%*	*15.0%*
SIMD 3	*n/a*	*n/a*	*n/a*	*9.2%*	*19.9%*	*n/a*	*n/a*	*n/a*	*16.3%*	*15.0%*
SIMD 4	*n/a*	*n/a*	*n/a*	*7.6%*	*15.7%*	*n/a*	*n/a*	*n/a*	*12.4%*	*11.4%*
SIMD 5[b]	*n/a*	*n/a*	*n/a*	*5.8%*	*12.5%*	*n/a*	*n/a*	*n/a*	*8.6%*	*8.0%*

[a] Most deprived [b] Least deprived

Table 3b: E**stimated p**revalence of obesity (≥95th BMI percentile) in rural areas

	Boys					**Girls**				
	Pre-birth	**<1**	**1-2 y**	**2-4y**	**5-9 y**	**Pre-birth**	**<1 y**	**1-2 y**	**2-4y**	**5-9 y**
All				8.0%	17.2%				13.3%	12.2%
SIMD 1[a]	*n/a*	*n/a*	*n/a*	*9.5%*	*20.5%*	*n/a*	*n/a*	*n/a*	*12.0%*	*11.0%*
SIMD 2	*n/a*	*n/a*	*n/a*	*7.9%*	*17.0%*	*n/a*	*n/a*	*n/a*	*16.8%*	*15.4%*
SIMD 3	*n/a*	*n/a*	*n/a*	*9.5%*	*20.5%*	*n/a*	*n/a*	*n/a*	*16.8%*	*15.4%*
SIMD 4	*n/a*	*n/a*	*n/a*	*7.5%*	*16.2%*	*n/a*	*n/a*	*n/a*	*12.8%*	*11.7%*
SIMD 5[b]	*n/a*	*n/a*	*n/a*	*6.0%*	*12.9%*	*n/a*	*n/a*	*n/a*	*8.9%*	*8.2%*

[a] Most deprived [b] Least deprived

Likely impact of actions on prioritised chains in Scottish children

1. Sedentary behaviour

Evidence from the US suggests that it is possible to reduce sedentary leisure activity in children in this age group and that this leads to a reduction in BMI. In the 2006 Survey of Sugar Intake in Children in Scotland it was reported that children aged 3-7y spent on average 1.6 hours sitting at a screen (other than at school)[7]. A recent cross-sectional study of children aged 4 in Scotland reported that each hour of TV viewing was associated with an extra 1kg body fat[9]. For children aged 1.5 – 7.5y with a BMI on the 95th centile to reach the weight of a child of the same age with a BMI on the 85th centile, about one hour per day of sedentary activity would need to be replaced by moderate activity, or half an hour per day of sedentary activity would need to be replaced by vigorous activity. Less time would be needed if, as several reports suggest, the effect of sedentary activity on body weight is partly mediated through snacking.

2. Physical activity in schools and nurseries

The literature provides reasonably consistent evidence that activity in schools and pre-school nurseries improved motor skills and fitness, but effects on BMI were only seen when the time spent in vigorous activity was at least an hour per week. For pre-school children vigorous activity may not be appropriate: in children above 5 years over 3 hours of vigorous activity each week would be needed to achieve the difference in energy balance between a child on the 95th centile of BMI and one on the 85th centile. For children of all age groups about one hour per day of moderate activity each week would be needed to achieve this difference in energy balance. This suggests that while increases in activity will help to prevent excess body weight, the magnitude of the difference in energy balance required is unlikely to be met through solely through increased physical activity.

3. Breast feeding and weaning practices

The literature from different countries is consistent with breast fed infants having a lower risk of obesity in later childhood than those who are bottle fed: a meta-analysis of observational studies suggests that the odds of overweight or obesity for children breast fed for more than one month was about 20% lower in all studies, including in those which adjusted for socio-economic status and parental anthropometry[10]. Whether this is a causal relationship or reflects unmeasured confounding is difficult to assess: one cluster randomised trial of breast feeding promotion in Belarus which increased breast feeding rates in the mothers in the intervention group but had no effect on BMI of the children at 6.5y, though obesity prevalence was much lower in this population than in the Scotland[11]. A longitudinal study of children from Avon, UK found that breast feeding and timing of introduction of solids did not have a significant association with obesity at age 7 years after adjustment for a wide range of other factors[12], though the study from Dundee suggests that current

guidance to avoid introduction of solids till after 16 weeks may help to prevent excess weight gain in Scottish children.

4. Sugar-sweetened soft drinks

The evidence from studies in different countries suggests that soft drink consumption can be reduced and that this may have a greater effect on BMI in overweight children. In Scottish children aged 3-7y in 2006 the average consumption of sugar-sweetened soft drinks among consumers (85% of children in this age group) was 122 ml/d, with significantly higher consumption in more deprived socio-economic groups.

5. Snack food consumption

The evidence for snacking as a cause of obesity is less clear-cut, with no intervention studies. In Scottish children aged 5-11y in 2006 the majority had 3 meals and 2 snacks each day, of which one was frequently in the mid-morning break at school and one after school: only a quarter of the children had snacks three or more times a day[12]. However the data from TV viewing studies support the possibility that snacking could contribute to the association between sedentary activity and higher BMI. In addition snack foods tend to be high in fat, sugar and salt with low amounts of fibre, vitamins or minerals so are more appropriate targets for reduction in intake than other foods. Most snack items contain at least 100 kcal (see appendix 7): to achieve the energy balance change required for a reduction from 95th to 85th centile of BMI would require children aged 7.5y to eat one less item of 150 kcal each day, while for younger children a smaller portion of common snacks would achieve this reduction.

6. Portion size of manufactured foods

The evidence for portion size influencing energy intake is limited but all suggests that there could be a benefit of offering smaller portions of meals and snack foods. In some outlets only adult size portions of meals are offered, while drinks and snacks containing 100 kcal or less, which would be more suitable for small children (as well as weight conscious adults) are either not available or only available in multi-packs. Larger size snack foods e.g. crisps and chocolate bars are also promoted through value pricing which may increase the tendency to consume larger portions.

7. Fast food consumption

All the evidence for fast food consumption was from N or S America, with no intervention studies attempting to reduce fast food consumption. It is not clear how much the association with fast food consumption could be mediated through large portions, sugar-sweetened soft drinks and/or parental overweight. Larger fast food chains now offer fresh fruit and salad vegetables, but the more

traditional items tend to be more energy dense: a portion of four chicken nuggets, a small portion of fries with ketchup and a chocolate milkshake provides around 650kcal, or 35-40% of the estimated daily energy requirements of a boy aged between 3.5 and 5.5y with a BMI on the upper boundary of normal weight. Including a cheeseburger instead of chicken nuggets brings the energy content of the meal to 770 kcal, or 39% of the energy requirement of a boy of 7.5 years with a BMI on the upper boundary of normal weight. If consumed as a main meal these menus could be consistent with an appropriate daily energy intake if the energy intake from other meals and snacks are not excessive.

Discussion

The use of the DPSEEA chains to classify the different environmental influences on health and to identify possible actions is a unique feature of the EDPHiS project. The range of environmental influences in the initial chains was broad, and for some little or no evidence was found in the scientific literature. It should be noted that this does not imply that actions on these chains would not have beneficial impacts on childhood obesity, but only that evidence was not found to support this. The use of rating by experts to select the chains with the strongest evidence and/or greatest likely effect size provided a more robust approach to selection of the chains on which further effort is justified. The number of people rating the evidence was smaller than hoped, though the exercise required more time and experience than initially anticipated. Some problems were encountered using the Gee approach for rating environmental studies, as this relies on the Bradford Hill 'criteria for causality', some of which are qualities of individual studies and some of the weight of evidence: in addition the studies reviewed for this case study were predominantly intervention and longitudinal studies rather than cross sectional studies for which the Bradford Hill approach is particularly suited.

The information gained from published surveys on variation in prevalence in overweight and obesity by sex, age, socio-economic status and rural/urban area of residence was based on relatively small numbers of children in the cells of cross-tabulated data, and for one of the two studies used the published data is for children aged 3-17y. The similar prevalence of overweight and obesity and the consistency of the pattern of variation by socio-economic status between the two surveys is reassuring. Further information will be available each year as the new rolling programme of the Scottish Health Survey accumulates data, and it will therefore be possible to look at more detailed subgroups as the numbers of children surveyed grows by combining several years of survey data.

The findings of this report are designed to inform the development of an action plan to support the Obesity Route Map published by the Scottish Government in 2010[13]. The route map highlights the need for preventative actions on energy consumption and energy expenditure, with particular focus on early years and working lives. The evidence presented here suggests priority areas for interventions on energy consumption and energy expenditure in the early years, which is complemented by a similar evidence gathering and rating exercise for working lives being undertaken by the Scottish Collaboration for Public Health Research and Policy.

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Appendix 1: EDPHiS obesity case study DPSEEA chains

Chain	Drivers	Pressures	State	Exposure	Effect	Contexts
A1: Unsafe and unsightly environment	Derelict land, crime levels, litter, low levels of lighting, dog ownership, graffiti	Neighbourhoods perceived as unsafe, especially for children	Neighbourhoods which are unsightly and unattractive and perceived to be unsafe	Low levels of physical activity. Children remain indoors or are transported by car	Excess weight gain and lower fitness	Rural/urban; socio-economic
A2: Traffic levels	Increasing car ownership, lack of public transport alternatives, busy lifestyles	Neighbourhoods perceived as unsafe, especially for children, time pressure to get to school if working parents	Neighbourhoods with high traffic levels perceived to be unsafe	Low levels of physical activity. Children remain indoors or are transported by car	Excess weight gain and lower fitness	Rural/urban; weather; working hours?
A3: Provision of high quality greenspace and paths	Lack of priority in planning strategy, new housing developments away from amenities	Lack of play areas and opportunities for cycling and walking for children, perception of safety	Neighbourhoods without attractive green spaces (rich, natural environments) with poor provision of safe paths, or facilities for walking or cycling	Low levels of physical activity. Children remain indoors or are transported by car	Excess weight gain and lower fitness	Rural/urban; socio-economic
A4: Access to amenities within a neighbourhood	Pressure for new housing developments away from amenities, increasing car ownership,	Loss of services (shops, libraries, post-offices) within neighbourhoods	Lack of shops and other services accessible by walking/cycling within neighbourhoods	Low levels of physical activity. Children remain indoors or are transported by car	Excess weight gain and lower fitness	Rural/urban
A5: Safe routes to schools and nurseries	Increased car use for school transport; lack of walking and cycling routes	Concerns about safety; time pressures for working parents	Neighbourhoods perceived as unsafe or unsuitable for children to walk or cycle to	Low levels of physical activity. Children transported by	Excess weight gain and lower fitness	Rural/urban; working hours; weather

			school or nursery	car		
A6: School and nursery outdoor play and sports facilities	Low priority for physical activity in schools; concerns about safety; financial constraints	Limited and low quality playgrounds and school and nursery outdoor sports and play facilities	Schools and nurseries which do not have outdoor facilities conducive to children's play and sport	Low levels of physical activity during and after school and nursery hours	Excess weight gain and lower fitness	
A7: School and nursery indoor play and sports facilities	Low priority for physical activity in schools; concerns about safety; financial constraints	Limited and low quality playgrounds and school and nursery indoor sports and play facilities	Schools and nurseries which do not have indoor facilities conducive to children's play and sports	Low levels of physical activity during school and nursery hours	Excess weight gain and lower fitness	
Chain	**Drivers**	**Pressures**	**State**	**Exposure**	**Effect**	**Contexts**
A8: Sedentary leisure activities	Increased TV channels, low cost DVDs and computer games designed for children	Increased time spent indoors; increased exposure to advertising of snack foods, snacking while watching TV	Indoor environment which encourages snack foods and is not conducive to children's play and sport	Low levels of physical activity and high snack food intake	Excess weight gain and lower fitness	Weather, working hours?
A9: School and nursery physical education	Low priority for physical activity in schools; concerns about safety; financial constraints; health and safety restrictions	Trend to reduced time for PE; PE generally physically inactive, health and safety restrictions	School timetable which does not include time for active PE	Low levels of physical activity, reduced motor skills	Excess weight gain and lower fitness	
A10: Lack of affordable out-of-school active leisure activities	Financial constraints; lack of transport to leisure facilities	Out-of-school activities only available for children of more affluent parents	Neighbourhoods which do not have accessible outdoor and indoor facilities for play and sport	Low levels of physical activity, reduced motor skills	Excess weight gain and lower fitness	Socio-economic

B1: Demand for easy to prepare food and individual meals	Availability of a wide range of palatable processed foods, esp. individual portions	Time pressure on working parents; not cooking seen as social norm; risk, waste and mess aversion, lack of motivation / desire to cook	Meals in the home with high content of processed or partially processed food	Over-consumption of calories	Excess weight gain	Working hours; motivation
B2: Food promotion	Heavy marketing of foods; low price of fat and sugar; high prices for 'healthy foods'; advertising of 'unhealthy' foods	BOGOFs and other promotions; promotion of food for celebrations; perceived cost of 'healthy eating'	Large quantities of high calorie foods easily available	Over-consumption of calories	Excess weight gain	Socio-economic
B3: Food availability and access	Supermarket dominance; increasing neighbourhood take-away shops	Readily available energy dense foods, increased choice of foods (children can all have different meals within the same family if desired)	Large quantities of high calorie foods easily available	Over-consumption of calories	Excess weight gain	Rural/urban

Chain	**Drivers**	**Pressures**	**State**	**Exposure**	**Effect**	**Contexts**
B4: Large portions	Profit-led food industry	Increasing portion size, desire for value for money	Large quantities of high calorie foods easily available	Over-consumption of calories	Excess weight gain	
B5: Restaurants, fast food outlets and coffee bars	Food as a treat; lack of planning control	Easy availability of large portions of low cost, high fat, high sugar foods and drinks	Large quantities of high calorie foods easily available	Over-consumption of calories	Excess weight gain	
B6: High energy snack consumption in children	Availability of child-oriented snack foods; multipacks; advertising of snack foods to children	Demand for snack foods; children have free access to food between meals	Large quantities of high calorie foods easily available	Over-consumption of calories	Excess weight gain	
B7: School and nursery catering	Low budget; need to produce foods which children will eat	Use of processed foods and lower quality fresh foods	Calorie-rich meals provided within schools and nurseries	Over-consumption of calories	Excess weight gain	

B8: Changing design of homes	Demand for lower cost, smaller size housing; availability of easy-to-prepare foods; tendency to graze; reduced social function of mealtimes	Lack of food preparation and separate dining space; TVs available during mealtimes	Homes with small kitchens & limited dining space – driving demand for processed foods	Over-consumption of calories	Excess weight gain	Socio-economic
B9: Sugar-sweetened soft drinks	Low cost and ready availability of sugar-sweetened soft drinks; tap water not always available; lack of knowledge of energy content of soft drinks	Heavy brand marketing; cultural acceptability of giving sweet drinks to young children	High sugar juices and fizzy drinks widely available and accessible for children	Over-consumption of calories	Excess weight gain	
B10: Infant feeding practices	Promotion of formula milk Lack of post-natal support for breast feeding	Cultural acceptability; social norm; financial need or desire to return to work	Environment which is not conducive to breast feeding	Mechanisms unclear- likely overconsumption of calories	Excess weight gain	

Chain	**Drivers**	**Pressures**	**State**	**Exposure**	**Effect**	**Contexts**
B11: Desire for highly palatable foods	Appetite for fat, sugar; marketing (low fat foods may be high in sugar)	Tendency for fat, sugar and salt to be added during food processing; 'masking' of fat and sugar by flavourings;	Easily available highly palatable & calorie-rich foods	Overconsumption of calories		
C1: Health awareness of parents & carers	Lack of awareness of overweight and health risks; overweight becoming the cultural norm	Lack of knowledge of and confusion about fat and sugar content of foods; lack of demand for healthy foods and physical activity; lack of concern about diet	Social environment. Communities with reduced access to a healthy diet and physical activity	Low levels of physical activity and high calorie intake	Excess weight gain and lower fitness	Socio-economic
C2: Health awareness of	Lack of awareness of overweight and health risks;	Lack of knowledge (and confusion) of fat and sugar	Social environment. Family environment	Low levels of physical activity	Excess weight gain	Socio-economic

children	overweight becoming the cultural norm	content of foods; lack of demand for healthy foods and physical activity , lack of concern about diet and physical activity	which is not conducive to undertaking physical activity and eating healthy foods	and high calorie intake	and lower fitness	
C3: Changing family structure and work patterns	Extended family support less common; parental separation; smaller family size; loss of parental income during 'credit crunch'	Parental stress; children at out-of-school activities to allow parents to work. Less time and energy for child-centred family activities; succumbing to 'pester power', parents compensating for guilt	Social environment. Family environment which is not conducive to undertaking physical activity and eating healthy foods	Low levels of physical activity and high calorie intake	Excess weight gain and lower fitness	Working hours

Appendix 2: Literature Search strategies

Search Strategy for Medline and EMBASE

1. exp OBESITY/
2. exp Weight Gain/
3. exp Weight Loss/
4. obes$.af.
5. (weight gain or weight loss).af.
6. (overweight or over weight or overeat$ or over eat$).af.
7. weight change$.af.
8. ((bmi or body mass index) adj2 (gain or loss or change)).af.
9. or/1-8
10. exp Behavior Therapy/
11. exp Social Support/
12. exp Family Therapy/
13. ((psychological or behavio?r$) adj (therapy or modif$ or strateg$ or intervention$)).af.
14. ((psychological or behavio?r$) adj (therapy or modif$ or strateg$ or intervention$)).af.
15. (group therapy or family therapy or cognitive therapy).af.
16. ((lifestyle or life style) adj (chang$ or intervention$)).af.
17. counsel?ing.af.
18. social support.af.
19. (peer adj2 support).af.
20. (children adj3 parent$ adj therapy).af.
21. or/10-20
22. exp OBESITY/dh [Diet Therapy]
23. exp Diet, Fat-Restricted/
24. exp Diet, Reducing/

25. exp Diet Therapy/

26. exp FASTING/

27. (diets or diet or dieting).af.

28. (diet$ adj (modif$ or therapy or intervention$ or strateg$)).af.

29. (low calorie or calorie control$ or healthy eating).af.

30. (fasting or modified fast$).af.

31. exp Dietary Fats/

32. (fruit or vegetable$).af.

33. (high fat$ or low fat$ or fatty food$).af.

34. formula diet$.af.

35. or/22-34

36. exp EXERCISE/

37. exp Exercise Therapy/

38. exercis$.af.

39. (aerobics or physical therapy or physical activity or physical inactivity).af.

40. (fitness adj (class$ or regime$ or program$)).af.

41. (aerobics or physical therapy or physical training or physical education).af.

42. dance therapy.af.

43. sedentary behavio?r.af.

44. or/36-43

45. ((diet or dieting or slim$) adj (club$ or organi?ation)).af.

46. (fat camp$ or diet$ camp$).af.

47. 45 or 46

48. exp Health Promotion/

49. exp Health Education/

50. (health promotion or health education).af.

51. (media intervention$ or community intervention$).af.

52. health promoting school$.af.

53. ((school or community)adj2 program$).af.

54. ((school or community)adj2 intervention$).af.

55. (family intervention$ or parent$ intervention).af.

56. (parent$ adj2 (behavio?r or involve$ or control$ or attitude$ or educat$)).af.

57. or/45-56

58. exp Health Policy/

59. exp Nutrition Policy/

60. (health polic$ or school polic$ or food polic$ or nutrition polic$).af.

61. or/58-60

62. exp OBESITY/pc [Prevention & Control]

63. exp Primary Prevention/

64. (primary prevention or secondary prevention).af.

65. (preventive measure$ or preventative measure$).af.

66. (preventive care or preventative care).af.

67. (obesity adj2 (prevent$ or treat$)).af.

68. or/62-67

69. exp Randomized Controlled Trial/

70. exp Randomization/

71. exp Double-Blind procedure/

72. exp Single-Blind procedure/

73. 78. exp control/

74. random$.tw

75. comparative Study/

76. exp Evaluation/

77. intervention trial.tw.

78. intervention.pt.

79. (before adj2 after adj3 (stud$ or trial$ or design$)).tw.

80. ((singl$ or doubl$ or trebl$ or tripl$) adj5 (blind$ or mask)).tw.

81. pre/post test.tw.

82. random$.tw.

83. (matched communities or matched schools or matched populations).tw.

84. control$.tw.

85. (comparison group$ or control group$).tw.

86. matched pairs.tw.

87. (outcome study or outcome studies).tw.

88. (quasiexperimental or quasi experimental or pseudo experimental).tw.

89. (nonrandomi?ed or non randomi?ed or pseudo randomi?sed or quasi randomi?ed).tw.

90. prospectiv$.tw.

91. (longitudinal study or longitudinal studies).tw.

92. longitudinal evaluation.tw.

93. or/69-93

94. food promotion.af.

95. snack$.af.

96. (food) adj (portion size).af.

97. restaurant.af.

98. fast foods.af.

99. (School catering or nursery catering).af.

100. (sugar) adj (sweetened drinks).af.

101. “fizzy” drinks).af.

102. (carbonated drinks or soft drinks).af.

103. breast milk.af.

104. (breastfeeding or breast feeding).af.

105. formula milk.af.

106. formula feeding.af.

107. family structure.af.

108. maternal employment.af.

109. paternal employment.af.

110. (unsafe environment or unsightly environment)..af.

111. traffic levels.af

112. (greenspace or green space).af.

113. (walking path$ or cycling path$).af.

114. (school play$ or nursery play$).af.

115. (school sport$ facilit$ or nursery sport$ facilit$).af.

116. (sedentary activit$ or leisure activit$).af.

117. (television watching or TV watching).af.

118. (video game$ or computer game$).af.

119. school physical education or nursery physical education).af.

120. or /94-119

121. 21 or 35 or 44 or 47 or 61 or 68 or 120

122. 9 and 93 and 121

123. exp CHILD/

124. exp CHILD, PRESCHOOL/or CHILD/

125. exp INFANT/

126. (child$ or infant$).af.

127. (schoolchildren or school children).af.

128. (pediatr$ or paediatr$).af.

129. (boys or girls).af.

130. or/123-130

131. 122 and 130

132. limit 131 to humans

Strategy for CENTRAL (on The Cochrane Library)

1. exp OBESITY/

2. exp Weight Gain/

3. exp Weight Loss/

4. obes$.af.

5. (weight gain or weight loss).af.

6. (overweight or over weight or overeat$ or over eat$).af.

7. weight change$.af.

8. ((bmi or body mass index) adj2 (gain or loss or change)).af.

9. or/1-8

10. exp Behavior Therapy/

11. exp Social Support/

12. exp Family Therapy/

13. ((psychological or behavio?r$) adj (therapy or modif$ or strateg$ or intervention$)).af.

14. (group therapy or family therapy or cognitive therapy).af.

15. ((lifestyle or life style) adj (chang$ or intervention$)).af.

16. counsel?ing.af.

17. social support.af.

18. (peer adj2 support).af.

19. (children adj3 parent$ adj therapy).af.

20. or/10-19

21. exp OBESITY/dh [Diet Therapy]

22. exp Diet, Fat-Restricted/

23. exp Diet, Reducing/

24. exp Diet Therapy/

25. exp FASTING/

26. (diets or diet or dieting).af.

27. (diet$ adj (modif$ or therapy or intervention$ or strateg$)).af.

28. (low calorie or calorie control$ or healthy eating).af.

29. (fasting or modified fast$).af.

30. exp Dietary Fats/

31. (fruit or vegetable$).af.

32. (high fat$ or low fat$ or fatty food$).af.

33. formula diet$.af.

34. or/21-33

35. exp EXERCISE/

36. exp Exercise Therapy/

37. exercis$.af.

38. (aerobics or physical therapy or physical activity or physical inactivity).af.

39. (fitness adj (class$ or regime$ or program$)).af.

40. (aerobics or physical therapy or physical training or physical education).af.

41. dance therapy.af.

42. sedentary behavio?r.af.

43. or/35-42

44. ((diet or dieting or slim$) adj (club$ or organi?ation)).af.

45. (weightwatcher$ or weight watcher$).af.

46. (correspondence adj (course$ or program$)).af.

47. (fat camp$ or diet$ camp$).af.

48. or/44-47

49. exp Health Promotion/

50. exp Health Education/

51. (health promotion or health education).af.

52. (media intervention$ or community intervention$).af.

53. health promoting school$.af.

54. ((school or community)adj2 program$).af.

55. ((school or community)adj2 intervention$).af.

56. (family intervention$ or parent$ intervention).af.

57. (parent$ adj2 (behavio?r or involve$ or control$ or attitude$ or educat$)).af.

58. or/49-57

59. exp Health Policy/

60. exp Nutrition Policy/

61. (health polic$ or school polic$ or food polic$ or nutrition polic$).af.

62. or/59-61

63. exp OBESITY/pc [Prevention & Control]

64. exp Primary Prevention/

65. (primary prevention or secondary prevention).af.

66. (preventive measure$ or preventative measure$).af.

67. (preventive care or preventative care).af.

68. (obesity adj2 (prevent$ or treat$)).af.

69. or/63-68

70. randomized controlled trial.pt.

71. controlled clinical trial.pt.

72. exp Controlled Clinical Trials/

73. exp Random Allocation/

74. exp pre/post test/

75. exp Intervention studies/

76. exp Evaluation studies/

77. exp Comparative Study/

78. exp Follow-Up Studies/

80. exp Prospective Studies/

81. (before adj2 after adj3 (stud$ or trial$ or design$)).tw.

82. ((singl$ or doubl$ or trebl$ or tripl$) adj5 (blind$ or mask)).tw.

83. random$.tw.

84. (matched communities or matched schools or matched populations).tw.

85. control$.tw.

86. (comparison group$ or control group$).tw.

87. matched pairs.tw.

88. (outcome study or outcome studies).tw.

89. (quasiexperimental or quasi experimental or pseudo experimental).tw.

90. (nonrandomi?ed or non randomi?ed or pseudo randomi?sed or quasi randomi?ed).tw.

91. prospectiv$.tw.

92. (longitudinal stud$).tw.

93. (longitudinal evaluation).tw.

94. or/70-93

95. food promotion.af.

96. snack$.af.

97. (food) adj (portion size).af.

98. restaurant.af.

99. fast foods.af.

100. (School catering or nursery catering).af.

101. (sugar) adj (sweetened drinks).af.

102. “fizzy” drinks).af.

103. (carbonated drinks or soft drinks).af.

104. breast milk.af.

105. (breastfeeding or breast feeding).af.

106. formula milk.af.

107. formula feeding.af.

108. family structure.af.

109. maternal employment.af.

110. paternal employment.af.

111. (unsafe environment or unsightly environment)..af.

112. traffic levels.af

113. (greenspace or green space).af.

114. (walking path$ or cycling path$).af.

115. (school play$ or nursery play$).af.

116. (school sport$ facilit$ or nursery sport$ facilit$).af.

117. (sedentary activit$ or leisure activit$).af.

118. (television watching or TV watching).af.

119. (video game$ or computer game$).af.

120. school physical education or nursery physical education).af.

121. or /95-120

122. 99. 20 or 34 or 43 or 48 or 58 or 62 or 69 or 121

123. 100. 9 and 94 and 122

124. exp CHILD/

125. exp CHILD, PRESCHOOL/or CHILD/

126. exp INFANT/

127. (child$ or infant$).af.

128. (schoolchildren or school children).af.

129. (pediatr$ or paediatr$).af.

130. (boys or girls).af.

131. or/124-130

132. 123 and 131

133. Limit 132 to humans

Search strategy for PsycINFO

1. exp OBESITY/

2. exp Weight Gain/

3. exp Weight Loss/

4. obes$.af.

5. (weight gain or weight loss).af.

6. (overweight or over weight or overeat$ or over eat$).af.

7. weight change$.af.

8. ((bmi or body mass index) adj2 (gain or loss or change)).af.

9. or/1-8

10. exp Behavior Therapy/

11. exp Social Support/

12. exp Family Therapy/

13. ((lifestyle or life style) adj (chang$ or intervention$)).af.

14. counsel?ing.af.

15. social support.af.

16. (peer adj2 support).af.

17. (children adj3 parent$ adj therapy).af.

18. or/10-17

19. exp OBESITY/dh [Diet Therapy]

20. exp Diet, Fat-Restricted/

21. exp Diet, Reducing/

22. exp Diet Therapy/

23. exp FASTING/

24. (diets or diet or dieting).af.

25. (diet$ adj (modif$ or therapy or intervention$ or strateg$)).af.

26. (low calorie or calorie control$ or healthy eating).af.

27. (fasting or modified fast$).af.

28. exp Dietary Fats/

29. (fruit or vegetable$).af.

30. (high fat$ or low fat$ or fatty food$).af.

31. formula diet$.af.

32. or/19-31

33. exp EXERCISE/

34. exp Exercise Therapy/

35. exercis$.af.

36. (aerobics or physical therapy or physical activity or physical inactivity).af.

37. (fitness adj (class$ or regime$ or program$)).af.

38. (aerobics or physical therapy or physical training or physical education).af.

39. dance therapy.af.

40. sedentary behavio?r.af.

41. or/33-40

42. ((diet or dieting or slim$) adj (club$ or organi?ation)).af.

43. (weightwatcher$ or weight watcher$).af.

44. (correspondence adj (course$ or program$)).af.

45. (fat camp$ or diet$ camp$).af.

46. or/42-45

47. exp Health Promotion/

48. exp Health Education/

49. (health promotion or health education).af.

50. (media intervention$ or community intervention$).af.

51. health promoting school$.af.

52. ((school or community)adj2 program$).af.

53. ((school or community)adj2 intervention$).af.

54. (family intervention$ or parent$ intervention).af.

55. (parent$ adj2 (behavio?r or involve$ or control$ or attitude$ or educat$)).af.

56. or/47-55

57. exp Health Policy/

58. exp Nutrition Policy/

59. (health polic$ or school polic$ or food polic$ or nutrition polic$).af.

60. or/66-68

61. exp OBESITY/pc [Prevention & Control]

62. exp Primary Prevention/

63. (primary prevention or secondary prevention).af.

64. (preventive measure$ or preventative measure$).af.

65. (preventive care or preventative care).af.

66. (obesity adj2 (prevent$ or treat$)).af.

67. or/60-66

68. 94. food promotion.af.

69. 95. snack$.af.

70. 96. (food) adj (portion size).af.

71. 97. restaurant.af.

72. 98. fast foods.af.

73. 99. (School catering or nursery catering).af.

74. 100. (sugar) adj (sweetened drinks).af.

75. 101. “fizzy” drinks).af.

76. 102. (carbonated drinks or soft drinks).af.

77. 103. breast milk.af.

78. 104. (breastfeeding or breast feeding).af.

79. 105. formula milk.af.

80. 106. formula feeding.af.

81. 107. family structure.af.

82. 108. maternal employment.af.

83. 109. paternal employment.af.

84. 110. (unsafe environment or unsightly environment)..af.

85. 111. traffic levels.af

86. 112. (greenspace or green space).af.

87. 113. (walking path$ or cycling path$).af.

88. 114. (school play$ or nursery play$).af.

89. 115. (school sport$ facilit$ or nursery sport$ facilit$).af.

90. 116. (sedentary activit$ or leisure activit$).af.

91. 117. (television watching or TV watching).af.

92. 118. (video game$ or computer game$).af.

93. 119. school physical education or nursery physical education).af.

94. or/68-93

95. 18 or 32 or 41 or 46 or 56 or 60 or 67 or 94

96. (child$ or infant$).af.

97. (schoolchildren or school children).af.

98. (pediatr$ or paediatr$).af.

99. (boys or girls).af.

100. or/96-99

101. 9 and 68 and 100

102. Limit 101 to humans

Search strategy for CINAHL

1. exp OBESITY/

2. exp Weight Gain/

3. exp Weight Loss/

4. obes$.af.

5. (weight gain or weight loss).af.

6. (overweight or over weight or overeat$ or over eat$).af.

7. weight change$.af.

8. ((bmi or body mass index) adj2 (gain or loss or change)).af.

9. or/1-8

10. exp Behavior Therapy/

11. exp Social Support/

12. exp Family Therapy/

13. exp Psychotherapy, Group/

14. ((psychological or behavio?r$) adj (therapy or modif$ or strateg$ or intervention$)).af.

15. (group therapy or family therapy or cognitive therapy).af.

16. ((lifestyle or life style) adj (chang$ or intervention$)).af.

17. counsel?ing.af.

18. social support.af.

19. (peer adj2 support).af.

20. (children adj3 parent$ adj therapy).af.

21. or/10-20

22. exp OBESITY/dh [Diet Therapy]

23. exp Diet, Fat-Restricted/

24. exp Diet, Reducing/

25. exp Diet Therapy/

26. exp FASTING/

27. (diets or diet or dieting).af.

28. (diet$ adj (modif$ or therapy or intervention$ or strateg$)).af.

29. (low calorie or calorie control$ or healthy eating).af.

30. (fasting or modified fast$).af.

31. exp Dietary Fats/

32. (fruit or vegetable$).af.

33. (high fat$ or low fat$ or fatty food$).af.

34. formula diet$.af.

35. or/22-34

36. exp EXERCISE/

37. exp Exercise Therapy/

38. exercis$.af.

39. (aerobics or physical therapy or physical activity or physical inactivity).af.

40. (fitness adj (class$ or regime$ or program$)).af.

41. (aerobics or physical therapy or physical training or physical education).af.

42. dance therapy.af.

43. sedentary behavio?r.af.

44. or/36-43

45. ((diet or dieting or slim$) adj (club$ or organi?ation)).af.

46. (weightwatcher$ or weight watcher$).af.

47. (correspondence adj (course$ or program$)).af.

48. (fat camp$ or diet$ camp$).af.

49. or/46-49

50. exp Health Promotion/

51. exp Health Education/

52. (health promotion or health education).af.

53. (media intervention$ or community intervention$).af.

54. health promoting school$.af.

55. ((school or community)adj2 program$).af.

56. ((school or community)adj2 intervention$).af.

57. (family intervention$ or parent$ intervention).af.

58. (parent$ adj2 (behavio?r or involve$ or control$ or attitude$ or educat$)).af.

59. or/50-58

60. exp Health Policy/

61. exp Nutrition Policy/

62. (health polic$ or school polic$ or food polic$ or nutrition polic$).af.

63. or/65-67

64. exp OBESITY/pc [Prevention & Control]

65. exp Primary Prevention/

66. (primary prevention or secondary prevention).af.

67. (preventive measure$ or preventative measure$).af.

68. (preventive care or preventative care).af.

69. (obesity adj2 (prevent$ or treat$)).af.

70. or/64-69

71. exp study design/

72. exp evaluation research/

73. exp comparative studies/

74. exp Random Assignment/

75. exp Random sample/

76. exp Placebos/

77. exp Prospective Studies/

78. ((singl$ or doubl$ or trebl$ or tripl$) adj5 (blind$ or mask)).tw.

79. random$.tw.

80. (matched communities or matched schools or matched populations).tw.

81. control$.tw.

82. (comparison group$ or control group$).tw.

83. matched pairs.tw.

84. (outcome study or outcome studies).tw.

85. (quasiexperimental or quasi experimental or pseudo experimental).tw.

86. (nonrandomi?ed or non randomi?ed or pseudo randomi?sed or quasi randomi?ed).tw.

87. prospectiv$.tw.

88. (longitudinal study or longitudinal studies).tw.

89. (longitudinal evaluation).tw.

90. or/70-89

91. food promotion.af.

92. snack$.af.

93. (food) adj (portion size).af.

94. restaurant.af.

95. fast foods.af.

96. (School catering or nursery catering).af.

97. (sugar) adj (sweetened drinks).af.

98. “fizzy” drinks).af.

99. (carbonated drinks or soft drinks).af.

100. breast milk.af.

101. (breastfeeding or breast feeding).af.

102. formula milk.af.

103. formula feeding.af.

104. family structure.af.

105. maternal employment.af.

106. paternal employment.af.

107. (unsafe environment or unsightly environment)..af.

108. traffic levels.af

109. (greenspace or green space).af.

110. (walking path$ or cycling path$).af.

111. (school play$ or nursery play$).af.

112. (school sport$ facilit$ or nursery sport$ facilit$).af.

113. (sedentary activit$ or leisure activit$).af.

114. (television watching or TV watching).af.

115. (video game$ or computer game$).af.

116. school physical education or nursery physical education).af.

117. or /91-116

118. 21 or 35 or 44 or 49 or 59 or 63 or 70 or 90 or 117

119. exp CHILD/

120. exp CHILD, PRESCHOOL/or CHILD/

121. exp INFANT/

122. (child$ or infant$).af.

123. (schoolchildren or school children).af.

124. (pediatr$ or paediatr$).af.

125. (boys or girls).af.

126. or/119-125

127. 9 and 118 or 126

128. Limit 127 to humans

Websites searched

A number of websites were searched:

• The Evidence for Policy and Practice Information and Coordinating Centre (EPPI Centre) database of health promotion research, http://eppi.ioe.ac.uk;

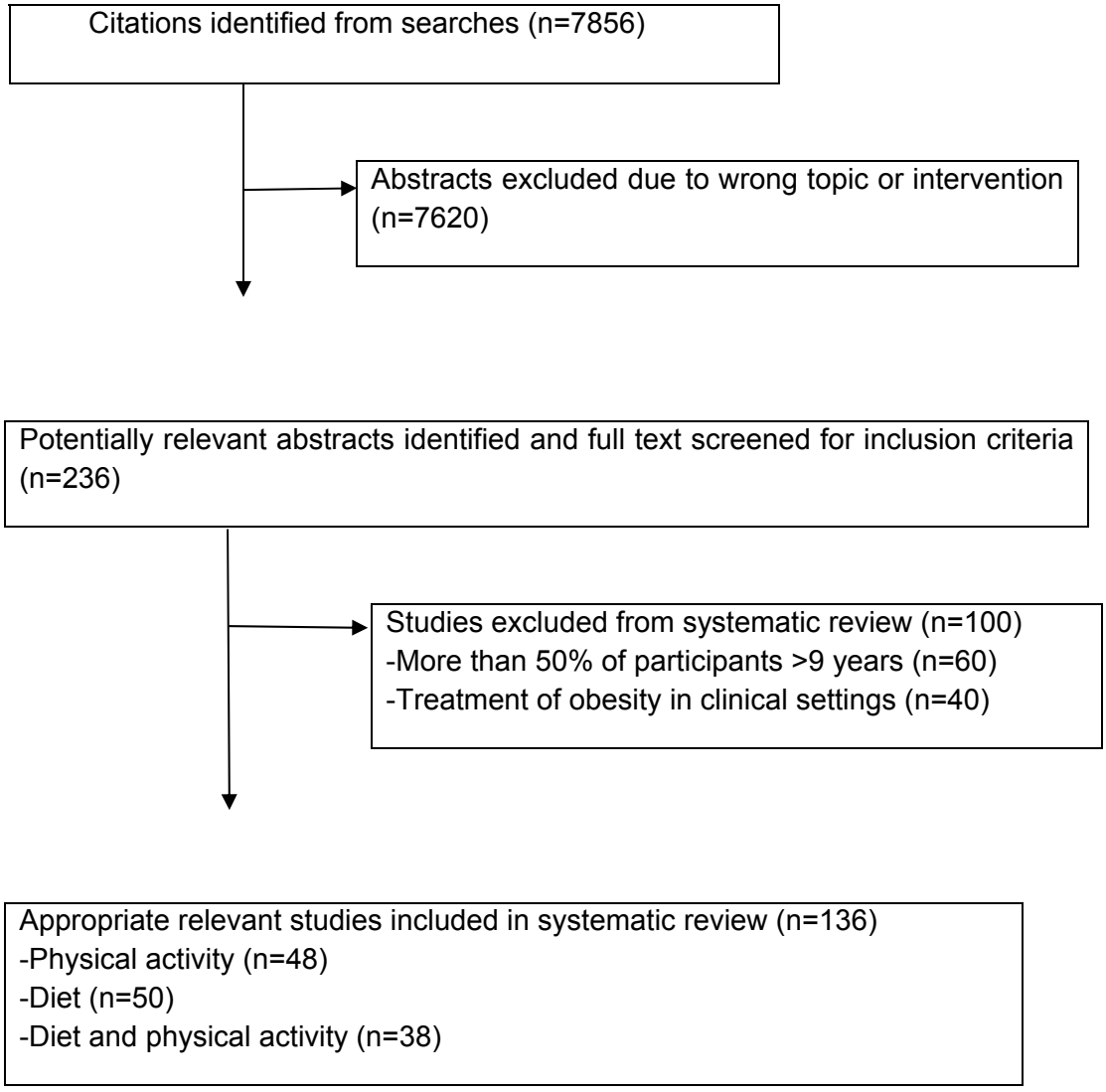
• The Health Technology Database through the University of York NHS Centre for Reviews and Dissemination, http://www.york.ac.uk/inst/crd;

• The Community Guide - Guide to Community Preventive Services - Systematic reviews and evidence-based recommendations, http://www.thecommunityguide.org/

Reference lists checked

The reference lists of systematic reviews (identified from searches detailed above) which included information on interventions for the prevention of childhood obesity were scanned.

Appendix 3: QUOROM Statement Flow Chart



Appendix 4: Bibliographic list of selected studies

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Appendix 5: Details of selected studies for each chain

Classifying evidence for causality - towards consistency of terminology

Evidence of association	Causality		
	Consider causal	Don't know	Consider non-causal
Very strong	★★★	★★	★
Strong	★★★	★★	★
Moderately strong	★★★	★★	★
Moderately weak	★★	★	★
Weak	★★	★	★
Very weak	★★	★	★

Characteristics of included studies

A1: Unsafe or unsightly neighbourhood environment						
Study	**Design**	**Study population**	**Objectives**	**Programme content**	**Outcome**	**EDPHiS Grade**
Farley *et al.* [1] USA	Non-RCT	Low income children in 2nd-5th grades	To evaluate effect of providing a safe play space on the physical activity of school children	Schoolyard of the intervention school remained open during school days after school and during school holidays.	More children outdoors and active in the intervention than the comparison neighbour-hood/school yard (71.1% *vs*. 38.7%, p<0.001)	★★★
Gable *et al.* [2] USA	Longitudinal, 3 years	Children aged 4-5 years (n=8000)	To identify activity factors associated with onset of overweight.	Data collected at 4 time points. Information was obtained for time spent viewing TV and video, activity and perception of neighbourhood safety.	More TV viewing and living in unsafe neighbourhoods were linked to persistent childhood obesity (γ = -0.27; p<0.01, OR 0.76, 95% CI 0.65-0.89)	★★★
A2: Traffic levels						
No study identified						
A3: Provision of high quality greenspace and paths						
Bell *et al.* [3] USA	Longitudinal 2 years	Children aged 3-16 years, from low income families (n=3901)	To assess the effect of greenness and residential density on BMI.	Greenness and neighbour-hood density were calculated. BMI change over time was analysed.	Inverse relation between neighbour hood greenness and BMI (OR= 0.87, 95% CI: 0.79 to 0.97)	★★★
A4: Access to amenities within neighbourhood						
Dunton *et al.* [4]	Review evidence					

A5: Safe routes to school and nurseries						
Study	**Design**	**Study population**	**Objectives**	**Programme content**	**Outcome**	**EDPHiS Grade**
Metcalf *et al.* [5] UK	Non-RCT	School children aged 4.9 years (n=550)	To measure the activity cost of the school run in young children.	Accelerometers worn by children on 5 consecutive days and at weekend.	No difference in activity between active and non active commuters (difference 0.04 units or 0.1%, p=0.97)	★
Rosenberg *et al.* [6] USA	Longitudinal 2 years	Fourth grade students (n=924)	To examine health benefits of active modes of transport to school	Data for commuting was collected at 4 time periods. Accelerometers were worn on weekday	No difference in BMI at two year follow up (boys p=0.88, girls p=0.57)	★
Kong *et al.* [7] USA	Non-RCT, 10 weeks	Kindergarten children from low income families (n=25)	To examine the feasibility of a walking school bus (WSB) program	WSB programme initiated at the school. Health themes were also emphasized.	BMI percentile remained unchanged (pre WSB 51st percentile, post WSB 49th percentile, p=0.10)	★
Mendoza *et al.* [8] USA	Non-RCT, 12 months	School children aged 5-11 years (n=820)	To assess effect of a WSB programme in a low income community.	A walking school bus (WSB) programme operated in the intervention school.	Higher proportion walking to school in intervention group at 12 months (Intervention school 25% ± 2% *vs.*control school 7% ±1%, p=0.001)	★
A6: School and nursery outdoor play and sports facilities						
Stratton *et al.* [9] UK	RCT, 8 weeks	5-7 year olds (n=60)	To assess activity levels of before and after painting of the school playground	Playground markings in intervention school were designed by children. No markings in the control school.	Significant increase in vigorous PA in the intervention group (F_{1278} = 6.0; p ≤ 0.01)	★★★

A6: School and nursery outdoor play and sports facilities (contd.)						
Study	**Design**	**Study population**	**Objectives**	**Programme content**	**Outcome**	**EDPHiS Grade**
Stratton *et al.* [10] UK	Non-RCT, 8 weeks	4-11 years old (n=120)	To assess activity levels of before and after painting of the school playground	Playground markings in intervention school were designed by children. No markings in the control school.	Increase in MVPA from 36.7% to 50.3% in intervention compared to decrease from 39.9% to 33.4% in control (F_{1204} = 13.7, p<0.01)	★★★
Ridgers *et al.* [11] UK	Non-RCT, 6 months	Children from elementary schools (n=470)	To asses effect of playground redesign on recess activity levels.	Playgrounds in the intervention schools divided into 3 colour coded areas, and schools received sports equipment.	Intervention schools engaged in 4.0% and 2.4 % more MVPA and VPA respectively than control schools (p<0.05 for MVPA and VPA).	★★★
Alhassan *et al.* [12] USA	RCT 4 days	3-5 year old children from low income families (n=32)	To asses whether outdoor free play time increases PA levels.	Controls had 60 mins recess time in two 30 min blocks. Intervention group had extra 60 min daily free play time.	No difference in % daily time spent in moderate to VPA (intervention 0.3 ± 0.8; control 0.4 ± 1.3; p>0.05)	★★
Cardon *et al.* [13] Belgium	RCT	4-5 year old children (n=583)	To asses effects of play equipment and playground markings on physical activity	Preschoolers were grouped as 1) play equipment only 2) playground markings 3) play equipment and markings and 4) controls.	No increase in activity or decrease in time spent in sedentary activity in groups	★★
A7: School and nursery indoor play and sports facilities						
No evidence identified						

A8: Sedentary leisure activities						
Study	**Design**	**Study population**	**Objectives**	**Programme content**	**outcome**	**EDPHiS Grade**
Robinson *et al.* [14] USA	RCT, 8 months	School children aged 8.9 years (n=192)	To assess effects of reducing TV and videogame use on changes in adiposity and physical activity	School based programme where children received six months of classroom sessions 30-50 minute duration.	Decrease in BMI in intervention *vs* control (diff: -0.45 kg/ m^2; 95% CI: -0.73 to -0.17) and TV viewing (diff:-5.53hrs/ week; 95% CI -8.64 to -2.42).	★★★
Ford *et al.* [15] USA	RCT 4 weeks	7-12 year olds from low income families (n= 28).	To reduce television viewing time in the children	Children randomly assigned to receive counselling and behavioural intervention or counselling alone.	Increase in organized PA in behavioural intervention compared to counselling alone (2.5±5.9 *vs.* -3.6± 4.7 hours per week; p=0.004)	★★
Proctor *et al.* [16] USA	Longitudinal	Preschoolers (n=106)	To examine effect of TV viewing on body fat change.	Questionnaires were filled by parents on the child's TV and video habits	Watching TV for ≥3 hours/day was linked to higher BMI	★★★
Dennison *et al.* [17] USA	Longitudinal & RCT	2-5 year olds (n=77)	To reduce television viewing in preschool children	Questionnaire data collected for hours spent during the past week in sedentary screen time.	Decrease in TV viewing in intervention *vs.* control (diff:-4.7 hours/week; 95% CI: -8.4 to -1.0 hours/week)	★★★
Gable *et al.* [18] USA	Longitudinal, 3 years	Children aged 4-5 years (n=8000)	To identify activity factors associated with onset of overweight.	Data collected at 4 time points on time spent viewing TV and video, activity and perception of neighbourhood safety.	TV viewing linked to over-weight onset (OR=1.2, p< 0.001) and persistent over-weight (OR=1.03, p< 0.001)	★★★

A8: Sedentary leisure activities (contd.)						
Design	**Study population**	**objectives**	**Programme content**	**outcome**	**EDPHiS Grade**	
Danner *et al.* [19] USA	Longitudinal 6 years	Children from kindergarten to grade 5 (n=7334)	To assess relation between hours of TV viewing and BMI from preschool	Data collected at 5 time points on child's TV viewing habits, video and DVD for weekdays and weekends.	Hours of TV viewing were associated with increased BMI (coefficient 0.0012, SE 0.0002, p<0.001).	★★★
Epstein *et al.* [20] US	RCT, 2 years	4-7 year olds (n=70)	To assess effects of reducing TV viewing and computer use on BMI.	TV allowance was attached to the TV units. Alternative behaviours were available. Controls had free access to TV.	Decrease in mean BMI z-scores at 24 months in intervention *vs* control (-0.24 ± 0.32 *vs.* -0.13 ± 0.37, p<0.05).	★★★
Maloney *et al.* [21] USA	RCT, 28 weeks	7-8 year olds (n= 60)	To evaluate a dance video game on activity and screen time behaviours	Intervention group had equipment to play video game for 1st 10 weeks, followed by 18 weeks where both groups had access to the videogame.	Increase in VPA in intervention (6.2 mpw, p< 0.0005) and decrease in sedentary screen time in intervention *vs.* control (-1.2 ± 3.7 *vs.* 3.0 ± 7.7 hrs/ week p<0.03).	★★★
A9: School and nursery physical activity						
Gutin *et al.* [22] USA	Non-RCT, 10 weeks	7-11 year old obese black girls (n=22)	To determine effects of a high intensity physical training (PT) program	Girls assigned to PT (5 days/ week) or to a lifestyle (behaviour change to increase activity)	Decrease in % body fat in intervention *vs*. control (1.4% *vs.* 0.4%, p<0.05).	★★★
Moore *et al.* [23] USA	Longitudinal	3-5 year old children and their parents (n=106)	To examine effect of preschool physical activity on body fatness	Physical activity was assessed twice/year. Accelerometers worn for 5 consecutive days 6 months apart.	Inactive children are more likely than active children to have increasing triceps slope OR= 3.8 (95% CI 1.4 to10.6).	★★★

A9: School and nursery physical activity (contd.)						
Study	**Design**	**Study population**	**Objectives**	**Programme content**	**Outcome**	**EDPHiS Grade**
Moore *et al.* [24] US	Longitudinal & non-RCT	3-5 yr old and their parents (n=106)	To examine effect of activity on body fat change	Physical activity was assessed twice/year. Accelerometers worn for 5 consecutive days 6 months apart.	Children in highest tertile of activity had lower BMI (p for trend= 0.052), and lower sum skin folds (p for trend =0.045)	★★★
McKenzie *et al.* [25] USA	RCT, 2.5 years	Third grade children (n=5106)	To test effectiveness of a cardiovascular health promotion programme.	Programme consisted of 90 min PE/ week and children engaged in activity during at least 40% of the PE class	More MVPA in intervention compared to control schools (51.9% *vs*. 42.3% of lesson time, p=0.002).	★★
Manios *et al.* [26] Greece	RCT 3 years	First grade children (n=5680)	To implement a school based health promotion program.	Intervention included health education and PA components and parental involvement. Control had no programme	Increase in out of school activity time (F = 41.3, p< 0.0005) in both groups, but higher in the intervention group (F=8.4, p<0.005).	★★★
Mo-suwan *et al.* [27] Thailand	RCT, 30 weeks	2nd year school pupils, aged 4.5 years (n= 210)	To evaluate effect of school based exercise program on obesity indexes.	In addition to 1 hour PE/week, intervention group did a 15 min walk before the morning class and a 20 min aerobic dance session in the afternoon.	Decrease in obesity rates in both groups, but significant only among girls (OR=0.32, 95% CI: 0.18 to 0.56)	★★★
Stephens *et al.* [28] USA	RCT, 15 week	8-10 year olds from low income families (n=99)	To evaluate a class-room based PA program in children	3 activity sessions/week 20 min aerobic activity and 5-10 min cool down period. Controls had one 45 min session/week	Decrease in triceps and calf skin folds in intervention than controls (25 to 23.5 mm *vs*. 26 to 28.5mm, p<0.01).	★★★

A9: School and nursery physical activity (contd.)						
Study population	**design**	**Study population**	**Objectives**	**Programme content**	**outcome**	**EDPHiS Grade**
Gutin *et al.* [29] USA	RCT, 8 months	7-11 year olds (n=79)	To assess effect of physical training (PT) on body composition	1st group received PT for 4 months and no PT for the next 4 months. Controls had no PT for the first 4 months and PT for next 4 months	Reductions in % BF in the intervention by 2.2 units, no change in controls ($p<0.01$) during the training period.	★★★
Owens *et al.* [30] USA	RCT, 8months	7-11 year olds, (n=74)	To asses PT program on visceral adipose tissue (VAT) and total body fat mass (TFM)	Intervention had PT for 4 months and no PT for the next 4 months. Controls had no PT for the first 4 months and PT for next 4 months.	Reduction in TFM in intervention *vs.* controls (-0.8±0.5 kg *vs.* +0.9±0.3 kg, $p<0.01$) and increase in VAT (1.3± 8.3 cm^2 *vs.* 20.9±4.3 cm^2, $p=0.02$).	★★★
Van- Beurden *et al.* [31] Australia	Non-RCT, 6 months	7-10 year olds (n=1045)	To improve movement skills and increase PA	Children were tested and compared for improvements in fine motor skills and PA during PE classes	3.3% increase in vigorous PA in intervention compared to control schools ($z=2.43$, $p=0.008$)	★★★
Going *et al.* [32] USA	RCT, 3 years	Native Indian children, aged 6-8 years (n=1704)	To increase PA and energy expenditure in by increasing frequency of PE classes	PE lessons ≥ 3 times/week, and exercise breaks 1-2/ day for 5-10 min each with 1 or 2 activities to target a single fitness component.	Intervention schools more active (+6.3 to +27.2%) than controls, but difference in PA was not significant ($p>0.05$)	★★
Datar *et al.* [33] USA	Longitudinal, 5 years	preschoolers followed for a period of 5 years (n=9751)	To asses effect of PE instruction time on BMI	Children followed from pre-school to 5th grade. Data was also collected on duration of exposure to PE classes.	1 hour increase in PE instruction time with reduction in BMI in overweight girls (coefficient = -0.31, $p<0.001$).	★★★
Reilly [34] UK	Longitudinal, 2 years	3 year olds followed up to age 5 (n=78)	To test whether the lifestyle of children is sedentary	Energy expenditure (EE) was measured for 7 days (3 year olds) and10 days (5 year olds). PA measured for 3 days (3 year olds) and 5 days in 5 year olds.	Lower levels of EE and PA at age 3 and age 5; with very low levels in girls.	★★

A9: *School and nursery physical education (contd.)*						
Study	**Design**	**Study population**	**Objectives**	**Programme content**	**Outcome**	**EDPHiS Grade**
Reilly *et al.* [35] UK	RCT, 12 months	Preschool children (n=545)	To assess whether a PA intervention reduces BMI in young children	Intervention received 3 PA sessions for 24 weeks, and materials for parents. Control group followed the standard curriculum.	Intervention had no effect on BMI, PA or sedentary behaviour (p>0.05)	★★
Valdimarsson *et al.* [36] Sweden	Non-RCT, 2 years	7-9 year old girls (n=103)	To asses an exercise program on bone mineral content and increase bone width.	Regular PA increased to 40 min/day for intervention group. Controls followed the regular activity session 60min/week	Higher gains in total lean mass in intervention than controls 11.1% vs. 9.2% (p=0.002)	★★★
Linden *et al.* [37] Sweden	Non-RCT, 2 years	7-9 year old girls (n=105)	To evaluate school-based exercise intervention program.	Regular PA increased to 40 min/day for intervention group. Controls followed the regular activity session 60min/week	Higher gains in total lean mass in intervention than controls (mean difference, 0.14, p=0.01)	★★★
Barbeau *et al.* [38] USA	RCT, 10 10 months	8-12 yr old Black girls (n=201)	To asses impact of after school PA programme on body composition and cardiovascular fitness	Intervention consisted of 30 min homework and 80 min PA (25 min skills instruction, 35 min aerobic PA and 20 min stretching).	Decrease in % BF in intervention (30.2 ±11.9 to 29.1± 11.8) *vs*. control (30.7 ± 12.7 to 31.0 ±12.2), adjusted change -2.01 (p< 0.0001)	★★★
Lazaar *et al.* [39] France	RCT, 6 months	Children aged 6-10 years (n=425)	To asses effect of a school based PA on body composition in children	Control group took part in 2 one hour PE sessions/ week. Intervention group took part in additional 2 one hour sessions	More obese children became overweight in the intervention than the control group; 16.3% (p<0.05) *vs*. 9.3% (p<0.05).	★★★

A9: *School and nursery physical education (contd.)*						
Study	**Design**	**Study population**	**Objectives**	**Programme content**	**Outcome**	**EDPHiS Grade**
Hughes *et al.* [40] UK	Non-RCT, 10 weeks	Overweight and obese primary school children (n=142)	To evaluate a pilot activity programme for overweight and obese children	Extra after school PA sessions for 45 min/week for the study sample.	Raised awareness of diet and PA issues and different ways of being active.	★
Ildiko *et al.* [41] Hungary	Non-RCT, 35 weeks	7 year old obese boys (n=118)	To asses effects on body composition by increasing duration of extra curricular PA	Intervention group took part in 2 regular 45 min PE classes and 3 additional sessions/ week, 60 min each.	Decrease in skin folds thickness (p=0.005), but no change in BMI	★★★
Graf *et al.* [42] Germany	Non-RCT, 4 years	Primary school children (n=611)	To study effect of the intervention on obesity and physical performance after four years	Intervention group received an extra health education lesson per week. PA breaks (5 min) were allowed once a morning. Data collected in 1st, 2nd and 4th year of school.	23.2% of obese and over-weight children in intervention schools reached normal weight while 19.2% from control schools did (p=0.374).	★★
Gutin *et al.* [43] USA	RCT, 3 years	3rd grade pupils followed up to 5th grade (n=316)	To evaluate effect of an after school PA intervention on aerobic fitness and % Body fat	Intervention group received a 2 hour sessions of snack and activities to promote sports skills, aerobic fitness, strength and flexibility.	Significantly improved fitness and body fat composition ($p<0.05$) and fat free soft tissue ($p<0.01$) among the intervention group	★★★
Sollerhed *et al.* [45] Sweden	Non-RCT, 3 years	6-9 year old children (n= 134)	To assess a school based program with expanded PE in decreasing weight	Intervention had 4 lessons/ week and 1 day of outdoor PA for an hour. Control group took part in 1-2 lessons/ week	Significant reduction in BMI in intervention compared to control school (-0.32 *vs.* 0.25 kg/m^2, p=0.033.	★★★

A9: *School and nursery physical education (contd.)*						
Study	**Design**	**Study population**	**Objectives**	**Programme content**	**Outcome**	**EDPHiS Grade**
Liu *et al.* [44] China	Non-RCT 9 months	Children aged 6-12 years (n=753)	To evaluate effect of a PA promotion program on growth and development of children.	This HAPPY-10 programme was implemented by teachers for 10 min/day. Energy expenditure was monitored with the help of PA monitors.	Significant change in BMI among girls in the intervention and control schools (0.47 *vs.* 0.66 kg/m^2, p<0.05), and a significant increase in energy expenditure (intervention schools 15.0 to 18.2 kcal/ kg vs. control schools 24.3 to 14.7 kcal/kg).	★★★
Sigmund *et al.* [46] Czech Republic	Longitudinal, 1 year	Preschoolers followed into first grade (n=176)	To identify changes in children's PA upon entry to first year at school.	Children were monitored twice (seven days each time) using accelerometer and pedometer.	Lower PA levels on week days and weekends among first grade children compared to preschoolers (p<0.0001)	★
Williams *et al.* [47] USA	Pilot observational study 10 weeks	Children aged 3-5 years from low income households (n=270)	To evaluate a program designed to increase PA during school day.	Daily PA at least 10 min achieved using the Animal Tracker program where each unit includes 6 activities to develop motor skills	Increase in PA time in schools and an improvement in motor skills.	★
Kovacs *et al.* [48] Hungary	Non-RCT, 15 weeks	Overweight children aged 6–12 years (n=51)	To asses effect of an exercise programme on body composition, fitness and cardio-vascular risk.	15 week exercise training. Three 1 hour sessions/week after school. 3 children were randomly selected to wear heart rate monitors	Significant reduction in the waist circumference from 85.9 ± 12.4 cm to 80.9 ± 10.2 cm, p=0.002.	★★★
McGuigan *et al.* [49] Australia	Non-RCT, 8 weeks	7-12 yr old overweight and obese children (n=48)	To assess effect of 8 week resistance training programme on overweight or obese children	Supervised training program 3 days/ week for 8 weeks.	Significant decrease in %BF of 2.6% (p<0.003) and an increase in lean body mass of 5.3% (p=0.07).	★★★

A10: Lack of affordable out- of- school active leisure activities						
Study	**Design**	**Study population**	**Objectives**	**Programme content**	**Outcome**	**EDPHiS Grade**
No evidence identified						
B1: Demand for easy to prepare food and individual meals						
Anderson *et al.* [50] USA	Longitudinal	Children aged 3-11 years	To assess effect of maternal employment on childhood obesity	Analysis of matched mother–child data from the National Longitudinal Survey of Youth (NLSY)	10-hour increase in work/ week by mother was linked to child overweight by 0.5-1%	★★★
Crawley *et al.* [51] USA	Longitudinal	Children from low income families aged age 7 years	To explore the link between maternal employment and childhood obesity.	Analysis of data from the American Time Use Survey (ATUS) conducted annually between 2003 and 2006.	Working 36 hours/ week by mother is associated with 126 fewer minutes spent in cooking, eating and playing with children ($p<0.01$)	★★★
Hawkins *et al.* [52, 53] UK	Longitudinal	Children aged 3 years (n=13113)	To examine risk factors for over-weight in children.	Analysis of data in children in the Millennium Cohort Study, born 2000-2002.	Children were more likely to be overweight for every 10 hours a mother worked per week (OR=1.10, 95% CI: 1.04 to 1.1.7)	★★★
McDonald *et al.* [54] Colombia	Longitudinal	5-12 year olds (n=3075) from low economic backgrounds	to examine risk of overweight and its association with dietary patterns	Analysis of data obtained from children attending public primary schools in Colombia	Obesity linked to frequent intake of hot dogs and ham-burgers (OR =1.93; 95% CI: 1.03, 3.62)	★★★
Novaes *et al.* [55] Brazil	Longitudinal	Normal weight and obese 6-8 year olds (n=100)	To identify risk factors for obesity in children	Analysis of data from children followed up for information on family structure, socioeconomic level, feeding habits, obesity	Frequent snacking at commercial outlets was risk factor (OR=10.44; 95% CI: 1.3 to 83.9) for childhood obesity.	★★★

B2: Food Promotion						
Study	**Design**	**Study population**	**Objectives**	**Programme content**	**Outcome**	**EDPHiS Grade**
Borzekowski *et al.* [56] USA	RCT	2-6 year old preschoolers (n=46) from low income families	To examine the influence of televised food commercials on children's food preferences.	Children watched program with or without advertisements, and asked to identify preferences from pairs of similar products, one of which was in the videotape with ads	Children exposed to tape with advertisements likely to choose advertised foods than tape without advertisements (Cochran Q Statistic = 8.13, df=1, p= 0.004)	★
Robinson *et al.* [57] USA	Pre/post	3-5 year old preschoolers (n=63) from low income families	To examine effects of food branding on young children's taste preferences	Children tasted 5 identical foods from McDonald's and matched but unbranded foods, and asked to indicate if they tasted the same.	Increase in taste preference scores of foods (0.37±0.45, p<0.001) if children thought they were from McDonalds.	★
Goldberg *et al.* [58] USA	RCT	5-6 year old first graders (n=122) from middle class suburbs	To examine effect of messages on TV on children's snack food selections	Children were exposed to Public Announcements (PSA) or 'Yogi Gang' cartoon or 'Fat Albert Junk Food ' programs, with food ad breaks in each case	Mean number of less nutritious foods selected was less in Fat Albert compared with Gang and PSA's (2.87 *vs.* 8.70, p<0.05)	★★★
Ross *et al.* [59] USA	RCT	4-12 year old school children (n=100)	To asses accuracy of judgments of real fruit content in 3 sets of foods advertised on TV	Experimental children saw ads for cereals and real or artificial fruit drinks. Control group saw 6 irrelevant (toy) adverts	Judgement accuracy of advertisements for artificial fruit was lower than baseline in experimental *vs.* control [F(1, 87) =5.97, P<0.05]	★
Peterson *et al.* [60] USA	Non-RCT	5-6 year old children from 6 kindergartens	To assess how TV nutrition programs affect children's dietary habits	Children viewed videotapes of popular programs and Public Service Announcements on healthy eating habits.	Experimental and control groups scored higher on nutritional knowledge (main effect for trials: F (1, 4) =10.13, p< 0.05).	★★

B2: Food Promotion (contd.)						
Study	**Design**	**Study population**	**Objectives**	**Programme content**	**Outcome**	**EDPHiS Grade**
Forman *et al.* [61] USA	Non-RCT	4-6 year old (n=43) children, from low income families	To test if children are more sensitive to effects of food branding	Children were tested for intake of meals with brands. Brand awareness assessed by testing abilities to match logos with correct foods.	Non-overweight children ate 45.3 kcal less, while over-weight ate 40.7 kcal more of branded food (p = 0.04).	★
Anschutz *et al.* [62] Netherlands	Experimental	Children aged 8-12 years (n=120)	To test the side effects of TV food commercials on advertised sweet snack intake in young children	Children watched a movie and 2 ad breaks, while freely eating palatable food. Afterward, they filled out questionnaires and were weighed and measured.	Higher food intake in boys when watching food ads than compared to girls (53.8 *vs.* 14.6g, p<0.004).	★★
B3: Food availability and access						
Study	**Design**	**Study population**	**Objectives**	**Programme content**	**Outcome**	**EDPHiS Grade**
Novaes *et al.* [55] Brazil	Longitudinal	6-8 year old children (n=100)	To identify risk factors for obesity in children	Analysis of data from children followed up for information on family structure, socioeconomic level, feeding habits, obesity	Parental constant limitation on food was a risk factor (OR: 62.91; CI: 5.37 to 92.1) for childhood obesity.	★★★
Bowman *et al.* [64] USA	Longitudinal	4-8 year olds (n=6212)	To test if fast food consumption affects dietary factors linked to obesity risk	Analysis of data of children participating in a nationally representative continuing survey of food intake.	Children who ate fast food consumed more total energy (187 kcal; 95% CI: 109 to 265) than those who did not.	★★★

B3: Food availability and access (contd.)						
Study	**Design**	**Study population**	**Objectives**	**Programme content**	**Outcome**	**EDPHiS Grade**
McDonald *et al.* [54] Colombia	Longitudinal	5-12 year olds (n=3075)	To examine risk of overweight and its association with dietary patterns	Analysis of socio-demographic and anthropometric data from children attending public primary schools in Columbia	Childhood obesity associated with frequent intake of ham-burgers (OR = 1.93; 95% CI: 1.03, 3.62)	★★★
Zoumas-Morse *et al.* [65] USA	Longitudinal	Children from multi-ethnic backgrounds aged 7-11 yrs	To examine if macronutrient composition would vary based on eating location	Analysis of data (dietary and socio-demographic) of children participating in the Olestra Post Marketing Surveillance Study	Restaurant eating in children was associated with 55% higher intake of energy compared to home-made meals ($p<0.05$)	★★★
Thompson *et al.* [66] USA	Longitudinal	Girls aged 8-12 years (median: 9 years) (n=101)	To assess relation between eating food purchased away from home (FAH) and change in BMI among girls	Analysis of data on girls who kept 7-day dietary records at two points in time. The records included the place and time for all foods consumed.	Frequency of consuming quick-service food was positively related to change in BMI z-score ($F=3.37$, $p< 0.05$)	★★★
Gable *et al.* [18] USA	Longitudinal, 5 years	4-5 year old kindergarten children (n=8459)	To identify eating and activity factors associated with overweight	Analysis of data collected at 4 time points from parents and children using a computer-assisted telephone interview or personal interview.	Eating fewer family meals associated with overweight (OR=0.92, $p<0.001$).	★★★
Fisher *et al.* [67] USA	Non-RCT	Preschoolers aged 2-5 years (n=35) from middle income families	To examine effects of exposure to large portion of an entrée on food intake and weight status	Energy intake and bite size were evaluated at 2 series of lunches using either an age-appropriate portion or a large portion of an entrée	Doubling an age appropriate portion of entrée increased entrée by 25% ($p<0.05$) and total energy by 15% ($p=0.06$) intakes at lunch.	★★★

B4: Large portions						
Study	**Design**	**Study population**	**Objectives**	**Programme content**	**Outcome**	**EDPHiS Grade**
Rolls *et al.* [68] USA	Non-RCT	White preschool children aged 3-6 years (n=32)	To examine effects of portion size on children's food intake	Children's intake of lunch was assessed once a week for 3 weeks. Portion sizes were larger than, smaller than, or equal to the US serving sizes.	Food intake in older children when served medium and larger portions were 100.7g and 122.7g respectively ($p<0.002$).	★★
Huang *et al.* [69] USA	Longitudinal	Children age 3-19 (n=1955).	To examine effect of eating patterns and energy intake with BMI in U.S children.	Analysis of data obtained from dietary recalls from surveys of food intakes by individuals 1994 to 1996 and 1998.	Positive relation between BMI percentile and portion size of snacks ($\beta=0.029$, $p=0.01$) only in boys 6-11 years	★★★
Fisher *et al.* [70] USA	Non-RCT	girls at 5 and 7 years of age (n=192)	To evaluate whether young girls' eating in the absence of hunger was associated with an increased risk of overweight	Girls visited laboratory for 1 day. Eating in absence of hunger was measured after consumption of a standard lunch on the 2nd visit.	Girls who ate more snack foods (201-263 Kcal) in the absence of hunger were 4.6 times more likely to be overweight	★★★
McConahy *et al.* [71] USA	Longitudinal	Children aged 2-5 years from multi-ethnic backgrounds (n=5447)	To examine the relationship of food intake behaviours to total energy intake among children	Analysis of data (portion size, number of eating occasions per day, and number of foods consumed) from the Continuing Survey of Food Intakes by Individuals.	Portion size accounted for the greatest variance in energy intake in 2-3 (constant=3.14, $\beta=0.1$, $R^2=0.17$) and in 4-5 (constant=3.20, $\beta=0.11$, $R^2=0.19$) year olds respectively	★★★
McConahy *et al.* [72] USA	Longitudinal	Multi-ethnic children aged 1-2 years	To identify portion sizes consumed in early childhood and relations to weight status	Analysis of data obtained from the Continuing Survey of Food Intakes by Individuals, Nation-wide Food Consumption and a longitudinal sample (n=55)	Average portion size *z* scores were positively related to both body weight and energy intake	★★★

B5: Restaurants, fast food outlets and coffee bars						
Study	**Design**	**Study population**	**Objectives**	**Programme content**	**Outcome**	**EDPHiS Grade**
Bowman *et al.* [64] USA	Longitudinal	4-8 year olds (n=6212) surveyed from 1994 to 1998	To test if fast food consumption affects dietary factors linked to obesity risk	Analysis of data of children participating in a nationally representative continuing survey of food intake.	Children who ate fast food consumed more total energy (187 kcal; 95% CI: 109 to 265) than those who did not.	★★★
Zoumas-Morse *et al.* [65] USA	Longitudinal	Children from multi-ethnic backgrounds aged 7-11 yrs	To examine if macronutrient composition would vary based on eating location	Analysis of data (dietary and socio-demographic) of children participating in the Olestra Post Marketing Surveillance Study	Restaurant eating in children was associated with 55% higher intake of energy compared to home-made meals ($p<0.05$)	★★
Thompson *et al.* [66] USA	Longitudinal	Girls aged 8-12 years (median: 9 years) (n=101)	To examine relation between eating food purchased away from home (FAH) and change in BMI	Analysis of data on girls who kept 7-day dietary records at two points in time. Records include place and time for all foods consumed.	Weekly frequency of consuming quick-service food at was positively associated with change in BMI z-score ($F=3.37$, $p< 0.05$)	★★★
Duerksen *et al.* [73] USA	Longitudinal	Mexican American children aged 4-7 years (n=223)	To examine whether type of restaurant a family visits most often is associated with the BMI	Analysis of data of Children, aged 4 to 7, and caregiver for each child were recruited through public schools with at least 70% Latino enrolment.	Children in families who ate most often at fast-food chains at risk of obesity (OR= 2.2, 95% CI: 1.2 to 4.3)	★★★
McDonald *et al.* [54] Columbia	Longitudinal	5-12 year olds (n=3075) from low and middle socioeconomic backgrounds	to examine risk of overweight and its association with dietary patterns	Analysis of data obtained from children attending public primary schools in Columbia	Child obesity linked to frequent intake of ham-burgers (OR = 1.93; 95% CI: 1.03 to 3.62)	★★★
Novaes *et al.* [55] Brazil	Longitudinal	Normal weight and obese 6-8 year old children (n=100)	To identify risk factors for obesity in children	Analysis of data from children followed up for information on family structure, socioeconomic level, feeding habits, obesity	Frequent snacking at commercial outlets was a risk (OR: 10.44; I95% CI: 1.30–83.92) for childhood obesity.	★★★

B6: High energy snack foods						
Study	**Design**	**Study population**	**Objectives**	**Programme content**	**Outcome**	**EDPHiS Grade**
McDonald *et al.* [54] Colombia	Longitudinal	5-12 year olds (n=3075) from low and middle socioeconomic backgrounds	To examine risk of overweight and its association with dietary patterns	Analysis of data obtained from children attending public primary schools in Columbia	Overweight was associated with adherence to ‘‘snacking’’ (p-trend= 0.06)	★★★
Francis *et al.* [74] USA	Longitudinal	White girls at ages 5, 7 and 9 years (n=173)	To assess whether TV viewing was related to snacking frequency and obesity in children	Analysis of data from girls and their parents from central Pennsylvania assessed longitudinally when girls were 5, 7, and 9 years old.	Bivariate relationships between change in BMI and fat from snack foods was 0.26 ($p<0.05$) in the over-weight and non-overweight children aged 5-9 years.	★★★
Jahns *et al.* [75] USA	Longitudinal	Children aged 2-18 years from different backgrounds	To assess effect of snacking trends and changes in nutrient content over time.	Analysis of data from Nation-wide Food Survey & Continuing Survey of Food Intake by Individuals	In 2-5 year olds, snacking contributed in total daily energy from 1386 kcals in 1977 to 1505 kcals in 1996.	★★★
Huang *et al.* [69] USA	Longitudinal	Children age 3-5 (n=1077), 6-11 (n=537) and 12-19 years (n=381).	To examine effect of eating patterns and energy intake with BMI in U.S children.	Analysis of data obtained from two 24-hour dietary recalls from the Continuing Surveys of Food Intakes by Individuals 1994 to 1996 and 1998.	Positive relation between BMI percentile and portion size of snacks ($\beta=0.029$, $p= 0.01$) in boys 6-11 years, and a negative relation with snack frequency in girls aged 6-11 years ($\beta=-3.447$, $p= 0.02$)	★★★

B7: School and nursery catering						
Study	**Design**	**Study population**	**Objectives**	**Programme content**	**Outcome**	**EDPHiS Grade**
Bollella *et al.* [76] USA	Longitudinal	3-5 year preschoolers (n=358)	To determine nutrient intake of preschoolers	Analysis of data from 24-hour food intakes for 358 Head Start children obtained by observing food intake at school	Energy intake was <100% of recommendation, total fat (30.1%) and saturated fat (12.1%) of energy intake	★★
Bartholomew [77] 2006	RCT	4-11 year olds, 76% from minority ethnic backgrounds	to examine effect of an intervention to increase low fat entrees at school cafeterias	In Phase 1, entrees were modified such that 1 of 3 choices was low or moderate in fat. In phase 2, high- fat entrees was reduced from 2 to 1.	Low/moderate fat entrees selected at higher rate in intervention (32.1% and 26.4%) than the control (13.8% and 7.5%), p<0.01.	★★★
Himes *et al.* [78] and Story *et al.* [117] USA	RCT	5-11 year old American Indian children (n=470)	To assess whether "Pathways" program can decrease calories eaten as fat	Intervention schools received healthy eating and low fat food alternatives from school food service. Controls had normal instructions	Decrease in mean percent calories from total fat (3.6%) and saturated fat (2.1%) in intervention relative to controls (p<0.05)	★★★
Williams *et al.* [80] USA	Non-RCT	3-5 year old children in Head Start Centres (n=787)	To evaluate impact of a health program in Head Start centres	Centres received program (food service and nutrition education), control centres had food service and safety advice.	Decrease in total cholesterol in children in intervention compared to controls (-6.0 *versus* -0.4 mg/dL, p<0.05).	★★★
Ransley *et al.* [81] UK	Non-RCT (10 months)	4-6 year old school children (n=3703) in north of England	To evaluate impact of a school fruit and vegetable scheme (SFVS)	Children received one portion of fruit or vegetable provided per child on each school day	Increase in fruit intake in reception (0.4 portions; 95% CI: 0.2-0.5) and year 1 (0.6 portions; 95% CI: 0.4 to 0.9) pupils at 3 months.	★★
Webber *et al.* [82] USA	Multicenter-RCT, $2^1/_2$ years	7-9 year olds from schools in 4 states (n=4019)	To evaluate risk factors for cardio-vascular health in a school program	Intervention schools had goals to reduce total/saturated fat and Na in school meals. Control schools had no goals	Decrease in total cholesterol in intervention *vs.* control (1.3 *vs.* 0.9 mg/dl, p>0.05)	★★

B8: Changing design of homes						
Study	**Design**	**Study population**	**Objectives**	**Programme content**	**Outcome**	**EDPHiS Grade**
No evidence identified						
B9: Sugar-sweetened soft drink consumption						
Alexy *et al.* [83] Germany	Longitudinal, 2 years follow-up	3-5 year old preschoolers (n=205)	To examine fruit juice consumption and BMI	Analysis of nutrient and anthropometrics data obtained from preschoolers annually	BMI did not correlate with the fruit juice consumption((r= -0.117, p=0.094)	★★
James *et al.* [84] U.K	Cluster RCT, 12 months	644 children aged 7-11 years in 6 primary schools	To test if a program to reduce soft drink consumption can prevent weight gain	Intervention discouraged "fizzy" drink by encouraging drinking of water through education on healthy eating	Mean difference in change in percent obesity in favour of intervention group (7.7%; 95% CI: 2.2% to 13.1%)	★★★
Mrdjenovic *et al.* [85] USA	Non-RCT 8 weeks	children aged 6-13 years	To test effect of sweetened drink consumption on energy balance	Children were provided food, snacks and drinks during camping.	Consumption of sweetened drink of >12 oz /day was related to weight gain of 1.12 ± 0.7 kg	★★★
Muckelbaur *et al.* [86] Germany	Cluster RCT, 12 months	6-8 year olds (n=2950)	To test if promotion of water drinking was effective in obesity prevention.	Water fountains were installed and teachers promoted water consumption. Control schools did not receive intervention.	Reduction in overweight risk in intervention compared to control (OR=0.69; 95% CI: 0.48 to 0.98).	★★★
Ruottinen *et al.* [87] Finland	Prospective randomized trial	Children aged 13 months to 9 years (n=543)	To examine relation between sucrose intake and growth	Analysis of data of food consumption and nutrient intake were using food records	Higher BMI in high sucrose group than low sucrose group (p=0.001)	★★
Welsh *et al.* [88] USA	Longitudinal, 35 months follow up	2 and 3 year olds (n=10904)	To examine relation between sweet drink consumption and overweight	Analysis of data on height, weight, and dietary intake between	Children who consumed 1 to <2 drinks /day were 2.0 (95% CI: 1.3 to 3.2) likely to become overweight	★★★

B10: Infant feeding practices						
Study	**Design**	**Study population**	**Objectives**	**Programme content**	**Outcome**	**EDPHiS Grade**
Huus *et al.* [89] Sweden	Longitudinal, 5 years follow up	5 year olds followed from birth (n=7356)	To examine if exclusive breast feeding is related to childhood obesity	Analysis of data from babies. Short-term exclusive/full breastfeeding referred to < 4 months	Short term breastfeeding was related to obesity in 5-year olds (OR= 1.44; 95% CI: 1.00–2.07)	★★★
Kalies *et al.* [90] Germany	Longitudinal, 2 years	Healthy full-term neonates (n=2624)	To examine duration of breast feeding to prevent weight gain	Analysis of data obtained from healthy term neonates followed from birth to age 2 years in 4 German study centres.	Full breastfeeding for <6 months related to risk of weight gain at 2 years (OR= 1.65, 95%CI: 1.17- 2.3).	★★★
Karaolis-Danckert *et al.* [91] Germany	Longitudinal, 5 years follow up	249 (51.4% female) term Infants	To examine relation -ship between nutrition in early life and rapid weight gain.	Analysis of data from Dortmund Nutritional and Anthropometric Longitudinally Designed Study.	Children fully breastfed for ≥4 months had lower BF% than those not been fully breastfed for ≥4 months (β + SE: -1.53 ± 0.59%; p=0.009)	★★★
Koletzko *et al.* [92] 5 European countries	Double-blind RCT, 2 years	Healthy full term infants	To examine if breast feeding protects against obesity at 2 years	Healthy infants born at term were assigned to receive for the first year infant formula and follow-on formula with higher or lower protein contents	At 24 months weight-for-length z-score was 0.2 (95 % CI: 0.06 to 0.34) greater in the higher- than in the lower-protein formula group	★★★
Scaglioni *et al.* [93] Italy	Longitudinal, 5 years follow up	1 year old healthy children (n=147)	To asses influence of nutrient intake in early life on the development of overweight	Analysis of data obtained from children followed from birth and assessments made at birth, 1 and 5 years of age.	Overweight children had a higher percent intake of proteins at the age of 1 year than non over-weight children (22% *vs.* 20%, p=0.024)	★★★
Scholtens *et al.* [94] Netherlands	Longitudinal, followed up to 7 years of age	3 month old (n= 2605) children	To examine effect of breastfeeding on BMI	Analysis of data of children in the Prevention and Incidence of Asthma and Mite Allergy study	Children breastfed for >16 weeks had a 0.20 kg/m^2 (95% CI: -0.37 to -0.03) lower BMI	★★★

B10: Infant feeding practices (contd.)						
Study	**Design**	**Study population**	**Objectives**	**Programme content**	**Outcome**	**EDPHiS Grade**
Spyrides *et al.* [95] Brazil	Longitudinal, 9 month follow up	0.5 month old children (n= 479)	To assess effect of breastfeeding duration on infant growth	Four follow-up evaluations at ≤9 months after birth, including structured interviews on infant growth and breastfeeding practices.	Breastfeeding duration had a greater effect on rate of infant growth (0.0746) than on the equilibrium length (-1.5422).	★★★
Wilson *et al.* [96] UK	Longitudinal, 2 year follow up	7.3 year old children (n= 545)	To investigate relation between infant feeding practice and body composition	Analysis of data (infant and demographic) of children collected prospectively during the first two years of life.	Children who had solids before 15 weeks heavier than those who had at 15 weeks or later (0.02 *vs*. -0.09 kg, p<0.01)	★★★
Bogen *et al.* [97] USA	Longitudinal	73,458 white and black low-income children followed from birth to 4 years of age	To determine the minimal duration of breastfeeding to protect against later obesity	Analysis of data of children followed from birth through 4 years of age. Feeding exposure was based on breastfeeding duration and the age of formula initiation.	Breast-feeding for ≤16 weeks associated with reduced risk of obesity (OR= 0.71, 95% CI: 0.56 to 0.92)	★★★
Grummer-Strawn *et al.* [98] USA	Longitudinal, 2 year follow up from birth	4 year olds from low income families (n=177 304)	To examine whether duration of breastfeeding is associated with a lower risk of over-weight in 4-year	Analysis of data from the Nutrition Surveillance System, which extracts breast feeding, height, and weight data f	In whites, the risk of over-weight by breastfeeding for 6 to 12 months versus never breastfeeding was OR= 0.70 (95% CI: 0.50–0.99)	★★★
Walshaw *et al.* [99] UK	Longitudinal, 8 weeks	32 babies born before and 31 babies born after a change in breastfeeding advice.	To assess effect of traditional and "baby -led" breast feeding advice on early infant weight gain	Analysis of follow-up data of children whose mothers received traditional advice and those who received baby-led advice	Babies on traditional advice more likely to gain more weight up to 6-8 weeks than those given baby-led advice (0.41 *vs.* -0.23, p<0.05)	★★★

B11: Desire for highly palatable foods						
Study	**Design**	**Study population**	**Objectives**	**Programme content**	**Outcome**	**EDPHiS Grade**
McDonald *et al.* [54] Colombia	Longitudinal	5-12 year olds (n=3075)	To examine dietary risk factors of overweight	Analysis of data obtained from children attending public primary schools	Obesity related to frequent intake of hamburgers (OR= 1.93; 95% CI:1.03 to 3.6)	★★★
Novaes *et al.* [55] Brazil	Longitudinal	Children aged 6-8 years (n=100)	To identify risk factors for obesity in children	Analysis of data from children followed up for information on family structure, socioeconomic level, feeding habits, obesity	Frequent snacking at commercial outlets was a risk factor (OR= 10.44; 95% CI: 1.30 to 83.92) for obesity.	★★★
Robinson *et al.* [57] USA	Pre/post	3-5 year old pre-schoolers (n=63)	To examine effect of food branding on taste preferences	Children tasted foods packaged by McDonald's and matched but unbranded packaging	Increase in taste preference scores of branded foods (0.37 ± 0.45, p<0.001)	★★
C1: Health awareness of parents and carers						
Haire-Joshu *et al.* [100] USA	Randomized nested cohort design, 5 years	Children aged 1-6 years parents (n=1306)	To asses effect of a positive fruit and vegetable (FV) environment on children's intake	Intervention received program to increase knowledge and FV servings, child feeding practices and newsletters. Controls only received newsletters	FV servings increased in normal weight (mean=0.35, p=0.02) but not in overweight (mean= −0.10, p=0.48), relative to controls	★★
Muller *et al.* [101] and Danielzik *et al.* [102] Germany	Longitudinal, 8 year follow-up	5-7 year old (n=1640) over-weight and normal weight children	To test if a program aimed to improve health behaviours can prevent obesity	Intervention children received program on reduction in intake of high fat foods, increase intake of FV, keeping active, and decrease TV viewing.	Daily fruit and vegetable consumption increased by 50% (p<0.05) and frequency of daily intake of low fat food increased by 30% (p<0.05)	★★★
Epstein *et al.* [103] USA	RCT, 1 year	6-11-year old children (n=27)	To evaluate effect of a parent-focused intervention on child eating and % of overweight	Families received program to increase FV intake or decrease intake of high-fat/high-sugar foods. Control received only materials	Differences in FV intake over time (F=.20; p=0.025) and in high-fat/high-sugar food intake for both groups over time (F=18.14; p <0.001).	★★★

C1: Health awareness of parents and carers (contd.)						
Study	**Design**	**Study population**	**Objectives**	**Programme content**	**Outcome**	**EDPHiS Grade**
Rasanen *et al.* [104]; Talvia *et al.* [105]; Saarilehto *et al.* [106]; Lagstrom *et al.* [107] and Hakanen *et al.* [108] Finland	RCT, 7 years follow-up	8 month old children (n=1062)	To evaluate the longitudinal impact of dietary advice on children's nutrient intake.	Families in the intervention group received advice to modify quality and quantity of fat in the child's diet, with the goal of unsaturated- saturated fat ratio of 2:1.	Fat intake was 30% of energy intake and 2-3% higher in controls ($p<0.001$), with higher increases (1-2%, $p< 0.001$) in carbohydrate and protein intake (0.5%, $p= 0.005$) in intervention group	★★★
Kalavainen *et al.* [109] Finland	RCT, 6 months	Seventy obese children aged 7–9 years	To compare effect of healthy lifestyle with routine advice on obesity	Children received routine advice or family-based group advice on nutrition, physical activity and behaviour control.	Children in group treatment lost more weight (6.8%) than children receiving routine counselling (1.8%) ($p=0.001$)	★★★
Worobey *et al.* [110] USA	Non-RCT, 8 months follow-up	27 months old children and their parents (n=60), mostly Hispanics	To assess effect of health promotion programme in at-risk families.	Parents received nutrition and health program on feeding, menu planning, and food	Significant decrease in energy intake in children by 17% ($p=0.004$).	★★★
Burrows *et al.* [111] Australia	Multi-centre RCT, 12 months	5–9 year olds (58% female) (n=165)	To describe dietary intakes and impact of best practice dietary change program	A program using parent support with allocation to parent-centred nutrition program or child-centred physical activity program or both programs.	Decrease energy intake from sweetened drinks (5.0 ± 0.4 *vs.* $2.9 \pm 0.3\%$, $p<0.001$)	★★★
Horodynski *et al.* [112] USA	Non-RCT, 6 months	Low income families with toddlers (n=135)	To assess effect of a programme to improve parent-toddler feeding	Program focused on improving toddler mealtime behaviours and consisted of nutrition education lessons and activities	Knowledge scores improved in intervention than control (1.3 *vs.* 0.6, $p<0.05$)	★★

C1: Health awareness of parents and carers (contd.)						
Study	**Design**	**Study population**	**Objectives**	**Programme content**	**Outcome**	**EDPHiS Grade**
Harvey-Berino *et al.* [113] USA	RCT, 16 weeks intervention	Native American children aged 22 months (n=43)	To test if maternal participation would reduce childhood obesity	Mother and child received a program on prevention +parent support (OPPS) or program on the child's goals (PS).	Weight-height z-scores decreased in PS and increased in OPPS (-0.27 ± 1.1 *vs*. 0.31± 1.1, p=0.06)	★★★
Golley *et al.* [114] Australia	RCT, 12 month	Children aged 6-9 years (n=111)	To asses effect of parenting-skills training for over-weight children.	Children assigned to parenting-skills training + lifestyle (PL) or parenting-skills training alone (P) or wait-listed control (WLC)	BMI *z* score, reduced by 9% in the PL group, 6% in the P group, and 5% in the WLC group (linear mixed model, group by time, P=0.76)	★★★
Jouret *et al.* [115] France	RCT, 2 years follow up	Children aged 3 years (n=79)	To asses effect of a programme for overweight preschoolers	Intervention received program on healthy eating and activity or to a group at risk of overweight followed by physicians	Reduction in overweight prevalence in intervention *vs*. control (OR=0.19, 95% CI: 0.07 to 0.51)	★★★
Shelton *et al.* [116] Australia	RCT, 3 months follow up	Overweight children aged 3-10 years	To asses a group parent education program in over-weight children	Parents attended weekly sessions and also received a parent treatment manual developed by the team.	Change in BMI in intervention (26.4 ± 2.1 to 24.8 ± 3.2) *vs.* control (26.4 ±2.3 to 26.5 ± 4.0), F(1,41)=4.53, p<0.05	★★★
Brownell *et al.* [117] USA	Non-RCT, 10 weeks	5-12 year old school children (n=63)	To assess nutrition education program administered in a school setting	Children participated in program involving parents, teachers, PE instructors and food service personnel on healthy lifestyle. Control schools had no program	Mean change in weight in intervention *vs*. control (-4.4 *vs.* 1.2 kg, p<0.0001)	★★★
McGarvey *et al.* [118] USA	Non-RCT, 1 year	children aged 2-4 years, mostly ethnic minorities (n=336)	To assess obesity prevention program in children served by nutrition program	Parents attended sessions on increase PA, limit TV viewing, and encouraging children to drink water instead of soft drinks	Frequency of offering the child water was (0.64 *vs.* 0.16 p=0.01) and engaging in active play (0.47 *vs.* -0.22, p=0.01) in intervention *vs*. control respectively	★★★

C2: Health awareness of children						
Study	**Design**	**Study population**	**Objectives**	**Programme content**	**Outcome**	**EDPHiS Grade**
Perry *et al.* [119] USA	Non-RCT, 5 weeks	Children aged 7-9 years (n=2250)	To compare school *vs.* home-based program in children	Children received school-based Hearty Heart program (HH) or home based team program (HT) or both HH & HT or control	Children in HT had 2% reduction in the percent of calories from fat	★★★
Matvienko [120] USA	Non-RCT, 4 months	6-7 year old children (n=59)	To asses impact of nutrition education on snack choices of children	Intervention schools received nutrition lessons on healthy snack choices. Controls did not receive any intervention	Intervention chose more healthy snacks compared to control (33.3 *vs.* 18.2%, p=0.023)	★★★
Muller *et al.* [101] and Danielzik *et al.* [102] Germany	RCT, 1 year	5-7 year old children (n=1640)	To asses if a program to improve health behaviours can prevent obesity	Children received program in eating FV each day, reduction in intake of high fat foods, and keeping active. Controls received program in the 2nd year	Daily fruit and vegetable consumption increased by 50% (p<0.05) and frequency of daily intake of low fat food increased by 30% (p<0.05)	★★★
Eriksen *et al.* [121] Denmark	RCT, 5 weeks	School children aged 6-10 years (n=1493)	To assess a school FV scheme on intake of fruit and vegetables	Intervention children received FV subscription. Controls were not offered the subscription.	Increased intake of fruit by 0.3-0.4 (p<0.05) pieces per school day in intervention, but no change in vegetable	★★★
Horne *et al.* [122] Ireland	RCT, 12 month follow-up	children aged 4-11 years (n=435)	To evaluate effect of "Food Dudes" in school children in Ireland	Children watched videos of "Food Dudes" and received rewards for eating fruits and vegetables. Control children did not watch video.	Change in consumption of school-provided fruit (11g *vs.* 4g, p<0.001) and vegetable (13g *vs.* 2g, p<0.001) in intervention *vs.* control	★★★
Story *et al.* [79] USA	RCT, 12 weeks	Low income African American girls aged 8-10 years (n=54)	To assess an after-school obesity-prevention program for African-American girls	Intervention focused on increasing PA and healthy eating. Control group received a program unrelated to PA/nutrition	Intervention was associated with significant decreases in mean percentage of calories from total fat (3.6%) and saturated fat (2.1%) relative to controls (p<0.05)	★★★

C2: Health awareness of children (contd.)						
Study	**Design**	**Study population**	**Objectives**	**Programme content**	**Outcome**	**EDPHiS Grade**
Perry *et al.* [123] USA	RCT, 2 year follow up	1668 children aged 6-9 years	To assess a cafeteria-based program on FV intake of children	Intervention schools were encouraged to increase intake and availability of FV. Controls had no program	The difference between intervention and controls in FV servings was 0.14 to 0.17	★★★
Peterson *et al.* [60] USA	Non-RCT	5-6 year old children from 6 kindergartens	To assess how TV nutrition programs affects children's dietary habits	Children viewed tapes of programs and PSAs on healthy eating habits. Effects were measured using recall	Higher scores on nutritional knowledge at post-test, (main effect for trials: F (1, 4) =10.13, p< 0.05).	★★★
Stewart *et al.* [124] USA	Non-RCT, 3 year follow up	6-7 year olds from 12 schools	To asses effect of health knowledge on risk factors	Children received a health pro-motion program involving heart healthy knowledge and foods.	Increase knowledge by 30%, use of high fat foods fell 16% and sugared foods by 3%.	★★★
Bayer *et al.* [125] Germany	RCT, 18 months follow-up	Children aged 3-5 years in 64 Kindergartens in 4 Bavarian regions	To assess effects of prevention program in a preschool setting	Intervention had enhanced regular physical activity and to modify habits of food and drink consumption. Control schools had no intervention.	Increase proportion of FV consumption at 6 months (OR= 1.59, 95% CI=1.26 to 2.01) and 18 months (OR= 1.48, 95% CI:1.08 to 2.03)	★★★
Coleman *et al.* [126] USA	RCT	Children aged 7-9 years (n=896)	To assess impact of intervention on low-income schools	Intervention schools received a program on healthy lifestyle. Controls had no program	Lower increase in overweight in intervention *vs.* control (2% *vs*. 13%, p<0.05)	★★★
Economos *et al.* [127] USA	Non-RCT	Children aged 6-8 years (n =1178)	To assess environ-mental change intervention on weight gain	Intervention received program to increase activity and availability of healthful foods. Controls received no program	Average change in BMI *z*-score was -0.1005 (p=0.001) in intervention *vs.* control	★★★
Kelder *et al.* [128] USA	Pre/post-test	School children aged 4-11 years (n=182)	To test-pilot and evaluate an intervention program in schools	Intervention received PA (walk /run/jog and aerobic recreation games) and healthy snack choices	Increase in food knowledge by 1.45 points (p=0.036), and FV behaviours by 0.24 points (p=0.0398)	★★★

C2: Health awareness of children (contd.)						
Study	**Design**	**Study population**	**Objectives**	**Programme content**	**Outcome**	**EDPHiS Grade**
Kalavainen *et al.* [109] Finland	RCT, 6 months	children aged 7–9 years (n=70)	To compare 2 programs in the control of obesity	Children received routine advice or family-based group nutrition and physical activity education	Children in group treatment lost more weight than routine counselling (6.8% *vs.* 1.8%, p=0.001)	★★★
Brownell *et al.* [117] USA	Non-RCT, 10 weeks	5-12 year old school children (n=63)	To assess nutrition education program in a school setting	Intervention had a program on healthy lifestyle choices. Controls had no program	95% of program children lost weight, compared to only 21% in control.	★★★
Fitzgibbon *et al.* [129] USA	RCT, 2 years follow up	Children aged 5-6 years (n=197)	To assess impact of a diet and activity program on changes in BMI.	Intervention received weekly healthy eating and exercise program. Controls received weekly lesson on health	Intervention had smaller gain in BMI than control (0.06 *vs.* 0.59 kg/m^2, p=0.01)	★★★
Marcus *et al.* [130] Sweden	cluster RCT	children aged 6-10 years (n=3135)	To assess efficacy of a school-based program to reduce overweight	Intervention received program on low-fat products and sweetened drinks. PA was aimed at 30 mins/ day.	Decrease in overweight by 3.2% in intervention compared to control (p<0.05)	★★★
Resnicow *et al.* [131] USA	Non-RCT, 1-2 years	School children mean age 8.5 years (n=1680)	To assess school-based behaviour change program	Schools received Michigan Model School Health Curriculum	Improvement in health knowledge in intervention *vs.* control (60 *vs*. 53%, p< 0.05)	★★
Tamir *et al.* [132] Israel	Non-RCT, 2 years	First graders aged 5-6 years (n=406)	To evaluate school health promotion program	Children received workbooks and posters, Controls received parent materials.	BMI change in intervention *vs.* control in all groups (F(1.387)=7.23, p <0.01)	★★★
Yin *et al.* [133] USA	RCT, 8 months	Children with mean age 8.7 years	To assess an after-school program on risk factors	Children received program on healthy snack and PA. Controls had no program.	Reduction of % bf (-0.76, 95 % CI: -1.42, to -0.09) in intervention *vs.* control	★★★
Warren *et al.* [134] U.K	RCT, 20 weeks	5-7 year olds 9n=213)	To evaluate a school -based intervention	Children received program in nutrition or physical activity or both in lunch time club settings	Nutrition scores improved in all groups	★★★

C2: Health awareness of children (contd.)						
Study	**Design**	**Study population**	**Objectives**	**Programme content**	**Outcome**	**EDPHiS Grade**
Blom-Hoffman *et al.* [135] USA	RCT, 2 years	4-7 year old school children (n=297)	To asses effect of school-based health education program	Children received program to increase FV intake, and increase PA. Controls received PA promotion	Intervention children consumed 0.54 and 0.36 additional servings of FV per day *vs.* control	★★★
Foster *et al.* [136] USA	Non-RCT, 12 weeks	Children with mean age 9.2 years	To assess effect of using peers in health promotion	Peers offered nutrition advice to children. Control school had no program.	Change in weight between intervention and control was -0.15kg *vs*. 1.3kg (p<0.0001)	★★★
C3: Changing family structure and working patterns						
Straus *et al.* [137] USA	Longitudinal, 6 years follow up	Children aged 0-8 years (n=2913)	To asses relation between environmental factors and obesity prevalence	Analysis of follow up data on children for socioeconomic status and childhood obesity	Single motherhood (OR= 1.36, 95%CI: 1.04-1.78) and parental unemployment (OR=2.36, 95%CI: 1.5- 4.2) were risks to obesity.	★★★
Anderson *et al.* [50] USA	Longitudinal	Children aged	to asses relation between maternal employment and childhood obesity	Analysis of matched mother–child data from the National Longitudinal Survey of Youth	10-hour increase in hours worked per week by mother associated with a child being over-weight by 0.5-1%	★★★
Crawley *et al.* [51] USA	Longitudinal	Children aged 7 years	To explore the link between maternal employment and childhood obesity.	Analysis of data from the American Time Use Survey (ATUS)	Working 36 hours/ week was associated with 126 fewer minutes spent in cooking, eating and playing with children (p<0.01)	★★★
Hawkins *et al.* [52, 53] UK	Longitudinal, 3 years follow up	Children aged 3 years (n=13188)	To examine risk factors for overweight in children	Analysis of data in children in the Millennium Cohort Study, born 2000-2002.	Children were likely to be overweight for every 10 hours mother worked/week (OR=1.10, 95%CI:1.04-1.2)	★★★

Appendix 6: Rating form for evidence rating exercise

From stakeholder 'brainstorming' sessions 26 environmental chains were identified: 10 for physical activity (A1-10), 11 for diet (B1-11) and 3 diet & physical activity (C1-3) to review. From each chain an environmental change was identified.
We completed a systematic review of the literature, restricted to intervention and longitudinal studies, focusing on the evidence linking obesity and these environmental chains. The summary table (table 1 - enclosed) from the review shows the scientific evidence gathered for the environmental changes listed overleaf. The study design, population, objectives, intervention and outcome (including the effect size) of all the individual paper included in the review are described in the summary table. The last column entitled 'EDPHiS GRADE' reflects both 1) the reviewers' assessment of the quality of the individual study and 2) relevance of the findings to the environmental change it is listed under. This grading is subjective and for guidance only. We have not included chains for which we found no scientific studies.

Based on the studies presented, your knowledge and expert opinion of the area, we would like to ask you to rate:
- the strength of the evidence for each proposed environmental change
- the size of effect each environmental change could have on reducing the prevalence of obesity amongst children.

All the information you provide will be anonymous. However, to help us analyse the results we would be grateful if you could answer the following questions.

1. Which sector best describes where you currently work?

a. National government ☐
b. Local government ☐
c. Government agency (e.g. FSA, Health Scotland) ☐
d. University / research institute ☐
e. Other ..... ☐

2. How many years experience do you have of working in the following areas?

	none	less than 1 year	between 1 & 5 years	more than 5 years
a. Public Health	☐	☐	☐	☐
b. Nutrition	☐	☐	☐	☐
c. Physical activity	☐	☐	☐	☐
d. Obesity	☐	☐	☐	☐

Using the description of the research papers in the tables provided combined with your expert opinion, please rate each of the 'environmental change' on the following parameters:

1. The *strength of the evidence* that each environmental change could effectively reduce the prevalence of obesity among children.
2. The *size of the effect* that each environmental change could have on reducing the prevalence of obesity among children.

Environmental change	***strength of evidence***					***size of effect***				
PHYSICAL ACTIVITY	***very weak***	weak	moderate	strong	***very strong***	***none***	small	moderate	large	***very large***
A1: create safer and more attractive environments for children to play	1	2	3	4	5	1	2	3	4	5
A3: increase the provision of high quality green space	1	2	3	4	5	1	2	3	4	5
A4: improve access to local amenities to reduce car use	1	2	3	4	5	1	2	3	4	5
A5: create safe routes to school & nurseries (walking, cycling)	1	2	3	4	5	1	2	3	4	5
A6: create good quality safe *outdoor* play and sport facilities for schools & nurseries	1	2	3	4	5	1	2	3	4	5
A8: reduce sedentary leisure activities	1	2	3	4	5	1	2	3	4	5
A9: increase the priority of physical education in schools & nurseries	1	2	3	4	5	1	2	3	4	5

Note: A2, A7, *A10 are not included in these tables as no evidence was found in the literature for these environmental changes*

Environmental change	***strength of evidence***					***size of effect***				
DIET	***very weak***	weak	moderate	strong	***very strong***	***none***	small	moderate	large	***very large***
B1: reduce the demand for easy to prepare food and meals	1	2	3	4	5	1	2	3	4	5
B2: reduce the promotion of high fat, sugar & salt products	1	2	3	4	5	1	2	3	4	5
B3: reduce availability and access to high fat, sugar & salt products	1	2	3	4	5	1	2	3	4	5
B4: reduce the portion size of manufactured food & drinks	1	2	3	4	5	1	2	3	4	5
B5: reduce portion size of high fat, sugar & salt products in fast food, restaurants & coffee bars	1	2	3	4	5	1	2	3	4	5
B6: reduce consumption of high energy dense snacks	1	2	3	4	5	1	2	3	4	5
B7: improve the food provided at school & nursery	1	2	3	4	5	1	2	3	4	5
B9: reduce availability of sugar-sweetened drinks	1	2	3	4	5	1	2	3	4	5
B10: increase the proportion of mothers breastfeeding & reduce early introduction of solids	1	2	3	4	5	1	2	3	4	5
B11: reduce the addition of fat, sugar or salt to food to increase desirability of products	1	2	3	4	5	1	2	3	4	5
DIET & PHYSICAL ACTIVITY	***very weak***	weak	moderate	strong	***very strong***	***none***	small	moderate	large	***very large***
C1: increase parents knowledge of the health risk to children of obesity	1	2	3	4	5	1	2	3	4	5
C2: increase children's knowledge of the health risk of obesity	1	2	3	4	5	1	2	3	4	5
C3: create family structures and work patterns to reduce risk of obesity of children	1	2	3	4	5	1	2	3	4	5

Note: B8 is *not included as in the table as no evidence was found in the literature for this environmental change*

Please use this space to add any comments

Thank you for completing the form.

Please return the completed form in the FREEPOST envelope provided.

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Appendix 7: Estimation of change in energy intake or expenditure required to reduce overweight and obesity in children

Many calculations of the impact of changes in energy intake and energy expenditure on body weight are made assuming that the energy excess or deficit is all reflected in changes in body weight gained or lost, but this ignores the fact that as body weight changes the energy requirements for maintaining the new body weight will increase or decrease, which will gradually reduce the rate of weight change for a given energy intake or expenditure change.

The calculations below are therefore based on the difference in energy requirements for weight maintenance at different BMI levels. To provide an average change in energy intake or expenditure needed to reduce overweight or obesity would be equivalent to the difference in energy requirements for a child with a BMI at the lower boundary of obesity (95th centile for age and sex) and one with a BMI at the upper boundary of normal weight (85th centile for age and sex). For individual children, particularly those with BMI above the 95th centile, the change in energy intake or expenditure to achieve a BMI at or below the 85th centile would be greater than this while for others, e.g. those with a BMI between the 85th and 95th centile, the change required would be less.

In the table below, the BMI values for 95th and 85th centiles were estimated from the UK 1990 growth chart[4], with the 95th centile value taken as one third of the distance from the 91st to 98th centile line and the 85th centile value taken as equidistant between the 75th to 91st centile lines, since the charts do not show the 85th and 95th centiles. The 50th centile for height was taken from the UK Dietary Reference Value report[8] and used to calculate the weight for a given BMI as {weight (kg) = BMI x height (m)^2}. The estimated average requirement per kg body weight was also taken from the UK Dietary Reference Value report[9], in which values have been based on studies of the energy intake of healthy children prior to 1990. The average requirement per kg body weight was used to calculate the estimated average energy requirement for the two weights. The difference between the estimated requirements for the two weights is the difference in daily energy intake and/or energy expenditure required to maintain the higher as opposed to the lower weight, and represents the long-term change needed for children at the 95th centile to reach the 85th centile. The amount needed ranges from about 60kcal/d for the 1.5 year olds to 150 kcal per day in the 7.5 year olds, or 6-7% of the energy requirement of a child on the 95th centile (table A8.1).

The energy expended by 30 minutes per day of moderate and high physical activity at each o the four ages has been calculated for physical activity values (expressed as the Physical Activity Ratio, a multiple of Basal Metabolic Rate) of 2.8 (moderate activity) and 4.8 (vigorous activity) respectively. This shows that 20 minutes of moderate activity or 10 minutes of vigorous activity each day would increase energy expended by around 30 kcal/d (table A8.2)

The amount of foods and drinks commonly consumed by children was derived from back of packet information on branded products: for most snack foods the energy content was between 100 and 200 kcal while for most drinks the energy content was around 100 kcal (table A8.3).

Table A7.1: Estimation of difference in energy balance between children on the lower boundary of obese (95th centile) and upper boundary of normal weight (85th centile)

	Boys				Girls			
	1.5y	3.5y	5.5y	7.5y	1.5y	3.5y	5.5y	7.5y
BMI at 95th centile	19.4	18.2	18.1	18.8	19.1	18.2	18.2	19.2
BMI at 85th centile	18.5	17.3	16.9	17.4	18.9	17.2	17.1	17.9
50th centile for height or length (cm)	82.0	98.6	112.4	124.5	80.6	97.6	111.6	123.6
Weight at 95th centile of BMI (kg)	13.0	17.7	22.7	29.1	12.4	17.3	22.7	29.3
Weight at 85th centile of BMI (kg)	12.4	16.9	21.4	27.0	11.7	16.4	21.3	27.3
Estimated average requirement (kcal/kg/d)	95	94	84	73	95	87	76	66
Est. average requirement at 95th centile (kcal/d)	1,235	1,665	1,905	2,125	1,180	1,505	1,725	1,935
Est. average requirement at 85th centile (kcal/d)	1,180	1,590	1,800	1,970	1,110	1,425	1,620	1,800
Difference in est. average requirement (kcal/d)	55	75	105	155	70	80	105	135

Table A7.2: Estimation of increase in energy expenditure associated with an increase in moderate or vigorous physical activity in children

	Boys				Girls			
	1.5y	**3.5y**	**5.5y**	**7.5y**	**1.5y**	**3.5y**	**5.5y**	**7.5y**
A: EAR (kcal/d)	1,235	1,665	1,905	2,125	1,180	1,505	1,725	1,935
B:BMR (kcal/d) (A/1.5)	825	1,110	1,270	1,415	785	1,005	1,150	1,290
C: BMR (kcal/min) (B/1440)	0.57	0.77	0.88	0.98	0.55	0.70	0.80	0.90
D: EE at PAR 2.8[a] (kcal/min) (C x 2.8)	1.60	2.15	2.46	2.75	1.53	1.96	2.24	2.52
E: EE at PAR 4.8[b] (kcal/min) (C x 4.8)	n/a[c]	n/a[c]	4.22	4.70	n/a[c]	n/a[c]	3.84	4.30
F: EE above BMR for PAR 2.8 (kcal/min) (D-C)	1.03	1.38	1.58	1.77	0.98	1.26	1.44	1.62
G: EE above BMR for PAR 4.8 (kcal/min) (E-C)	n/a[c]	n/a[c]	3.34	3.72	n/a[c]	n/a[c]	3.04	3.40
H: Additional energy expended by 20 mins/d at PAR 2.8 (kcal) (Fx30)	21	27	31	36	19	25	29	33
I: Additional energy expended by 10 mins/d[d] at PAR 4.8 (kcal) (Gx30)	n/a[c]	n/a[c]	33	37	n/a[c]	n/a[c]	30	34

[a] Examples for adults include walking at 3-4 km/h, playing cricket

[b] Examples for adults include walking at 6-7 km/h, dancing, moderate swimming, gentle cycling, volleyball

[c] Vigorous activity was not considered appropriate for pre-school children

[d] Approx 1 hour per week

Table A7.3: Energy content of common snack foods and drinks and fast food meals commonly consumed by children

Food or drink	Portion or unit	Weight or volume	Energy (kcal/100g)	Energy (kcal/portion)
Crisps	Single bag	34.5g	525	181
Crisps	Bag from multi-pack	25g	525	131
Baked crisps	Bag from multi-pack	25g	390	98
Hula Hoops	Bag from multi-pack	25g	515	129
Rice Krispie squares	1 bar	28g	406	114
Kit Kat	2 finger bar	24g	510	107
Chocolate mini roll	1 roll	29g	445	120
Chocolate Hob Nob	1 biscuit	20g	482	93
Jaffa Cakes minis	1 pack	40g	385	154
Smarties	1 tube	40g	466	186
Fruit Gums	1 tube	48g	344	170
Fruit Shoot orange	1 bottle	200ml	48	96
Capri Sun Orange	1 pouch	200 ml	43	86
Ribena	1 carton	200ml	43	86
Coca cola	1 can	330 ml	42	139
Irn Bru	1 bottle ('Wee Bru')	250 ml	43	108
7 up	1 can	330 ml	30	99
Chocolate milkshake[a]	Small	177g	124	220
Cheeseburger[a]	1 standard (happy meal)	100g	295	295
Chicken nuggets[a]	4 pieces	70g	243	170
Fries[a]	Small serving	80g	288	230
Ketchup[a]	1 portion	25g	103	25

[a] data obtained from http://www.mcdonalds.co.uk

Appendix 8: Results of evidence rating exercise

	Strength of evidence				Effect size			
	n	Mean	SD	Median	n	Mean	SD	Median
A1: create safer and more attractive environments for children to play	14	2.7	0.91	3	14	2.8	0.70	3
A3: increase the provision of high quality green space	14	2.4	1.16	2	14	2.6	0.94	2
A4: improve access to local amenities to reduce car use	9	1.4	0.73	1	10	1.5	0.71	1
A5: create safe routes to school & nurseries (walking, cycling)	12	2.1	1.08	2	12	1.5	1.00	1
A6: create good quality safe *outdoor* play and sport facilities for schools & nurseries	13	2.8	1.17	3	13	2.3	1.03	2
A8: reduce sedentary leisure activities	14	3.5	0.94	4	14	3.1	0.83	3
A9: increase the priority of physical education in schools & nurseries	12	3.7	1.07	4	14	3.2	1.05	3
B1: reduce the demand for easy to prepare food and meals	12	2.8	0.97	3	12	3.2	0.83	3
B2: reduce the promotion of high fat, sugar & salt products	12	2.1	0.67	2	12	2.5	0.90	2
B3: reduce availability and access to high fat, sugar & salt products	13	3.2	0.69	3	13	3.3	0.75	3
B4: reduce the portion size of manufactured food & drinks	13	3.1	0.76	3	13	3.3	0.75	3
B5: reduce portion size of high fat, sugar & salt products in fast food, restaurants & coffee bars	13	3.1	1.04	3	13	3.2	1.01	3
B6: reduce consumption of high energy dense snacks	13	3.2	0.99	3	13	3.6	0.87	4
B7: improve the food provided at school & nursery	13	2.2	0.83	2	13	2.3	0.48	2
B9: reduce availability of sugar-sweetened drinks	13	3.3	0.63	3	13	3.4	0.87	4
B10: increase the proportion of mothers breastfeeding & reduce early introduction of solids	12	3.4	1.16	3	13	3.2	1.17	4
B11: reduce the addition of fat, sugar or salt to food to increase desirability of products	12	2.4	0.67	2	12	2.8	0.62	3
C1: increase parents knowledge of the health risk to children of obesity	14	3.1	0.86	3	14	2.9	0.86	3
C2: increase children's knowledge of the health risk of obesity	14	3.4	1.02	4	14	2.8	0.80	3
C3: create family structures and work patterns to reduce risk of obesity of children	13	2.9	0.99	3	13	2.8	1.09	3

Appendix 9: Prevalence of overweight and obesity in Scottish surveys.

In the 2008 Scottish Health Survey participants the proportion of children who were overweight but not obese was higher in boys than girls but was not different between 2-6 year olds and 7-11 year olds. The prevalence of obesity in 2-6 year olds was a little higher in girls than boys but in 7-11 year olds the prevalence of obesity was much higher in boys (Table 1).

	Boys		**Girls**	
	2-6 years (n 215)	**7-11 years** (n 240)	**2-6 years** (n 205)	**7-11 years** (n 217)
Overweight but not obese	18.1%	20.5%	13.1%	11.8%
Obese	7.8%	22.9%	13.0%	11.3%
Overweight including obese	25.9%	43.4%	26.0%	23.1%

Table A9.1: Prevalence of overweight and obesity in children in the 2008 Scottish Health Survey

Due to the small numbers of participants the 2008 survey does not provide prevalence by socio-economic deprivation or rural/urban area of residence, but in the 2003 Scottish Health Survey and the 2006 Survey of Sugar Intake among Children in Scotland the prevalence of overweight and obesity tended to be higher among children in the middle and/or lower three quintiles, and lower in the least deprived quintiles though the trend was not a clear linear relationship. In both surveys the difference in the prevalence by SIMD quintile was not statistically significant, as shown in tables 2 and 3.

Boys aged 2-15y	SIMD 1* n 216	SIMD 2 n 222	SIMD 3 n 242	SIMD 4 n 276	SIMD 5 n 259
Overweight but not obese	13.3%	17.6%	16.1%	19.3%	16.6%
Obese	15.6%	19.9%	25.9%	14.3%	15.6%
Overweight including obese	28.9%	37.5%	42.0%	33.6%	32.2%
Girls aged 2-15y	SIMD 1* n 229	SIMD 2 n 249	SIMD 3 n 219	SIMD 4 n 266	SIMD 5 n 260
Overweight but not obese	16.1%	15.7%	17.2%	15.3%	16.7%
Obese	18.2%	14.4%	15.3%	9.0%	12.8%
Overweight including obese	34.3%	30.0%	32.6%	24.3%	29.5%

* Most deprived

Table A9.2: variation in prevalence of overweight and obesity in boys and girls in the 2003 Scottish Health Survey by socio-economic status

Boys aged 3-17y	SIMD 1* n 163	SIMD 2 n 163	SIMD 3 n 158	SIMD 4 n 156	SIMD 5 n 176
Overweight but not obese	12%	17%	14%	13%	12%
Obese	19%	15%	19%	15%	12%
Overweight including obese	31%	32%	33%	28%	25%
Girls aged 3-17y	SIMD 1* n 187	SIMD 2 n 142	SIMD 3 n 145	SIMD 4 n 142	SIMD 5 n 187
Overweight but not obese	17%	16%	14%	14%	14%
Obese	16%	22%	22%	17%	12%
Overweight including obese	32%	34%	36%	30%	25%

* Most deprived

Table A9.3: variation in prevalence of overweight and obesity in boys and girls in the 2006 Survey of Sugar Intake in Children in Scotland by socio-economic status

The variation by urban/rural area of residence is not reported in the 2003 Scottish Health Survey but is reported for boys and girls combined in the 2006 Survey of Sugar Intake in Children in Scotland, as shown in Table 4. The prevalence of both overweight and obesity were highest in those living in remote small towns but the differences between the prevalence were not found to be statistically significant, probably reflecting the small numbers of children measured, particularly in the remote areas.

Boys and girls aged 3-17y	Large urban areas n 529	Other urban areas n 542	Accessible small town n 192	Remote small town n 84	Accessible rural areas n 215	Remote rural areas n 53
Overweight but not obese	15%	14%	12%	20%	13%	13%
Obese	18%	17%	13%	21%	15%	20%
Overweight including obese	33%	31%	25%	40%	28%	33%

Table A9.4: prevalence of overweight and obesity by urban/rural area of residence in children in the 2006 Survey of Sugar Intake in Children in Scotland

To estimate the prevalence of overweight and obesity in boys and girls aged 2-4 and 5-8y according to socio-economic deprivation and rural/urban area of residence, the ratio of the prevalence for each SIMD quintile or residential area to the mean prevalence for all children in the above surveys were calculated. For socio-economic deprivation the mean ratio for the two surveys was used, while for rural/urban area of residence only the 2006 survey ratios could be calculated. These ratios were then applied to the mean prevalence for the age and sex groups in the 2008 Scottish Health Survey. The results of these calculations are given in appendix 9. However, as the tables above show, the values need to be interpreted with caution as they are derived from small numbers of children and, for variation by socio-economic deprivation and rural/urban area of residence, are based on data which included children of secondary school age.