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Maintaining a healthy weight and preventing excess weight gain in children and adults – partial update of CG43

Evidence review 1: An evidence review of modifiable diet and physical activity components, and associated behaviours

Evidence review for Centre for Public Health at NICE

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List of Abbreviations

Abbreviation	Full
BMI	Body mass index
CI	Confidence interval
D	Study design
d	day
FO	Food only (energy density)
FD	Food and drink (energy density)
HFCS	High fructose corn syrup
HR	Hazard ratio
kg	kilograms
lb	Pound (weight)
MD	Mean difference
MET	Metabolic equivalent
MJ	Megajoule
MVPA	Moderate to vigorous physical activity
n	Number of participants
NIH	National Institutes of Health
NR	Not reported
OR	Odds Ratio
OECD	Organisation for Economic Co-operation and Development
oz	Fluid ounce
P	Population
PA	Physical activity
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
RCT	Randomised controlled trial
RFS	Recommended Foods Score
RR	Relative risk
SD	Standard deviation
SDS	Standard deviation score
Set	Setting
SMD	Standardised mean difference
TEI	Total energy intake
USDA	US Department of Agriculture
WC	Waist circumference
WCRF	World Cancer Research Fund
WMD	Weighted mean difference

Glossary

The glossary below defines terms included in the review, including broad definitions of the factors being assessed. Included reviews could use differing definitions.

Physical activity section

Active leisure Any physical activity undertaken for leisure or recreation purposes (i.e. outside of work or school settings or purposeful active travel/commuting).This includes active play in children. Reviews included in this section addressed active leisure/recreation as a whole, reviews on specific activities that could form part of active leisure (e.g. sport, walking, cycling, strength or aerobic exercise) are covered as are covered as separate factors.

Activities of daily living Includes physical activities such as housework, gardening, or do it yourself (DIY) activities. There may be overlap between this factor and active leisure (e.g. gardening) and incidental physical activity.

Active travel or commuting Using a physically active mode of transport (e.g. cycling or walking) for moving between destinations such as home and work or school, as an alternative to a less active mode of transport (e.g. car or bus). Reviews included for this factor addressed active travel/commuting as a whole rather than specific modes of active travel, reviews on these individual activities are covered as separate factors.

Aerobic exercise Activity in which the body's large muscles move in a rhythmic manner for a sustained period of time at an intensity that can be supported by aerobic metabolism. Aerobic activity, such as walking, running, or cycling, improves cardiorespiratory fitness.

Incidental physical activity Physical activity undertaken as part of a person's daily routine (e.g. climbing the stairs), as opposed to physical activity undertaken for its own sake. There may be overlap between this factor and activities of daily living.

Physical activity Any bodily movement produced by skeletal muscles that results in energy expenditure

Physical activity duration Length of time over which a bout of physical activity is performed.

Physical activity frequency Number of physical activity bouts over a specified period.

Physical activity intensity (PAI) The rate of energy expenditure (the number of calories burned) that a physical activity demands. This is usually measured in kcals per kg of body weight per minute or in multiples of 'metabolic equivalents' (METs). One MET (1 kcal/kg/h) is the rate of energy expenditure when a person is at rest. PAI is often defined as not active (<1.5 METs), gentle/low/light (1.5 to 2.9 METs), moderate (3 to 6 METs), or vigorous (>6 METs) intensity.

Sport A physical activity in which an individual or team competes against another or others.

Strength exercise Exercise performed against resistance, which specifically aims to increase muscle strength, power and mass.

Sedentary behaviour section

Breaks in sedentary time Periods of physical activity to break up lengths of time spent in sedentary behaviour. For example, standing up and/or having a walk during periods of working at a desk.

More active screen time Screen based activities that require more physical activity than conventional, sedentary screen time. For example, video games which involve dancing or other movements (active video games).

Other sedentary activities Any sedentary activities that have not been covered as individual sections within the review i.e. activities such as reading that do not fall under screen time or sitting.

Screen time Total time spent watching a screen, for example watching TV, using the internet, using a computer, or playing video games.

Sedentary behaviour Any behaviour where sitting or lying is the dominant mode of posture and energy expenditure is very low. Sedentary behaviour is not simply a lack of physical activity.

Sedentary time Total time spent engaging in sedentary behaviours.

Food and drinks section

Dietary pattern Pattern of food consumption across the whole diet. Analyses of dietary patterns may assess adherence to a pre-specified pattern such as the Mediterranean diet or a pattern recommended by dietary guidelines, or may look for data driven patterns (common combinations of food intake), identified through using, for example, principal component analysis or cluster analysis.

Legumes The edible seeds of plants in the legume family, including beans, peas, and lentils.

Mediterranean diet A dietary pattern typically including high olive oil, fruit, vegetables, legumes, nuts, fish and wine and low meat and dairy, and saturated fats.

Refined grains Grains (also called cereals) which have been significantly broken down from their original form, or from which the outer layer (husk) and germ of the whole grain has been removed, and products made from such grains. Includes, for example, white flour, finely ground wholemeal flour, extensively processed ready-to-eat breakfast cereals.

Sugar-sweetened beverage Can be defined as any beverage with sugar added to it (this would not include pure fruit juices with no sugar added) or any beverage with sugar contained in it, whether added or naturally occurring (this would include pure fruit juices and milk).

Vegetarian diets Diets containing little or no meat or other foods of animal origin. This can include semi-vegetarian diets (which exclude selected kinds of meat, poultry, or fish), lacto and lacto-ovo vegetarian diets (which exclude meat or fish, but

include dairy products only or dairy products and eggs respectively), or vegan diets (which exclude all foods of animal origin).

Whole grains Grains (also called cereals) that retain most or all of the outermost layer (husk or bran), for example, brown rice or whole oats. This also includes products made with whole grains, such as whole grain bread.

Energy and nutrients section

Catechins Flavonoid compounds found in certain plants, and found at particularly high levels in green tea.

Dietary sugars Includes glucose, fructose, sucrose, honey, and syrups refined from cane, beet, corn, and other sources, either added to foods or intrinsically found in foods, particularly fruits.

Energy density Total energy content (kJ) divided by total weight (grams). Can be calculated for individual foods, drinks or for diets as a whole (including food and drinks to varying extents, which is subject to academic debate).

Glycaemic index A measure of how quickly blood glucose rises after consuming carbohydrate containing foods compared with a standard dose of glucose. A high glycaemic index (GI) indicates that carbohydrates in the food are broken down quickly to glucose, causing a more rapid increase in blood glucose. A low GI indicates that foods are broken down more slowly and lead to a more gradual rise in blood glucose over time.

Glycaemic load Combines the quality (glycaemic index) and quantity of carbohydrate being eaten. It is calculated by multiplying the glycaemic index of a food by the amount of carbohydrate in the food being eaten in grams and dividing by 100.

Non-nutritive sweetener A synthetic sweetener used to provide sweetness but few or no calories, which may be derived from naturally occurring substances. Also known as artificial or low calorie sweeteners.

Eating patterns section

Breakfast The first meal of the day, eaten in the morning.

Eating meals prepared outside of the home Includes eating in restaurants, as well as fast food or takeaways.

Eating occasions The number of episodes of eating over a specified period (e.g. a day).

Eating out Eating food outside of the home that was also prepared outside of home, for example eating at a restaurant. May also include food eaten in e.g. coffee or sandwich shops, or fast food restaurants, and could include take away foods eaten outside of the home.

Fast food Food designed for ready availability, use or consumption and sold at eating establishments for quick availability to eat in or take out. Often used to refer to less healthy, more energy-dense, foods such as fried chicken, hamburgers, chips, or pizza. Fast food intake can refer to the frequency of eating in restaurants defined as fast food restaurants or to the frequency of eating food defined as fast food in any location (at home, work or in the restaurant itself). See also definition for take away.

Family meals Meals where the children eat with their parents or guardians rather than children and adult family members eating separately.

Gorging An eating pattern where the day's consumption is mainly in large infrequent meals, as opposed to grazing, where small meals or snacks are eaten frequently throughout the day.

Grazing An eating pattern where small meals or snacks are eaten frequently throughout the day, as opposed to gorging, where consumption is mainly in large, less frequent, meals.

Meal setting or distractions The conditions under which a meal is consumed, e.g. whether at a table with no distractions or in front of the TV.

Portion size The amount of food or drink consumed in a single occasion. May refer to single types of foods or drinks within a meal or to the meal as a whole.

Snacks or snacking May refer to the frequency of eating or drinking between meals (based on the size (kcal) of an intake occasion or the timing being at culturally defined 'non-mealtimes') or consumption of specific foods considered to be snacks (usually less healthy, sometimes more energy-dense, foods such as crisps or biscuits).

Take away Ready prepared food that is ready to eat, and taken away from the place of purchase to eat elsewhere. Examples may include, among others, take away pizza, curries, or Chinese food. May also include take away fast foods.

Other factors section

Holiday weight gain Weight gain occurring over any holiday period (absence from work of school), such as the Christmas holidays or school holidays.

Monitoring Any self-monitoring behaviour allowing assessment of either dietary or physical activity or other of the individually modifiable behaviours being assessed (such as use of a pedometer or calorie counting), or of weight and related outcomes (such as checking fit of clothes or weighing oneself).

Support Social support offered by others (e.g. friends or family) for individually modifiable behaviours. For example, having an exercise buddy.

Other definitions

Beta Regression coefficient, indicates the amount which the dependent variable changes for a 1 unit change in the independent variable.

Body Mass Index (BMI) Weight in kilogrammes divided by height in metres squared. In adults, a BMI <18.5 kg/m^2 is classified as underweight, 18.5 to 24.99 kg/m^2 as normal, 25.0 to 29.99 kg/m^2 as overweight, 30.0 to 39.99 kg/m^2 as obese, and ≥40.0 kg/m^2 as morbidly obese.

I^2 Statistic indicating heterogeneity in a meta-analysis. A higher I^2 score indicates greater between study heterogeneity in the effect estimates compared with the pooled effect estimate.

Inverse association Indicates that as the specified behaviour/factor increases weight related outcomes decrease.

Positive association Indicates that as the specified behaviour/factor increases weight related outcomes also increase.

Z score Number of standard deviations an individual observation is away from the mean of a specified population (may be sample-specific or compared with national reference data), with positive values being above the mean and negative values being below the mean.

1 Review overview

Figures 1 and 2 below summarise the findings of the evidence review on the individually modifiable behaviours that may help adults, children and young people to maintain a healthy weight or prevent excess weight gain. An inverse association indicates that an increase in the behaviour is associated with a decrease in weight related outcomes, a positive association indicates that an increase in the behaviour is associated with an increase in weight related outcomes. The colours indicate the strength of the evidence, not the magnitude of the association.

Factors for which evidence was identified in at least one of the age groups (adults or children and young people) are displayed in the Figures 1 and 2. No systematic reviews containing studies in either age group matching the scope of the review were identified on the following factors:

- standing (also no relevant primary studies identified)
- breaks in sedentary time
- other sedentary activities (such as reading not covered as individual factors)
- watching what you eat
- eating speed
- portion size
- grazing or gorging
- meal planning (also no relevant primary studies identified)
- meal setting or distractions
- drinks with meals
- other eating patterns (such as consistency of eating across the week that were not covered as individual factors)
- holiday weight gain
- stress minimising activities
- avoiding screen advertising
- monitoring (other than physical activity monitoring)

Figure 1: Summary of strength of evidence for associations between individually modifiable behaviours and weight related outcomes in adults

Association	Physical Activity (PA)										Sedentary Behaviour			Food and Drinks																	Energy and Nutrients										Eating Patterns						Other Factors		
	Active leisure	Sport	Active travel or commuting	Walking	Cycling	Activities of daily living	Incidental physical activity	Strength training	Aerobic exercise	PA intensity/frequency/duration	Sedentary time	Screen time	Active screen time	Sugar sweetened beverages	Fruit juice	Water	Tea and coffee	Alcohol	Milk and dairy	Whole grains	Refined grains	Fruit/vegetables	Meat	Fish	Legumes	Nuts	Mediterranean diet	Guideline adherence	Other dietary patterns	Vegetarian/vegan	Fat	Protein	Carbohydrate	Glycaemic index/glycaemic load	Fibre	Energy density	Non-nutritive sweeteners	Dietary sugars	Catechins	Caffeine	Food prepared outside the home	Eating frequency	Evening eating	Family meals	Breakfast	Snacking	Sleep	Physical activity monitoring	Support*
Inverse		No evidence											No evidence																															No evidence						
Positive																																																	
No association																																																	
Inconclusive			•			•	•	•			•				•	•	•	•	•						•				•	•				•			•										•		•

Legend: Weak Moderate Strong • Inconclusive

Figure 2: Summary of strength of evidence for associations between individually modifiable behaviours and weight related outcomes in children and young people

Association	Physical Activity (PA)										Sedentary Behaviour			Food and Drinks														Energy and Nutrients										Eating Patterns						Other Factors		
	Active leisure	Sport	Active travel	Walking	Cycling	Activities of daily living	Incidental physical activity	Strength training	Aerobic exercise	PA intensity/frequency/duration	Sedentary time	Screen time	Active screen time	Sugar sweetened beverages	Fruit juice	Water	Tea and coffee	Alcohol	Milk and dairy	Whole grains	Refined grains	Fruit/vegetables	Meat	Fish	Legumes	Nuts	Dietary patterns	Vegetarian/vegan	Fat	Protein	Carbohydrate	Glycaemic index/glycaemic load	Fibre	Energy density	Non-nutritive sweeteners	Dietary sugars	Catechins	Caffeine	Food prepared outside the home	Eating frequency	Evening eating	Family meals	Breakfast	Snacking	Sleep	Physical activity monitoring	Support*
Inverse				No evidence	No evidence	No evidence	No evidence		Weak	Weak	No evidence						No evidence	Not applicable		No evidence			No evidence	No evidence	No evidence	No evidence		No evidence				No evidence					No evidence	No evidence			No evidence	Weak	Weak		Weak	No evidence	No evidence
Positive												Strong		Strong															Moderate	Weak				Weak		Moderate			Moderate								
No association																						Weak									Weak		Weak														
Inconclusive	●	●	●					●					●		●	●			●		●						●								●					●				●			No evidence	No evidence

Legend: Weak Moderate Strong ● Inconclusive

2 Introduction

In 2012, the mean body mass (BMI) of adults in England was approximately 27 kg/m^2. Adults with a healthy weight (BMI 18.5 to 24.9 kg/m^2) were in the minority (32% of men and 41% of women). Most people were either overweight (BMI 25 to 30) or obese (BMI over 30). Around 28% of children aged 2 to 15 were classified as either overweight or obese (The Health and Social Care Information Centre 2014). Being overweight or obese can lead to both chronic and severe medical conditions, and the cost to society and the economy of these conditions is high and increasing (Foresight 2007).

This systematic review of systematic reviews was commissioned by the NICE Centre for Public Health to support the partial update of section 1.1.1 guidance on obesity (NICE clinical guideline 43, Issued 2006). The update focuses on Section 1.1.1 of this guidance (recommendations for the public). It covers strategies that may help people maintain a healthy weight and prevent excess weight gain.

Research questions

This evidence review aims to address the following questions:

1. What individually modifiable behaviours may help children and young people to maintain a healthy weight or prevent excess weight gain?

2. What individually modifiable behaviours may help adults to maintain a healthy weight or prevent excess weight gain?

3 Methods

3.1 Review approach

Due to the wide range of behaviours which could be covered, and the large volume of literature in these areas, a pragmatic stepped approach based mainly on a review of reviews was chosen. Methods are summarised below,

with the full table of behaviours being assessed presented in Appendix A, and additional detail of the methods reported in Appendix B.

3.2 Modifiable behaviours covered by the review

The evidence review covers specific individually modifiable behaviours, which may support children and adults to maintain a healthy weight or prevent excess weight gain. An initial list of behaviours to be covered was developed by NICE based on the recommendations in section 1.1.1 of NICE Clinical Guideline 43 (CG43), and the systematic review of determinants of weight gain, overweight and obesity carried out on behalf of the World Cancer Research Fund (Kelly et al. 2006, referred to in this report as WCRF 2006).

This list was refined and agreed in discussion between NICE, Bazian and expert advisers (see Appendix A for final list). The behaviours fall into six broad areas: physical activity, sedentary behaviour, food and drinks, energy and nutrients, eating patterns, and other factors.

3.3 Systematic searches and filtering

The searches were carried out in three stages:

1. A ***broad systematic review search*** (2005 to November 2013) in bibliographic databases for published literature and key websites for grey literature.
2. A ***targeted systematic review search*** (2005 to November-December 2013) for an agreed subset of factors not well covered by reviews identified in stage 1. The 9 factors targeted were: eating patterns, caffeine, coffee, holiday weight gain, incidental physical activity, breaks in sedentary time, sitting, stress-minimising activities, monitoring, and support.
3. A ***primary study search*** (1995 to December-January 2013) for an agreed subset of factors not well covered by systematic reviews identified in the first two searches in bibliographic databases. The 3 factors targeted were: meal planning, holiday weight gain, and standing.

At the end of Stage 1 and 2 searches, reviews were mapped against the list of factors based on their title and abstract, to identify gaps in the literature to be targeted in the next stage of searches. Factors were considered for Stage 2 or 3 searches if no reviews or a limited number of reviews, were identified during the previous stage, and rapid scoping searches in PubMed suggested that there may be additional literature available, and if it the factor could be targeted with high specificity searches.

3.4 Selecting studies for inclusion

Studies assessing the association between the individually modifiable behaviours listed in Appendix A and healthy weight maintenance or overweight and obesity prevention were included. Briefly, inclusion criteria were:

- **Study designs:** Cohort studies and RCTs (primary study searches) and systematic reviews of these (systematic review searches)
- **Population:** Adults and children in the general population not undergoing management or treatment for overweight or obesity
- **Exposure/intervention:** The individually modifiable behaviours listed in Appendix A, and interventions assessing the effect of changing these (outside of NHS, school, workplace, local authorities, early years, or self-help, commercial and community programme settings)
- **Outcome:** Weight-related outcomes (such as weight, BMI, waist circumference, fat mass, overweight or obesity)

No systematic reviews completely matched all of the current review's inclusion criteria, therefore reviews were included if they wholly or partially overlapped with the current review's individual inclusion criteria, or the match was unclear. Studies that completely did not match any of the criteria were usually excluded, except where an exception was agreed with NICE (e.g. reviews looking at non-related outcomes were included for some factors where no reviews assessing weight related outcomes were identified).

Potentially relevant references were filtered twice at the title and abstract level, and once at full text. Inter-rater agreement at each level was good.

3.5 Quality assessment and data extraction

Quality assessment checklists (provided in Appendix D) were used to rate studies as high [++], moderate [+], or low [-] quality. For systematic reviews, this quality rating refers to the quality of the review itself, rather than the quality of the primary studies it includes.

Applicability to the UK was judged at review level, if the majority of studies were performed in Organisation for Economic Co-operation and Development (OECD) countries, reviews were judged to be applicable to the UK. If countries of the individual studies were not reported, applicability was rated as unclear.

Due to the large volume of reviews identified, where multiple reviews were identified for a single factor, the reviews were assessed and the highest quality, most up-to-date, and most relevant (i.e. best match for the scope) review(s) were selected for extraction. Match to the scope was assessed in the following areas, as these were the key areas in which reviews differed:

- Study design – reviews including some studies not matching the current review scope (e.g. cross sectional studies) were considered a partial match
- Population – reviews including some studies not matching the current review scope (e.g. overweigh/obese people and/or people with specific conditions) were considered a partial match
- Setting - reviews including some studies not matching the current review scope (e.g. school- or work-based studies) were considered a partial match

The aim was to have at least one review covering children and young people, and at least one review covering adults for each factor. Multiple reviews could be included for a factor if they covered differing pools of studies (e.g. different study designs or numbers of studies) and were of similar quality, date, and relevance. For reviews not prioritised for extraction, reasons were recorded

(see Appendix E). Reviews generically addressing overweight and obesity prevention, rather than specific factors, were also de-prioritised and are listed in Appendix C.

Where reviews provided separate results and conclusions based on the different populations, settings, or outcomes, those most relevant to the current review (i.e. most closely matching the scope) were extracted. Because the majority of the reviews synthesised results of included studies narratively, adjustment for confounders was not carried out on a review-wide level. Reviews varied in their reporting of study-level adjustments (e.g. for total energy intake), and whether these were explicitly considered in the review conclusions. Adjustment for confounders has not been recorded on a study-by-study basis in the current review, but if noted as a limitation by authors of the individual reviews or reviewers this has been recorded in the evidence tables. Where adjustment for confounders was explicitly considered in the conclusions of the included reviews or if adjustment for confounding was noted by reviewers as potentially explaining patterns of results in included reviews, this has been discussed in the current summary.

3.6 Evidence statements

Evidence statements were drafted in line with guidance from the NICE public health methods manual 2012, and feedback from the NICE project team. Draft evidence statements were discussed with the Public Health Advisory Committee and revised based on feedback received. The following general guidelines were used for the strength of evidence ratings:

- Strong evidence: Two or more reviews of good match to the current review scope, of which at least one should be of high quality, with most reviews finding a consistent and statistically significant direction of effect, with any non-significant effects heading in the same direction of effect as the significant effects.
- Moderate evidence: More than one review with at least one review of moderate quality, with some level of consistency, or one high quality review with some limitations (e.g. scope match, number of studies or participants).

- Weak evidence: Evidence from low quality review(s) only, or a moderate or high quality review(s) with considerable limitations (e.g. poor match to current review scope, small numbers of studies or participants).
- Inconclusive evidence: Reviews identified insufficient evidence to conclusively describe the strength and/or direction of the association.
- No evidence: No reviews identified that specifically addressed this factor and contained studies relevant to the scope of the current review.

If a range of effect sizes could not be provided, the size of the effect or correlation was indicated using the following guidelines:

- Large: increase/decrease in relative risk (RR), odds ratio (OR) or hazard ratio (HR) of >20% or effect size of ≥0.8
- Medium: increase/decrease in RR/OR/HR of 10-20% or more, effect size of 0.5 to 0.8
- Small: increase/decrease in in RR/OR/HR of <10%, effect size of <0.5

For other measures a judgment relating to the size of the effect was made on a case-by-case basis.

4 Results

In total, 4,934 studies were identified during the search (4,590 systematic reviews and 370 primary studies), and 80 studies (76 prioritised reviews and 4 primary studies) were included in the review. See Figure 3 for the flow of studies from search to inclusion. At the top of each factor, a table summarises the reviews prioritised for this factor, and a summary table listing all prioritised studies for each section is presented along with data extracted from these (evidence tables) in Appendix F.

In some cases, the definition of a factor or the reviews identified relating to it overlapped considerably with another factor and the factors were merged. Merged sections included: high and low energy dense food consumption merged with energy density; sitting merged with sedentary time; sedentary

time in children and young people merged with screen time; low calorie/low sugar drink and non-nutritively sweetened drink consumption merged with non-nutritive sweeteners; active play merged with active leisure/recreation; take away meal/fast food consumption merged with eating out; meal skipping merged with breakfast consumption.

In total, 76 reviews were included, each including between 1 and 56 relevant primary studies with between 29 and 623,922 participants in total for each factor. The reviews were in adults (35 reviews), children and young people (25 reviews), or both (16 reviews). The reviews included relevant randomised controlled trials (RCTs; 21 reviews), cohort studies (37 reviews), or both (18 reviews). Some studies also included other non-relevant study types (e.g. cross sectional studies).

Searches for primary studies for 3 behaviours for which there were no relevant reviews identified yielded 4 primary studies (3 in adults, 1 in children) that met the review inclusion criteria, with between 37 and 3,588 participants.

Most of the reviews (65 out of 76) are applicable to the UK, as they included mostly studies conducted in OECD countries. The remaining 11 did not report countries in which the studies were undertaken, therefore applicability to the UK is unclear.

For some factors, no systematic reviews including studies matching the scope of this review were identified on the relationship between the following factors and weight related outcomes in adults or children and young people:

- Standing (also no relevant primary studies identified)
- Breaks in sedentary time
- Other sedentary activities such as reading not covered as individual factors
- Watching what you eat
- Eating speed
- Portion size
- Grazing or gorging

- Meal planning (also no relevant primary studies identified)
- Meal setting or distractions (some related evidence identified and described in Section 4.7)
- Drinks with meals (some related evidence identified and described in Section 4.7)
- Eating patterns such as consistency of eating across the week that were not covered as individual factors
- Holiday weight gain (4 primary studies identified and described in Section 4.7)
- Stress minimising activities (some related evidence identified and described in Section 4.7)
- Avoiding screen advertising
- Monitoring (other than physical activity monitoring)

In addition, in adults no relevant evidence was identified on the relationship between weight related outcomes and:

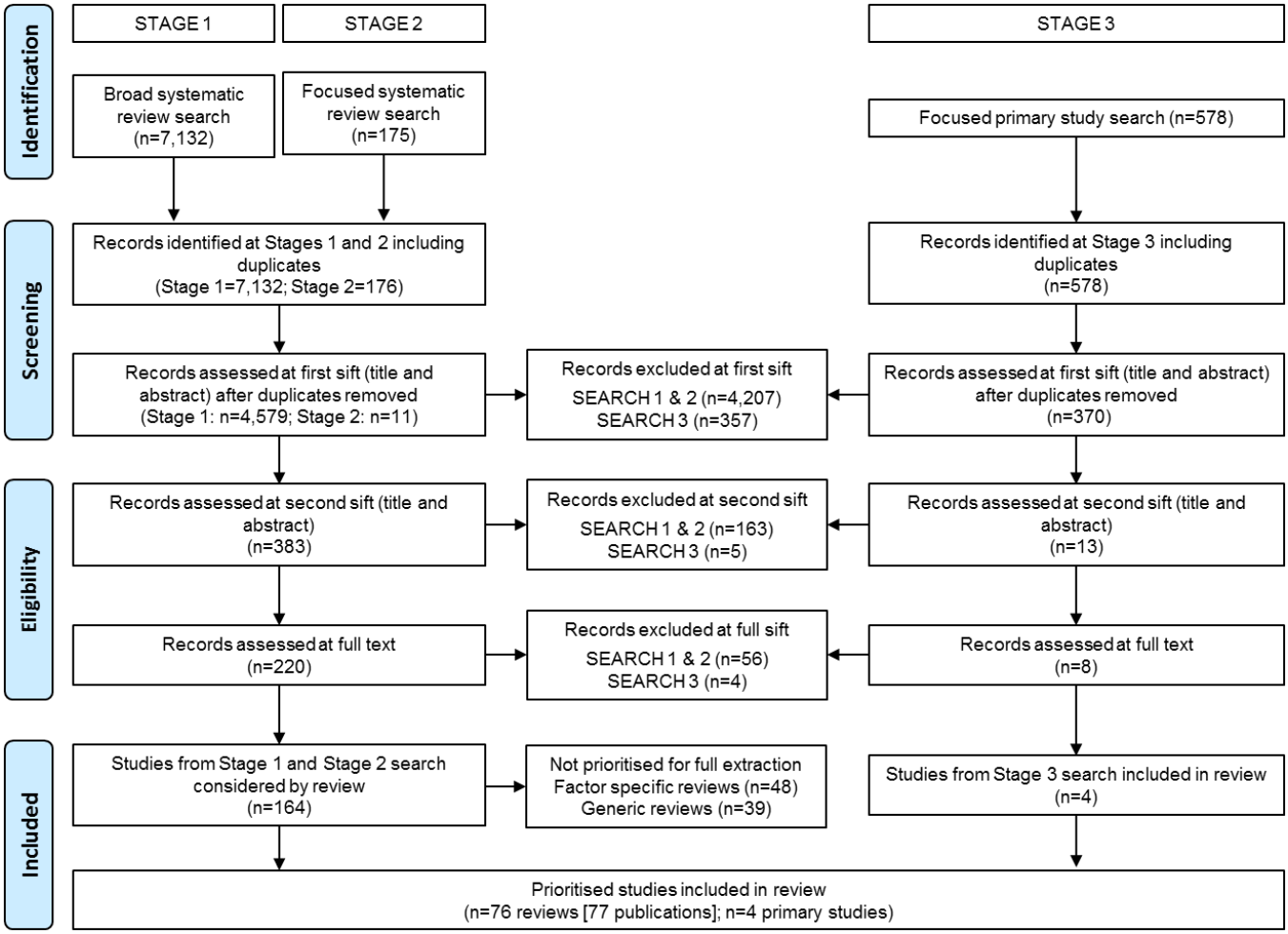
- Sport
- More active screen time
- Breaks in sedentary time
- Family meals

In children and young people, no relevant evidence was identified for:

- Walking
- Cycling
- Activities of daily living
- Incidental physical activity
- Sedentary time (other than screen time)
- Breaks in sedentary time
- Consumption of tea and coffee
- Whole grains

- Meat
- Fish
- Legumes
- Nuts
- Vegetarian/vegan diet
- Catechins or caffeine
- Glycaemic index/load of the diet
- Eating pattern (e.g. timing during the day [including evening eating] or consistency during the week)
- Physical activity monitoring
- Support

Figure 3: PRISMA chart showing study flow in the review



Evidence Statement 1: Summary of behaviours assessed, and included systematic reviews

The review covered 64 individually modifiable behaviours relating to physical activity, diet, and other behaviours that could affect maintenance of a healthy weight and prevention of excessive weight gain. Seventy six systematic reviews met the inclusion criteria, each including between 1 and 56 relevant primary studies with between 29 and 623,922 participants in total for each factor. The reviews were in adults (35 reviews), children and young people (25 reviews), or both (16 reviews). The reviews included relevant randomised controlled trials (RCTs, 21 reviews), cohort studies (37 reviews), or both (18 reviews).

Applicability to the UK: The majority of included systematic reviews (65 out of 76) were conducted in OECD countries and are applicable to the UK. The remainder did not report where studies were undertaken, and applicability to the UK is therefore unclear.

Evidence Statement 2: Modifiable factors for which no relevant systematic review level evidence was identified

There was no systematic review level evidence published between 2005 and 2013 for a number of the modifiable factors of interest and weight related outcomes.

For all population groups, no review levels evidence was identified for: standing (also no relevant primary studies identified); breaks in sedentary time; other sedentary activities such as reading not covered as individual factors; watching what you eat; eating speed; portion size; grazing or gorging; meal planning (also no relevant primary studies identified); meal setting or distractions; drinks with meals; eating patterns (such as consistency of eating across the week that were not covered as individual factors); holiday weight

gain; stress minimising activities; avoiding screen advertising; monitoring (other than physical activity monitoring).

For adults no systematic review level evidence was identified for sport, more active screen time, breaks in sedentary time, or family meals.

For children and young people, no systematic review level evidence was identified for: walking; cycling; activities of daily living; incidental physical activity; sedentary time (other than screen time); breaks in sedentary time; consumption of tea and coffee, whole grains, meat, fish, legumes, nuts, a vegetarian/vegan diet, catechins, or caffeine; glycaemic index/load of the diet; eating pattern (e.g. timing during the day [including evening eating] or consistency during the week); physical activity monitoring, or support.

4.1 Physical activity and exercise

4.1.1 Active leisure or recreation

Table 1: Prioritised reviews assessing leisure or recreation

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Summerbell et al. 2009 [++]	Complete: P Partial: D Unclear: Set	RCT: 0 Cohort: 25 (17, n=265,337 adults/ 8, n=1,956 children) Other: 1	Not reported (NR) (adults) NR (children)	Yes
te Velde et al. 2012 [+]	Complete: D Partial: None Unclear: P, Set	RCT: 0 Cohort: 3 (3, n=529) Other: 0	Inconclusive (children)	Yes
Scope match abbreviations: D design (study design), P population, Set setting				

Adults A high quality review (Summerbell et al. 2009 [++]) found an inconsistent relationship between leisure (recreational) activity and weight in adults, although a general trend towards an inverse association was observed.

Thirteen of the 16 prospective cohort studies among adults identified by the review (n=287 to n=184,448) reported a statistically significant inverse relationship with this factor and a variety of weight related outcomes. The association with weight tended to be moderate to large in size (range: ≥10lb weight gain over 7 years OR 0.88, 95% CI 0.77 to 0.99; risk of 5.7 year substantial weight gain RR 1.9, 95% CI 1.5 to 2.3). Small associations were observed for BMI (e.g. 10 year change in BMI ranged from -0.08 to -0.34 kg/m^2).

Three cohort studies (n=121 to 9,325) found no significant association between leisure or recreational activity and weight; data on the direction of these non-significant associations were generally not reported.

The review did not report which confounders were adjusted for in the individual studies.

Children and young people

Two reviews among children (Summerbell et al. 2009 [++], te Velde et al. 2009 [+]) found inconsistent results, in terms of size, direction and significance of the association. The included studies were small, and may have lacked power to detect any effect of leisure time activity.

Summerbell et al. 2009 [++] found inconsistent results across 8 cohorts: 3 individual studies (n=168 to 355) found significant inverse associations between children's leisure or recreational activity and weight related outcomes; the magnitude of these associations ranged from small (4 year change in BMI regression coefficient -0.08, $p<0.05$) to large (odds of BMI change to ≥90th percentile in boys with no school sports participation: OR 2.14, 95% CI 0.96 to 4.77; findings not significant for girls [figures NR]). One of the identified studies (n=436) reported a significant positive correlation between baseline leisure time physical activity (LTPA) level and subsequent BMI, although the difference was small (0.3 kg/m^2, $p=0.04$). This study did not find differences on other outcomes (body fat, waist circumference, sum of skinfolds). One study (n=198) found mixed directions of association with

subscapular skinfold thickness: play outside was inversely associated in boys ($r=-0.26$, $p<0.05$; no association in girls, figures NR); positive associations were found for involvement in community sports for girls ($r=0.21$, $p<0.05$; no association in boys, figures NR) and involvement in summer sports activities (girls: $r=0.21$, $p<0.05$; boys: $r=0.32$, $p<0.01$). Three studies (n=41 to 278) reported no association between childhood or adolescence recreational or leisure sport participation and weight outcomes in children or later during adulthood. The review did not report which confounders were adjusted for in the individual studies.

Te Velde et al. 2009 [+] found that there was insufficient evidence to support conclusions regarding the association between leisure activity in preschool children and overweight later in childhood. One of the three small prospective cohort studies identified (n=138) found significant inverse relationships between baseline recreational activity and subsequent weight, and percentage body fat (data NR). Another of the studies (n=203; results from a different analysis [for aerobic activity, showing an inverse association] reported from this study in Summerbell et al. 2009 [++], reported there as n=168) found a non-significant trend for less weight gain with greater leisure activity ($p=0.086$). The third study (n=188) found very little evidence of an association between time spent outdoors and BMI z-scores (data NR). It was not clear whether these analyses were adjusted for confounders.

A wide variety of activities were considered in these reviews; where specified, this included aerobic, sport and lifestyle activities (e.g. gardening and play). The majority of the studies reported activity as LTPA not otherwise specified. The individual studies in these two reviews assessed activities that may be relevant to other factors covered by this review, for example sport participation, or activities of daily living.

This variation in exposure definition, combined with lack of review level discussion and little detail on the content of individual studies limits the ability of the current evidence to identify which leisure or recreational activities may

be beneficial in terms of preventing obesity or maintaining a healthy weight in both adults and children.

Evidence Statement 3: Relationship between leisure and recreational activity and weight related outcomes in adults and children

Adults: Moderate evidence from 1 high quality[1] review of cohort studies suggests that there may be an inverse relationship between leisure or recreational activity and weight related outcomes in adults.

The majority of studies (13/16) found significant inverse relationships. The association with weight tended to be moderate to large in size (range: OR ≥10lb weight gain over 7 years: 0.88, 95% CI 0.77 to 0.99; RR 5.7 year substantial weight gain: 1.9, 95% CI 1.5 to 2.3). Small associations were observed for BMI (e.g. 10-year BMI change ranged from -0.08 to -0.34 kg/m^2).

Children and young people: Inconclusive evidence from 1 high quality[1] and 1 moderate quality[2] review of small cohort studies was identified regarding the relationship between leisure and recreational activity and weight related outcomes in children and young people.

The findings of the individual studies in the reviews[1,2] varied: 3 studies found small to large inverse associations (4 year change in BMI: regression coefficient=-0.08, $p<0.05$; BMI change to ≥90th percentile: OR 2.14, 95% CI 0.96 to 4.77). One study found a small positive relationship (correlation between baseline LTPA level and subsequent BMI: 0.3 kg/m^2, $p=0.04$), 1 had mixed inverse and non-significant findings, and 1 found mixed positive and inverse directions of effect (different activities showed significant correlation with skinfold thickness, correlation coefficients ranging from $r=-0.26$ to $r=0.32$). Four studies reported no association between childhood or adolescence recreational or leisure sport participation and weight outcomes in children or later during adulthood.

Applicability to the UK: These results are applicable to the UK.

[1] Summerbell et al. 2009 [++]

[2] te Velde et al. 2009 [+]

4.1.2 Sport participation

Table 2: Prioritised reviews assessing sport participation

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Nelson et al. 2011 [+]	Complete: Set Partial: P, D Unclear: None	RCT: 1 (0) Cohort: 1 (1, n=5,184) Other: 19	Inconclusive (children)	Yes
Scope match abbreviations: D design (study design), P population, Set setting				

Adults

No evidence was identified on the relationship between sport and weight related outcomes in adults.

Children and young people

One moderate quality review (Nelson et al. 2011 [+]) found that there may be an inverse relationship between sport participation and weight outcomes in children, however, there were inconsistencies in the significance of the effect. Thirteen of the 21 identified studies reported a significant inverse relationship, however, the vast majority of these studies were cross-sectional in nature and could be affected by reverse causality. The single longitudinal study (n=5,184) reported that males who participated in sports at age 11 to 12 were significantly less likely to be overweight at age 14. However, there was no significant association between sport and weight status amongst males or females between the ages of 14 and 17 (data NR).

Due to limited prospective data, the review offers no conclusive evidence on the relationship.

Evidence Statement 4: Relationship between sport and weight related outcomes

Adults: No reviews were identified on the relationship between sport and weight related outcomes in adults.

Children and young people: Inconclusive evidence was identified from 1 moderate quality review[1] regarding the relationship between sport and weight related outcomes in children and young people. The review[1] identified only 1 cohort study relevant to the scope of the current review, which had inconsistent findings across different age groups.

Applicability to the UK: These results are applicable to the UK.

[1] Nelson et al. 2011 [+]

4.1.3 Active travel or commuting

Table 3: Prioritised reviews assessing active travel or commuting

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Saunders et al. 2013 [+]	Complete: P, D Partial: Set Unclear: None	RCT: 3 (2, n=282 adults) Cohort: 16 (5, n=4,149 children) Other: 2	Inconclusive (adults) Inconsistent (Children)	Yes
Schoeppe et al. 2013 [++]	Complete: Set Partial: D Unclear: P	RCT: 0 Cohort: 4 (4, n=4,354) Other: 16	Inconsistent (Children)	Yes
Scope match abbreviations: D design (study design), P population, Set setting				

Adults

One moderate quality review (Saunders et al. 2013 [+]) found mixed associations between active travel and weight related outcomes among adults. The review included only a few RCTs, which found no significant effect of the active commuting interventions (cycling 3 km each way 3 times a week for 6 months; mean 2.4 km walk or 9.7 km cycle for 10 weeks) on weight (figures NR). These RCTs were small, and may not have been sufficiently

powered to detect an effect. The review did not report whether the groups differed in overall physical activity during the studies.

Children and young people

One high quality (Schoeppe et al. 2013 [++]) and 1 moderate quality (Saunders et al. 2013 [+]) review identified a small number of studies which assessed the relationship between walking or cycling to school and weight status. The majority of the identified studies reported no significant association; where significant relationships were found, they were inverse and ranged from small (differences in mean BMI z-scores: 0.18, p=0.05) to large (OR overweight among cyclists vs. non-cyclists: 0.63, 95% CI 0.45 to 0.89).

Due to the limited number of studies, overlap in identified cohorts between the two reviews, and reportedly weak study quality, no robust conclusions can be drawn regarding the role of active travel to school and healthy weight maintenance.

"Active travel" was not defined consistently across studies, and there were high dropout levels in some studies. For example, the study that reported the largest associations (OR 0.63, 95% CI 0.45 to 0.89 and OR 0.44, 95% CI 0.21 to 0.88 for cyclists vs. non-cyclists) appeared in both reviews, and had a reported dropout rate of 56%; no information was provided on differences between completers and non-completers, and this high attrition rate may have biased the results. Journey times were relatively short, and there is difficulty in disentangling the effects of active travel from more general physical activity. The frequency and duration of active travel/commuting was self-assessed and may not have been reliable.

For additional evidence on the association between general walking or cycling (not necessarily for active travel), see Sections 4.1.4 and 4.1.5.

Evidence Statement 5: Relationship between active travel and weight related outcomes

Adults: Inconclusive evidence was identified from 1 moderate quality review[1] of RCTs regarding the relationship between active travel and weight related outcomes in adults. Two small RCTs matched the scope of this review, neither of which found a significant effect of active travel interventions on weight. The review did not report whether the interventions increased overall physical activity.

Children and young people: Inconclusive evidence was identified from 1 high quality[2] and 1 moderate quality review[1] of cohort studies on the relationship between active travel and weight related outcomes in children. There was substantial overlap of individual studies between the 2 reviews.

One moderate quality[1] review of studies among normal and overweight children recruited from the general population identified 5 prospective cohort studies assessing weight outcomes. One of the studies found a significant large inverse relationship between those who continuously cycled to school and risk of overweight (OR 0.44, 95% CI 0.21 to 0.88). The remaining 4 studies reported no significant differences in active travel (cycling or walking) and BMI.

One high quality review[2] of cohort and cross sectional studies revealed no consistent association between active school travel and weight status in children. Across the 4 identified cohort studies, 1 study found no significant relationship, and the remaining 3 studies reporting inverse relationships (range in magnitude small: differences in mean BMI z-scores: 0.18, p=0.05; to large: OR for overweight among cyclists vs. non-cyclists: 0.63, 95% CI 0.45 to 0.89).

Applicability to the UK: These results are applicable to the UK.

[1] Saunders et al. 2013 [+]
[2] Schoeppe et al. 2013 [++]

4.1.4 Walking

Table 4: Prioritised reviews assessing walking

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Murphy et al. 2007 [++]	Complete: P, D Partial: None Unclear: Set	RCT: 24 (20, n=894) Cohort: 0 Other: 0	Inverse (adults)	Unclear
Scope match abbreviations: D design (study design), P population, Set setting				

Adults

One high quality review (Murphy et al. 2007 [++]) found that a programme of regular brisk walking is sufficient to produce modest reductions in body weight (1.4% reduction), BMI (1.1% reduction) and body fat (1.9% reduction) in previously sedentary but otherwise healthy individuals ('healthy' not further defined). Meta-analysis found a weighted mean treatment effect of -0.95 kg (standard deviation [SD] 0.61 kg), $p<0.001$. This represents a relative reduction in body weight of 1.4%. Analysis of BMI revealed a weighted mean treatment effect of -0.28 kg/m^2 (SD 0.2 kg/m^2), $p<0.001$, a relative reduction in BMI of 1.1%. Finally, the weighted mean treatment effect in terms of percentage body fat was -0.63% (SD 0.66%), $p=0.015$. This is a relative reduction in percent body fat of 1.9%.

Walking interventions in the review involved walking on average 38.3 minutes on 4.4 days a week, at an average intensity of 70.1% maximum heart rate or 56.3% maximum oxygen consumption.

Two components of the study selection criteria increase the likelihood that the observed reductions were the result of increased energy expenditure due to walking. First, none of the interventions included a dietary change component, so there was no prescribed reduction in energy intake; second, none of the interventions had weight loss as a goal, therefore, participants wouldn't be expected to have reduced energy intake of their own accord.

It should be noted that the review and meta-analysis included mainly female participants (82.9%). The included studies were also very small in size (ranging from 9 to 55 participants per arm), and some primary studies analysed data from completers only instead of taking an intention-to treat-approach. These limitations may reduce the degree to which review findings can be generalised to the general population.

This section covers walking as a whole. Reviews covering walking (or cycling) in the context of commuting to work or school are included in Section 4.1.3.

Children and young people

No evidence was identified on the relationship between walking and weight related outcomes in children or young people.

Evidence Statement 6: Relationship between walking and weight related outcomes

Adults: Moderate evidence identified from 1 high quality review[1] (including meta-analysis) of RCTs suggests that regular brisk walking (an average of about 38 minutes on 5 days a week) may be effective at reducing weight by around 1.4% (-0.95 kg [standard deviation [SD] 0.61 kg], $p<0.001$), BMI by around 1.1% (-0.28 kg/m^2 [SD 0.2 kg/m^2], $p<0.001$) and percentage body fat by around 1.9% (-0.63% [SD 0.66%], $p=0.015$) among previously sedentary but otherwise healthy adults.

Children and young people: No reviews were identified on the relationship between walking and weight related outcomes in children and young people.

Applicability to the UK: The countries in which the studies included in the review were performed was not reported, therefore applicability to the UK is unclear.

[1] Murphy et al. 2007 [++]

4.1.5 Cycling

Table 5: Prioritised reviews assessing cycling

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Oja et al. 2011 [+]	Complete: P, Set Partial: D Unclear: None	RCT: 4 (0) Cohort: 8 (1, n=18,414) Other: 4	Inverse (adults)	Yes
Scope match abbreviations: D design (study design), P population, Set setting				

Adults

One moderate quality review (Oja et al. 2011) found evidence that commuter cycling is associated with health benefits (e.g. cardiovascular and all-cause mortality). The evidence on the association with weight outcomes was limited, but suggests that increasing amounts of daily cycling may be associated with small decreases in overweight and obesity.

The review had poor overlap with the current review scope, with the majority of studies assessing non-weight outcomes; only one of the 16 included studies matched the current review scope in terms of population, study design and outcomes.

This large prospective cohort study included women only, which may reduce the generalizability of the results to the general population as a whole. It found small but statistically significant reductions in self-reported weight over 16 years for each 30 min/day increase in self-reported cycling time (-1.59 kg, 95% CI -2.0 to -1.08).

Several reviews assessed cycling in the context of commuting to work or school; see Section 4.1.3 for more information on cycling in this context.

Children and young people

No evidence was identified on the relationship between cycling and weight related outcomes in children and young people.

Evidence Statement 7: Relationship between cycling and weight related outcomes

Adults: Weak evidence from 1 moderate quality review[1] suggests that there may be an inverse relationship between cycling and weight in adults.

The 1 prospective cohort study of women in the review relevant to the current review scope found a significant reduction in self-reported weight over 16 years for each 30 min/day increase in self-reported cycling time (-1.59 kg, 95% CI -2.0 to -1.08).

Children and young people: No reviews were identified on the relationship between cycling and weight related outcomes in children and young people.

Applicability to the UK: The results of this review are applicable to the UK.

[1] Oja et al. 2011 [+]

4.1.6 Activities of daily living

Table 6: Prioritised reviews assessing activities of daily living

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
WCRF 2006 [++]	Complete: D Partial: None Unclear: P, Set	RCT: 0 Cohort: 3 (3, n=54,169 adults) Other: 0	NR (adults)	Yes
Scope match abbreviations: D design (study design), P population, Set setting NR not reported				

Adults

One high quality review (WCRF 2006 [++]) found limited evidence on the relationship between household activities and weight related outcomes, ranging from large inverse associations to non-significant positive associations.

One study (n=3,604) reported a non-significant positive relationship between household and caregiving physical activity and weight (regression coefficient: 0.43, p=0.30) and waist circumference (WC) over 3 years (regression coefficient: 0.17, p=0.20; units NR). A second large cohort study (n=50,277) reported a large reduction in risk of obesity among women who spent 40 hours or more per week walking or standing in the home compared to 0-1 hour per week (RR 0.77, 95% CI 0.61 to 0.96). A third cohort (n=288) found that household activity was associated with a non-significant reduction in WC over 5 years (regression coefficient: -0.03, p=0.07; units NR). It is unclear whether this study was sufficiently powered to detect an effect.

Due to inconsistencies in direction and significance of the observed associations across the studies, as well as limited information on the types of activities included in 'household activity' exposures, there is insufficient evidence to draw conclusions on the relationship between activities of daily living and weight outcomes in adults.

This factor is may overlap with incidental physical activity, which covers activities such as climbing the stairs (see Glossary for full definitions of factors). Incidental physical activity is covered in the following section.

Children and young people

No evidence was identified on the relationship between activities of daily living and weight related outcomes in children and young people.

Evidence Statement 8: Relationship between activities of daily living and weight related outcomes

Adults: Inconclusive evidence from 1 high quality review[1] of cohort studies was identified regarding the relationship between activities of daily living and weight related outcomes in adults. The studies identified by the review varied in terms of direction and significance of the association.

Three prospective cohort studies of household activities, 1 found non-significant positive associations between household and caregiving activities

and 3 year change in weight (regression coefficient: 0.43, p=0.30) or WC in women (regression coefficient: 0.17, p=0.20). A second study in women found a large inverse relationship between obesity at 6 year follow-up among those who stood or walked at home for >40 hr/week vs. 0-1 hr/week (RR 0.77, 95% CI 0.61 to 0.96). The third cohort study found a small non-significant reduction in WC over 5 years in older men (regression coefficient: -0.03, p=0.07).

Children and young people: No evidence was identified on the relationship between activities of daily living and weight related outcomes in children and young people.

Applicability to the UK: The results of this review are applicable to the UK.

[1] WCRF 2006 [++]

4.1.7 Incidental physical activity

Table 7: Prioritised reviews assessing incidental physical activity

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Summerbell et al. 2009 [++]	Complete: D Partial: None Unclear: P, Set	RCT: 0 Cohort: 2 (2, n=3,957 adults) Other: 0	Inconclusive (adults)	Yes
Scope match abbreviations: D design (study design), P population, Set setting NR not reported				

Adults

One high quality review (Summerbell et al. 2009 [++]) found inconsistent relationships between measures of incidental physical activity and weight in adults in 2 cohort studies.

One study found no association between the self-reported average number of stairs climbed each day and excess weight gain over a decade in women. However, this study was quite small (n=353) and it is unclear whether it was

sufficiently powered to detect a large change in outcome (≥10 lb weight gain over 10 years).

The other study (n=3,604) reported a significant inverse association between mean levels of baseline routine PA (not further defined) and weight and WC increase at 4 year follow-up (regression coefficients [units NR] -3.31, 95% CI -4.21 to -2.41, p<0.0001; and -0.92, 95% CI -1.21 to -0.63, p<0.0001, respectively).

Due to the limitations in both quantity and consistency of the assessed studies, no conclusive relationship was found between incidental physical activity and weight outcomes. Furthermore, both studies included female participants only, limiting the generalizability of the findings to the broader population.

Children and young people

No evidence was identified on the relationship between incidental physical activity and weight related outcomes in children and young people.

Evidence Statement 9: Relationship between incidental physical activity and weight related outcomes

Adults: There was inconclusive evidence from 1 high quality review[1] on the relationship between routine physical activity and weight related outcomes in adults.

The review identified 2 prospective cohort studies only; 1 small study found no significant association between the average stairs climbed per day and risk of gaining ≥10lbs over 10 years. One large study found a significant inverse association between mean levels of baseline routine PA (not further defined) and weight and WC increase at 4 year follow-up (regression coefficients -3.31, 95% CI -4.21 to -2.41, p<0.0001; and -0.92, 95% CI -1.21 to -0.63, p<0.0001, respectively).

Children and young people: No evidence was identified on the relationship between incidental physical activity and weight related outcomes in children and young people.

Applicability to the UK: The results of this review are applicable to the UK.

[1] Summerbell et al. 2009 [++]

4.1.8 Strength training

Table 8: Prioritised reviews assessing strength exercise

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Ismail et al. 2012 [++]	Complete: D Partial: P Unclear: Set	RCT: 35 (4, n=196) Cohort: 0 Other: 0	No (adults)	Unclear
Benson et al. 2008 [+]	Complete: None Partial: P, D Unclear: Set	RCT: 6 (1, n=29) Cohort: 0 Other: 6	Inconclusive (children)	Yes
Scope match abbreviations: D design (study design), P population, Set setting				

Adults

One high quality review (Ismail et al. 2012 [++]) assessed the impact of strength training on body composition (visceral fat) of adults, and found no association.

Overall, meta-analysis found that resistance training did not significantly affect visceral fat compared with control over 3 months to 2 years (14 comparisons, n=NR; effect size 0.09, 95% CI -0.17 to 0.36; p=0.49; random effects analysis). The 4 RCTs relevant to the current scope (total n=196) had mixed results, with 3 finding no significant effect (effect sizes -0.340 to 0.000), and 1 finding a significant reduction in visceral fat over 1 year (effect size -0.59, 95% CI -1.16 to -0.02).

The review included mainly RCTs in overweight or obese participants, or individuals with type 2 diabetes or metabolic syndrome, therefore applicability to the general population is unclear.

Children and young people

One moderate quality review (Benson et al. 2008 [+]) assessed the impact of strength training on body composition of children and adolescents, and found inconsistent results.

The 1 small RCT relevant to this review reported that the intervention group increased body mass more than the control group (reviewer calculated change in mean body mass [units NR], intervention: 1.6 vs. control: 0.6; $p<0.05$). Similarly, significant increases in WC were seen in the resistance/strength training (RT) group but not in the control (reviewer calculated change in mean WC, intervention: 2.4 cm vs. control: 0.0 cm; $p<0.05$ within the intervention group and between groups).

Additionally, it is important to note that increases in body mass following strength training may reflect increases in muscle mass and not be indicative of unhealthy weight change.

Evidence Statement 10: Relationship between strength training and weight related outcomes

Adults: Inconclusive evidence was identified from 1 high quality review[1] of RCTs of strength training in adults.

Meta-analysis[1] of studies among obese and general populations found that resistance training did not significantly affect visceral fat compared with control over 3 months to 2 years (effect size 0.09, 95% CI -0.17 to 0.36; $p=0.49$). This finding was supported by 3 out of 4 RCTs of resistance training in healthy participants not selected based on weight status

Children and young people: Inconclusive evidence from 1 moderate quality review[2] of RCTs was identified regarding the relationship between strength (resistance) training and weight related outcomes in children and adolescents.

Only 1 small RCT included in the review was relevant to the current scope. This small study suggested that that resistance training (with or without aerobic exercise) may result in small increases body mass (reviewer calculated mean change body mass [units NR], intervention: 1.6 vs. control: 0.6; $p<0.05$) and WC (reviewer calculated mean change WC, intervention: 1.6 cm vs. comparator: 0.0 cm; $p<0.05$). These changes may represent changes in muscle mass.

Applicability to the UK: The results of 1 review[2] are applicable to the UK, the countries in which the studies in the other review were performed were not reported, therefore applicability of this reviews to the UK is unclear.

[1] Ismail et al. 2012 [++]
[2] Benson et al. 2008 [+]

4.1.9 Aerobic exercise

Table 9: Prioritised reviews assessing aerobic exercise

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Ismail et al. 2012 [++]	Complete: D Partial: P Unclear: Set	RCT: 35 (5, n=402) Cohort: 0 Other: 0	Inverse (adults)	Unclear
Kelley and Kelley 2006 [++]	Complete: D Partial: P Unclear: Set	RCT: 5 (2, n=201) Cohort: 0 Other: 0	Inverse (adults)	Yes
Laframboise and Degraauw 2011 [+]	Complete: D Partial: P Unclear: Set	RCT: 10 (2, n=2,184) Cohort: 0 Other: 0	Inconclusive (children)	Unclear
te Velde et al. 2012 [+]	Complete: D Partial: P Unclear: Set	RCT: 0 Cohort: 2 (2, n=8,203) Other: 0	Inconclusive (children)	Yes

Scope match abbreviations: D design (study design), P population, Set setting

Adults

Two high quality reviews (Ismail et al. 2012 [++], Kelley and Kelley 2006 [++]) found evidence from RCTs that aerobic exercise improves body composition.

One review (Kelley and Kelley 2006 [++]) of 5 RCTs (n=323), found that aerobic exercise reduces body weight (3 comparisons, n=NR; mean change: -3.4 kg, 95% CI -5.3 to -1.5) and percentage of body fat (3 RCTs, n=NR; mean change: -1.4%, 95% CI -2.3 to -0.6) in adults by approximately 4%.

The second review (Ismail et al. 2012 [++]) found that aerobic exercise reduced visceral adiposity compared to control over 1 month to 2 years (29 comparisons, n=NR; effect size -0.33, 95% CI -0.52 to -0.14, $p<0.01$; random effects analysis with 1 outlier with large effect size removed). Overall, the aerobic interventions included 45 to 60 minute sessions, on 1 to 7 days per week (most commonly 3 days). Intensity was most commonly 60-75% maximal heart rate (moderate intensity), and ranged between 40% to 90% of peak aerobic capacity (sometimes starting at lower intensity and increasing over time).

Individual effect sizes for the 5 relevant RCTs in this review were all non-significant (ranging from -0.492 to 0.095), with the non-significant direction of effect favouring aerobic exercise in most (4/5) studies. The individual studies were small (total n=402) and therefore may have lacked power to detect an effect.

While both reviews found significant improvements in body composition, due to limitations in review reporting, and that recruitment was based on overweight status or on health status (e.g. type 2 diabetes or metabolic syndrome) in some RCTs, it is unclear how applicable these conclusions are to healthy weight adults or the general population.

Children and young people

Two moderate quality reviews (Laframboise and Degraauw 2011 [+], te Velde et al. 2013 [+]) assessed the association between aerobic exercise and weight status. There was weak evidence of a negative association between aerobic activity and weight related outcome status, although the effect was not consistent across the included studies.

The review by Laframboise and Degraauw 2011 [+] was of RCTs. Two out of the 10 RCTs (n=2,184; children aged 9-14 years) were relevant to the scope of the current review. One of these RCTs found that aerobic exercise (90 minutes daily on 3 days a week for 28 weeks) decreased BMI (figures NR), the other found no change in BMI or body composition with aerobic exercise (30 minutes daily on 3 days a week for 8 weeks; results figures NR). The longer duration of individual exercise sessions and of the intervention may contribute to the difference in effectiveness seen.

The review of cohort studies (te Velde et al. 2013 [+]) focused specifically on pre-school children and identified 2 cohort studies. One study (n=203) reported that higher levels of baseline aerobic activity were associated with subsequent decreases in BMI (p=0.033). The other study (n=8,000) reported no association between number of days in the week on which aerobic exercise was performed and either onset of overweight or persistent overweight later in childhood (figures NR). The assessment of the number of days on which aerobic activity was performed may not adequately capture differences in total volume of aerobic activity between participants, and this could limit ability to detect an effect.

The review noted that few studies were of high methodological quality, but did not explicitly report whether confounders were adjusted for. This and the lack of information on actual activity levels and results mean that limited conclusions can be drawn from this cohort study evidence.

Evidence Statement 11: Relationship between aerobic exercise and weight related outcomes

Adults: Weak evidence from 2 high quality systematic reviews[1,2] of RCTs suggests that aerobic exercise is inversely associated with weight related outcomes in adults.

One review[1] and meta-analysis of small RCTs suggests that 4 weeks or more of aerobic exercise interventions significantly reduce body weight (mean change: -3.4 kg, 95% CI -5.3 to -1.5) and percentage body fat (mean change: -1.4%, 95% CI -2.3 to -0.6). This was equivalent to a relative reduction of approximately 4% of body weight and body fat percentage in adults. The second review[2] and meta-analysis found that aerobic exercise interventions reduced visceral fat over 4 weeks to 1 year (effect size -0.33, 95% CI -0.52 to -0.14, $p<0.01$). Both reviews largely included RCTs in overweight and obese participants or people with type 2 diabetes. However, the RCTs among general populations included in the review tended to support this finding (they did not reach significance, but this may have been due to small sample sizes of these studies).

Children and young people: Weak evidence was identified from 2 moderate quality reviews[2,3] that aerobic exercise may be inversely associated with weight related outcomes in children and adolescents.

In 1 review[2] 1 RCT found that 90 minutes daily on 3 days a week for 28 weeks aerobic exercise decreased BMI (figures NR), but another found that 30 minutes daily on 3 days a week for 8 weeks did not change BMI or body composition (figures NR). The difference in session and intervention duration may account for the variation in significance. Two cohort studies in another review[3] also had similarly mixed findings; limited reporting of this review limits conclusions that can be drawn from this cohort study evidence.

Applicability to the UK: The results of 2 reviews[2,3] are applicable to the UK, while the countries in which the studies in 2 reviews were performed were not reported, therefore applicability of these reviews to the UK is unclear .

[1] Ismail et al. 2012 [++]
[2] Kelley and Kelley 2006 [++]

[3] Laframboise and Degraauw 2011 [+]
[4] te Velde et al. 2012 [+]

4.1.10 Physical activity intensity, frequency and duration

Table 10: Prioritised reviews assessing physical activity intensity, frequency and duration

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Murphy et al. 2009 [-]	Complete: None Partial: P, D Unclear: Set	RCT: 9 (4, n=265) Cohort: 0 Other: 7	Inconclusive (adults)	Yes
Summerbell et al. 2009 [++]	Complete: D Partial: P, Set Unclear: None	Intensity: RCT: 0 Cohort: 8 (2, n=23,530 adults/5, n=3,406 children) Other: 0 Frequency & Duration: RCT: 0 Cohort: 8 (3, n=21,240 adults/4, n>733 children) Other: 0	Inconsistent (intensity, adults) No (frequency & duration, adults) Inconsistent (children)	Yes
Janssen and Leblanc 2010 [+]	Complete: None Partial: P, D, Set Unclear: None	RCT: 24 (7, n=483) Cohort: 5 (3, n=4,370) Other: 42	Inverse (children)	Yes
Ekelund et al. 2012 [+]	Complete: None Partial: P Unclear: D, Set	Overall: 14 (7, n=6,413) RCT: unclear Cohort: unclear Other: unclear	Inverse (children)	Yes
Scope match abbreviations: D design (study design), P population, Set setting				

Adults

The 2 reviews in adults found inconsistent associations between physical activity (PA) intensity, frequency and duration and weight related outcomes in adults. Due to limitations in the number of studies identified and poor review quality, only weak conclusions can be drawn regarding the impact of these factors on weight in this age group.

One low quality review (Murphy et al. 2009 [-]) found insufficient evidence to determine whether performing an equivalent amount (volume) of exercise in shorter accumulated bouts was as effective as a single continuous bout in terms of adiposity. In general the PA interventions were inversely associated with weight related outcomes in adults, with associations ranging from small to large (0.3% reductions in WC to 11.7% reductions in body weight).

One high quality review (Summerbell et al. 2009 [++]) assessed each component of PA separately. There was generally no significant association between physical activity frequency or duration and weight outcomes among adults. The 2 intensity studies both reported inverse relationships ranging from relatively small (moderate intensity PA and 14 year weight change regression coefficient -0.13, p=0.79) to relatively large (difference in weight gain between very active vs. least active: -35%, p<0.01). However, the association was statistically significant in the larger study with self-reported weight outcomes only. Whether this difference in significance is due to larger sample size, outcome assessment measures, or reflects a true difference in the association between the two study populations cannot be determined based on the available information.

Children and young people

Three reviews among children (Summerbell et al. 2009 [++], Janssen and Leblanc 2010 [+], Ekelund et al. 2012 [+]) assessed the relationship between PA intensity, frequency and duration and weight related outcomes in children. The reviews found a trend towards an inverse relationship between these PA components and weight in this age group, however, there was variation in the significance of the relationship, and at least one individual study reported a significant positive relationship between the variables.

The magnitude of the relationship ranged from small (overweight/obesity in most vs. least active: effect size <0.5) to large (OR excess weight gain in least vs. most active: 2.18, 95% CI 1.01 to 4.71). Evidence from 1 review (Janssen and Leblanc 2010 [+]) suggested as little as 2 to 3 hours of moderate to

vigorous physical activity (MVPA) per week is associated with health benefits. However, this overall finding was based on all assessed outcomes and not limited to the association with weight.

One of the reviews (Ekelund et al. 2012 [+]) found a small inverse relationship when assessing both cross-sectional and prospective analyses (specific study designs not reported): a 10 minute per day increase in MVPA was correlated with a 0.54 cm reduction in WC (95% CI -0.79 to -0.30) after adjusting for sedentary time. When assessing prospective studies alone (mixed designs, including RCTs and cohort studies), no significant relationship was found, suggesting that the modest reduction seen in the overall analysis may have been due to reverse causality, with children with higher WC less likely to participate in MVPA.

There was wide variation in the types, frequency, intensity and duration of PA assessed in these reviews. This, combined with inconsistencies in the direction, size and significance of the observed associations, and potential confounding due to the inclusion of cross-sectional studies, makes it difficult to precisely define the total volume of physical activity that is needed to maintain a healthy weight or prevent overweight/obesity in children.

Evidence Statement 12: Relationship between physical activity (PA) intensity/frequency/duration and weight related outcomes in adults

Adults: Weak evidence from 1 high quality review[1] of cohort studies and 1 low quality review[2] of RCTs suggests that there is no association between PA frequency or duration (as isolated factors) and weight outcomes in adults, although there may be an inverse relationship between total PA volume and PA intensity and weight status in this population.

The review of RCTs[2] found that there was insufficient evidence to determine whether the same volume of exercise accumulated in shorter bouts is as effective as continuous bouts in terms of adiposity. Across all studies, PA interventions tended to be inversely associated with weight related outcomes compared to control.

Applicability to the UK: These results are applicable to the UK.

[1] Summerbell et al. 2009 [++]
[2] Murphy et al. 2009 [-]

Evidence Statement 13: Relationship between physical activity intensity/frequency/duration and weight related outcomes in children and young people

Weak evidence from 1 high quality review[1] and 2 moderate quality reviews[2,3] of RCTs, cohort and cross sectional studies suggests that there may an inverse relationship between moderate to vigorous physical activity (MVPA) and weight outcomes in children. However, there were substantial variations in the size and significance of the association.

One review[1] of cohort studies found inconsistent direction of association: 3 studies reported significant inverse relationships, ranging in magnitude from medium sized (2 year BMI change regression coefficient -0.732, 95% CI -1.159 to -0.305, p=0.001) to large (excess weight gain least vs. most active OR 2.18, 95% CI 1.01 to 4.71). One study found that high levels of MVPA was associated with a small but significant increase in mean BMI compared to low MVPA levels (19.7 kg/m^2 vs. 19.4 kg/m^2, p=0.03).

Meta-analysis of 4 small prospective cohort studies in 1 review[2] found no significant association between MVPA and WC.

One review[3] of RCTs, cohorts, and other study designs concluded that there is strong and consistent evidence that as little as 2 to 3 hours of MVPA is associated with health benefits (both weight and non-weight health outcomes). No conclusions were drawn for weight outcomes separately.

Applicability to the UK: These results are applicable to the UK.

[1] Summerbell et al. 2009 [++]
[2] Ekelund et al. 2012 [+]
[3] Janssen and Leblanc 2010 [+]

4.2 Sedentary behaviour

4.2.1 Amount of sedentary time

Table 11: Prioritised reviews assessing amount of sedentary time

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Summerbell et al. 2009 [++]	Complete: None Partial: D Unclear: P, Set	RCT: 0 Cohort: 4 (4, n=77,922 adults) Other: 0	NR (adults)	Yes
van Uffelen et al. 2010 [+]	Complete: None Partial: D, Set, P Unclear: None	RCT: 0 Cohort: 3 (3, n=66,912) Other: 9	Inconclusive (adults)	Yes
Scope match abbreviations: D design (study design), P population, Set setting				

Adults

Two reviews in adults (Summerbell et al. 2009 [++], van Uffelen et al. 2010) reported inconsistent associations between amount of sedentary time and weight related outcomes.

The high quality review by Summerbell et al. 2009 [++] included 4 prospective cohort studies (n=77,922), which had inconsistent results in terms of the direction and significance of the effects.

One study reported no significant association between hours per day spent lying down or sitting and a 10 lb or more weight gain at follow-up (n=336, data NR). One study (n=18,583) reported a significant positive association among women who were not overweight at baseline for >6 hours/day of non-occupational sedentary behaviour and likelihood of weight gain of at least 10 lb over 7 years compared to <3 hour/day (OR 1.47, 95% CI 1.21 to 1.79).

One study (n=50,277) found positive associations of mixed statistical significance: a non-significant association between sitting at home >40

hours/week and obesity at 6 years' follow-up compared to 0-1 hours/week (RR 1.11, 95% CI 0.85 to 1.45); and a significant association between sitting for >40 hours per week at work, away from home or while driving and greater obesity risk at 6 years compared to 0-1 hours/week (RR 1.28, 95% CI 1.04 to 1.58).

The final study (n=8,726) found a significant inverse association: sitting ≥52 hours/week was associated with a lower risk of weight gain over four years compared to sitting ≤33 hours/week (RR 0.8, 95% CI 0.7 to 0.91).

The moderate quality review by van Uffelen et al. 2010 [+] specifically assessed occupational sitting and included any study design. As most of the studies assessing sedentary time in Summerbell et al. 2009 [++] also addressed sitting, both reviews have been considered together in this section.

Of the 3 cohort studies (n=66,912) included in the van Uffelen et al. 2010 [+] review, the largest (n=50,277 women) was also included in Summerbell et al. 2009 [++] and found a significant positive association between occupational sitting and BMI. The other 2 cohort studies found no association (figures not reported). The review reported that overall, based on these cohort studies and additional cross sectional studies, the findings were inconclusive about the association between occupational sitting and BMI.

Children and young people

Reviews assessing the association between amount of sedentary time (primarily TV viewing) and weight in children primarily included studies that assessed screen time, therefore these reviews were considered alongside reviews for that factor.

Evidence Statement 14: Relationship between amount of sedentary time and weight related outcomes

Adults: Inconclusive evidence was identified from 1 high quality review[1] of cohort studies and 1 moderate quality review[2] of cohort studies and cross sectional studies regarding the association between amount of sedentary time

(mainly time spent sitting) and weight related outcomes; variations were seen in both the direction and significance of the association across the 2 reviews.

The size of effect in the 4 cohort studies where this was reported ranged from medium to large, with obesity or weight gain for longer periods (above about 6 to 8 hours a day) of sedentary behaviour versus shorter periods (below between about to 5 hours per day and 1 hour per week) associated with relative risks (RR) or odds ratios (OR) from 0.8 (i.e. a positive relationship) to 1.47 (i.e. an inverse relationship).

Sedentary behaviour was not assessed in the same way across studies, being variously assessed as sitting (any, occupational sitting, sitting split into at home or elsewhere), sitting or lying, or non-occupational sedentary behaviour.

Children and young people: The reviews of sedentary behaviour in children and young people identified mostly related to screen time, and are reviewed in the section on screen time.

Applicability to the UK: These results are applicable to the UK.

[1] Summerbell et al. 2009 [++]
[2] van Uffelen et al. 2010 [+]

4.2.2 Screen time

Table 12: Prioritised reviews assessing screen time

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
US Department of Agriculture (USDA) 2010l [++]	Complete: None Partial: D, P Unclear: Set	RCT: 0 Cohort: 8 (6, n=88,900) Other: 1	Positive (adults and children)	Yes
Costigan et al. 2013 [++]	Complete: None Partial: D Unclear: P, Set	RCT: 0 Cohort: 7 (5, n=14,138) Other: 25	Positive (children)	Yes

Leblanc et al. 2012 [++]	Complete: D Partial: None Unclear: P, Set	RCT: 1 (1, n=163) Cohort: 21 (10, n=15,187) Other: 1	Positive (children)	Yes
Tremblay et al. 2011 [++]	Complete: None Partial: D Unclear: P, Set	RCT: 7 (7, n=1,752) Cohort: 32 (29, n=78,256) Other: 172	Positive (children)	Yes
Wahi et al. 2011 [++]	Complete: D Partial: Set Unclear: P	RCT: 13 (3, n=311) Cohort: 0 Other: 0	No (children)	Yes
Scope match abbreviations: D design (study design), P population, Set setting				

Adults

One review (USDA 2010l [++]) suggested that TV viewing during adulthood is positively associated with adult obesity.

The association between time spent watching TV as an adult and weight was significant in the 2 studies identified: 1 reported that each additional 2 hours per day of TV viewing was associated with a 23% (95% CI 17% to 30%) increase in obesity. The other reported that higher daily TV viewing (hours not reported) was associated with a 0.30 cm increase in waist circumference (p=0.02). The review also included other studies that assessed the effect of TV viewing in childhood on obesity in adulthood, but these are not described in detail here as the effects of childhood viewing are considered below.

Children and young people

Five reviews in children and young people (Costigan et al. 2013 [++], Leblanc et al. 2012 [++], Tremblay et al. 2011 [++], Wahi et al. 2011 [++], USDA 2010l [++]) found a positive association between amount of screen time in childhood and weight related outcomes, although the relationship was not statistically significant in 1 review (Wahi et al. 2011 [++]).

The reviews all stated that they were assessing screen time rather than TV specifically. However, TV viewing (with or without other forms of screen time) was the most commonly assessed form of screen time in the included studies. Few studies in the reviews assessed only non-TV forms of screen time (e.g.

computers, video games). No reviews synthesised or discussed results of relevant studies related to non-TV screen time separately, nor did any state the proportion of assessed screen time that was attributable to TV or non-TV time.

Two of the 5 reviews found that TV viewing for more than 2 hours per day is particularly associated with higher weight related outcomes in children. The 2 hour threshold was an *a priori* categorical classification selected to represent high viewing time, and the association may also apply at lower levels of viewing.

One review (Costigan et al. 2013 [++]) found a positive association between screen-based sedentary behaviours (TV and other screen time) and weight status amongst adolescent females, particularly when screen time exceeded 2 hours (outcome data NR; association size cannot be estimated).

One review (Leblanc et al. 2012 [++]) of children aged from birth to 6 years found that there is low- to moderate-quality evidence that increased TV viewing is associated with unfavourable measures of adiposity amongst young children. Association sizes were not consistently reported in the review.

One review (USDA 2010l [++]) suggested that TV viewing during childhood is positively associated with adult obesity. The individual cohort studies identified in the review found that: each hour of screen time during childhood (age 5 to 16) was associated with an increase in obesity during adulthood (weekend viewing: OR 1.07, 95% CI 1.01 to 1.13 [p=0.02]; total viewing: OR 1.25, 95% CI 1.16 to 1.70). Two hours or more of TV viewing on weeknights during childhood accounted for 17% of overweight in adulthood (population attributable fraction 17%, 95% CI 7% to 25%). Finally, watching TV often at age 16 was also associated with significant increases in the yearly rate of change in BMI between adolescence and middle age (men: 0.011 kg/m^2/year, 95% CI 0.0003 to 0.019; women: and 0.013 kg/m^2/year (95% CI 0.003 to 0.023).

One review (Tremblay et al. 2011 [++]) in children aged 5 to 17 years included a meta-analysis of 4 RCTs, and found that interventions that aimed to reduce screen time (TV and other screen time) significantly reduced mean BMI (-0.89 kg/m^2, 95% CI -1.67 to -0.11). The review found that each additional hour of TV viewing increased risk for obesity and more than 2 hours TV per day significantly increased risk for overweight/obesity (association sizes not reported). This finding was based on all identified studies including a large number of cross sectional studies, so may be influenced by reverse causality.

One review (Wahi et al. 2011 [++]) included a meta-analysis of 6 RCTs (3 matched the scope of this review) aiming to reduce screen time (type of screen time not specified) and found a non-significant difference in mean change in BMI in the intervention vs. control groups (mean change -0.10 kg/m^2, 95% CI -0.28 to 0.09, p=0.32). The review concluded that pooled analysis of low quality evidence showed no apparent effect of the interventions on BMI. The lack of a significant effect on BMI may reflect that the interventions did not significantly reduce screen time. Many of the RCTs were short term and conducted in a school setting.

Evidence Statement 15: Relationship between TV and other screen time and weight related outcomes

Adults: Moderate evidence from 1 high quality review[1] of cohort studies suggests that there is a positive association between screen time (specifically TV) in adulthood and measures of overweight and obesity in adults. The associations in the 2 cohort studies identified ranged in size from relatively small (higher daily viewing [hours not reported] associated with a 0.30 cm increase in waist circumference, p=0.02) to relatively large (each additional 2 hours of TV viewing associated with a 23% [95% CI 17% to 30%] increase in risk of obesity).

Children and young people: Strong evidence from 5 high quality reviews[1,2,3,4,5] of RCTs, cohort studies, and other study designs, including cross sectional studies, suggests that there is a positive relationship between

childhood screen time (primarily assessed as TV viewing time) and weight related outcomes in childhood and adulthood.

There was some suggestion that this is particularly for TV viewing exceeding 2 hours per day. Two hours per day was selected as the a priori threshold for categorical analysis in some included studies; it is unclear whether this reflects the true level at which positive associations emerge or whether the association also applies at lower levels of viewing.

One review[1] found that associations between childhood viewing and adult obesity in cohort studies ranged from relatively small (watching TV often at age 16 associated with 0.011 kg/m^2/year change in BMI up to middle age for men) to relatively large (each additional hour of TV associated with an 25% increase in risk of obesity in adulthood [OR 1.25, 95% CI 1.16 to 1.70]). Two meta-analyses of RCTs included in the reviews suggested that interventions aimed at reducing screen time could reduce mean BMI by up to 0.89 kg/m^2.

Applicability to the UK: The results of these reviews are applicable to the UK.

[1] USDA 2010l [++]
[2] Costigan et al. 2013 [++]
[3] Leblanc et al. 2012 [++]
[4] Tremblay et al. 2011 [++]
[5] Wahi et al. 2011 [++]

4.2.3 More active screen time

Table 13: Prioritised reviews assessing more active screen time

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Leblanc et al. 2013 [+]	Complete: None Partial: D, P Unclear: Set	RCT: 6 (3, n=unclear) Cohort: 0 Other: 4	Inconclusive (children)	Yes
Scope match abbreviations: D design (study design), P population, Set setting				

Adults

No reviews were identified assessing the effect of more active screen time on weight-related outcomes in adults.

Children and young people

One moderate quality review (Leblanc et al. 2013 [+]) of RCTs and other non-randomised intervention and cross-sectional studies provided inconclusive evidence about the effects of more active screen time on adiposity in groups of children and young people that include individuals of normal weight.

Only 1 out of 3 RCTs in the review including individuals of normal weight was reported to identify a beneficial effect of an active video game on a measure of adiposity. This appeared to refer to a slightly greater reduction in waist circumference from baseline to 12 weeks with the active video game intervention compared with control (-1.4 cm, 95% CI -2.68 to -0.04, p=0.04 [n=20]), but due to poor reporting this could not be determined conclusively. This RCT appeared to also have assessed BMI, but results for this outcome were not reported.

Results figures for the other 2 RCTs including individuals of normal weight were not reported.

Evidence Statement 16: Relationship between more active screen time and weight related outcomes

Adults: No reviews were identified assessing the effect of more active screen time in adults.

Children and young people: Inconclusive evidence was identified from 1 moderate quality review[1] of RCTs and other study designs regarding the relationship between more active screen time and weight related outcomes in children and young people.

Only 1 of 3 RCTs in the general population found a small beneficial effect of a 12 week active video gaming intervention compared with control (difference in mean change in waist circumference -1.4 cm, 95% CI -2.68 to -0.04, p=0.04; results for BMI not reported). No results were reported for the remaining RCTs in this population.

Applicability to the UK: The results of this review are applicable to the UK.

[1] Leblanc et al. 2013 [+]

4.3 Food and drinks

4.3.1 Sugar sweetened beverage consumption

Table 14: Prioritised reviews assessing sugar sweetened beverage consumption

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Malik et al. 2013 [++]	Complete: D Partial: Set, P Unclear: None	RCT: 10 (5, n=953) Cohort: 22 (19, n=198,533) Other: 0	Positive (adults & children)	Yes
Kaiser et al. 2013 [++] & Mattes et al. 2011 [++]	Complete: D Partial: Set, P Unclear: None	RCT: 18 (unclear) Cohorts: 0 Other: 0	Inconclusive (adults & children)	Unclear
Te Morenga et al. 2013 [++]	Complete: D Partial: P Unclear: Set	RCT: 30 (0) Cohort: 38 (unclear) Other: 0	Positive (children)	Unclear
USDA 2010u [++]	Complete: D, P Partial: Set Unclear: None	RCT: 2 (1, n=103) Cohorts: 17 (17, n=38,037) Other: 0	Positive (children)	Yes
Scope match abbreviations: D design (study design), P population, Set setting				

Four high quality reviews of RCTs and cohort studies (Malik et al. 2013 [++], Kaiser et al. 2013 [++], Te Morenga et al. 2012 [++], USDA 2010u [++]) provided evidence of a positive association between sugar sweetened

beverage (SSB) consumption and weight related outcomes. However, 1 of these reviews judged that the evidence that reducing SSB could reduce obesity was equivocal (Kaiser et al. 2013 [++]). This review, while funded by the US National Institutes of Health (NIH), had authors who had received various fees from food and beverage companies, as did their university.

Adults

Two reviews (Malik et al. 2013 [++], Kaiser et al. 2013 [++]) analysed the effect of SSBs on weight related outcomes in adults. Both reported small but statistically significant increases in weight with higher SSB consumption in adults (range: 0.22 to 0.85 kg).

One high quality systematic review and meta-analysis (Malik et al. 2013 [++]) of cohort studies found that each additional 12-oz serving of SSB per day was associated with a 0.22 kg increase in weight over a year (95% CI 0.09 to 0.34; 7 studies, n=170,141). However, this estimate showed heterogeneity (I^2=70.2%), and possible effect publication bias (p=0.02).

Meta-analysis of RCTs (Malik et al. 2013 [++]) found that addition of 600 mL to 1.1 L of SSB daily (310 to 530 kcal) to the diet compared with control (mainly added diet drinks) over between 3 weeks and 6 months was associated with a mean increase in body weight of 0.85 kg (95% CI 0.50 to 1.20; 5 RCTs, n=292). Meta-analysis in another review (Kaiser et al. 2013 [++]) also showed increased weight when SSB were added to the diet (7 RCTs, n=NR; standardised mean difference [SMD] 0.28, 95% CI 0.12 to 0.44).

There was limited evidence on the effect of interventions aiming to reduce SSB consumption in adults. One review (Kaiser et al. 2013 [++]) included 2 RCTs in adults, only one of which (n=303) was in a general (not specifically overweight or obese) population. It found a similar reduction in SSB consumption (about 355 ml/day) in the 2 educational intervention groups and the no intervention group, and no significant effect on BMI (positive direction

of effect indicates that reducing SSB is effective, SMD -0.10, 95% CI -0.34 to 0.15, based on BMI).

Children and young people

Four reviews (Malik et al. 2013 [++], Kaiser et al. 2013 [++], Te Morenga et al. 2012 [++], USDA 2010u [++]) analysed the effect of SSBs on weight related outcomes in children and young people.

Meta-analysis of cohort studies (Malik et al. 2013 [++]) found that each additional 12-oz (355 ml) serving of SSBs consumed per day in children aged 2 to 16 years was associated with a 0.07 kg/m^2 increase in BMI over a year (95% CI 0.01 to 0.12; 15 studies, n=25,745). Another meta-analysis (Te Morenga et al. 2012 [++]) of 5 cohort studies found that children consuming about 1 daily serving (8-oz; 237 ml) of SSBs at baseline were more likely to be overweight at follow-up than those consuming little or no SSB (n=NR; OR 1.55, 95% CI 1.32 to 1.82).

Meta-analysis of RCTs in children and young people (Malik et al. 2013 [++]) found a non-significant trend towards reduced BMI with interventions aiming to reduce SSB consumption (5 RCTs, n=2,772; weighted mean difference [WMD] -0.17 kg/m^2, 95% CI -0.39 to +0.05; I^2=74.6%). Meta-analysis in a second review of similar SSB reduction trials (Kaiser et al. 2013 [++]), mostly in children and young people, also found a trend towards the interventions being associated with weight loss (positive direction of effect indicates that reducing SSB is effective, 8 RCTs, 6 in children, n=3,639 total, n=3,018 in children; SMD +0.06, 95% CI -0.01 to +0.13; I^2=59%).

The interventions in these RCTs included school-based education programmes aimed at reducing SSB, or trials where SSBs were substituted with provided non-caloric beverages. In both reviews there was a suggestion that the non-significant effect may reflect the difficulty in achieving SSB reduction, particularly in the interventions not directly providing substitution beverages.

A narrative synthesis of RCTs and cohort studies in a third review (USDA 2010u [++]) also found that SSB consumption was associated with adiposity in children.

Evidence Statement 17: Relationship between sugar sweetened beverage (SSB) consumption and weight related outcomes

Adults: Strong evidence from 2 high quality reviews[1,2] of RCTs and cohort studies suggests that there is a positive association between SSB consumption and weight related outcomes in adults.

One review[1] of cohort studies found each additional 355 ml serving of SSB per day was associated with a 0.22 kg increase in weight over a year (95% CI 0.09 to 0.34). One review[1] of RCTs found each additional 600mL to 1.1L of SSB per day compared with control over 3 weeks and 6 months was associated with a mean increase in body weight of 0.85 kg (95% CI 0.50 to 1.20). A second review[2] of RCTs found a mean increase in body weight of 0.28 kg (95% CI 0.12 to 0.44) compared to control with additional daily SSB (amount and timescale not stated).

Children and young people: Strong evidence from 4 high quality reviews[1,2,3,4] of RCTs and cohort studies suggests that there is a positive relationship between SSB consumption and weight related outcomes in children and young people.

One review of cohort studies found each additional 355 ml of SSB per day was associated with a 0.07 kg/m^2 increase in BMI over a year (95% CI 0.09 to 0.34).[1] Children who consumed at least 237 ml of SSBs per day were more likely to be overweight than their peers (OR 1.55, 95% CI 1.32 to 1.82).[3]

Applicability to the UK: The countries in which the included studies were performed was not reported for 2 reviews, therefore applicability to the UK is unclear.

[1] Malik et al. 2013 [++]
[2] Kaiser et al. 2013 [++]

[3] Te Morenga et al. 2012 [++]
[4] USDA 2010u [++]

4.3.2 Fruit juice consumption

Table 15: Prioritised reviews assessing fruit juice consumption

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Summerbell et al. 2009 [++]	Complete: D Partial: None Unclear: Set, P	RCT: 0 Cohort: 7 (1, n=7,194 adults/ 6, n=20,114 children) Other: 0	No (adults & children)	Yes
USDA 2010s [++]	Complete: D Partial: None Unclear: Set, P	RCT: 0 Cohort: 12 (12, n=47,201) Other: 0	Inconsistent (children)	Yes
Scope match abbreviations: D design (study design), P population, Set setting				

Adults

One high quality review (Summerbell et al 2009 [++]) identified a single prospective cohort study (n=7,194) in adults, which found no link between sweetened juice consumption on weight related outcomes in adults over 28 months (figures NR). This analysis was adjusted for confounders including total energy intake, which would tend to remove any association. The review did not identify any studies of unsweetened fruit juice in adults.

The limited number of studies identified and lack of evidence on unsweetened fruit juice means that no firm conclusions can be drawn.

Children and young people

Two high quality reviews (Summerbell et al. 2009 [++]; USDA 2010s [++]) investigated the link between fruit juice consumption and body weight and related outcomes in children and young people.

One review (Summerbell et al. 2009 [++]) included 6 prospective cohorts (2 reported as assessing 100% fruit juice, in 6 ‘fruit juice’ was not further defined) with 3 to 11 years of follow up.

The studies all found non-significant effects (directions mixed) for BMI, obesity or fat mass. Effect sizes in individual studies were generally small, with regression coefficients ranging from 0.001kg/m^2 for BMI per ounce per day over 8 months to 0.25 for change in fat mass per serving of juice (not further defined in the review) over 2 years.

The second review (USDA 2010s [++]) was reported to assess 100% fruit juice, but only 3 out of the 12 individual cohort studies were explicitly described as assessing 100% fruit juice. The review included 12 cohorts with follow up of 1 to 6 years.

Nine cohorts (including 2 of 100% fruit juice) found no association between intake of fruit juice and adiposity outcomes in children (results figures NR). Two cohorts (including 1 of 100% fruit juice) found either no association overall or for normal weight children, but a significant positive association for children who were at-risk of overweight or overweight. One cohort found mixed results by sex (no association for boys; positive association for girls, p=0.01).

Results from 1 study in the Summerbell et al. 2009 [++] review and 2 studies in the USDA 2010s [++] review were explicitly reported as being adjusted for energy intake; but adjustments for the other studies were unclear. Adjusting for energy intake may remove associations.

The reviews did not provide their definitions of fruit juice, and may have included a mixture of fruit juice types (e.g. sweetened and unsweetened; 100% fruit juice and juices from concentrates). This heterogeneity and the lack of clarity about adjustment for energy intake in most studies limits the ability to draw firm conclusions about the effects of 100% unsweetened fruit juice.

Sugar sweetened fruit juices would be classified as sugar sweetened beverages and these are assessed in Section 4.3.1.

Evidence Statement 18: Relationship between fruit juice consumption and weight related outcomes

Adults: Inconclusive evidence was identified from 1 high quality review[1] of cohort studies regarding the association between 100% unsweetened fruit juice consumption and weight related outcomes in adults. The review identified no studies of unsweetened fruit juice. The 1 study of sweetened juice consumption found no association with weight after adjustment for confounders including total energy intake (TEI; exposure and results figures NR); adjustment for TEI may remove any association.

Children and young people: Inconclusive evidence was identified from 2 high quality reviews[1,2] of cohort studies on the relationship between 100% unsweetened fruit juice consumption and weight related outcomes in children and young people. The majority of studies included in the reviews had non-significant findings over 1 to 11 years of follow up, with mixed directions of effect. Some studies suggested a possible positive association between fruit juice and weight related outcomes in those at risk of overweight or obesity. However, the types of juice, including whether sweetened or not, and whether results were adjusted for energy intake were unclear for most of the included studies.

Effect sizes in individual studies were generally small, with regression coefficients ranging from 0.001 kg/m^2 for BMI per ounce per day over 8 months to 0.25 for change in fat mass per serving of juice (not further defined in the review) over 2 years.

Applicability to the UK: These results are applicable to the UK.

[1] Summerbell et al. 2009 [++]
[2] USDA 2010s [++]

4.3.3 Water consumption

Table 16: Prioritised reviews assessing water consumption

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Muckelbauer et al. 2013 [++]	Complete: None Partial: P, D Unclear: Set	RCT: 3 (2, n=52) Cohort: 0 Other: 8	Inconclusive (adults)	Yes
Summerbell et al. 2009 [++]	Complete: P, D Partial: None Unclear: Set	RCT: 0 Cohort: 1 (1, n=1,432) Other: 0	No (children)	Yes
Scope match abbreviations: D design (study design), P population, Set setting				

Adults

One high quality review (Muckelbauer et al. 2013 [++]) provided insufficient evidence to draw conclusions about the effect of water consumption on weight related outcomes in adults.

It identified 2 small short-term crossover RCTs that assessed body weight outcomes, but this was not their primary focus. One RCT (n=32) compared the effect of additional water consumption (average 685 mL daily) versus replacing water with caffeine free diet cola for 3 days on hydration (mean difference between intervention and control: 0.1 kg (SD NR), p=0.146). The other RCT (n=20) compared the effect of increased water consumption (average 2.1 L daily) versus no intervention for 2 weeks on blood pressure (mean difference between intervention and control: 0.18 kg (SD 1.5), p=0.613). The RCTs showed no effect of increased water consumption on body weight. However, they are likely to have been too small and short-term to show an effect on body weight. In addition, the RCT comparing water versus non-caloric (diet) beverage may not be representative of what would be seen if water was replacing a caloric beverage.

Children and young people

One high quality review (Summerbell et al. 2009 [++]) identified one prospective cohort study in children from the UK (n=1,432) on the association

between water consumption and weight related outcomes. This study (n=1,432) found no significant association between servings of water consumed (not further defined in the review) at the age of 5 or 7 years and change in fat mass at the age of 9 years (regression coefficient 0.25 [p=0.22] and 0.06 [p=0.58] respectively; fat mass units NR).

The review reported that the study adjusted for confounders, but not whether this included energy intake or intake of calorific beverages that could be substitutes for water.

No firm conclusions can be drawn on the basis of the limited evidence from a single, relatively small, cohort study.

Evidence Statement 19: Relationship between water consumption and weight related outcomes

Adults: Inconclusive evidence was identified from 1 high quality review[1] of RCTs regarding relationship between water consumption and weight related outcomes. The 2 cross over RCTs included in the review both found very small (0.1 kg to 0.18 kg) non-significant effects of increased water consumption (685 mL additional water versus additional diet drink; or 2.1 L water total daily versus no intervention) on body weight over 3 days to 2 weeks compared to alternative non-caloric drink or no intervention.

Children and young people: Inconclusive evidence was identified from 1 high quality review[2] of cohort studies on the association between water consumption and weight related outcomes in children. The single cohort study identified by this review found no association between servings of water (not further defined) consumed by children aged 5 or 7 years and change in fat mass at the age of 9 years (regression coefficients 0.25 [p=0.22] and 0.06 [p=0.58] respectively; fat mass units NR).

Applicability to the UK: The results of the reviews are applicable to the UK.

[1] Muckelbauer et al. 2013 [++]
[2] Summerbell et al. 2009 [++]

4.3.4 Tea and coffee consumption

Table 17: Prioritised reviews assessing tea and coffee consumption

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Summerbell et al. 2009 [++]	Complete: D Partial: None Unclear: P, Set	RCT: 0 Cohort: 2 (2, n=30,038) Other: 0	No (adults)	Yes
Scope match abbreviations: D design (study design), P population, Set setting				

Adults

One high quality review (Summerbell et al. 2009 [++]) found inconsistent effects of tea and coffee consumption on weight in adults. This may reflect the differing exposures assessed in the included studies (hot drinks in one and coffee in the other).

One cohort (n=17,369) found no association between hot drink consumption (including tea and coffee) and subsequent excess weight gain and obesity (not defined) over 2 years (OR 1.01 in women and OR 1 in men for highest vs. lowest consumption in g/day). The study adjusted for confounders but this did not appear to include use of milk or sugar in hot drinks.

The other cohort (n=12,669) found that drinking more than 8 cups of coffee a day was associated with a small but significant increase in risk of substantial weight gain (not defined) in women, but with a reduced risk (significance not reported) in men. Overweight was reported to be “somewhat more common” in those who drank more than 8 cups of coffee a day than those who drank less; the review reported that confounders (details not provided) could explain these differences in overweight. No results figures were presented for this study.

Children and young people

No reviews were identified assessing tea and coffee consumption and weight-related outcomes in children or young people.

Evidence Statement 20: Relationship between tea and coffee consumption and weight related outcomes

Adults: Inconclusive evidence from 1 high quality review[1] of cohort studies was identified regarding the relationship between tea and coffee consumption and weight-related outcomes. One of the included cohort studies found no significant effect of hot drink consumption (including tea and coffee) on subsequent excess weight gain and obesity (not defined) over 2 years (OR 1.01 in women and OR 1 in men for highest vs. lowest consumption in g/day). The other cohort study found conflicting effects of coffee consumption (more than 8 cups a day versus less) on substantial weight gain (not defined) across genders (small significant positive relationship in women, inverse relationship in men – size and significance NR).

Children and young people: No evidence was identified that assessed the relationship between tea and coffee consumption and weight-related outcomes in children or young people.

Applicability to the UK: The results of the review are applicable to the UK.

[1] Summerbell et al. 2009 [++]

4.3.5 Alcohol consumption

Table 18: Prioritised reviews assessing alcohol consumption

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Bendsen et al. 2013 [+]	Complete: None Partial: D Unclear: P, Set	RCT: 9 (7, n=157) Cohort: 10 (10, n=215,997) Other: 28	Moderate drinking (beer): inconclusive Heavy drinking (beer): positive (adults)	Yes

Sayon-Orea et al. 2011 [+]	Complete: None Partial: D Unclear: P, Set	RCT: 1 (0) Cohort: 13 (13, n=207,533) Other: 19	Inconclusive (adults, young people)	Yes
Summerbell et al. 2009 [++]	Complete: D Partial: None Unclear: P, Set	RCT: 0 Cohort: 20 (20, n= 375,421) Other: 0	No (adults, young people)	Yes
USDA 2010x [++]	Complete: D Partial: None Unclear: P, Set	RCT: 1 (0) Cohort: 7 (7, n=124,768) Other: 0	Moderate drinking: No Heavy drinking: Positive (adults)	Yes
Scope match abbreviations: D design (study design), P population, Set setting				

Adults

Four reviews (Summerbell et al. 2009 [++], USDA 2010x [++], Bendsen et al. 2013 [+], Sayon-Orea et al. 2011 [+]) assessed the association between alcohol consumption (total or for specific types of alcoholic drinks) and weight related outcomes in adults. Two reviews included studies in adolescents (Summerbell et al. 2009 [++], Sayon-Orea et al. 2011 [+]), but the majority of studies were in adults (all except 1 or 2 studies in these reviews).

Overall, the studies in the reviews (mainly observational) had mixed findings in terms of significance and direction of effect. Three reviews (USDA 2010x [++], Bendsen et al. 2013 [+], Sayon-Orea et al. 2011 [+]) suggested that while moderate consumption of alcohol either has no or inconclusive effects (similar to the overall conclusion on alcohol intake in the Summerbell et al. 2009 [++] review), heavier consumption may be associated with weight gain.

Assessments of the effect of alcohol consumption may be particularly challenging for a number of reasons, including that individuals may abstain from alcohol for medical reasons which may affect weight-related outcomes, thus confounding comparisons. In addition, self-reported alcohol consumption may be particularly prone to under-reporting.

One high quality review (USDA 2010x [++]) assessed total alcohol consumption and concluded that moderate alcohol consumption was not

associated with weight gain, but that heavier consumption over time was. It based these conclusions on 1 weight loss RCT (that did not match the scope of this review) and 7 prospective cohorts with a follow up of 4 to 10 years. Of these cohorts, 5/7 found no significant association or a significant inverse association between alcohol consumption and weight gain or WC. The other two studies found that light to moderate drinking (up to about 20 to 26 units a week, or about 3 to 4 units per day [reviewer calculated]) appeared not to significantly increase weight, but heavier drinking was associated with increased weight. In these 2 studies, compared with non-drinkers the odds of weight gain (>4% or ≥5kg) over 5 to 8 years in light to moderate drinkers were between 0.86 to 0.96 and in heavier drinkers 1.07 to 1.29.

A second high quality review (Summerbell et al. 2009 [++]) included studies assessing both total alcohol consumption and consumption of specific types of alcoholic beverages. It concluded that the consumption of beverages of any type (including alcohol) was not associated with subsequent weight gain and obesity, although results were inconsistent. It included 20 prospective cohorts with follow up between 1 and 18 years. The majority of these studies (14/20) found no significant association between alcohol consumption and weight related outcomes (mixed directions of effect), and the remaining 6 studies also showed mixed directions of the significant effects.

One moderate quality review (Sayon-Orea et al. 2011 [+]) concluded that it was unclear whether total alcohol consumption is a risk factor for weight gain because of the mixed findings of studies (positive, inverse or no associations). This review included 13 cohorts, which had mixed findings (in direction and significance), and precluded firm conclusions. However, the review also noted that positive associations tended to be found in studies assessing heavier alcohol intake or intake of spirits.

A second moderate quality review (Bendsen et al. 2013 [+]) specifically assessed beer consumption and was funded by the Dutch Beer Institute, with some of the authors employed by or board members of the Institute. Based on data from 9 RCTs, 10 cohorts, and 28 other studies (cross-sectional and non-

randomised experimental studies) it concluded that there was insufficient evidence to draw conclusions about the effect of moderate beer intake (<500 mL/day; equivalent to about 2 units if the beer is 4% alcohol by volume [reviewer calculated]) on general or abdominal obesity, but that higher beer intake may be positively associated with abdominal obesity.

Evidence Statement 21: Relationship between alcohol consumption and weight related outcomes

Adults and young people: Inconclusive evidence was identified from 2 high quality reviews[1,2] and 2 moderate quality reviews[3,4] of RCTs and cohort studies regarding the relationship between alcohol consumption (total or of specific types of drinks) and weight related outcomes in adults and young people. Directions of effect identified in individual studies differed, as did the significance of findings, with no clear patterns emerging. This may reflect variation in association by level of alcohol intake.

There was some suggestion from 3 reviews[1,2,4] that heavier alcohol intake may be associated with weight gain. In 1 review this was based on 2 cohort studies where, compared with non-drinkers the odds of weight gain (>4% or ≥5 kg) over 5 to 8 years in light to moderate drinkers (up to about 3-4 units of alcohol per day [reviewer calculated]) were between 0.86 to 0.96 and in heavier drinkers 1.07 to 1.29.

Applicability to the UK: These results are applicable to the UK.

[1] Summerbell et al. 2009 [++]
[2] USDA 2010x [++]
[3] Bendsen et al. 2013 [+]
[4] Sayon-Orea et al. 2011[+]

4.3.6 Milk and other dairy food consumption

Table 19: Prioritised reviews assessing milk and dairy food consumption

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Abargouei et al. 2012 [++]	Complete: D Partial: None Unclear: P, Set	RCT: 16 (unclear) Cohort: 0 Other: 0	No (adults)	Yes
Louie et al. 2011 [++]	Complete: D Partial: None Unclear: P, Set	RCT: 0 Cohort: 19 (9, n=93,006 adults/ 10, n=18,529 children) Other: 0	Inconclusive (adults & children)	Yes
USDA 2010r [+]	Complete: None Partial: D Unclear: P, Set	RCT: 5 (1, n=59) Cohort: 12 (12, n=35,799) Other: 4	No (children)	Yes
Scope match abbreviations: D design (study design), P population, Set setting				

Adults

Two high quality reviews (Abargouei et al. 2012 [++]; Louie et al. 2011 [++]) provided evidence that milk and dairy consumption may not affect weight related outcomes in adults, if it does not increase total energy intake.

One review of RCTs (Abargouei et al. 2012 [++]) concluded that increasing dairy consumption to recommended daily intakes in adults who do not follow any calorie restricted diet would not affect weight, fat mass, lean body mass and WC. The other, dairy industry funded, review (Louie et al. 2011 [++]) found a suggestive, but not conclusive, protective effect of dairy products (including milk). It concluded that at the very least dairy products showed no harmful effect on weight status.

The first review (Abargouei et al. 2012 [++]) found that increased dairy consumption (not further defined in 5 RCTs, milk in 2 RCTs) had no significant effect on weight-related outcomes in people not on a calorie restricted diet (weight change: 5 RCTs, n=453; WMD 0.33 kg, 95% CI -0.35 to 1.00; fat mass: 4 RCTs, n=253, WMD -0.16 kg, 95% CI -0.97 to 0.66). Overall energy intakes across all RCTs included in the meta-analysis were not reported. Some of these RCTs appeared to be in overweight or obese participants.

Of the 3 RCTs that appeared to not be solely in overweight or obese participants, the review reported that 2 found that increasing dairy consumption (3 servings of milk, or 610 mg calcium per day through milk) increased total energy intake and weight (data NR); the third found no effect of increasing dairy consumption (type of dairy not specified) on energy intake or weight (data NR for energy intake, mean difference in weight 0.70 kg, 95% CI -0.74 to 2.14).

One other review (Louie et al. 2011 [++]) included 9 prospective cohorts with follow up of 7 months to 12 years. Five of the 9 cohorts (n=70,352) found an inverse effect of dairy consumption (varying exposures, including total dairy, cheese, milk, high fat dairy, low fat dairy, yoghurt) on weight related outcomes (e.g. ORs for obesity or weight gain were between 0.70 and 0.85). The review did not assess the different types of dairy products separately. Three studies showed mixed positive and inverse effects (e.g. beta=0.42 for association between low fat yoghurt and WC, but beta=-0.23 for skimmed and partly skimmed milk) depending on type of dairy and the population subgroup assessed, and 1 study showed no association. Most analyses in Louie et al. 2011 [++] adjusted for total energy intake, which may remove any impact that dairy has through an effect on this variable.

Children and young people

One high quality review (Louie et al. 2011 [++]) and 1 moderate quality review (USDA 2010r [+]) assessed the link between milk and dairy products and weight and related outcomes in children and young people.

Both reviews tended to find that milk and dairy products were not associated with weight related outcomes, based on the non-significant findings of most included cohort studies (11/16 studies; directions of effect NR for the majority; adjusted for energy intake in 6 studies, unadjusted in 3, unclear in 2 studies) and 1 small RCT (n=59; no difference in BMI between a diet rich in calcium [mean 1,656 mg/day, mostly from dairy] and a normal diet [mean 961 mg/day calcium] at 2 years; unclear if total energy intake equivalent or adjusted for).

Both reviews included studies of various dairy exposures (milk, but also total dairy, or total calcium in the diet) and did not assess different types of dairy products separately.

Four small cohort studies (n=658) in the reviews found an inverse association between milk, dairy, or dietary calcium intake and weight related outcomes (0.35 to 0.91 kg reduction in body fat per serving over 3-4 years, or 1.8 kg/m^2 difference in mean BMI over 8 years between the highest tertile [>1.85 or >2.35 servings/day for girls and boys respectively] and lowest tertile [<1.25 or <1.70 servings/day for girls and boys respectively] of consumption). However, the largest cohort study identified but the reviews (n=12,829) found a significant positive association with BMI over 3 years (0.081 kg/m^2 to 0.093 kg/m^2 increase with >3 vs. ≤0.5 servings of milk/day). Three out of 4 studies finding inverse associations had adjusted for total energy intake or total fat intake, while the study finding positive associations had not.

Evidence Statement 22: Relationship between milk and dairy consumption and weight related outcomes

Adults: Inconclusive evidence was identified from 2 high quality reviews[1,2] of RCTs and cohort studies on the effects of milk and dairy consumption in adults.

RCTs in 1 review[1] found that increasing dairy intake (mostly 3 to 5 servings of dairy per day) did not significantly impact weight change (WMD 0.33 kg, 95% CI: -0.35 to 1.00) or fat mass (WMD -0.16 kg, 95% CI -0.97 to 0.66) in adults not following a calorie controlled diet (energy intake not reported for meta-analysed RCTs). However, 2 of the 3 RCTs not solely in overweight or obese populations found that increased dairy consumption increased total energy intake and weight gain (figures NR).

Five of the 9 cohort studies in 1 dairy organisation funded review[2] found an inverse association (ORs for obesity or weight gain ranged from 0.70 to 0.85). Mixed directions of effect were observed across different dairy products in 3

studies. These studies largely adjusted for total energy intake, which may remove associations that result from changes in this variable.

Children and young people: Inconclusive evidence was identified from 1 high quality[2] and 1 moderate quality review[3] of RCTs and cohort studies on the relationship between milk and dairy and weight related outcomes in children and young people.

The majority of studies found no association (direction of effects mostly NR, varying in adjustment for energy intake). Some small cohort studies found an inverse association for milk or total dairy (0.35 to 0.91 kg reduction in body fat per serving over 3-4 years, or 1.8 kg/m^2 reduction in mean BMI for a difference of about 0.6 serving/day over 8 years), while the largest cohort study found a positive association (a 0.081 kg/m^2 to 0.093 kg/m^2 increase with >3 vs. ≤0.5 servings of milk/day). These differences may reflect lack of adjustment for total energy or fat intake in the study with a positive finding.

Applicability to the UK: These reviews are applicable to the UK.

[1] Abargouei et al. 2012 [++]
[2] Louie et al. 2011 [++]
[3] USDA 2010r [+]

4.3.7 Whole grain consumption

Table 20: Prioritised reviews assessing whole grain consumption

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Bautista-Castano and Serra-Majem 2012 [++]	Complete: None Partial: D, P Unclear: Set	RCT: 3 (0) Cohort: 11 (6, n=171,714) Other: 24	Inverse (adults)	Yes
Pol et al. 2013 [++]	Complete: D Partial: P Unclear: Set	RCT: 26 (unclear) Cohort: 0 (0) Other: 0	Inverse (adults)	Yes

WCRF 2006 [++]	Complete: D Partial: None Unclear: Set, P	RCT: 0 (0) Cohort: 4 (4, n=121,209) Other: 0	Inconclusive (adults)	Yes
Scope match abbreviations: D design (study design), P population, Set setting				

Adults

Three high quality reviews (Bautista-Castano and Serra-Majem 2012 [++]; Pol et al. 2013 [++]; WCRF 2006 [++]) assessed the relationship between whole grain consumption and weight and related outcomes.

The 2 more recent reviews came to similar conclusions. One review of mostly observational studies (Bautista-Castano and Serra-Majem 2012 [++]) found that dietary patterns that include whole-grain bread did not increase weight gain and may have beneficial effects on weight related outcomes. A second review (Pol et al. 2013 [++]) including short term RCTs (2 to 16 weeks) concluded that whole-grain consumption (18.2 to 150 g/day) did not decrease body weight compared with control, but may lead to a small reduction in body fat. The oldest review (WCRF 2006 [++]) did not draw conclusions; the 4 included cohort studies all found an inverse direction of effect (small [40 g/day increase in wholegrain associated with 0.49 kg lower weight over 8 years] to medium [OR for obesity in highest vs. lowest quintile of intake 0.81, 95% CI 0.73 to 0.91] in size), which was statistically significant in 2 studies.

The review by Pol et al. 2013 [++] included 26 RCTs in generally healthy adults that varied in length between 2 and 16 weeks (most between 4 and 6 weeks). Meta-analysis found that interventions adding whole grain intake to the diet (target 18.2 to 150 g/day) did not affect body weight compared with the same background diet without whole grains (n=2,060; WMD 0.06 kg, 95% CI -0.09 to 0.20 kg; p=0.45). There was a small beneficial effect on body fat compared to control (7 RCTs, WMD -0.48%, 95% CI -0.95% to -0.01%; p=0.04). Whether the diet was calorie restricted or not did not affect body weight results, but the effect on body fat was greater in trials that applied calorie restriction. This suggests that the effects on body fat may be greatest

in those attempting to lose weight. The weight status of people included in the RCTs was unclear. At least 1 study was in overweight individuals and the results may not be representative of effects in the general population.

One review (WCRF 2006 [++]) noted that some of the included studies were funded by food manufacturers and food industry-related organisations, pharmaceutical companies, as well as the USDA. The review by Bautista-Castano and Serra-Majem 2012 [++] was funded by the Spanish Association of Bread Producers and Retailers. The studies in this review tended to look at dietary patterns rich in whole grain rather than whole grain food consumption per se. The results may not be representative of the effects of whole grain foods alone.

Evidence Statement 23: Relationship between whole grain consumption and weight related outcomes

Adults: Moderate evidence from 3 high quality reviews[1,2,3] of RCTs and cohort studies suggested that whole grain consumption or dietary patterns rich in whole grains may be inversely associated with weight related outcomes in adults.

One review[2] found that adding whole grain to the diet (18.2 to 150 g/day) had no effect on body weight over 2 to 16 weeks in 26 small RCTs (0.06 kg, 95% CI -0.09kg to 0.20kg). It also found that consuming 18.2 to 150 g whole grain per day was associated with small reductions in body fat over up to 16 weeks (7 RCTs, WMD -0.48%, 95% CI -0.95% to -0.01%; p=0.04), but this may primarily have been in people trying to lose weight.

Cohort studies in the reviews[1,3] tended to find an inverse direction of effect for weight related outcomes although this was not consistently significant (effects small [40 g/day increase in wholegrain associated with 0.49 kg lower weight over 8 years] to medium [OR for obesity in highest vs. lowest quintile of intake 0.81, 95% CI 0.73 to 0.91]).

Children and young people: No evidence was identified that assessed the effects of whole grain consumption on weight related outcomes in children or young people.

Applicability to the UK: The results of these reviews are applicable to the UK.

[1] Bautista-Castano and Serra-Majem 2012 [++]
[2] Pol et al. 2013 [++]
[3] WCRF 2006 [++]

4.3.8 Refined grain consumption

Table 21: Prioritised reviews assessing refined grain consumption

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Bautista-Castano and Serra-Majem 2012 [++]	Complete: None Partial: D, P Unclear: Set	RCT: 3 (0) Cohort: 11 (5, n=146,764) Other: 24	Positive (adults)	Yes
Fogelholm et al. 2012 [+]	Complete: None Partial: D Unclear: Set, P	RCT: 0 Cohort: 5 (5, n=290,852) Other: 0	Positive (adults)	Yes
Summerbell et al. 2009 [++]	Complete: D Partial: None Unclear: Set, P	RCT: 0 Cohort: 7 (6, n=112,589 adults/ 1, n=737 children) Other: 0	No (adults & children)	Yes
Scope match abbreviations: D design (study design), P population, Set setting				

Adults

Two high quality reviews (Bautista-Castano and Serra-Majem 2012 [++]; Summerbell et al. 2009 [++]) and 1 moderate quality review assessed the relationship of refined grains on weight related outcomes.

The reviews came to differing conclusions. Two reviews (Bautista-Castano and Serra-Majem 2012 [++]; Fogelholm et al. 2012 [+]) concluded that cohort studies had shown a positive association between refined grain foods and

weight related outcomes in adults. The third review (Summerbell et al. 2009 [++]) concluded that there were no associations between the consumption of cereals or cereal products as a whole (which included refined grains) and subsequent excess weight gain or obesity.

One moderate quality review (Fogelholm et al. 2012 [+]) included 5 cohorts with a follow up of 5 to 20 years, all of which found positive associations with weight (weight gain: 0.18 kg [95% CI 0.10 to 0.26] to 0.43 kg [reviewer calculated, 95% CI NR] difference between lower and higher intake groups [not further defined] at 2-4 years) and refined bread and carbohydrates from refined grains on WC (beta= 0.01 for annual change in WC [95% CI 0.01 to 0.02], 0.29 [95% CI 0.07 to 0.51] over 6 years, where reported; exposure quantities not defined). The review concluded that suggestive evidence was found for high intake of refined grains and more weight gain and refined (white) bread intake and larger increases in WC.

The other 2 reviews included studies assessing dietary patterns containing refined grains or studies with food groupings including refined grains, as well as studies looking specifically at refined grain foods.

One high quality review (Bautista-Castano and Serra-Majem 2012 [++]) funded by The Spanish Association of Bread Producers and Retailers identified 5 cohort studies of refined grains (with a follow up of 4 to 12 years), as well as other studies (including cross-sectional studies) that did not match the scope of the current review. For refined bread, it concluded that most of the cohort studies showed a possible positive association with abdominal fat.

A second high quality review (Summerbell et al. 2009 [++]) included 6 prospective cohorts with follow up of 2 to 12 years. Three of these studies found a positive association with weight related outcomes in at least one analysis (by gender or outcome), and 3 found no association (1 data NR, 2 with mixed directions of non-significant effect). The individual cohorts had funding sources which included governmental organisations, as well as some food manufacturers and related bodies.

Children and young people

One of the high quality reviews described above (Summerbell et al. 2009 [++]) also included 1 small cohort study (n=737) in children with mean follow up of 10.9 years. It found no association between bread and wheat consumption or high rice intake at age 3 (not quantified) and obesity in adolescents (bread and wheat: OR 0.87, 95% CI 0.65 to 1.16; rice: OR 1.20, 95% CI 0.78 to 1.84).

It was unclear whether the study assessed whether these grains were refined or not (although it was in the "refined grains" section of the review). It was a Japanese study, and as such may not reflect dietary habits in the UK.

Although overall the review concluded that there were no associations between the consumption of cereals or cereal products and subsequent excess weight gain or obesity, the limited evidence means that no conclusions can be drawn for children and young people specifically.

Evidence Statement 24: Relationship between refined grain consumption and weight related outcomes

Adults: Moderate evidence was identified from 2 high quality reviews[1,2] and 1 moderate quality review[3] of cohort studies of a small positive association between refined grain consumption and weight related outcomes in adults.

One moderate quality review[3] of cohort studies identified consistent evidence of a positive association with weight related outcomes, showing small effects of refined grains on weight gain (weight gain: 0.18 kg [95% CI 0.10 to 0.26] to 0.43 kg [reviewer calculated, 95% CI NR] difference between lower and higher intake groups [not further defined] at 2-4 years).

Two other high quality reviews[1,2] of overlapping cohort studies assessed consumption of refined grains, and tended to find positive associations for at least one comparison (4 of 8 unique studies), or non-significant associations of mixed direction (4 of 8 unique studies: 1 inverse, 2 reporting mixed directions across genders, and 1 not reporting the direction of association).

Children and young people: Inconclusive evidence was identified from 1 high quality review[2] of cohort studies regarding the relationship between refined grain consumption and weight related outcomes in children and young people. The review[2] identified a single cohort study, which found no association between bread and wheat consumption or high rice intake at age 3 and obesity in adolescents (bread and wheat: OR 0.87, 95% CI 0.65 to 1.16; rice: OR 1.20, 95% CI 0.78 to 1.84).

Applicability to the UK: The results of the reviews in adults are applicable to the UK, but the results for children and young people may not be applicable.

[1] Bautista-Castano and Serra-Majem 2012 [++]
[2] Summerbell et al. 2009 [++]
[3] Fogelholm et al. 2012 [+]

4.3.9 Fruit and vegetable consumption

Table 22: Prioritised reviews assessing fruit and vegetable consumption

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Summerbell et al. 2009 [++]	Complete: D Partial: None Unclear: Set, P	RCT: 0 Cohort: 8 (7, n=107,643 adults/ 1, n=16,882 children) Other: 0	No (adults & children)	Yes
USDA 2010e [+]	Complete: None Partial: D Unclear: Set, P	RCT: 3 (0) Cohort: 3 (3, n=163,701) Other: 5	Inverse (adults)	Yes
USDA 2010t [++]	Complete: D Partial: P Unclear: Set	RCT: 1 (0) Cohort: 5 (4, n=25,438) Other: 0	Inverse (children)	Yes
Scope match abbreviations: D design (study design), P population, Set setting				

Adults

One high quality review (Summerbell et al. 2009 [++]) and 1 moderate quality review (USDA 2010e [+]) found differing results regarding the effect of fruit

and vegetable consumption on weight related outcomes, with one finding no association with weight gain and obesity and the other a protective effect.

The higher quality review (Summerbell et al. 2009 [++]) included 7 cohort studies, 5 of which (n=28,291) showed no significant effect of fruit and/or non starchy vegetables on weight (mixed directions of mostly small effects). The remaining 2 studies showed significant inverse associations between vegetables and weight related outcomes. This included one small study (n=116, women with increased BMI over one year less likely to eat cruciferous vegetables: OR 0.15, 95% CI 0.05 to 0.52, $p<0.001$) and also the largest study (n=79,236) (10-year mean BMI change in highest vs. lowest non-starchy vegetable consumption quintile [not quantified] -0.12 kg/m^2, $p \leq 0.05$ for men and women 95% CI -0.22 to -0.02). Adjustments were reported to have been carried out 4/7 studies (3 with non-significant findings, 1 with an inverse association), although exact confounders were not listed for all studies; whether the other 3 studies were adjusted was unclear.

The more recent review (USDA 2010e [+]) included 3 different prospective cohorts (n=163,701), as well as 3 RCTs and 5 other studies outside of the scope of the current review. The review found a significant inverse association between fruit and vegetable consumption (not including juice) and weight related outcomes over 6.5 to 12 years, ranging in size from small (each additional 100 g fruit and vegetable intake associated with -14 g [95% CI -19 to -9 g] weight change per year over 6.5 years) to relatively large (highest vs. lowest increase in intake: RR of obesity 0.76 [95% CI 0.69 to 0.86] over 12 years; OR of weight gain ≥3.41 kg 0.22 [95% CI 0.06 to 0.81] over 10 years). One of these studies was reported to be adjusted for confounders including total energy intake; adjustment in the other studies was unclear.

There was no overlap in the studies included in the reviews, and reasons for the contrasting significance of the findings are unclear. While the evidence suggests at least that fruit and vegetable consumption are not associated with weight gain, whether there is a protective effect is less certain, including the magnitude of such an effect.

Children and young people

Evidence from 2 reviews (Summerbell et al. 2009 [++]; USDA 2010t [++]) suggests that fruit and vegetable consumption is not associated with weight related outcomes in children and young people.

The first review (Summerbell et al. 2009 [++]) concluded that there was no association between fruit and non-starchy vegetable consumption and weight related outcomes, based on 1 cohort study (n=16,882) which found no significant association with 3 year changes in BMI z-scores (unclear if adjusted for confounders). The second review (USDA 2010t [++]) included this cohort study plus 3 other cohort studies relevant to the scope of the current review (n=25,438), and these also found no significant associations after adjustment for potential confounders. This review also included a small RCT (n=27) and cohort study (n=95) in overweight children which found a protective (inverse) effect. On this basis it concluded that limited evidence suggested a potential protective effect of fruit and vegetables against increased adiposity in children and young people. However, this may not be applicable to the general population as a whole.

Evidence Statement 25: Relationship between fruit and vegetable consumption and weight related outcomes

Adults: Weak evidence from 1 high quality review[1] and 1 moderate quality review[2] of cohort studies suggests that fruit and vegetable consumption has an inverse association with weight related outcomes.

One review[2] found a significant inverse association between fruit and vegetable consumption and weight gain over 6.5 to 12 years in 3 cohort studies. The effect size ranged from small (each additional 100 g fruit and vegetable intake associated with -14 g [95% CI -19 to -9 g] weight change per year over 6.5 years) to relatively large (highest vs. lowest intake: RR of obesity 0.76 [95% CI 0.69 to 0.86] over 12 years; OR of weight gain ≥3.41 kg 0.22 [95% CI 0.06 to 0.81] over 10 years).

A second review[1] found that most (5/7) cohort studies found no significant association between fruit and/or non-starchy vegetable consumption and weight related outcomes, but 2 studies, including the largest study, found an inverse association for non-starchy or cruciferous vegetable consumption.

Children and young people: Weak evidence from 2 high quality reviews[1,3] of cohort studies suggests that fruit and vegetable consumption is not associated with weight related outcomes in children and young people.

Applicability to the UK: The results of these reviews are applicable to the UK.

[1] Summerbell et al. 2009 [++]
[2] USDA 2010e [+]
[3] USDA 2010t [++]

4.3.10 Meat consumption

Table 23: Prioritised reviews assessing meat consumption

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Fogelholm et al. 2012 [+]	Complete: D Partial: None Unclear: Set, P	RCT: 0 Cohort: 8 (8, n=623,922) Other: 0	Positive (adults)	Yes
Summerbell et al. 2009 [++]	Complete: D Partial: None Unclear: Set, P	RCT: 0 Cohort: 6 (6, n=219,671) Other: 0	Positive (adults)	Yes
USDA 2010n [+]	Complete: None Partial: D, P Unclear: Set	RCT: 1 (0) Cohort: 1 (1, n=1,152) Other: 1	Inconclusive (adults)	Yes
Scope match abbreviations: D design (study design), P population, Set setting				

Adults

Three reviews (Fogelholm et al. 2012 [+]; Summerbell et al. 2009 [++], USDA 2010n [+]) assessed the relationship between meat intake and weight related outcomes. Two reviews came to similar conclusions, finding that there were

positive associations between total meat intake and weight change (Fogelholm et al. 2012 [+]; Summerbell et al. 2009 [++]). This was based on all 3 cohorts in Fogelholm et al. 2012 [+], and 3/4 in Summerbell et al. 2009 [++]) finding positive associations.

The cohorts finding an association for overall meat intake found small to medium sized positive associations with weight (100 kcal/day increase in meat consumption associated with a 30 g [95% CI 24 to 36 g] annual increase in weight; mean annual weight gain about 120 g more in meat eaters than vegans [reviewer calculated, CI or p value not reported]; 0.44 kg greater weight gain in highest vs. lowest tertile of meat consumption over 28 months [reviewer calculated, CI or p value not reported]; exposure quantities NR except where specified).

This finding was generally supported by the cohorts in the 2 reviews looking at individual types of meat (poultry, red meat, processed meat), which mostly found positive associations with weight-related outcomes. However, these were not consistently significant (sometimes differing across genders), and direction of effect was not uniformly positive (for example, beta coefficients for WC ranged from -0.13 [95% CI -0.24 to -0.03] in women for red meat in one study to 0.20 [95% CI 0.04 to 0.36] for women for processed meat in another). Both reviews noted the less conclusive nature of the evidence relating to individual types of meat.

The third review (USDA 2010n [+]) concluded there was insufficient evidence to link meat and body weight, but it included only a single cohort study. This study also found a significant positive longitudinal association for red and processed meats combined with BMI and WC in men, but not for each type individually (results for women NR).

Children and young people

No evidence was identified specifically on the effect of meat consumption on weight related outcomes in children or young people.

Evidence Statement 26: Relationship between meat consumption and weight related outcomes

Adults: Moderate evidence from 1 high quality review[1] and 2 moderate quality reviews[2,3] of cohort studies suggests that total meat consumption is positively associated with weight related outcomes.

The cohorts finding an association with weight found that this ranged in size from small (100 kcal/day increase in meat consumption associated with a 30 g [95% CI 24 to 36 g] annual increase in weight) to medium (440 g greater weight gain in highest vs. lowest tertile of meat consumption over 28 months [reviewer calculated]; further details NR).

Children and young people: No evidence was identified specifically on the effect of meat consumption on weight related outcomes in children or young people.

Applicability to the UK: The results of these reviews are applicable to the UK.

[1] Summerbell et al. 2009 [++]
[2] Fogelholm et al. 2012 [+]
[3] USDA 2010n [+]

4.3.11 Fish consumption

Table 24: Prioritised reviews assessing fish consumption

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Summerbell et al. 2009 [++]	Complete: D Partial: None Unclear: Set, P	RCT: 0 Cohort: 3 (3, n= 27,473) Other: 0	No (adults)	Yes
Scope match abbreviations: D design (study design), P population, Set setting				

Adults

One review (Summerbell et al. 2009 [++]) assessed the relationship between fish intake and weight related outcomes.

The 3 cohorts in Summerbell et al. 2009 [++] consistently found no association between fish intake and weight related outcomes.

The cohorts all found no significant association between fish intake and weight or WC change over 2 to 6 years (OR for weight change lowest vs. highest consumption: 0.92 for women and 1 for men; mean change in body weight: 0.71 in the lowest consumption group vs. 0.88 in the highest consumption group, p for trend 0.92; change in WC: regression coefficient for women -0.07, men -0.08; outcome and exposure units, CI and p values NR except where specified).

Children and young people

No evidence was identified specifically on the effect of fish consumption on weight related outcomes in children or young people.

Evidence Statement 27: Relationship between fish consumption and weight related outcomes

Adults: Weak evidence from 1 review[1] of cohort studies suggests that fish consumption is not associated with weight related outcomes over 2 to 6 years.

Children and young people: No evidence was identified specifically on the effect of fish consumption on weight related outcomes in children or young people.

Applicability to the UK: The results of this review are applicable to the UK.

[1] Summerbell et al. 2009 [++]

4.3.12 Legume consumption

Table 25: Prioritised reviews assessing legume consumption

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Summerbell et al. 2009 [++]	Complete: D Partial: None Unclear: Set, P	RCT: 0 Cohort: 2 (2, n=23,688) Other: 0	No (adults)	Yes
USDA 2010o [+]	Complete: None Partial: P, D Unclear: Set	RCT: 3 (2, n=83) Cohort: 1 (1, n=1,418) Other: 5	Inconclusive (adults)	Yes
Scope match abbreviations: D design (study design), P population, Set setting				

Adults

One high quality review (Summerbell et al. 2009 [++]) and 1 moderate quality review (USDA 2010o [+]) assessed the effect of legume consumption (e.g. chickpeas, soy) on weight related outcomes in adults. Overall, the studies identified tended to find no significant effect of legume consumption on weight, or an inverse association.

One high quality review (Summerbell et al. 2009 [++]) identified 2 prospective cohorts (n=23,688), one of which found that consumption of legumes was associated with weight loss in men but not women (men OR 0.68, 95% CI 0.49 to 0.94; women OR 0.71 for highest vs. lowest legume consumption, further details NR), while the other found no effect (p=0.96), over about 2 to 2.3 years. The review concluded that there was limited but consistent evidence that legume consumption is not associated with subsequent excess weight gain and obesity.

One moderate quality review (USDA 2010o [+]) had inconclusive findings. It identified 2 small crossover RCTs (n=83) comparing supplementing the diet with 140 g/day chickpeas vs. supplementing with wheat), and 1 prospective cohort (n=1,418) on soy food intake in women relevant to the current review scope. The cohort study found that high soy food intake in childhood and adulthood was associated with lower BMI in adulthood ($p<0.0001$, further figures for this analysis NR). There was also an association between adult soy consumption and BMI (high vs. low soy intake [not defined]: -0.9 kg/m^2;

p=0.002). It was unclear whether adult intake measurement preceded outcome measurement or whether the assessments were cross sectional.

The RCTs found no significant difference in weight between the chickpea and wheat supplemented diets at 5 weeks (p>0.2 for 1 RCT, further figures NR), but may have been too small and short to detect an effect.

Children and young people

No evidence was identified regarding the relationship between legume consumption and weight related outcomes in children and young people.

Evidence Statement 28: Relationship between legume consumption and weight related outcomes

Adults: Inconclusive evidence was identified from 1 high quality review[1] and 1 moderate quality review[2] of RCTs and cohort studies regarding the relationship between legume consumption and weight related outcomes.

The 2 prospective cohorts identified by 1 high quality review[1] found mixed results: consumption of legumes was associated with weight loss in men but not women in 1 study, while the other found no effect, over about 2 to 2.3 years.

The prospective cohort identified by the moderate quality review[2] found that high soy food intake in childhood and adulthood was associated with lower BMI in adulthood among women. This review[2] also identified 2 small and short term RCTs that found no effect on weight of a chickpea-supplemented diet (140 g/day) compared with similar supplementation with wheat over 5 weeks.

Children and young people: No evidence was identified on the relationship between legume consumption and weight related outcomes in children and young people.

Applicability to the UK: The results of these studies are applicable to the UK.

[1] Summerbell et al. 2009 [++]
[2] USDA 2010o [+]

4.3.13 Nut consumption

Table 26: Prioritised reviews assessing nut consumption

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Flores-Mateo et al. 2013 [+]	Complete: None Partial: D Unclear: Set, P	RCT: 31 (unclear) Cohort: 0 Other: 1	No (adults)	Yes
Fogelholm et al. 2012 [+]	Complete: D Partial: None Unclear: Set, P	RCT: 0 Cohort: 3 (3, n=180,930) Other: 0	Inverse (adults)	Yes
Summerbell et al. 2009 [++]	Complete: D Partial: None Unclear: Set, P	RCT: 0 Cohort: 3 (3, n=32,553) Other: 0	No (adults)	Yes
Scope match abbreviations: D design (study design), P population, Set setting				

Adults

One high quality review (Summerbell et al. [++]) and 2 moderate quality reviews (Flores-Mateo 2013 [+]; Fogelholm et al. 2012 [+]) suggest that nut consumption does not increase weight, and may have a beneficial effect in reducing weight gain.

One moderate quality review (Flores-Mateo 2013 [+]) included 31 small RCTs (some crossover RCTs) and 1 quasi-experimental trial lasting 2 weeks to 3 years found no significant effect of diets including nuts compared to control diets (usually isocaloric, and usually habitual diet) on body weight, BMI or WC (direction of effects all inverse, e.g. body weight: 28 trials, n=1,836; WMD -0.47 kg, 95% CI -1.17 to 0.22 kg). It concluded that nut enriched diets did not increase weight related outcomes compared to control diets. Some of these

RCTs may be in overweight and obese populations, which may limit applicability to the current scope.

One high quality review (Summerbell et al. [++]) included 3 cohort studies (n=32,553) with follow up of 2.2 to 2.3 years. One of the studies assessed nuts and seeds. Two of the cohorts found a significant inverse association between nuts or nuts and seeds and weight (50 g of nuts ≥ 2 times/week vs. never or rarely eating nuts OR for weight gain ≥5 kg over 2 years: 0.69, 95% CI 0.53 to 0.90; ORs from highest vs. lowest consumption of nuts and seeds significant for women 0.33, 95% CI 0.12 to 0.90 but not men, exact exposure or outcomes being compared unclear). The third cohort found no significant effect on mean change in body weight but the direction of the effect was inverse (0.73 in lowest consumption group vs. 0.57 in highest consumption group [units NR]; p for trend=0.07). These cohort studies were reported to be adjusted (whether this includes adjustment for energy intake is unclear), with the cohort with non-significant results explicitly adjusted for total energy intake.

The review concluded that there was limited but generally consistent evidence that nut and seed consumption was not associated with subsequent excess weight gain and obesity.

The third review (Fogelholm et al. 2012 [+]) included 3 cohorts (n=180,930; possible overlap between 2 cohorts; one included in Summerbell et al. 2009 [++]) lasting from 2.3 to 20 years. All 3 cohorts found significant inverse associations with weight gain. The effect of higher nut intake ranged from small (0.26 kg less weight gain over 4 years [95% CI 0.08 to 0.44 kg]) to relatively large (≥2 times a week vs. never or almost never eating nuts: OR for weight gain ≥5 kg over 2 years: 0.69, 95% CI 0.53 to 0.90; the latter study included in Summerbell et al. 2009 [++]). These analyses were adjusted for various confounders, but these did not appear to include total energy intake.

It concluded that higher intake of nuts probably predicts less weight gain.

Children and young people

No evidence was identified regarding the relationship between nut consumption and weight related outcomes in children and young people.

Evidence Statement 29: Relationship between nut consumption and weight related outcomes

Adults: Weak evidence from 1 high quality review[3] and 2 moderate quality reviews[1,2] of RCTs and cohort studies suggests that nut consumption may have an inverse association with weight related outcomes.

Meta-analysis[1] of RCTs found no significant effect of nut consumption (usually 35 to 120 g/day) on weight related outcomes compared to control diets (usually isocaloric) at 2 weeks to 3 years (WMD -0.47 kg, 95% CI -1.17 to 0.22 kg).

Four of the 5 cohort studies from 2 reviews[2,3] found a significant inverse association between nut intake and weight, ranging from relatively small (eating nuts [not further defined] associated with 0.26 kg [95% CI 0.44 to 0.08] less weight gain over 4 years), to relatively large (OR for weight gain ≥5 kg over 2 years of 0.69 [95% CI 0.53 to 0.90] with frequent nut intake [50 g of nuts ≥ 2 times/week] vs. never or rarely). The cohort with non-significant findings had a negative direction of effect and was the only one which explicitly adjusted for energy intake.

Children and young people: No evidence was identified on the relationship between nut consumption and weight related outcomes in children and young people.

Applicability to the UK: The results of these studies are applicable to the UK.

[1]Flores-Mateo et al. 2013 [+]
[2]Fogelholm et al. 2012 [+]
[3]Summerbell et al. 2009 [++]

4.3.14 Specific dietary patterns

Table 27: Prioritised reviews assessing specific dietary patterns

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Fogelholm et al. 2012 [+]	Complete: D Partial: None Unclear: Set, P	RCT: 0 Cohort: 5 (5, n=529,768) Other: 0	Adherence to guidelines: Inverse Mediterranean diet: Inconclusive (adults)	Yes
Kastorini et al. 2011 [+]	Complete: None Partial: D, P Unclear: Set	RCT: 11 (0) Cohort: 1 (1, n=2,563) Other: 4	Mediteranean diet: Inverse (adults)	Yes
Vadiveloo et al. 2013 [+]	Complete: None Partial: D Unclear: Set, P	RCT: 3 (0) Cohort: 1 (1, n=100,886) Other: 22 (0)	Dietary variety: Inconclusive (adults)	Yes
Smithers et al. 2011 [+]	Complete: None Partial: D Unclear: Set, P	RCT: 0 Cohort: 2 (2, n=5,292) Other: 8	Inconclusive (children)	Yes
Kuhl et al. 2012 [-]	Complete: D Partial: None Unclear: Set, P	RCT: 0 Cohort: 1 (1, n=7,758) Other: 0	NR (children)	Yes
Scope match abbreviations: D design (study design), P population, Set setting				

Adults

Three moderate quality reviews assessed the relationship between dietary pattern and body weight and related outcomes in adults (Fogelholm et al. 2012 [+]; Kastorini et al. 2011 [+]; Vadiveloo et al. 2013 [+]). The reviews assessed different dietary patterns and are grouped according to these below.

Mediterranean diet

One review (Fogelholm et al. 2012 [+]) found that the evidence on compliance with a Mediterranean diet (3 cohorts) was inconclusive. Two studies (n=513,074) found a significant inverse association with weight gain at an average of about 5 years (high vs. low adherence: mean difference -0.059 kg/year [p for trend=0.02]; -0.16 kg, 95% CI -0.24 to -0.07). The smallest and

shortest study (n=7,908; 28 months' follow up) also showed an inverse relationship with weight , but this did not remain significant after adjustment for confounders (figures NR).

A second review (Kastorini et al. 2011 [+]) included RCTs, 1 cohort study, and other study designs. The only study relevant to the current review scope was a cohort study (n=2,563), which found no association between compliance with a Mediterranean diet and WC (direction of effect inverse; highest vs. lowest compliance groups: -0.5 cm, 95% CI -1.96 to 0.96 cm). Overall the review concluded that a Mediterranean diet did have a beneficial effect on WC, but this was based on a meta-analysis of RCTs solely in individuals who were overweight or obese or with health conditions such as diabetes.

It was unclear whether the individual cohort studies used the same definitions of the Mediterranean diet.

Adherence to population dietary guidelines

One review (Fogelholm et al. 2012 [+]) identified 2 cohorts (n=8,786) assessing the effect of adherence to US dietary guidelines over 8 to 20 years.

One study reported these guidelines as fat intake <30% of energy, saturated fatty acids <10% of energy, cholesterol <300 mg/day, sodium <2.4 g/day, carbohydrate >50% of energy, but the other just noted that these dietary components were targeted. Both cohorts found a significant inverse association between adherence to the dietary guidelines and weight gain; 1 found that a 1-unit improvement in adherence score was associated with 0.22 kg to 0.27 kg at 8 years (reviewer calculated, p for trend <0.01), with the other finding 2.7 kg lower weight gain with high adherence (reviewer calculated; follow up period unclear, 7 or 20 years). The review concluded that this was suggestive evidence of an association.

Other dietary patterns

A third review (Vadiveloo et al. 2013 [+]) assessed dietary variety in RCTs, cohorts and other study designs. The majority of studies in this review were

not relevant to the current review scope due to their design or inclusion of solely overweight or obese participants.

The single relevant cohort study (n=100,886) found that eating more of 23 recommended foods (Recommended Food Score [RFS], not further specified) at least weekly was associated with lower mean BMI after 8 to 12 years in men but the opposite was true for women (mean difference in BMI for highest vs. lowest RFS quintile for men: -0.2 kg/m^2; women: 0.3 kg/m^2; p for trends <0.001).

Children and young people

One moderate quality review (Smithers et al. 2011 [+]) and 1 low quality review (Kuhl et al. 2012 [-]) assessed the relationship between dietary pattern and body weight and related outcomes in pre-school children (age 1 to 5 years).

The cohorts identified by the moderate quality review (Smithers et al. 2011 [+]) found that (n=782) higher "infant guidelines" pattern score at 12 months was associated with increased lean mass but not with fat mass or BMI at age 4 (figures NR), and also (n=4,510) that a pattern including meat at age 3, but not other patterns (patterns: staples, noodles & pasta, fruit and vegetables, breakfast foods, snacks, no further detail provided), were associated with increased odds of BMI>85th percentile (OR 1.37, 95% CI 1.04 to 1.81).

The review concluded that overall, more research was needed to establish the validity of whole of diet approaches in children.

The low quality review (Kuhl et al. 2012 [-]) identified 1 cohort study (n=7,758) which found no association between junk, healthy, traditional and fussy dietary patterns at age 3 and BMI at age 7 (figures NR).

Overall, the variety of potential dietary patterns and ways of analysing these may make comparison across studies and drawing firm conclusions difficult.

Evidence Statement 30: Relationship between Mediterranean diet and weight related outcomes in adults

Moderate evidence from 2 moderate quality reviews[1,2] of cohort studies suggests that adhering more closely to a Mediterranean dietary pattern may be inversely associated with weight related outcomes. Two large cohort studies in 1 review[1] suggested that adhering more closely to a Mediterranean dietary pattern is associated with less weight gain over 5 years (mean difference -0.059 kg/year, p for trend =0.02; or -0.16 kg, 95% CI -0.24 to -0.07). Two smaller cohorts in the reviews[1,2] found inverse directions of effect on weight or waist circumference that were either non-significant, or became non-significant after adjustment.

Applicability to the UK: The results of these reviews are applicable to the UK.

[1] Fogelholm et al. 2012 [+]
[2] Kastorini et al. 2011 [+]

Evidence Statement 31: Relationship between adherence to population dietary guidelines and weight related outcomes in adults

Weak evidence from 1 moderate quality review[1] of cohort studies suggests that greater adherence to population dietary guidelines may be inversely associated with weight gain.

The review included 2 cohorts: 1 found that a 1-unit improvement in adherence score was associated with 0.22 kg to 0.27 kg at 8 years (reviewer calculated, p for trend <0.01), and the other found 2.7 kg lower weight gain with high adherence (reviewer calculated; follow up period unclear, 7 or 20 years).

Applicability to the UK: The results of this review are applicable to the UK.

[1] Fogelholm et al. 2012 [+]

Evidence Statement 32: Relationship between other dietary patterns and weight related outcomes in adults

Inconclusive evidence was identified from 1 review[1] of cohort studies on the effect of greater dietary variety (eating more of 23 recommended foods at least weekly) and weight related outcomes. The 1 cohort study in this review relevant to the current scope found small significant effects on BMI in men and women over 8 to 12 years, but these conflicted in the direction of effect (difference between highest and lowest dietary variety quintiles: -0.2 kg/m^2 in men, 0.3 kg/m^2 in women, reviewer calculated, p for trends<0.001).

Applicability to the UK: The results of this review are applicable to the UK.

[1] Vadiveloo et al. 2013 [+]

Evidence Statement 33: Relationship between dietary pattern and weight related outcomes in children and young people

Inconclusive evidence from 1 moderate quality[1] and 1 low quality review[2] of cohort studies was identified regarding the relationship between dietary pattern on weight related outcomes in pre-school aged children (1 to 5 years).

Three cohort studies identified by the reviews[1,2] found that most dietary patterns assessed at age 1 to 3 years were not associated with BMI or fat mass at age 4 to 7. One study found that a pattern containing meat (not further specified) at age 3 was associated with increased odds of BMI>85th percentile at age 4 (OR 1.37, 95% CI 1.04 to 1.81).

Applicability to the UK: The results of these reviews are applicable to the UK.

[1] Smithers et al. 2011 [+]
[2] Kuhl et al. 2012 [-]

4.3.15 Vegetarian or vegan diet consumption

Table 28: Prioritised reviews assessing vegetarian or vegan diet consumption

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
USDA 2010v [+]	Complete: None Partial: D Unclear: Set, P	RCT: 0 Cohort: 7 (3, n=22,365) Other: 11	Inverse(adults)	Yes
Scope match abbreviations: D design (study design), P population, Set setting				

Adults

One moderate quality review (USDA 2010v [+]) investigated the link between a vegetarian diet and health outcomes, one of which was BMI.

It included 1 cohort (n=21,966) that clearly assessed BMI over time (5 years). It found that mean annual weight gain was significantly less in vegans, but not lacto-ovo vegetarians than in meat eaters (vegans: 284 g in men and 303 g in women, vegetarians: 386 g for men and 392 g for women; meat eaters: 406 g in men and 423 g in women; $p<0.05$ comparison vegans vs. meat eaters for both sexes).

Two additional studies (n=399) were described as cohort studies, but no follow up period was described, and they seemed likely to have assessed BMI cross-sectionally. One found no difference in BMI between healthy lacto-ovo vegetarians and omnivores (data NR), and the other found significantly lower BMI in vegetarians (mainly lacto-ovo) than omnivores.

Overall, the relationship between vegetarian and vegan diets and weight related outcomes is inconclusive due to the limited prospective evidence identified and lack of consistent findings across the included cohort studies.

Children and young people

No evidence was identified regarding the relationship between vegetarian or vegan diet and weight related outcomes in children and young people.

Evidence Statement 34: Relationship between vegetarian or vegan diet and weight related outcomes

Adults: Inconclusive evidence was identified from 1 moderate quality review[1] of cohort and cross-sectional studies on the relationship between vegetarian or vegan diets and weight related outcomes. One cohort study in this review found mean annual weight gain was slightly but significantly (about 120 g) lower in male and female vegans than in meat eaters, the difference between vegetarians and meat eaters was smaller (20 g for men and 31 g for women) and not statistically significant. Two additional studies found either no difference in BMI or an inverse association between a vegetarian diet and BMI, but these analyses may have been cross-sectional.

***Child*ren and young people:** No evidence on the effects of vegetarian or vegan diets was identified specifically in children or young people.

Applicability to the UK: The results of this review are applicable to the UK.

[1] USDA 2010v [+]

4.4 Energy and nutrients

4.4.1 Total fat consumption

Table 29: Prioritised reviews assessing total fat consumption

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Hooper et al. 2012 [++]	Complete: D Partial: P, Set Unclear: None	RCT: 33 (3, n=1,131 adults) Cohort: 13 (10, n=107,624 adults; 3, n=1,337 children) Other: 0	Positive (adults & children)	Yes
Summerbell et al. 2009 [++]	Complete: D Partial: P Unclear: Set	RCT: 0 Cohort: 27 (15, n=126,891; 11, n=3,962 children) Other: 0	No (adults & children)	Yes

USDA 2010y [++]	Complete: D Partial: Set, P Unclear: None	RCT: 3 (1, n=1,062) Cohort: 23 (20, n= 14,186) Other: 1	Positive (children)	Yes
Scope match abbreviations: D design (study design), P population, Set setting				

Adults

Two high quality reviews assessed the effect of total fat intake on weight-related outcomes in adults (Hooper et al. 2012 [++]; Summerbell et al. 2009 [++]).

The reviews came to differing conclusions, with 1 concluding that there was a positive association (Hooper et al. 2012 [++]) and 1 concluding that there was no association (Summerbell et al. 2009 [++]). This may in part be due to the focus of the Hooper et al. 2012 [++] review on RCTs, which were not assessed by Summerbell et al. 2009 [++].

The more recent review by Hooper et al. 2012 [++] included 33 RCTs lasting 26 weeks or longer (n=73,589) and 10 prospective cohort studies lasting a year or longer (n=107,624) in trials not specifically aiming at weight loss. Overall meta-analysis of the RCTs found that reducing total fat intake (interventions reduced fat by between <5% to >15% energy from fat compared with controls with intake of 28-43% of energy from fat) was associated with a significantly lower body weight at 6 months to over 8 years' follow up (-1.6 kg, 95% CI -2.0 to -1.2 kg; 27 comparisons). There was heterogeneity in these analyses, and the effect appeared to be greater with greater reduction in total fat intake and lower baseline fat intake. Meta-regression found that each 1% reduction in energy from total fat reduction weight was associated with weight loss of 0.19 kg (95% CI −0.33 to −0.06, p=0.006).

While the majority of RCTs in this review (30/33; n=72,458) selected participants based on overweight, obesity or other health statuses, the reduction in body weight was also seen in a subgroup analysis of healthy

individuals (-0.98 kg, 95% CI -1.56 to -0.41; 3 comparisons). The cohort studies had mixed results and were mostly judged by the review to be at high risk of bias.

The review by Summerbell et al. 2009 [++] included 16 prospective cohorts with 3 months' to 12 years' follow up (n=126,891 in the 15 cohorts matching the current scope). The individual cohort studies found varying results: 7 studies did not find a significant association between total fat intake and weight-related outcomes at follow up of a year or longer. The other studies found a mix of positive and inverse associations, with results not always consistent across genders. A meta-analysis of 4 cohorts found no association between total fat intake (% energy from fat) and change in weight (n=9,753; regression slope +0.07, 95% CI -0.03 to +0.16; heterogeneity present). The review concluded that the levels of fat intake were not associated with subsequent excess weight gain or obesity.

Children and young people

The 2 high quality reviews described for adults above (Hooper et al. 2012 [++]; Summerbell et al. 2009 [++]) plus 1 additional high quality review (USDA 2010y [++]) assessed the effect of total fat intake on weight-related outcomes in children and young people.

The reviews came to differing conclusions, with the 2 reviews of RCTs and cohort studies concluding that there is a positive association (Hooper et al. 2012 [++], USDA 2010y [++]) and the third review of cohort studies concluding that there is no association (Summerbell et al. 2009 [++]).

The review by Hooper et al. 2012 [++] included 3 cohort studies (n=1,337), all of which found a positive association between fat intake and weight related outcomes. One study found that every 5% increase in energy from fat at baseline was associated with 0.17 kg/m^2 higher BMI at 2 year follow up (p=0.05).

The USDA 2010y [++] review included 3 RCTs (1 relevant to the current review, n=1,062), 23 cohort studies (20 relevant, n=14,186), and 1 other study. The relevant RCT compared a fat modified diet from 7 months of age (30-35% energy from fat at ages 1-2 years, and 30% afterwards) versus no dietary advice in the control group (fat intake reported as significantly higher in control group, p<0.001). It found a reduction in obesity with the intervention among girls at age 10 (10.2% vs. 18.8%, p=0.04) but not among boys at this age, and no effect in either gender at age 14. Of the 20 cohort studies, 11 found a positive association between total fat intake and adiposity in all or a sub-sample of the population studied, the other 9 found no significant effect (direction NR). The review noted that none of the studies were carried out under isocaloric conditions.

The Summerbell et al. 2009 [++] review (11 cohort studies, n=3,962) found that the results of the cohort studies were inconsistent in terms of significance and direction of effect. Six found a significant effect with varied direction of effect (5 positive, 1 inverse), and 5 found no significant effect. The size of the effects seen varied, for example regression coefficients ranged from -0.07 (for the relationship between % energy from fat intake and BMI, p=0.044) to +178.7 (fat intake in g/day and g body fat after 70 months, p=0.01). The varied results may be due to variation in measures of dietary fat and adiposity, and analyses in different subgroups.

Evidence Statement 35: Relationship between total fat consumption and weight related outcomes

Adults: Moderate evidence from 2 high quality reviews[1,2] of RCTs and cohort studies suggests that total fat consumption may be positively associated with weight related outcomes in adults; this may relate to fat increasing overall energy intake.

One review[1] found that reducing total fat intake (by <5% to >15% energy from fat) reduced body weight at 6 months to over 8 years' follow up (pooled mean difference in RCTs in healthy individuals: -0.98 kg [95% CI -1.56 to -0.41]).

Each 1% reduction in energy from total fat weight reduced weight by 0.19 kg during follow up (95% CI −0.33 to −0.06, p=0.006).

Meta-analysis of 4 cohort studies[2] found no association between total fat intake and change in weight (regression slope +0.07, 95% CI -0.03 to +0.16).

Children and young people: Moderate evidence from 3 high quality reviews[1,2,3] of RCTs and cohort studies suggested that total fat consumption may be positively associated with weight related outcomes in children and young people. This may be related to fat increasing overall energy intake.

One review[2] included 1 RCT relevant to the current scope, which found that a reduction in fat intake from before the age of 1 year (to 30-35% in the intervention group) was associated with reduced risk of obesity at age 10 in girls but not boys.

The cohort studies identified by the reviews had mixed results. The review[3] including the largest number of cohort studies found that just over half (11/20) showed a positive association in all or a sub-sample of the population; the remainder showed no significant effect (direction NR).

The most recent review[1] included 3 cohorts, all showing positive associations). The oldest review[2] concluded that there was no association (11 cohorts included: 5 with positive associations, 1 negative, and 5 no significant effect).

The size of the effects seen varied where reported, with 1 review[2] reporting regression coefficients ranging between 0.07 kg/m^2 reduction in BMI per unit increase in % energy from fat intake (p=0.044) to a 178.7 g increase in body fat per unit increase in fat intake in g/day over 70 months (p=0.01).

Applicability to the UK: These results are applicable to the UK.

[1] Hooper et al. 2012 [++]
[2] Summerbell et al. 2009 [++]

[3] USDA 2010y [++]

4.4.2 Total protein consumption

Table 30: Prioritised reviews assessing total protein consumption

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Santesso et al. 2012 [++]	Complete: D Partial: P Unclear: Set	RCT: 74 (6, n=143) Cohort: 0 Other: 0	Inverse (adults)	Yes
Schwingshackl and Hoffmann 2013 [++]	Complete: D Partial: P Unclear: Set	RCT: 15 (unclear, maximum 3, n=107) Cohort: 0 Other: 0	No (adults)	Unclear
Summerbell et al. 2009 [++]	Complete: D Partial: P Unclear: Set	RCT: 0 Cohort: 19 (8, n=81,286 adults/2, n=2, 396 children) Other: 0	No (adults & children)	Yes
Scope match abbreviations: D design (study design), P population, Set setting				

Adults

Three high quality reviews assessed the effect of total protein intake on weight-related outcomes in adults (Santesso et al. 2012 [++], Summerbell et al. 2009 [++], Schwingshackl and Hoffmann 2013 [++]).

Two reviews included only RCTs (Santesso et al. 2012 [++], Schwingshackl and Hoffmann 2013 [++]) comparing higher versus lower protein diets. Most of the RCTs were in overweight or obese individuals and aimed at weight loss. Schwingshackl and Hoffmann 2013 [++] also included RCTs in individuals with type 2 diabetes. The review by Santesso et al. 2012 [++] included RCTs of ≥28 days' length, while Schwingshackl and Hoffmann 2013 [++] included only long term RCTs (follow up >1 year).

Santesso et al. 2012 [++] found that higher protein diets (median 27% energy from protein) were associated with small to moderate weight, BMI, and WC reductions compared with lower protein diets (median 18% energy from

protein) (weight change: SMD -0.36, 95% CI -0.56 to -0.17; BMI change: SMD -0.37, 95% CI -0.56 to -0.19; WC change: SMD -0.43, 95% CI -0.69 to -0.16). Higher protein diets (median 27% energy from protein) compared to low protein diets (median 18% energy from protein) resulted in 1.21 kg (95% CI -1.88 to -0.57) greater weight loss and 0.51 kg/m^2 (95% CI -0.77 to -0.26) greater BMI reduction at 3 months. Meta-regression suggested that those with a higher BMI at the start of a study had greater weight loss. Few RCTs reported on adverse events but there was low quality evidence of increased gastrointestinal events with higher protein diets. The review identified no differences in overall adverse effects or indicators of kidney health. Schwingshackl and Hoffmann 2013 [++] found no significant differences between high and low protein groups (% energy from protein: 25-40% vs. 10-20%) in weight, WC, or fat mass at 1 to 2 years' follow up (weight: WMD -0.39 kg, 95% CI -1.43 to +0.65; WC: WMD -0.98 cm, 95% CI -3.32 to +1.37; fat mass: WMD -0.59 kg, 95% CI -1.32 to +0.13). The direction of the effects was towards a benefit with the higher protein diets, but the analyses may have lacked power to detect small effects.

In general in both reviews total energy intake was similar in the higher and lower protein groups of the RCTs, but some RCTs did have different energy intake in the higher protein group (8% of the trials in Santesso et al. 2012 [++] had lower calorie intake (≥100 kcal/day difference) in the high protein group, and 18% had higher calorie intake (≥100 kcal/day difference) in the high protein group; 1/15 trials in Schwingshackl and Hoffmann 2013 [++] had a lower energy intake in the high protein group, and 8/15 trials had no energy restrictions in at least one of the groups).

Summerbell et al. 2009 [++] identified 8 cohort studies (n=81,286) in adults lasting 1 to 12 years. Most (7/8 studies) had non-significant findings, with most (3 studies) finding a positive direction of effect where reported, although 1 large study did have an inverse direction of effect for WC. The one significant association was positive (2 kg difference in mean weight between highest and lowest quintiles of protein intake [not quantified] over 10 years in

white individuals, p<0.01; findings in black individuals non-significant). The review concluded that protein intake (across adults and children and young people) was not associated with subsequent excess weight gain or obesity, although the results were inconsistent. Although not explicitly reported, these studies appeared to be in general populations.

Children and young people

The review by Summerbell et al. 2009 [++] also assessed the effect of protein intake on weight related outcomes in children and young people.

This review included 11 prospective cohorts (n=2,396; possible overlap of 3 small cohorts) in children and young people (6 months to 19 years) and found mixed results at 1 to 9 years' follow up.

Six cohorts (n=942) showed a positive association between protein intake and at least 1 weight-related outcome in at least 1 analysis (e.g. in either boys or girls). The other 5 cohorts (n=1,454) had findings that were non-significant (direction of effect positive in 2, mixture of inverse and positive associations in 1, NR in 2 studies). Two of these non-significant studies potentially represented longer term follow up of one of the studies finding a positive association.

All of the studies were relatively small. The range of effects went from a small non-significant inverse association of kJ/g protein intake with skinfold thickness (the only inverse association, regression coefficient -0.001, p=0.79) to a relatively large association between high protein intake at 12 months and BMI above the 75th percentile at 7 years (BMI OR 2.39, 95% CI 1.14 to 4.99, p=0.02).

Evidence Statement 36: Relationship between total protein consumption and weight related outcomes

Adults: Moderate evidence from 3 high quality reviews[1,2,3] of RCTs and cohort studies suggested that total protein intake may not be associated with weight related outcomes.

Two meta-analytic reviews[1,2] of RCTs (mostly in overweight or obese individuals and including interventions aimed specifically at weight loss) suggested that high protein vs. low protein diets (median 27% vs. 18% energy from protein) resulted in greater weight reduction in the short term (1.21 kg, [95% CI -1.88 to -0.57] greater weight loss)[1] , but this difference is non-significant at longer term follow-up (WMD -0.39 kg, 95% CI -1.43 to +0.6). The findings of this meta-analysis may not apply to the general population and those not aiming to lose weight.

Cohort studies in a third review[3] mostly had non-significant findings over 1 to 12 years (3 of 8 reported a non-significant positive association, 1 of 8 a non-significant inverse association, and 3 of 8 did not report direction of non-significant effect); one study showed a significant positive association. These results may be more indicative of the effects of protein intake in the general population.

Children and young people: Weak evidence from 1 review[3] of cohort studies suggested that total protein intake may be positively associated with weight related outcomes in children and young people.

The review included 11 cohort studies, which either found a significant positive association between protein intake and at least 1 weight-related outcome, or no significant effect (effects mainly in a positive direction where reported) over 1 to 9 years. Associations ranged from a small non-significant inverse association of kJ/g protein intake with skinfold thickness (the only inverse association reported, regression coefficient -0.001, p=0.79) to a large

association between high protein intake at 12 months and BMI above the 75th percentile at 7 years (BMI OR 2.39, 95% CI 1.14 to 4.99, p=0.02).

Applicability to the UK: Two of the reviews[1,3] were applicable to the UK; the countries in which the included studies in one review[2] were performed were not reported, therefore applicability of this review to the UK is unclear.

[1] Santesso et al. 2012 [++]
[2] Schwingshackl and Hoffmann 2013 [++]
[3] Summerbell et al. 2009 [++]

4.4.3 Total carbohydrate consumption

Table 31: Prioritised reviews assessing total carbohydrate consumption

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Summerbell et al. 2009 [++]	Complete: D Partial: P Unclear: Set	RCT: 0 Cohort:16 (7, n=79,083 adults/9, n=2,625 children) Other: 0	No	Yes
Scope match abbreviations: D design (study design), P population, Set setting				

Adults

Summerbell et al. 2009 [++] included 7 prospective cohorts (n=79,083) in adults. The studies found mixed results at 1 to 12 years' follow up. The cohort studies assessed carbohydrate intake in various ways (% energy as carbohydrate or carbohydrate intake in g) and also assessed varied weight related outcomes.

Most cohort studies (4/7; n=44,180) found no association between carbohydrate intake and weight related outcomes (positive and inverse directions of effect, largest non-significant association: 0.599 increase in body weight [units NR] for each g increase in carbohydrate over 12 years (p=0.94)), Two studies (n=34,849) found an inverse association with weight gain over 4 to 10 years (regression coefficient=-0.001, 95% CI 0.0024 to 0.0004), and 1

small study (n=54) found a positive association with change in body weight and body fat (correlation coefficients for these outcomes ranging from 0.30 to 0.35 depending on how carbohydrate intake was measured).

Children and young people

Summerbell et al. 2009 [++] also included 9 prospective cohorts (n=2,625) in children and young people aged 10 months to 19 years, with 1 to 15 years' follow up.

Most of the studies (6/9; n=1,282) found no association between total carbohydrate intake and various weight related outcomes in children and young people (mixed directions of effect where reported). Three studies (n=1,343) found a significant inverse relationship between total carbohydrate and a weight related outcome (each 1% increase in energy from carbohydrates associated with −0.044 kg/year weight change or −11.70 kg/m^2 [95% CI −20.5 to −2.9] BMI change over 6 years; each 1kJ/g increase in carbohydrate intake associated with -0.003 change in subscapular skinfold), although the study assessing skinfold thickness found no association with BMI. The large regression coefficient came from a small study (n=70), and had wide confidence intervals. One study found a small, non-significant positive association with change in BMI over 15 years (0.02 kg/m^2 increase per 1 g increase in carbohydrate, p=0.33).

The review concluded overall (across adults and children and young people) that carbohydrate intake was not associated with subsequent excess weight gain or obesity, although the results of the included studies were inconsistent.

Evidence Statement 37: Relationship between total carbohydrate consumption and weight related outcomes

Adults: Weak evidence from one high quality review[1] of cohort studies suggests that total carbohydrate intake is not associated with weight related outcomes in adults, but results are inconsistent.

Four of 7 cohort studies found no significant associations of varying direction, while 2 found an inverse association with weight over 4 to 10 years, and 1 small study found a positive association with change in body weight and body fat (correlation coefficient range: 0.30 to 0.35).

Magnitude of associations ranged from a 0.001 reduction in body weight (units NR, 95% CI -0.0024 to -0.0004) for each g/day change in total carbohydrate intake over 4 years, to a non-significant 0.599 increase in body weight [units NR] for each g increase in carbohydrate over 12 years (p=0.94).

Children and young people: Weak evidence from one high quality review[1] of cohort studies suggests that carbohydrate intake is not associated with weight or obesity in children or young people, but results are inconsistent.

Six of the 9 cohort studies found no association between carbohydrate intake and weight related outcomes (positive and inverse directions of effect), while 3 found inverse associations over 1 to 15 years. Magnitude of the relationships ranged from a large significant inverse association between energy intake from carbohydrates and BMI (regression coefficient: −11.70, 95% CI −20.5 to −2.9) to a small non-significant positive association (0.02 kg/m^2 BMI change per 1 g increase in carbohydrate intake, p=0.33).

Applicability to the UK: The results of this review are applicable to the UK.

[1] Summerbell et al. 2009 [++]

4.4.4 Glycaemic index/load of the diet

Table 32: Prioritised reviews assessing glycaemic index/load of the diet

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
USDA 2010j [+]	Complete: None Partial: D, P Unclear: Set	RCT: 13 (1, n=203) Cohort: 2 (1, n=376) Other: 7	No (adults)	Yes
Scope match abbreviations: D design (study design), P population, Set setting				

Adults

One moderate quality review (USDA 2010j [+]) included 1 RCT and 1 cohort study with 6 years follow up relevant to the current review scope. The RCT compared a high glycaemic index (GI) versus a low GI diet (difference in GI 35 to 40 units). The RCT (n=203) found no significant difference in weight change over 18 months between the diets (weight change: -0.41kg with low GI diet vs. -0.26kg with high GI diet, p=0.93). The RCT had a high loss to follow up (40%), and although it was not in solely overweight or obese individuals, it did include people with relatively high BMI (23 to 29.9kg/m^2).

The cohort study (n=376) had differing results across the different exposures and outcomes assessed, and by gender. GI and glycaemic load of the diet at baseline was not associated with changes in weight-related outcomes in men over 6 years. In women, there was no significant association between glycaemic load and body weight or WC (the latter effect had an inverse direction). However, GI was positively associated with weight related outcomes in women over 6 years. A 10-unit increase in baseline GI was associated with a 2% increase in body weight (95% CI 0.1% to 4%), a 0.9% increase in percentage body fat (95% CI 0.04% to 1.7%), and a non-significant 1.6 cm increase in WC (95% CI -0.1 cm to 3.2 cm). Larger effects were seen in sedentary women, but it was unclear if this was a post-hoc or pre-specified analysis, and was likely to include relatively small numbers of women given the size of the study.

Although overall the review concluded that the evidence showed glycaemic index and/or glycaemic load is not associated with body weight, this was largely based on studies outside of the scope of the current review: RCTs solely in overweight and obese individuals, 1 cohort study in pregnant women, and cross sectional studies. The evidence directly relevant to the current scope was inconclusive.

Children and young people

No evidence was identified on the relationship between glycaemic load/index and weight related outcomes specifically in children or young people.

Evidence Statement 38: Relationship between glycaemic index/load and weight related outcomes

Adults: Inconclusive evidence from 1 moderate quality review[1] of RCTs and cohort studies was identified regarding the relationship between glycaemic load/index and weight related outcomes in adults.

The review found that glycaemic index (GI) and/or glycaemic load is not associated with body weight. One small RCT found no significant difference in weight change between a low GI diet and a high GI diet over 18 months (35-40 units difference in GI between diets; mean weight change: -0.41kg vs. -0.26kg respectively; p=0.93). One small cohort study found no effect of GI or glycaemic load on weight related outcomes in men over 6 years, but found that in women a 10-unit increase in baseline GI was associated with a 2% increase in body weight (95% CI 0.1% to 4%) and a 0.9% increase in percentage body fat (95% CI 0.04% to 1.7%).

Children and young people: No evidence was identified on the relationship between glycaemic load/index and weight related outcomes specifically in children or young people.

Applicability to the UK: The results of this review are applicable to the UK.

[1]USDA 2010j [+]

4.4.5 Fibre consumption

Table 33: Prioritised reviews assessing fibre consumption

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable

Summerbell et al. 2009 [++]	Complete: D Partial: None Unclear: Set, P	RCT: 0 Cohort: 5 (3, n=108,940 adults/ 2, n=11,506 children) Other: 0	NR (adults & children)	Yes
Wanders et al. 2011 [+]	Complete: D Partial: P Unclear: Set	RCT: 61 (unclear,) Cohort: 0 Other: 0	Inverse (adults)	Unclear
Ye et al. 2012 [+]	Complete: D Partial: P Unclear: Set	RCT: 0 Cohort: 2 (2, n=101,173) Other: 0	Inverse (adults)	Unclear
USDA 2010w [++]	Complete: D Partial: P Unclear: Set	RCT: 2 (0) Cohort: 4 (3, n=12,363) Other: 0	Inconclusive (children)	Yes
Scope match abbreviations: D design (study design), P population, Set setting				

Adults

One high quality review (Summerbell et al. 2009 [++]) and 2 moderate quality reviews (Ye et al. 2011 [+], Wanders et al. 2011 [+]) generally found an inverse association between total dietary fibre intake and weight related outcomes in adults. However, the statistical significance and magnitude of this association was inconsistent across reviews.

One high quality review (Summerbell et al. 2009 [++]) of 3 prospective cohorts with 4 to 12 years' follow up found mixed results: 2 found significant inverse associations for weight or obesity at 10 to 12 years (adjusted OR 0.66, 95% CI 0.58 to 0.74; p for trend<0.001; mean weight change [units NR] -3.6 to -3.7 in black and white participants, p≤0.001 for both trends). One study found a small but significant positive association between dietary fibre intake and weight change at 4 years (regression coefficient 0.006, 95% CI 0.002 to 0.01), although its participants were drawn from the same cohort as one of the studies that found a significant negative association.

One moderate quality review (Ye et al. 2011 [+]) included 1 additional prospective cohort which found an inverse association over 8 years' follow up

(significance NR); it did not report any specific conclusions related to fibre consumption.

One moderate quality review (Wanders et al. 2011 [+]) included 61 RCTs, the majority of which were in overweight or obese participants with a mean study duration of 11.1 weeks. RCTs in general population samples were not analysed separately, and overall results may not be representative of potential effects in the general population, particularly as some trials used supplements to deliver fibre as opposed to through food. Across fibre groups, there was a small reduction in body weight of 0.014% over 4 weeks per gram increase of fibre intake, with average mean reduction of 0.72 kg over an average of 11.1 weeks.

Children and young people

Two high quality reviews (Summerbell et al. 2009 [++]; USDA 2010w [++]) included 4 cohort studies (n=13,100), none of which found a significant association between fibre intake and weight related outcomes over 1 to 10.9 years.

Results figures were not reported for all of these studies, but where reported the direction and size of the non-significant effects differed (exposures not quantified). They ranged from a small positive association with % body fat over 4 years (0.02% body fat increase per SD increase in fibre intake, p=0.9) to a relatively large asociation between high fibre intake at age 3 and obesity 10.9 years later (OR 0.78, 95% CI 0.60 to 1.02).

Evidence Statement 39: Relationship between dietary fibre consumption on healthy weight maintenance

Adults: Weak evidence from 1 high quality review[1] and 2 moderate quality reviews[2,3] of RCTs and cohort studies suggested that dietary fibre consumption may have an inverse association with weight related outcomes.

Three of 4 cohort studies from 2 reviews[1,2] found an inverse association between fibre intake and weight or obesity over 8 to 12 years. The associations ranged from relatively small (mean difference [MD] in weight change, women: 0.76 kg, men: 1.01 kg; significance NR) to large (obesity OR, highest vs. lowest intake quintile: 0.66, 95% CI 0.58 to 0.74). One cohort found a small significant positive association between fibre and 4 year weight gain (regression coefficient 0.006 for dietary fibre intake).

A moderate quality review[3] of RCTs lasting 11 weeks on average, mainly among overweight and obese participants, found that fibre (using food or supplements) reduced body weight by an average of 0.014% per 4 weeks per gram increase of fibre intake compared with control (significance NR; equivalent to an average 0.72 kg over the mean 11 week follow-up period).

Children and young people: Weak evidence from 2 high quality reviews[1,4] of cohort studies suggested that fibre consumption is not associated with weight related outcomes in children and young people. The 4 cohort studies in these reviews consistently found no significant association with weight related outcomes (mixed direction of non-significant effects).

Applicability to the UK: The results of 2 reviews are applicable to the UK, but the country of origin of included studies in the other 2 reviews are not reported so their applicability to the UK is unclear.

[1] Summerbell et al. 2009 [++]
[2] Ye et al. 2012 [+]
[3] Wanders et al. 2011 [+]
[4] USDA 2010w [++]

4.4.6 Energy density of the diet

Table 34: Prioritised reviews assessing energy density of the diet

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable

Fogelholm et al. 2012 [+]	Complete: None Partial: P Unclear: Set, D	RCT: 0 Cohort: 4 (4, n=189,851) Other: 0	Positive (adults)	Yes
Johnson et al. 2009 [+]	Complete: None Partial: P Unclear: Set, D	RCT: 0 Cohort: 8 (3, n=51,974 adults/3, n=1,889 children) Other: 16	NR (adults & children)	Yes
Scope match abbreviations: D design (study design), P population, Set setting				

Adults

Two prioritised moderate quality reviews (Fogelholm et al. 2012 [+], Johnson et al. 2009 [+]) found inconsistent results for the relationship between energy density (ED) of the diet and weight related outcomes across 5 cohort studies. These studies varied in how they assessed energy density – some included food only (FO), while others assessed food and drink (FD). This variation may have influenced the results. Even across the studies assessing energy density as FO, results were not consistently significant.

The first review (Fogelholm et al. 2012 [+]) included 2 studies (n=138,063) assessing the association between FO energy density and WC; both found a positive association over 5.5 to 6.5 years, although the size of the effect in these studies was reported to vary (1 kcal/g increase in ED associated with: 0.09 cm [95% CI 0.05 to 0.13] increase in men and 0.15 cm [95% CI 0.09 to 0.21] for women over 5.5 years). The review concluded that there was suggestive evidence of an association with WC in adults. Four cohort studies (n=141,220) assessing the impact of energy density on weight found mixed results. One study (n=50,026) reported that an increase in FO energy density was associated with an increase in weight over the concurrent period among women, while 1 FO and 1 FD study (n=91,194) found no significant association (direction of non-significant associations NR). The study that found an association assessed change in dietary energy density and weight over the same period, therefore the sequence of these changes cannot be established.

The second review (Johnson et al. 2009 [+]) identified 1 additional cohort study (n=186) in adults relevant to the current review scope, and it found a significant association between FO energy density and weight.

Children and young people

The moderate quality review (Johnson et al. 2009 [+]) identified 3 cohort studies (n=1,889) in children. Food only energy density had a positive association with adiposity over 2 to 8 years in 2 studies (n=1,091), although the significance of the association varied with age of exposure and outcome (significant positive association between for excess adiposity at age 9 per kJ/g ED at age 7: 1.36, 95% CI 1.09 to 1.69; non-significant positive association for ED at age 5: 1.12, 95% CI 0.90 to 1.40; OR for gaining the most fat between ages 7 and 15 years 1.9, 95% CI 1.1 to 3.6), and 1 of these studies was very small (n=48). All of the analyses where ED of the diet was assessed based on food and drink (3 studies) found no significant association with adiposity or weight gain (2 showed a positive direction of effect and 1 showed an inverse direction of effect).

Evidence Statement 40: Relationship between energy density (ED) and weight related outcomes

Adults: Moderate evidence from 2 moderate quality reviews[1,2] of cohort studies suggests that energy density (ED) of the diet may be positively associated with waist circumference (WC) in adults; evidence on the relationship with weight is inconclusive.

One review[1] found a positive association between food only ED and WC over 5.5 to 6.5 years, but the size of this effect varied (1 kcal/g increase in ED associated with: 0.09 cm [95% CI 0.05 to 0.13] increase for men and 0.15 cm [95% CI 0.09 to 0.21] increase for women over 5.5 years).

The reviews[1,2] found mixed associations with weight across 4 cohort studies: 2 found a significant positive association, and 2 found no association

(direction of effect NR). Within studies assessing food only (the most commonly used method) results varied as well.

Children and young people: Weak evidence from 1 moderate quality review[2] of cohort studies suggested that food only ED of the diet is positively associated with adiposity in children and young people, although the significance of this association varied across studies.

The review[2] found a positive associations of varying statistical significance, between ED of food only and adiposity over 2 to 8 years, (OR for excess adiposity at age 9 per kJ/g ED at age 7: 1.36, 95% CI 1.09 to 1.69; at age 5: 1.12, 95% CI 0.90 to 1.40. These findings are limited by the small number and size of the studies. The links between ED of food and drink and weight or adiposity were non-significant (mixed directions of effect).

Applicability to the UK: The results of these reviews are applicable to the UK.

[1] Fogelholm et al. 2012 [+]
[2] Johnson et al. 2009 [+]

4.4.7 Non-nutritive sweetener consumption

Table 35: Prioritised reviews assessing non-nutritive sweetener consumption

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Wiebe et al. 2011 [++]	Complete: D Partial: P Unclear: Set	RCT: 53 (1, n=133) Cohort: 0 Other: 0	No (adults)	Yes
Summerbell et al. 2009 [++]	Complete: D Partial: None Unclear: Set, P	RCT: 0 Cohort: 3 (3, n=111,190) Other: 0	Positive (adults)	Yes
USDA 2010c [+]	Complete: None Partial: D, P Unclear: Set	RCT: 1 (0) Cohort: 1 (1, n=3,371) Other: 1	Positive (adults)	Yes

Brown et al. 2010 [-]	Complete: None Partial: D, P Unclear: Set	RCT: 3 (1, n=103) Cohort: 6 (6, n=16,119) Other: 9	Inconclusive (children)	Unclear
Scope match abbreviations: D design (study design), P population, Set setting				

Adults

Two reviews (USDA2010c [+], Summerbell et al. 2009 [++]) including cohort studies both found a positive association between non-nutritive sweetener consumption and weight related outcomes. However, both of these reviews suggested that this was likely to be due to reverse causality. A third high quality review (Weibe et al. 2011 [++]) found the evidence from RCTs about the effects of non-caloric sweeteners is inconclusive.

One high quality review (Summerbell et al. 2009 [++]), included 3 prospective cohort studies (n=111,190). The 2 largest cohort studies (both in women) both found significant positive associations with weight change over 1 to 4 years, in 1 study this association was particularly strong in women with the highest weight at baseline. The smallest study (n=556) found a positive association with weight gain over 4 years that was no longer significant after adjustment for confounders including baseline BMI.

The moderate quality review (USDA2010c [+]), included 1 cohort study (n=3,371) relevant to the current review scope, and this found significant positive associations with weight-related outcomes over 7 to 8 years.

The associations across the 2 reviews ranged from a weak correlation between saccharin intake and change in weight in women over 4 years (r=0.0024, 95% CI 0.00176 to 0.0030) to a doubling in the risk of obesity in people who consumed more than 21 non-nutritively sweetened beverages a week compared with none over 7 to 8 years (OR 2.03, CI NR). In terms of weight and BMI changes, these were medium in size (users vs. non-users of non-nutritive sweeteners: difference in mean weight gain 0.67 kg over 1 year;

difference in mean BMI change: 0.47 kg/m^2 over 7 to 8 years [reviewer calculated figures]).

The second high quality review (Wiebe et al. 2011 [++]), identified 1 RCT (n=133) of non-nutritive sweeteners that assessed weight related outcomes and matched the scope of the current review. This RCT found no significant difference between aspartame (3.56 g/day) and sucrose (42 g/day) in BMI change over 4 weeks (mean difference -0.3kg/m^2, 95% CI -1.1 to 0.5). The direction of the non-significant effect was inverse, and the study may have been too small and short to detect an effect.

Children and young people

One low quality review (Brown et al. 2010 [-]) identified 6 cohort studies assessing the effect of non-nutritive sweeteners (assessed as non-nutritively sweetened beverage intake) on body weight and related outcomes in children and young people. The cohort studies had inconsistent findings in terms of direction of effect and significance. Sizes of effects were not reported.

The review also included RCTs and cross sectional studies. Only 1 small RCT (n=103) was not in selected overweight/obese populations, but it could not determine the effect of non-nutritive sweeteners specifically as it assessed replacing sugar sweetened beverages with non-nutritively sweetened beverages or water. It found no significant difference in BMI overall at 25 weeks.

The review concluded that data from observational studies supports an association between non-nutritively sweetened beverage consumption and weight gain in children, but the limited RCTs are inconclusive. These conclusions included the studies relevant to the current review scope as well as cross sectional studies, and RCTs in overweight and obese participants.

Evidence Statement 41: Relationship between non-nutritive sweeteners and weight related outcomes

Adults: Inconclusive evidence was identified from 2 high quality[1,3] reviews and 1 moderate quality[2] review of RCTs, cohort studies, and cross sectional studies on the prospective relationship between non-nutritive sweeteners and weight related outcomes in adults.

The reviews of observational evidence[1,2] suggested that non-nutritive sweeteners are positively associated with weight, but that this is likely to reflect reverse causality. Associations in cohort studies ranged from relatively small (weight change r=0.0024, 95% CI 0.00176 to 0.0030) to large (OR 2.03 for obesity for those consuming 21 non-nutritively sweetened beverages/week vs. none, CI NR).

This was not supported by the RCT relevant to the current scope identified in another review[3]. This small RCT found a non-significant inverse association with BMI change over 4 weeks (aspartame vs. sucrose, mean difference: -0.3 kg/m^2, 95% CI -1.1 to 0.5). The RCT may have been too small and short to detect an effect.

Children and young people: Inconclusive evidence was identified from 1 low quality review[4] of cohort studies regarding the relationship between non-nutritive sweeteners and weight related outcomes in children and young people.

Three of 6 cohort studies found a positive association, 1 found an inverse association, and 2 found no association (figures NR).

Applicability to the UK: The results of 3 reviews are applicable to the UK. The country in which included studies were performed was not reported in the fourth[4] so its applicability to the UK is unclear.

[1] Summerbell et al. 2009 [++]
[2] USDA2010c [+]

[3] Wiebe et al. 2011 [++]
[4] Brown et al. 2010 [-]

4.4.8 Dietary sugar consumption (sucrose, glucose, fructose, high fructose corn syrup)

Table 36: Prioritised reviews assessing sugar consumption

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Te Morenga et al. 2013 [++] (dietary sugars)	Complete: D Partial: P Unclear: Set	RCT: 30 (13 n=1,387 adults/ 5, n=2,968 children) Cohort: 38 (16, n=289,614 adults/ 22, n=29,219 children) Other: 0	No (isocaloric consumption) Positive (hypercaloric consumption) (adults & children)	Unclear
Sievenpiper et al. 2012 [++] (fructose)	Complete: None Partial: D, P Unclear: Set	RCT: 21 (10, n=117) Cohort: 0 Other: 20	No (isocaloric consumption) Positive (hypercaloric consumption) (adults)	Yes
Wiebe et al. 2011 [++] (fructose, glucose, sucrose)	Complete: D Partial: P Unclear: Set	RCT: Unclear (6, n=240) Cohort: 0 Other: 0	Inconclusive (adults)	Yes
Scope match abbreviations: D design (study design), P population, Set setting				

Adults

Three high quality reviews (Te Morenga et al. 2013 [++], Sievenpiper et al. 2012 [++], Wiebe et al. 2011 [++]) generally found positive associations between dietary sugar intake and weight related outcomes in adults, however, this association may be due to overall increased energy intake, as significant associations were generally seen in hypercaloric but not isocaloric consumption.

A high quality review (Sievenpiper et al. 2012 [++]) of RCTs and non-randomised controlled feeding trials found an increase in weight when fructose was added to the diet hypercalorically in normal weight individuals over 1 to 4 weeks (18% to 97% excess energy; 0.37 kg, 95% CI 0.15 to 0.58). It found no effect when fructose was added to the diet isocalorically in normal weight individuals over 1 to 6 weeks (n=417; -0.13 kg, 95% CI -0.37 to 0.10). These findings may be impacted by confounding due to the inclusion of non-randomised studies.

One high quality review (Te Morenga et al. 2013 [++]) that included RCTs and cohort studies found that RCTs showed that reducing dietary sugar intake reduced body weight, while increasing sugar intake increased body weight. This appeared to be related to the effect of sugar intake on total energy intake, as trials where sugars were substituted for other macronutrients (mainly complex carbohydrates) with no change in total energy intake found no impact on body weight. Meta-analysis of 5 RCTs reported that a reduction in sugar intake by up to 14% of total energy intake reduced weight by 0.80 kg (95% CI 0.39 to 1.21), while increasing sugar intake by 6.6% to 23% of TEI increased body weight by 0.75 kg (95% CI 0.30 to 0.19).

The RCTs included in Te Morenga et al. 2013 [++] were small and short term. Some of the RCTs were in overweight and obese individuals or those with health conditions such as diabetes, as well as trials in normal weight participants, so may not reflect what would be seen in the general population as a whole in the longer term.

The 16 cohort studies identified by Te Morenga et al. 2013 [++] had longer follow up (2 to 9.9 years) and supported the findings, with most finding a positive association between dietary sugars and weight related outcomes, 1 showed mixed results (associated with both weight gain and loss), and 4 no significant associations (direction NR).

One high quality review (Wiebe et al. 2011 [++]) focused on the health effects of different sweeteners, (sugars, sugar alcohols and non-caloric sweeteners).

The 6 small RCTs (n=240) that it identified that compared different sugars or sugars versus other sweeteners found no significant difference in weight related outcomes between them.

Children and young people

One high quality review (Te Morenga et al. 2013 [++]) including RCTs and cohort studies found mixed results. The majority of studies in the review assessed sugar sweetened beverages (SSBs) rather than sugar as a whole. Results specifically focusing on SSB consumption are described in Section 4.3.1.

The 5 RCTs aimed to reduce sugar intake, mainly though educational or behavioural intervention alone. The interventions achieved reductions of sugar intake compared with control (usual diet, no education, or nutrition education/advice not aimed specifically at sugar reduction) of 4.5 g to 63 g of sugar per day, 0.1 glasses/day of sugar sweetened fizzy drinks, or 56 ml/day fizzy drinks. The RCTs found no significant effect of the interventions on BMI or BMI z-scores over 16 weeks to 8 months (WMD 0.09, 95% CI -0.14 to 0.32). This may have been due to the poor compliance with the intervention in 3 studies.

Of the 22 cohort studies identified in children, 13 found a positive association between increased sugar intake and a measure of adiposity, 2 reported mixed positive and inverse associations, 2 studies reported an inverse association, and 4 showed no significant effects (directions NR).

Evidence Statement 42: Relationship between dietary sugar consumption (sucrose, glucose, fructose, high fructose corn syrup) and weight related outcomes

Adults: Strong evidence from 3 high quality reviews[1,2,3] of RCTs and cohort studies suggests that consumption of dietary sugars increases body weight if

total energy intake (TEI) is increased, but has no effect if TEI remains the same.

Two meta-analysis[1,2] of RCTs and non-randomised trials found that changing sugar intake and TEI was positively associated with weight change (reducing sugar up to 14% TEI reduced weight by 0.80 kg [95% CI 0.39 to 1.21], and increasing sugar 6.6% to 23% TEI increased weight by 0.75 kg [95% CI 0.30 to 1.19]).[1] This positive association was supported by 10/16 cohort studies in the review. Isocaloric sugar intake (substituting 17% to 20% of energy from sugars with other energy sources) did not affect body weight.

One meta-analysis[2] of RCTs and non-randomised trials of fructose found a significant positive association when TEI increased, but no significant effect in isocaloric comparisons (hypercaloric: 0.37kg, 95% CI 0.15 to 0.58; isocaloric: -0.13 kg, 95% CI -0.37 to 0.10). RCTs included in a third review[3] which compared different sugars or sugars versus other sweeteners found no difference in weight related outcomes between them.

Children and young people: Moderate evidence from 1 high quality review[1] of cohort studies and RCTs suggests that there is a positive relationship between intake of dietary sugars and weight related outcomes in children.

The conclusion is based on cohort studies that assessed of sugar sweetened beverages. Meta-analysis of RCTs found no significant effect of interventions aimed at reducing sugar intake and change in BMI or BMI z-scores over 16 weeks to 8 months (WMD 0.09, 95% CI -0.14 to 0.32). This may have been due to poor compliance with the largely educational interventions.

Applicability to the UK: The results of 2 reviews are applicable to the UK. The country in which included studies were performed was not reported in one review so its applicability to the UK is unclear.

[1] Te Morenga et al. 2013 [++]
[2] Sievenpiper et al. 2012 [++]
[3] Wiebe et al. 2011 [++]

4.4.9 Catechins consumption

Table 37: Prioritised reviews assessing catechins consumption

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Phung et al. 2010 [++]	Complete: D Partial: P Unclear: Set	RCT: 15 (4, n=388) Cohort: 0 Other: 0	Inverse (adults)	Unclear
Scope match abbreviations: D design (study design), P population, Set setting				

Adults

Phung et al. 2010 [++] concluded that green tea catechins and caffeine combined were significantly associated with reduction in BMI, body weight, and WC but described the clinical significance as modest at best. The meta-analysis contained relevant and non-relevant studies in the context of this review.

The review included 15 RCTs of green tea catechins with or without caffeine, of which 4 were relevant to this review (the remainder were solely in overweight or obese individuals or in people with specific health conditions such as diabetes).

Meta-analysis found that green tea catechins (583 mg to 714 mg/day) with caffeine (70 to 114 mg/day) consumed for 3 to 12 weeks reduced BMI (-0.55 kg/m^2, 95% CI -0.65 to -0.40), body weight (-1.38 kg, 95% CI -1.70 to -1.06), and WC (-1.93 cm, 95% CI -2.82 to -1.04), but not waist to hip ratio (0.02, 95% CI -0.05 to 0.0008) compared with dose matched caffeine control (0 to 126 mg catechins plus 70 to 114 mg caffeine). The meta-analyses included some of the RCTs not relevant to the current review scope, including some which provided catechins as capsules rather than as tea. The review did not find benefits in trials looking at catechins alone (without caffeine, mainly given as capsules), but none of these trials matched the scope of the current review.

Children and young people

The review by Phung et al. 2010 [++] did include one RCT in children and young people, but they were all obese and therefore the RCT did not match the scope of the current review.

Evidence Statement 43: Relationship between catechin intake and weight related outcomes

Adults: Weak evidence from 1 high quality review[1] of RCTs suggests that catechins may be associated with reduced body weight and related outcomes in the short term.

Meta-analysis of small, short-term RCTs found that green tea catechins with caffeine significantly reduced BMI (-0.55 kg/m^2, 95% CI -0.65 to -0.40), body weight (-1.38 kg, 95% CI -1.70 to -1.06), and waist circumference (-1.93 cm, 95% CI -2.82 to -1.04), but not waist to hip ratio compared with a caffeine at 3 to 12 weeks. These analyses include some RCTs solely in overweight and obese individuals or individuals with health conditions, and may not reflect effects that might be seen in the general population.

Children and young people: No evidence was identified specifically about the effects of catechins on weight related outcomes in children or young people.

Applicability to the UK: The country of origin of included studies in the review was not reported, so its applicability to the UK is unclear.

[1]Phung et al. 2010 [++]

4.4.10 Caffeine consumption

Table 38: Prioritised reviews assessing caffeine consumption

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable

Summerbell et al. 2009 [++]	Complete: D Partial: None Unclear: P, Set	RCT: 0 Cohort: 3 (3, n=32,612) Other: 0	No (adults)	Yes
Scope match abbreviations: D design (study design), P population, Set setting				

Adults

One high quality review (Summerbell et al. 2009 [++] including 3 prospective cohort studies (n=32,612) with follow up of between 1 and 12 years, concluded that caffeine intake was not associated with subsequent excess weight gain or obesity.

Two out of the 3 studies (n=556 and n=31,940) found no significant association between caffeine intake and weight change over 1 to 4 years (regression coefficients 0.0003 and 0.143, units not specified). The third small study (n=116) found no association between caffeine and BMI change in men (figures NR), but found women in a 'BMI-gain' group (not further defined) were more likely to consume caffeine (OR 0.2, 95% CI 0.04 to 0.94, p=0.04; exact comparison this data refers to unclear).

Children and young people

Summerbell et al. 2009 [++] did not identify any studies of caffeine intake in children and young people.

Evidence Statement 44: Relationship between caffeine intake and weight related outcomes

Adults: Weak from 1 high quality review[1] of cohort studies suggests that caffeine intake is not associated with weight related outcomes in adults.

Two out of 3 cohort studies found no significant association between caffeine intake and weight gain, while the smallest cohort study found no association in men, but that caffeine consumption was more common in women who had BMI increases over 1 year (OR 0.2, 95% CI 0.04 to 0.94).

Children and young people: No evidence was identified on caffeine and weight related outcomes specifically in children or young people.

Applicability to the UK: The results of the review are applicable to the UK.

[1] Summerbell et al. 2009 [++]

4.5 Eating patterns

4.5.1 Eating meals prepared outside of home (eating out/take away meal/fast food)

Table 39: Prioritised reviews assessing eating meals prepared outside of home (eating out/take away meal/fast food)

Author, date [quality] (factor assessed)*	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Bezerra et al. 2012 [++] (eating out of home)	Complete: None Partial: D Unclear: Set, P	RCT: 0 Cohort: 8 (8, n=35,938) Other: 20	Positive (adults)	Yes
Mesas et al. 2012 [+] (eating out of home, fast food intake, takeaway food intake)	Complete: P Partial: D Unclear: Set	RCT: 0 Cohort: 10 (7, n=34,913 adults/ 3, n=24,375 children) Other: 32	Positive (adults & children)	Yes
Rosenheck 2008 [+] (fast food consumption)	Complete: None Partial: D, P Unclear: Set	RCT: 2 (1, n=891 adults) Cohort: 7 (4, n=23,538 adults/ 3, n=7,004 children) Other: 7	Positive (adults & children)	Yes
Summerbell et al. 2009 [++] (fast food consumption)	Complete: D Partial: None Unclear: Set, P	RCT: 0 Cohort: 6 (4 n=16,826 adults/ 2, n=1,626 children) Other: 0	Positive (adults & children)	Yes

USDA 2010i [+] (eating out of home, mainly fast food consumption)	Complete: None Partial: D Unclear: Set, P	RCT: 0 Cohort: 9 (5, n=18,380 adults/ 5, n=28,079 children) Other: 2	Positive (adults & children)	Yes
Scope match abbreviations: D design (study design), P population, Set setting *For each review the factor(s) they stated that they assesed is noted, however, there was overlap in the types of expsoures included between the reviews, and therefore they are considered together				

Five reviews in adults and children provided evidence of a positive association between eating food prepared out of the home (including eating out, takeaways, or fast food) and weight related outcomes. The reviews and included studies did not tend to use mutually exclusive definitions of these terms, and there was considerable overlap in included studies between the reviews. Therefore these reviews have been considered together.

All five reviews concluded that there was a positive association between eating food prepared out of the home (defined in various ways as described above) and weight related outcomes based on studies in adults only (Bezerra et al. 2012 [++]) or adults in children (Mesas et al. 2012 [+], Rosenheck 2008 [+], Summerbell et al. 2009 [++], USDA 2010i [+]). The majority of the studies assessed fast food.

Adults

Either all or the majority of relevant included studies in adults (4 to 8 studies in each review; total n ranged from 16,826 to 35,938) found a significant positive association between eating food prepared outside of home and weight related outcomes over between 1 and 15 years (7/8 studies in Bezerra et al. 2012 [++], 5/5 studies in Rosenheck et al. 2008 [+]; 4/4 cohorts in Summerbell et al. 2009 [++]; 5/7 studies in Mesas et al. 2012 [+]; 5/5 in USDA 2010i [+]). The remainder of studies found no significant association, no studies found a significant inverse association.

Effects on weight ranged from 0.09 units increase (units NR) for each additional restaurant eating occasion over 13 years (p=0.04) to 4.5 kg difference in weight gain between those eating fast food more than twice a week over 15 years and those eating fast food less than once a week (p=0.0054). Beta values for BMI or BMI

change (units of eating out of home increase not reported) ranged from -0.23 kg/m^2 for BMI change over 1 year for men (95% CI -0.56 to 0.11; from the one study with non-significant findings) to 0.85 kg/m^2 for BMI high income women at 1 year (95% CI 0.43 to 1.27).

In terms of dichotomous outcomes, the increase in risk associated with eating food prepared outside of home ranged from OR for weight gain (not defined) of 1.2 (95% CI 1.0 to 1.4; highest quintile of fast food intake vs. lowest quintile over 2.4 years), to an OR for gaining ≥2 kg of 1.36 (95% CI 1.13 to 1.63, eating away from home ≥2 times/week vs. 0-3 times/month over 4.4 years).

One review (USDA 2010i [+]) noted that most of the available evidence related to fast food intake, and that the strongest relationship between fast food and obesity has been observed for consuming one or more fast food meals per week.

Only some of the reviews provided definitions of eating out of home, fast food consumption or takeaway meals and these tended to be broad, with included studies also varying in the exposures assessed. This limits the ability to draw more specific conclusions on the effect of eating out at restaurants, fast food consumption or and takeaway meals individually. The majority of studies identified by the reviews assessed fast food intake.

Children and young people

There were fewer studies in the reviews assessing eating food prepared outside the home in children and young people. The majority of studies identified by the reviews assessed fast food intake.

Similarly to adults, either all or the majority of relevant included studies (2 to 5 studies in each review; total n ranged from 1,626 to 28,079) found a significant positive association between eating food prepared outside of home and weight related outcomes over 4 to 10 years (2/3 studies in Rosenheck et al. 2008 [+]; 1/2 in Summerbell et al. 2009 [++]; at least 2/3 studies in Mesas et al. 2012 [+] (results of one study unclear); 4/5 in USDA 2010i [+]). One cohort study in the USDA 2010i [+]

review found a significant inverse association between fast food consumption at baseline in 12 to 16 year old girls (but not boys) and being overweight after 5 years (OR 0.88, 95% CI 0.79 to 0.98; $p<0.05$). The remainder of studies found no significant association.

Few effect sizes were reported in the reviews, effects on BMI or BMI z score included a beta value for the association between eating fast foods at baseline and BMI z-score after 5 years of 0.02 ($p<0.05$), a mean difference in BMI z-score of 0.54 (reviewer calculated) between girls who ate fast food >2 times/week and those who never ate fast food ($p=0.0023$), and a 0.21 kg/m^2 increase in BMI among children who increased their consumption of fried foods outside of the home from <1 time/week to 4-7 times/week over 3 years. It was unclear if the categories being compared in individual studies were selected a priori, or if they represented thresholds at which an effect occurred identified by data analysis.

Evidence Statement 45: Relationship between eating meals prepared outside of home (eating out/fast food/takeaway meals) and weight related outcomes

Adults: Strong evidence from 2 high quality[1,2] reviews and 3 moderate quality reviews[3,4,5] of cohort studies and RCTs suggests there is a positive association between eating food prepared outside of the home (mainly 'fast food') and weight related outcomes in adults. One review[5] noted that the strongest relationship between fast food and obesity has been observed for consuming one or more fast food meals per week.

The majority of relevant included cohort studies in adults found a significant positive associations over 1 to 15 years. Effects on weight ranged from 0.09 units increase (units NR) for each additional restaurant eating occasion over 13 years ($p=0.04$) to 4.5 kg difference in weight gain between those eating fast food more than twice a week over 15 years and those eating fast food less than once a week ($p=0.0054$).

Children and young people: Moderate evidence from 1 high quality[2] review and 3 moderate quality reviews[3,4,5] of cohort studies suggests there is a positive association

between eating food prepared outside of the home (mainly fast food) and weight related outcomes in children and young people.

All or the majority of relevant included studies found a significant positive association, but 1 study did find an inverse association.

Effects on BMI z score ranged from a beta value for the association between eating fast foods at baseline and BMI z-score after 5 years of 0.02 ($p<0.05$) to a mean difference in BMI z-score of 0.54 (reviewer calculated) between girls who ate fast food >2 times/week and those who never ate fast food ($p=0.0023$).

Applicability to the UK: The results of these reviews are applicable to the UK.

[1] Bezerra et al. 2012 [++]
[2] Summerbell et al. 2009 [++]
[3] Mesas et al. 2012 [+]
[4] Rosenheck et al. 2008 [+]
[5] USDA 2010i [+]

4.5.2 Eating occasions (eating frequency)

Table 40: Prioritised reviews assessing eating occasions (eating frequency)

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Mesas et al. 2012 [+]	Complete: P Partial: D Unclear: Set, P	RCT: 0 Cohort: 4 (2, n=27,211 adults/ 2, n=2,476 children) Other: 35	No (adults & children)	Yes
Scope match abbreviations: D design (study design), P population, Set setting				

One moderate quality review (Mesas et al. 2012 [+]) of cohorts, case controls, cross-sectional, experimental and laboratory studies assessed the relationship between eating occasions (e.g. meal/eating/snacking frequency) on weight related outcomes in adults and children. Overall, it concluded that it did not find sufficient evidence of an association with excess body weight in any age group. Review conclusions were

based on studies in adults and children, and studies within and outside of the scope of the current review.

Adults

The review (Mesas et al 2012 [+]) included 2 cohort studies in adults (n=27,211). One study in adults found daily eating frequency was not associated with weight change (beta coefficients 0.02 for men and 0.11 for women, units NR, p>0.05 for both). This study adjusted for total energy intake. The other study found eating 4 meals (hazard ratio [HR] 1.07, 95% CI 1.02 to 1.14) or ≥5 meals (HR 1.15, 95% CI 1.06 to 1.25) a day was associated with a higher risk of 5 kg weight gain after 10 years compared with eating 3 meals a day. This study did not adjust for energy intake, which suggests that the effect could be related to an increased energy intake with more eating occasions.

Children and young people

The review (Mesas et al 2012 [+]) included 2 cohort studies in children (range 8 to 12 years; n=2,476). Both studies found that fewer eating occasions predicted higher BMI compared with more eating occasions, although one found no association with overweight.

One study found that eating 3 or more meals a day was associated with lower BMI z scores (beta -0.0472, p<0.0001), although the effect on overweight was non-significant (OR 0.91, 95% CI 0.79 to 1.05) compared to eating fewer than 3 meals a day (adjusted for average daily energy intake). The other study found eating 4 to 5 meals a day was associated with an increase in BMI z score after 10 years (beta 0.24, p=0.028) compared to eating 6 times or more a day (not adjusted for energy intake).

The relatively small size of these studies, means no firm conclusions can be made on the association between eating frequency and weight related outcomes in children and young people.

Evidence Statement 46: Relationship between eating occasions (eating/meal/snack frequency) and weight related outcomes

Adults: Inconclusive evidence was identified from one moderate quality review[1] of cohort studies.

The 2 cohort studies in adults included in the review had differing results. One study, which adjusted for total energy intake, found no association with weight change over 8 years (small non-significant positive direction of effect). The second, which did not adjust for total energy intake, found eating 4 or ≥5 meals a day was associated with a higher risk of 5 kg weight gain after 10 years compared to eating 3 meals a day (HR 1.07, 95% CI 1.02 to 1.14; HR 1.15, 95% CI 1.06 to 1.25, respectively).

Children and young people: Inconclusive evidence was identified from 1 moderate quality review[1] of cohort studies about eating frequency and weight related outcomes in children.

The 2 cohort studies in children included in the review both found an association between more frequent eating and lower BMI, although 1 found no significant association with overweight. One study found eating 3 or more meals a day was significantly associated with lower BMI z scores (beta -0.0472; adjusted for energy intake) compared to eating fewer than 3 meals a day. The other study found eating 4 to 5 meals a day was significantly associated with an increase in BMI z score after 10 years (beta 0.24; not adjusted for energy intake) compared to eating 6 times or more a day.

Applicability to the UK: The results of this reviews are applicable to the UK.

[1] Mesas et al. 2012 [+]

4.5.3 Eating in the evening

A variety of eating patterns were originally considered as part of this factor (e.g. timing of eating, consistency of eating across the week), however, evidence was identified for eating in the evening in adults only. No other

evidence was identified in adults, or on the association between eating patterns and weight related outcomes in children and young people. The results reported in this section relate to eating in the evening only.

Table 42: Prioritised reviews assessing eating in the evening

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Summerbell et al. 2009 [++]	Complete: D Partial: None Unclear: Set, P	RCT: 0 Cohort: 2 (2, n=13,411) Other: 0	No (adults)	Yes
Scope match abbreviations: D design (study design), P population, Set setting				

Adults

A single high quality review in adults (Summerbell et al. 2009 [++]) found no evidence of a consistent association between eating after 5pm and weight gain or obesity. The review included 2 prospective cohorts, both of which found no association between eating in the evening and change in weight over a 6 to 10 year follow up (figures not reported). The studies assessed slightly differing exposures, with one assessing the percentage of daily energy intake consumed after 5pm, and the other assessing whether people got up at night to eat.**Children and young people**

No evidence was identified on eating in the evening and weight related outcomes in children and young people was identified.

Evidence Statement 47: Relationship between eating in the evening and weight related outcomes

Adults: Weak evidence from one high quality review[1] of cohort studies suggests that there is no association between eating in the evening and weight change in adults.

No evidence was identified on the association between eating patterns other than night eating and weight related outcomes in adults.

Children and young people: No evidence was identified on eating in the evening or other eating patterns and weight related outcomes in children or young people.

Applicability to the UK: The results of the review are applicable to the UK.

[1] Summerbell et al. 2009 [+]

4.5.4 Family meals

Table 43: Prioritised reviews assessing family meals

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Hammons and Fiese 2011 [+]	Complete: None Partial: D Unclear: Set, P	RCT: 0 Cohort: 4 (4, n=29,961) Other: 4	Inverse (children)	Yes
Scope match abbreviations: D design (study design), P population, Set setting				

Adults

No evidence was identified on the associations between family meals and weight related outcomes in adults.

Children and young people

A single moderate quality review (Hammons and Fiese 2011 [+]) found that sharing 3 or more family meal times (not standardly defined) per week was associated with reduced risk of overweight among children and young people.

The review conducted a meta-analysis including 8 cohort studies of mixed study designs (4 cohorts and 4 cross sectional studies) and found children

and young people who took part in at least 3 shared family meals per week were less likely to be overweight compared with those who ate fewer family meals (OR 0.88, 95% CI 0.81 to 0.97, p value not reported). The meta-analysis had borderline significant heterogeneity (I^2=48.45%, p=0.06).

Meta-analysis of the cohort studies also showed that shared family meals were associated with a reduction in the risk of risk of overweight over 2 to 5 years (OR 0.93, 95% CI 0.90 to 0.95, p value not reported) The frequencies of family meals being compared in this analysis was not reported.

Individually, 1 study found a small significant reduction in obesity with more frequent family meals (OR 0.93), 2 found small to large non-significant reductions in overweight or obesity (ORs 0.55 and 0.99) and 1 found a large increase in overweight (OR 1.28). Family meals were defined in different ways in the included studies (at least 1 parent present, number of family members [relationship unspecified] present, or not defined) and this may contribute to inter-study variability.

The cohort studies were all adjusted for confounders. This included socioeconomic status (SES) or related factors (e,g. maternal education, household income) in 3 studies (including the study with significant results), physical activity in 2 studies, and energy intake in 1 study.

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Evidence Statement 48: Relationship between family meals and weight related outcomes

Adults: No evidence was identified on the relationship between family meals and weight related outcomes in adults.

Children and young people: Weak evidence from 1 moderate quality review[1] of cohort and cross sectional studies suggests that family meal frequency is inversely associated with weight related outcomes.

Meta-analysis of cohort and cross sectional studies[1] found that having at least 3 shared family meals per week was associated with a reduced risk of overweight compared with fewer shared meals (OR 0.88, 95% CI 0.81 to 0.97). Restricting the analysis to cohort studies reduced the size of the effect, but it remained significant (OR 0.93, 95% CI 0.90 to 0.95; frequency of family meals being compared not reported). Definitions of family meals varied, and only 1 cohort study adjusted for total energy intake.

Applicability to the UK: The results of the review are applicable to the UK.

[1] Hammons and Fiese 2011 [+]

4.5.5 Breakfast consumption

Table 44: Prioritised reviews assessing breakfast consumption

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Mesas et al. 2012 [+]	Complete: P Partial: D, Set Unclear: None	RCT: 0 Cohort: 10 (2, n=20,698 adults/8, n=unclear children) Other: 76	Inverse (adults and children)	Yes
USDA 2010f [+]	Complete: None Partial: D Unclear: Set, P	RCT:1 (0) Cohort: 16 (3, n=27,116 adults/ 13, n=unclear children) Other: 1	Inverse (adults and children)	Yes
Scope match abbreviations: D design (study design), P population, Set setting				

Two moderate quality reviews (Mesas et al. 2012 [+]; USDA 2010f [+]) found that the evidence suggested an inverse association between consuming breakfast and weight related outcomes, but study findings were inconsistent.

Adults

One review (Mesas et al. 2012 [+]) included 2 large cohort studies in men and 13 cross-sectional studies. The 2 cohorts, found inverse associations between

breakfast and weight related outcomes, with eating breakfast being associated with lower hazard of gaining 5 kg or more over 10 years compared to not eating breakfast (HR: 0.91, 95% CI 0.85 to 0.97), while the second study found that skipping breakfast was associated with increased odds of a 5% or greater BMI gain over the course of a year (OR: 1.34, 95% CI 1.12 to 1.61, p value NR). The review noted that it was difficult to separate the impact of eating breakfast per se, and what the breakfast contained (e.g. fibre, nutrients). Overall it concluded that there was only small or inconsistent evidence of a relationship between excess weight and various eating behaviours, including whether or not one ate breakfast.

One review (USDA 2010f [+]) concluded that there was inconsistent evidence that adults who skip breakfast are at increased risk for overweight and obesity based on 6 cohort studies in adolescents and adults. The 1 adult cohort study in this review not in Mesas et al. 2012 (n=6,764 men) found a small inverse association with weight change (% energy from breakfast and weight change: beta=-0.021, 95% CI -0.035 to -0.007). Another study described as a cohort study in the USDA 2010f [+] review, but as cross sectional by Mesas et al. 2012 [+], found a non-significant positive direction of effect (frequency of eating breakfast and weight gain beta=0.04 kg/year, p=0.21, units NR).

Children and young people

One review (USDA 2010f [+]) included 13 studies (based on 7 cohorts, n ranging from 355 to 14,586) relevant to the current review scope, plus 2 non-relevant intervention studies. It concluded that children who do not eat breakfast are at increased risk of being overweight and obese and that the evidence is stronger for adolescents (young people). The other review (Mesas et al. 2012 [+]) included 8 relevant cohorts (1 of which was not in USDA 2010f [+], n=508), as well as a large body of cross sectional studies.

The cohort studies included across the reviews had mixed findings, with most studies (9/14) finding at least one inverse association in at least one analysis. Five studies (4 cohorts) found an overall inverse association between

breakfast consumption and weight related outcomes, 5 found inverse associations in one subgroup analysis but no significant association in another subgroup (gender, weight or breakfast type subgroups; 1 study assessed cereal rather than breakfast as a whole), 1 found a significant positive effect in one subgroup (overweight children) and a non-significant inverse association in the other (normal weight children), and 3 studies found no significant association (2 with inverse direction of effect either of the adjusted analysis or adjusted analyses, 1 with direction NR).

Effect sizes ranged from small (beta for change in BMI z score in normal weight girls associated with eating breakfast ≥1 day a week over 10 years 0.02, 95% CI -0.01 to 0.05) to large (OR for overweight or obesity in boys who skipped breakfast in adolescence of 1.37 at 6 year follow up compared to those who did not, $p<0.05$).

Evidence Statement 49: Relationship between breakfast consumption or skipping and weight related outcomes

Adults: Weak evidence from 2 moderate quality reviews[1,2] of cohort studies suggests there may be an inverse association between breakfast consumption and weight related outcomes in adults.

This is based on the cohort studies, which found effect sizes ranging from small (regression coefficient=-0.021, 95% CI -0.035 to -0.007, p=0.004 for the association between % of daily energy consumed at breakfast and weight gain), to large (frequently skipping breakfast vs. not, OR for ≥5% increase in BMI after 1 year: 1.34, 95% CI 1.12 to 1.61, p value not reported).

Children and young people: Weak evidence from 2 moderate quality reviews[1,2] of cohort studies suggests there may be an inverse association between breakfast consumption and weight related outcomes in children and young people.

The studies (based on 8 cohorts) included in the reviews[1,2] had inconsistent results in terms of significance and direction of effect, although most found a significant inverse association in at least one analysis. The size of effect seen in the studies ranged from a small but non-significant positive association (eating breakfast ≥1 day a week associated with a beta for change in BMI z score in normal weight girls over 10 years of 0.02, 95% CI -0.01 to 0.05) to a large inverse association (OR for overweight or obesity in boys who skipped breakfast in adolescence of 1.37 at 6 year follow up compared to those who did not, p<0.05).

Applicability to the UK: The results of the reviews are applicable to the UK.

[1] Mesas et al. 2012 [+]
[2] USDA 2010f [+]

4.5.6 Snack consumption

Table 45: Prioritised reviews assessing snack consumption

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Mesas et al. 2012 [+]	Complete: P Partial: D, Set Unclear: None	RCT: 0 Cohort: 8 (4, n=73,068 adults/4, n=19,562 children) Other: 36	Inconclusive (adults and children)	Yes
USDA 2010m [+]	Complete: None Partial: D, P Unclear: Set	RCT: 0 Cohort: 5 (5, n=16,634) Other: 1	Positive (children)	Yes
Larson and Story 2013 [+]	Complete: None Partial: D Unclear: Set, P	RCT: 0 Cohort: 7 (7, n=28,958) Other: 25	Inconclusive (children)	Yes
Summerbell et al. 2009 [++]	Complete: D Partial: None Unclear: Set, P	RCT: 0 Cohort: 3 (3, n=16,069) Other: 0	No (children)	Yes
Scope match abbreviations: D design (study design), P population, Set setting				

Adults

One moderate quality review (Mesas et al. 2012 [+]) included 4 cohort studies relevant to the current review scope and 14 cross sectional studies in adults (outside of the current review scope). The cohort studies (n=73,068) all found positive associations between snacking and weight related outcomes in adults over 4 to 9 years. Associations ranged from small (every 60 kcal of snack food consumption associated with 0.06 cm increase [95% CI 0.003 to 0.11] in waist circumference over 5 years in women) to large (OR for gaining ≥5 kg/year over 4.6 years for usual snacking between meals vs. no usual snacking: 2.75, 95% CI 1.17 to 6.50). One found significant positive associations for snacking (eating between meals) in men aged 45 to 64 years, but not among older men. It was not clear if these analyses by age were specified a priori, or whether the study provided overall results across all ages.

The studies had differing definitions of snacking, with 2 considering eating between meals snacking, 1 considering variety of snack foods consumed (not further defined), and the fourth considering consumption of specific snack foods (not further defined in the review).The studies were reported to have adjusted for confounders, with 2 adjusting for energy intake.

Children and young people

One high quality (Summerbell et al. 2009 [++]) and 3 moderate quality reviews (Larson and Story 2013 [+], Mesas et al. 2012 [+] and USDA 2010m [+]) found no clear or consistent link between snacking or snacks on weight related outcomes in children and young people. The reviews included mixed observational study designs, including cross sectional and case control studies as well as cohort studies. Even within the studies relevant to the current review scope, results were not consistent.

The relevant studies (7 cohort studies, n= 28,958) from the most recent and largest review (Larson and Story 2013 [+]) found a positive association between snacking and weight related outcomes in 2 studies (n=2,175), an inverse association in 2 studies (n= 15,847; 1 of these associations were for reduced fat snack foods), and no association in 3 studies (n=10,936). Based on these and the studies with non-relevant study designs, the review concluded the majority of studies either found no evidence of a relationship between snacking behaviour and weight status or found evidence indicating that young people who consumed more snacks were less likely to be obese. The reviewers suggested that results might be influenced by reverse causality or biased self-reporting (overweight youth reducing their snacking for weight loss or under reporting snack intake more often than youth at a healthy weight).

The other reviews similarly found mixed results in the cohort studies, and came to differing conclusions. Mesas et al. 2012 [+] included 4 cohorts (n= 19,562): 3 finding no significant association, 1 finding some significant positive associations but some non-significant (including some with inverse direction of effect). Based on these results and the results in other study designs, it concluded that the studies showed no clear association between snacking and excess weight.

The USDA 2010m [+] included 5 cohorts (n=16,634), 2 of which found a significant positive association, and 3 found no association. Based on these and 1 other study outside the scope of the current review it concluded that the evidence was limited and inconsistent but suggests that snacking is associated with increased body weight.

Summerbell et al. 2009 [++] included 3 cohorts (n=16,069), 2 found a significant positive association in at least 1 analysis, and 1 found an inverse association. It concluded that there was no evidence of a consistent association between snacking frequency and subsequent excess weight gain or obesity.

There was overlap between the studies included in the reviews. The definitions of snacks in the included studies varied widely, and this is likely to have contributed to the variability seen in results. For example, within 1 study in the review by Mesas et al. 2012 [+], analyses using differing definitions of snacking (frequent snacking or replacing meals with snacks) altered the significance and direction of effect.

In addition, at least 1 large study (n=14,977) included by all 3 reviews, was reported as having different findings in these reviews (non-significant relationship between snack food consumption and BMI z score in Mesas et al. 2012 [+] and USDA 2010m [+]; reduced-fat snack food inversely associated with weight gain boys in Larson and Story 2013 [+]; a weak inverse association with the change in BMI z-score in girls in Summerbell et al. 2009 [++]). This may be due to different reviews focusing on different aspects of the analyses.

These considerations preclude drawing firm conclusions on the effect of snacking in children and young people.

Evidence Statement 50: Relationship between snacking/snacks and weight related outcomes

Adults: Weak evidence was identified from 1 moderate quality review[1] of cohort studies suggested that snacking or snacks are positively associated with body weight related outcomes in adults.

The review[1] found consistent positive associations between snacking and weight related outcomes over 4 to 9 years, ranging from relatively small (every 60 kcal of snack food consumption associated with 0.06 cm increase [95% CI 0.003 to 0.11] in WC over 5 years in women) to large (OR for gaining ≥5 kg/year over 4.6 years for usual snacking between meals vs. no usual snacking: 2.75, 95% CI 1.17 to 6.50).

The studies differed in their definitions of snacking (e.g. eating between meals, or defining certain foods as snack foods).

Children and young people: Inconclusive evidence was identified from 1 high quality review[4] and 3 moderate quality reviews[1,2,3] of cohort studies regarding the relationship between snacking or snacks and body weight and related outcomes in children and young people.

One review[3] found a positive association between snacking and weight related outcomes in 2 cohort studies, an inverse association in 2 cohort studies (1 of these associations were for reduced fat snack foods), and no association in 3 studies.

The other reviews[1,2] found inconsistent results in terms of significance and direction associations, this may be due to varied ways in which snacking was defined and analysed, and may also be affected by reverse causality or biased reporting of snack intake.

Applicability to the UK: The results of the reviews are applicable to the UK.

[1] Mesas et al. 2012 [+]
[2] USDA 2010m [+]
[3] Larson and Story 2013 [+]
[4] Summerbell et al. 2009 [++]

4.6 Other factors

4.6.1 Sleep

Table 46: Prioritised reviews assessing sleep

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Chen et al. 2008 [+]	Complete: None Partial: D Unclear: P, Set	RCT: 0 Cohort: 3 (3, n=10,189) Other: 14	Inverse (children)	Yes

Magee and Hale 2012 [+]	Complete: D Partial: P Unclear: Set	RCT: 0 Cohort: 20 (11, n=120,690 adults/ 7, n=10,959 children) Other: 0	Inverse (children) Inconclusive (adults)	Yes
Scope match abbreviations: D design (study design), P population, Set setting				

Adults

A single moderate quality review assessed the relationship between sleep and weight related outcomes in adults (Magee and Hale 2012 [+]) and found inconclusive results.

Four cohort studies found a significant inverse relationship between sleep duration and weight related outcomes, 4 found a significant U-shaped relationship and 5 found no significant relationship (mixed directions of effect, but mostly inverse). The effect sizes in the individual studies ranged from small (e.g. relationship between short sleep and BMI change: beta=0.015 kg/m^2, 95% CI 0.03 to 0.27) to large (e.g. short sleep at age 27 associated with OR 8.2, 95% CI 1.9 to 36.3 for obesity). The non-significant studies included the only study that used an objective sleep measure, which found an effect size close to zero (beta= -0.02, 95% CI -0.30 to 0.025, for relationship between sleep and 5 year change in BMI).

Children and young people

Two moderate quality reviews (Chen et al. 2008 [+], Magee and Hale 2012 [+]) found a significant inverse relationship between sleep duration and subsequent risk of overweight or obesity in children and young people.

One review of 7 cohort studies (Magee and Hale 2012 [+]) found significant effect sizes ranging from relatively small (e.g. beta coefficient=-0.061 for association between sleep duration in young children and probability of overweight 5 years later) to large (e.g. OR for overweight/obesity at age 6 years: 4.2, 95% CI 1.6 to 11.1 in persistent short sleepers up to 2.5 years of age). In most of the studies the effect was large. Studies did not consistently

report the sleep timings being compared. Where reported, the shorter sleep periods were <10.5 hours at age 3 (1 study), <12 hours (age unclear, between 0 and 3 years; 1 study), or persistently sleeping <10 hours up to 2.5 years (1 study); other studies reported the effect of incremental changes in sleep (1 hour or unspecified; 2 studies).

One review (Chen et al. 2008 [+]) of cohort, cross-sectional, and case-control studies carried out meta-analyses across these study designs. They found that, sleeping up to 1 hour less than age-specific recommended times was associated with a 43% increased odds of overweight or obesity (pooled OR 1.43, 95% CI 1.07 to 1.91); sleeping 1-2 hours less than recommended was associated with a 60% increased odds (pooled OR 1.60, 95% CI 1.22 to 2.10); and sleeping more than 2 hours less than recommended was associated with a 92% increased odds (pooled OR 1.92, 95% CI 1.15 to 3.20). Meta-regression found that for each 1 hour increase in sleep duration, there was a 9% reduction in odds of overweight/obesity (pooled OR 0.91, 95% CI 0.84 to 1.00, p=0.044). As these analyses included cross sectional studies, the results could to some extent arise due to reverse causality.

Evidence Statement 51: Relationship between sleep and weight related outcomes

Adults: Inconclusive evidence was identified from 1 moderate quality review[1] of cohort studies regarding the relationship between sleep duration and weight related outcomes in adults. Variation was seen across individual studies in terms of the significance, direction and size of the effect.

Four cohort studies found a significant inverse relationship, 4 found a significant U-shaped relationship and 5 found no significant relationship (mixed directions of effect, mostly inverse).

Children and young people: Moderate evidence from 2 moderate quality reviews[1,2] of cohort, cross sectional and case control studies suggests that

there is an inverse relationship between sleep duration and subsequent risk of overweight or obesity in children.

One review[1] of cohort studies found that shorter sleep duration was consistently inversely associated with weight change in children, with associations ranging from relatively small (beta=-0.061 for 1 hour greater sleep duration in young children and overweight 5 years later) to large (OR overweight/obesity at age 6 years: 4.2, 95% CI 1.6 to 11.1 in persistent short sleepers [<10 hours] up to 2.5 years of age). Most studies tended to find large effects.

One meta-analyses[2] found that sleeping ≤1, 1-2, or more than 2 hours less than age-specific recommendations was associated with 43%, 60%, and 92% increase in the odds of overweight/obesity, respectively. However, this review included mostly cross sectional studies and therefore reverse causality cannot be excluded.

Applicability to the UK: The results of these reviews are applicable to the UK.

[1] Magee and Hale 2012 [+]
[2] Chen et al. 2008 [+]

4.6.2 Physical activity monitoring

Table 47: Prioritised reviews assessing physical activity monitoring

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Bravata et al. 2007 [+]	Complete: D, Set Partial: P Unclear: None	RCT: 8 (unclear) Cohort: 18 (unclear) Other: 0	Inverse (adults)	Yes
Scope match abbreviations: D design (study design), P population, Set setting				

Adults

One moderate quality review (Bravata et al. 2007 [+]) found that self-monitoring of physical activity with a pedometer was associated with small reductions in BMI (mean change -0.38 kg/m^2, 95% CI -0.05 to -0.72, p=0.03). The association was particularly pronounced when self-monitoring was accompanied by setting a step goal (p=0.04), although no evidence was provided on the optimal threshold for such a goal.

No reviews were identified that assessed the relationship between other forms of monitoring (e.g. weighing oneself, checking fit of clothes) and weight related outcomes in adults.

Children and young people

No evidence was identified on the associations between monitoring and weight related outcomes in children or young people.

Evidence Statement 52: Relationship between physical activity monitoring and weight related outcomes

Adults: Weak evidence from one moderate quality review[1] of RCTs and cohort studies suggests that self-monitoring of physical activity with a pedometer, especially in combination with a step goal, is associated with reductions in BMI in adults.

Regression analysis of 18 RCTs and prospective cohort studies found that BMI significantly decreased from baseline in individuals who self-monitored physical activity with a pedometer (mean change -0.38 kg/m^2, 95% CI -0.05 to -0.72, p=0.03). The decrease was associated with having a step goal (p=0.04).

Children and young people: No reviews specifically on the relationship between physical activity monitoring and weight related outcomes were identified in children and young people.

Applicability to the UK: The results of this review are applicable to the UK.

[1] Bravata et al. 2007 [+]

4.6.3 Support

Table 48: Prioritised reviews assessing support

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Cunningham et al. 2012 [+]	Complete: None Partial: P, D Unclear: Set	RCT: 0 Cohort: 8 (1, n=790) Other: 8	Inconsistent (adults)	Yes
Scope match abbreviations: D design (study design), P population, Set setting				

Adults

One moderate quality review (Cunningham et al. 2012 [+]) found some evidence that communication among friends influences weight outcomes.

The review had poor overlap with the current review scope, and only 1 individual cohort study was identified that matched the scope. This study (n=790) among women aged 18 to 23 found mixed results. Friends encouraging unhealthy eating or discouraging PA (lack of support) was not significantly associated with BMI (data NR), and friends encouraging unhealthy eating (lack of support) or encouraging PA (support) was not significantly associated with 2-year weight change (data NR). Only one comparison found significant associations: when friends discourage physical activity (lack of support), a significant increase in 2-year weight change was seen (regression coefficient 0.14, $p \leq 0.01$).

Children and young people

No reviews that included studies on the effect of support in children and young people relevant to the current scope were identified.

Evidence Statement 53: Relationship between support and weight related outcomes

Adults: Inconclusive evidence was identified from 1 moderate quality review[1] of cohort studies about the association between communication with friends regarding weight and weight related behaviours and an individual's BMI. The 1 cohort study relevant to the current scope found mixed non-significant and significant positive associations between different types of communication supportive or non-supportive of unhealthy eating or physical activity behaviours.

Children and young people: No evidence on the effect of support on weight related outcomes in children and young people was identified.

Applicability to the UK: The results of this review are applicable to the UK.

[1] Cunningham et al. 2012 [+]

4.7 Primary studies and other evidence

Some additional evidence was identified and considered of potential relevance, it is described in this section. This includes:

- Primary studies on 1 factor (holiday weight gain) identified through focused primary study searches.
- Systematic reviews out of the current review scope, but considered factors of interest (meal setting or distractions; drinks with meals; stress minimising activities) returned in the searches.

4.7.1 Meal setting or distractions

Table 49: Prioritised reviews assessing meal setting or distractions

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Robinson 2013 [+]	Complete: D Partial: None Unclear: P, Set	RCT: 24 (24, n=961) Cohort: 0 Other: 0	No weight related outcomes. Positive (for outcome of food intake) (adults)	Unclear
Scope match abbreviations: D design (study design), P population, Set setting				

No evidence was identified for the association between meal setting or distractions and weight related outcomes in adults or children and young people.

Adults

One moderate quality review (Robinson 2008 [+]) was identified that examined whether cognitive processes such as attention and memory influence the amount of food eaten either immediately or in subsequent meals in adults. It was agreed with NICE that this review would be of interest and thus, included.

The review suggested reducing attention via distraction during eating may increase immediate and later food intake, enhancing memory for food consumed decreases later intake and that reducing awareness of food being consumed increases immediate food intake.

Twenty-four RCTs (n=961) were included examining the effect of manipulation, distraction, memory awareness or attention (no definitions provided) on food intake (energy intake or quantity).

Meta-analyses found that distracted eating (e.g. watching TV, listening to the radio, or reading) increased immediate food intake (SMD 0.39, 95% CI 0.25 to 0.53 [10 studies]) as well as later food intake (SMD 0.76, 95% CI 0.45 to 1.07 [4 studies]). Decreasing awareness of the amount of food being eaten (e.g. having plates removed when finished during a buffet meal or eating in a darkened room) increased immediate food intake (SMD 0.63, 95% CI 0.25 to 1.02 [4 studies]).

Increasing attention to food being eaten did not influence immediate intake (SMD -0.09, 95% CI -0.42 to 0.35 [2 studies]), however, enhancing memory of previous meals (e.g. asking people to remember what they had for lunch before eating a snack) reduced later intake (SMD -0.40, 95% CI -0.12 to -0.68 [6 studies]).

The number of studies and participants in each analysis was small. Most of the studies were laboratory experiments in young adults (usually university students), so performed under controlled conditions. Results may not be representative of effects that would be seen in usual eating settings or in more mixed populations.

Children and young people

No evidence was identified specifically in children or young people.

Evidence Statement 54: Relationship between meal setting or distractions and weight related or other outcomes

Adults: No reviews were identified on the association between meal setting or distractions and weight related outcomes in adults.

Moderate evidence from 1 moderate quality review[1] of 24 RCTs suggests that eating while distracted or decreased awareness of the food being consumed is associated with increased intake (immediate: SMD 0.39, 95% CI 0.25 to

0.53; later SMD 0.76, 95% CI 0.45 to 1.07). Enhancing memory of a previous meal was associated with reduced intake later (SMD -0.40, 95% CI -0.12 to -0.68), but increasing attention during a meal did not affect food intake (SMD -0.09, 95% CI -0.42 to 0.35).

Children and young people: No evidence was identified specifically in children or young people.

Applicability to the UK: The review did not report in which countries the included studies were performed, therefore applicability to the UK is unclear.

[1] Robinson 2013 [+]

4.7.2 Drinks with meals

Table 50: Prioritised reviews assessing drinks with meals

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Daniels and Popkin 2010 [+]	Complete: None Partial: D Unclear: Set, P	RCT: 3 (2, n=54 adults/1, n=24 children) Cohort: 0 Other: 21	No weight related outcomes Total energy intake: No (water, diet drinks) Positive (SSB-S/HFCS) Inconclusive (SSB-G/F) (adults)	Yes
Scope match abbreviations: D design (study design), P population, Set setting SSB sugar sweetened beverages; S/HFCS – sucrose or high fructose corn syrup, G/F – glucose or fructose				

Adults, children and young people

No reviews were identified assessing the impact of drinks with meals on weight related outcomes.

One moderate quality review (Daniels and Popkin 2010 [+]) looked at the impact of different beverages drunk before or during a meal on total energy intake (TEI) at that test meal in adults and children. In lieu of other evidence it was agreed with NICE that this review would be considered in this section as a proxy for weight related outcomes.

The review included 24 trials (some crossover trials). Only 3 of these were reported as randomised (2 in adults: 1 comparing water vs. no beverage drunk with or at varying times before a meal, 1 comparing water vs. lemonade sweetened with glucose or fructose; 1 in children of water versus sugar sweetened fruit drink or diet fruit drink). The review was sponsored in part by Nestlé Waters.

Overall, the review found the impact of replacing water drunk before or during a meal with no beverages or other beverages (of equal volume) on TEI varied with the substituted beverage. It suggested that, compared with drinking the same volume of water, certain drinks before or with a meal may increase TEI (beverages sweetened with sucrose or high fructose corn syrup), some have no effect (drinking no water, or non-nutritively sweetened drinks), and for some the evidence was unclear (milk or juice, drinks sweetened with glucose or fructose). However, as these conclusions are based almost exclusively on small non-randomised studies, they are of limited reliability.

Evidence Statement 55: Relationship between drinks with meals and weight related and other outcomes

Adults, children and young people: No reviews were identified which assessed the impact of drinks with meals on weight related outcomes.

Inconclusive evidence was identified from one moderate quality review[1] of a limited number of small RCTs and non-randomised comparative studies regarding the relationship between consumption of water or alternative beverages with or before meals on total energy intake at the meal. The reviewed studies were too small, varied, and susceptible to bias to be able to

draw clear conclusions on any effect; The review was sponsored in part by Nestlé Waters.

Applicability to the UK: The results of the review are applicable to the UK.

[1] Daniels and Popkin 2010 [+]

4.7.3 Stress minimising activities

Table 51: Prioritised reviews assessing stress and weight

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Wardle et al. 2011 [++]	Complete: D Partial: P, Set Unclear: None	RCT: 0 Cohort: 14 (13, n=22,571) Other: 0	No (adults)	Yes
Scope match abbreviations: D design (study design), P population, Set setting				

No systematic reviews were identified that assessed the impact of stress minimising behaviours or activities and weight. Stress itself is not an individually modifiable behavior, but it was agreed with NICE to consider reviews on the association between stress itself and weight related outcomes as a proxy for the potential effect of stress minimizing activities.

One review (Wardle et al. 2011 [++]) found small but significant positive associations between psychosocial stress and weight outcomes (r=0.014, 95% CI 0.002 to 0.025). However, this relationship was no longer significant when adjusting for potential confounding variables (r=0.013, 95% CI -0.000 to 0.026, p=0.056).

Evidence Statement 56: Relationship between stress minimising activities and weight related outcomes

Adults: No reviews were identified regarding the association between stress minimising activities and weight related outcomes. One review[1] assessed the effect of stress on weight related outcomes.

Inconclusive evidence was identified from 1 high quality review[1] of cohort studies about the relationship between stress and weight related outcomes.

Overall meta-analysis revealed a small significant association between all measures of psychosocial stress and all weight outcomes (r=0.014, 95% CI 0.002 to 0.025, p=0.023). Pooled analysis of studies that adjusted for potential confounders resulted in no significant correlation, however (r=0.013, 95% CI -0.000 to 0.026, p=0.056).

Children and young people: No reviews on stress minimising activities were identified in children and young people.

Applicability to the UK: The results of this review are applicable to the UK.

[1] Wardle et al. 2011 [++]

4.7.4 Holiday weight gain

Table 52: Primary studies assessing holiday weight gain prevalence and associated behaviours

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable
Yanovski et al. 2000 [+]	Complete: P, D, Set Partial: None Unclear: None	NA	Holidays: Positive PA over holidays: inverse (adults)	No
Cook et al. 2012 [+]	Complete: P, D, Set Partial: None Unclear: None	NA	Holidays: no (adults)	No

Wagner et al. 2012 [-]	Complete: P, D, Set Partial: None Unclear: None	NA	No (adults)	No
Moreno et al. 2013 [+]	Complete: P, D, Set Partial: None Unclear: None	NA	Holidays: Positive (children)	Partial
Scope match abbreviations: D design (study design), P population, Set setting				

No systematic reviews were identified that assessed the relationship between either holiday periods or modifiable behaviours over holiday periods and weight related outcomes. A search for primary studies was conducted, and 4 relevant prospective cohort studies were assessed to determine 1) whether holiday periods are associated with weight gain, and 2) whether specific behaviours were associated with weight gain during this period.

Given that the identified studies indicated that any changes in body composition during this time are quite small.

Adults

Two moderate quality studies (Yanovski et al. 2000 [+], Cook et al. 2012 [+]) and 1 low quality study (Wagner et al. 2012 [-]) from the United States were assessed among adults. The 2 moderate quality studies found small increases in body weight from Thanksgiving to New Year's (mean increase ranged from 0.48 kg to 0.90 kg). One of these studies found that self-reported physical activity was inversely associated with weight change during this time, while the other study found no significant association. The third small study (Wagner et al. 2012 [-]) found no significant change in body composition during the holiday period; the study was likely insufficiently powered to detect an effect.

Children and young people

One moderate quality study (Moreno et al. 2013 [+]) in children found that summer holidays were associated with more rapid increase in BMI (mean increase of 5.2 BMI percentiles) compared to school term (mean reduction of

1.5 BMI percentiles; mean difference in zBMI change -0.52, 95% CI -0.59 to -0.45, p<0.001), with the rate of change greatest in normal versus overweight children.

Inclusion of primary studies may skew the findings compared to other factors in this report, which relied solely upon review level evidence. Furthermore, holidays in themselves are not strictly individually modifiable behaviours, and this is the only factor for which prevalence outcomes were included in order to determine whether holiday weight gain is in fact a phenomenon.

Evidence Statement 57: Holiday weight gain among adults and children

No systematic reviews were identified that assessed holiday weight gain.

Adults: Inconsistent evidence was identified from 2 moderate quality[1,2] and 1 low quality[3] primary studies regarding weight change during the US holiday period.

Two studies[1,2] reported a significant positive association between holidays and weight change (ranging from +0.48 to 0.90 kg). A small study[3] reported no significant changes in weight.

Two studies found inconsistent associations between individually modifiable behaviours and change in body composition during the holiday period; 1 study[1] found significant inverse associations between change in physical activity and weight change, another study[2] found no correlation between either total energy expenditure or physical activity over the holiday period and weight.

Children and young people: Weak evidence from 1 moderate quality study[4] suggested that summer holidays may be associated with increased weight gain amongst school children (+5.2 BMI percentiles (SD 27.1). Overweight and obese children experienced an increase in zBMI during the summer months, but a reduction during the school year. Normal weight students

increased zBMI during both time periods, but experienced a more rapid change during the summer months.

Applicability to the UK: The studies may not be not directly applicable to the UK, as all were based in the US. The adult studies in particular assess a longer holiday period (Thanksgiving to New Year) than that observed in the UK.

[1] Yanovski et al. 2000 [+]
[2] Cook et al. 2012 [+]
[3] Wagner et al. 2013 [-]
[4] Moreno et al. 2013 [+]

5 Discussion

5.1 Overview of the body of evidence identified

The review identified a large number of reviews across the factors of interest, although not all target factors had identifiable reviews the results are summarised here.

Coverage of the individually modifiable behaviours was not uniform. Some areas were covered by large numbers of reviews (e.g. sugar sweetened beverages, breakfast consumption) whilst others had no reviews (e.g. breaks in sedentary time). In general, there was less evidence for children and young people than adults, except in certain areas (e.g. screen time). Certain factors that considered newer concepts (e.g. the effect of standing) also had no relevant reviews.

Fewer reviews were identified as being relevant to the physical activity section than other sections. This was in part due to the reviews tending not to ask questions specific to the behaviours of interest here. For example, they tended to assess the effectiveness of programmes of physical activity as a whole, rather than specifically assessing e.g. the effect of differing intensities of physical activity, or walking or cycling interventions.

The definitions of factors often varied across studies and reviews, and this heterogeneity complicates the identification of clear signals from the evidence. For example, some studies considered snacking as eating between meals, while others considered it to be the consumption of certain unhealthy snack foods. Some studies calculated energy density of the diet based on food alone, while others considered drinks as well. The inclusion of drinks may attenuate this factor's association with weight gain, due to the differing effect of food and beverages on satiety and energy intake (Johnson et al. 2009).

The majority of reviews included mainly cohort studies rather than RCTs. This is likely to be due to the fact RCTs may be more likely to be conceptualised

with the intention of reducing overweight/obesity than weight maintenance outcomes. The RCTs identified tended to be of shorter duration than the cohort studies, particularly those testing the effects of increasing rather than reducing intake of potentially obesogenic exposures. Due to the potential for detrimental effects on health it is likely to be unethical for RCTs to add potentially obesogenic exposures or remove protective exposures over the long term, or in children. RCTs therefore tend to assess the effects of reducing obesogenic exposures or increasing protective exposures, but may be hampered by the difficulty in achieving sustained behaviour change. Therefore cohort studies may be the most appropriate study design for assessing the effects of such exposures on weight maintenance.

Cohort studies do of course have limitations, including susceptibility to the effect of confounding. The individual studies included in the reviews varied in the extent to which they adjusted for confounding factors. In addition, individual reviews varied in the extent to which they reported on these adjustments and considered them in their conclusions. Over-adjustment may also make results tend towards null. For example, some of the reviews relating to foods or nutrients noted specifically whether total energy intake might be confounding results, or removing an association, while others did not draw out this issue. The potential for results to be impacted by confounding should be considered at a review-wide level.

Although the current review focused on cohort studies rather than cross sectional studies to reduce the potential for reverse causation, some of the included reviews based their conclusions on mixed study types including cross sectional studies. Some cohort studies may also still be susceptible to this, particularly if they assess changes in the exposure and outcome over follow up. Reverse causation has been suggested, for example, to potentially contribute to the link seen between non-nutritive sweeteners and weight related outcomes.

Exposure and outcome assessment methods varied among the primary studies included in the reviews, as did their robustness. For example, food and nutrient intakes were quantified, for example, as % total energy, grams per day, or as servings. Assessment methods ranged from undefined "questionnaires" used once to multiple 24-hour dietary recalls or weighed food records.

Most exposure assessments tended to be self-reported, and one review (Summerbell et al. 2009 [++]) noted that respondents tend to over report energy expenditure and under report dietary intake. These measurement concerns should be considered when interpreting the evidence on the relationship between dietary and physical activity behaviours and weight related outcomes.

Some reviews (particularly those carrying out meta-analysis) attempted to standardise varying exposure measures to simplify interpretation. While this may produce a less heterogeneous estimate of effect, it often requires assumptions to be made (e.g. about the size of an unspecified "serving") that may not be accurate.

Objective outcome measurement, as opposed to self-report, seemed to be more frequently used in child studies than in adult studies where reported (e.g. in Summerbell et al. 2009 [++]). Some outcomes (e.g. fat mass) require measurement, but even these outcomes may be estimated in different ways (Dual-energy X-ray absorptiometry, bioimpedance analysis, or skinfold thickness). Some of the reviews with clearer reporting separated results by outcome, allowing easier synthesis of findings. Only very rarely did reviews use robustness of exposure or outcome measurement methods as inclusion or exclusion criteria, or as a way of stratifying results.

Few reviews carried out meta-analysis, due to the heterogeneity of the exposures and outcomes assessed. The complexities of narrative synthesis of

heterogeneous studies, the inherent problem of confounding in the cohort studies, and the limited RCT evidence may have contributed to some of the differences in interpretation and conclusions drawn by different reviews on the same factor.

For example, many reviews conclude that there is a link between consumption of sugar sweetened beverages and weight related outcomes and that this evidence is sufficient to discourage consumption (e.g. Malik et al. 2013 [++]), while another recent review concluded that the evidence showing that reducing sugar sweetened beverages will reduce obesity is inconclusive (Kaiser et al. 2013 [++]). For sugar sweetened beverages, one recent review of reviews also concluded that reviews where a financial conflict of interest with some food industry was declared were five times more likely to present a conclusion of no positive association than those without them (Bes-Rastrollo et al. 2013).

In other cases, inclusion of different pools of studies may contribute to differing conclusions. For example in fat consumption, one review of RCTs concluded that reduced fat intake was associated with reduced weight, while a review of cohort studies concluded that level of fat intake was not associated with excess weight gain.

There was wide variation in the quality of systematic review methods and reporting across the included reviews, even within the individual quality ratings (i.e. high, moderate, and low quality). Most reviews provided limited details about exposures, or estimates of effect size or association, and there were examples of conflicting reporting between evidence tables and text in some reviews. Several reviews provided only descriptions of the significance of statistical comparisons (or lack thereof) without supporting figures. Often findings were reported for subgroups without the review specifying whether this was an a priori or post-hoc analysis.

Effects of the individual factors on continuous outcomes (e.g. change in weight or BMI) tended to appear small compared with those expressed as dichotomous outcomes (e.g. risk of overweight/obesity). This relatively small effect size may highlight the importance of targeting multiple factors.

The behaviours assessed in this review are often complementary, and changes in one may result in changes in the other. For example, increasing water consumption may result in less consumption of other beverages and vice versa; increasing time spent in active leisure or play may reduce sedentary time. In other cases the behaviours overlap, for example walking and cycling are covered as individual factors, but they are also active modes of transport, which is assessed separately.

The behaviours may also be linked in other ways, for example, screen time may be linked to distracted eating and other dietary factors or high levels of vigorous activity may increase sedentary “recovery” time. This may make the effects of individual behaviours difficult to disentangle, even within the context of RCTs. Consideration of the potential relationships between factors should

5.2 Strengths and limitations of the review

5.2.1 Strengths and limitations to the review of reviews approach

The evidence review assessed a wide range of individually modifiable behaviours, and the review of reviews approach allowed a rapid overview of existing literature in these broad areas.

There are also limitations to the approach. The review of reviews approach will miss some relevant primary studies. Even recent reviews may miss relevant primary studies due to additional studies being published in the time lag between review preparation and publication. Newer primary studies may overcome limitation of older literature and better reflect current knowledge and approach within an area. Areas where no systematic reviews have published

will also not be covered, although the review did search for primary studies in some of these areas (standing, holiday weight gain, meal planning).

Including reviews rather than primary studies reduces the ability to assess the detail of the individual studies. Many of the included reviews, even those of high quality, reported limited detail about the individual studies and drew broad conclusions on the associations between the factors of interest and weight related outcomes (rather than e.g. specifying exact doses of exposure relating to a given outcome).

Including reviews limits ability to ensure that included studies match the review scope completely. The current evidence review has a very detailed scope and no reviews clearly matched it completely. Therefore, conclusions have been drawn based on reviews including a mixture of studies relevant and not relevant to the current review scope.

5.2.2 Review-specific strengths and limitations

Other strengths of this review include its pre-specified scope and wide list of individually modifiable behaviours of interest. Double appraisal of random samples of the included research indicated that there was good inter-rater reliability for inclusions and exclusions. The use of standardised tools for quality assessment increases validity of these assessments.

Some factors, such as monitoring and support, are likely to be widely utilised in interventions not just in relation to maintaining a healthy weight. Searching for these broad terms, even combined with weight related terms, would result in a large volume of literature, much of which might not be directly relevant to the current update. For pragmatic reasons this could not be carried out for the current review.

Relevance to the UK was judged on a review-wide level, based on the proportion of included studies from OECD countries. While this may give a broad indication of applicability in similarly developed populations, there may

still be differences within the OECD countries which impact applicability to the UK. For example, certain factors (e.g. foods and drinks) may be defined differently in different OECD countries. Also, exposure levels may differ across OECD countries, which can impact the ability of a study to observe an effect if it truly exists.

Some exceptions to the inclusion criteria were agreed for areas where no reviews were identified that matched the scope at least partially. For example, for meal setting or distractions and drinks with meals, reviews that assessed the effect on energy intake were included, which provide less direct evidence about a potential effect on weight-related outcomes. In addition, primary study searches were not carried out for all factors. These variations may skew the results and findings should be interpreted in this context.

There is overlap in included studies between the reviews. This was not formally assessed, but was noted where it became apparent in preparing the synthesis. There is likely to be multiple ‘counting’ of some studies included in more than one review. Focusing on a smaller number of the highest quality, most recent, and most relevant reviews for each factor as undertaken here should manage the potential for multiple counting of studies across reviews.

In addition to overlap between reviews, certain studies assessed multiple factors and therefore contributed to multiple sections. For example, the large US Nurses’ Health Study in women and the complementary Health Professionals Follow-Up Study in men contributed to the evidence on many of the factors. Also, certain reviews, such as those by Summerbell et al. 2009 and the suite of reviews by the USDA provided a good match for the scope of the current review and covered multiple factors and are therefore cited in multiple sections. This overlap may make it appear that there is more evidence than there is.

Evidence gaps

No reviews were identified (in adults or children and young people) on several factors (see Section 4 for a complete list). This may represent either a lack of systematic reviews or a lack of primary studies specifically assessing these behaviours within the context of the publication period, population, settings, and outcomes addressed by the current review.

For meal planning, the lack of relevant primary study evidence may reflect that studies have not assessed this behaviour specifically and separately from other behaviours. For standing, this is likely to reflect the relatively new interest in the effect of this behaviour on healthy weight maintenance, particularly as an alternative to extended periods of sitting.

Acknowledgements

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6 Addendum section – confectionery

6.1 Glossary term

Confectionery Includes foods such as toffees, caramels, lollipops, marshmallows, fudge and chocolate (sometimes referred to as sweets or candies), that are high in added sugars and often eaten as snacks.

6.2 Background

Confectionery consumption was not one of the original behaviours specified in the list of individually modifiable behaviours to be covered, and therefore information on this behaviour had not been looked for when assessing studies for inclusion, or covered separately. On discussion with the Public Health Advisory Committee and NICE additional searches were carried out by NICE on confectionery in May 2014 to identify potentially relevant reviews on this behaviour. None of the 48 reviews identified met inclusion criteria based on assessment of title and abstract. A search was also carried out in the database of studies identified in the original searches for the text words “chocolate” and “confectionery”. The 15 studies identified in these searches also did not meet inclusion criteria based on assessment of title and abstract. Two key sources of evidence included in the evidence review, the review by Summerbell et al. 2009 [++] and the US Department of Agriculture 2010 suite of reviews were also assessed for relevant evidence. The review by Summerbell et al. 2009 [++] included relevant evidence which is reported below.

6.3 Results - Confectionery consumption

Table 53: Prioritised reviews assessing confectionery consumption

Author, date [quality]	NICE scope match	Studies included (Number relevant, n=)	Association found? (population)	UK Applicable

Summerbell et al. 2009 [++]	Complete: D Partial: None Unclear: P, Set	RCT: 0 Cohort: 6 (4, n=19,144 adults; 1, n=881 children) Other: 0	No	Unclear
Scope match abbreviations: D design (study design), P population, Set setting				

One high quality review (Summerbell et al. 2007 [++]) was identified which assessed the effects of “sugars as foods” on weight-related outcomes. The foods assessed in the studies included by the review were mostly “sweets”. These were defined in different ways in the studies, and included confectionery such as candy and chocolates, but also desserts in some studies. However, the lack of assessment of confectionery alone means that the evidence on its association with weight related outcomes in both adults and children and young people is inconclusive.

Adults

The review (Summerbell et al. 2007 [++]) identified 4 cohort studies (n=19,144) that found inconclusive evidence on effects of the consumption of “sweets” (including confectionery) or a dietary pattern high in “sweets” on weight related outcomes.

The studies had mixed findings over 2 to 12 years’ follow up: no significant association in 2, and mixed directions of effect across the other 2.

One study in women found an inverse association, with higher consumption of sweets (candy and desserts) associated with reduced risk of large weight gain (over 10 pounds; OR 0.74, 95% CI 0.6 to 0.91; p=0.004). The largest study (n=17,369) found mixed associations in men for ‘sweets’ (including confectionery, ice cream and sugar): those with higher sweets consumption were at increased risk of large weight gain (not defined; OR 1.48, 95% CI 1.03 to 2.13; p<0.05), but also at increased risk of small weight loss (not defined; OR 1.43, 95% CI 1.07 to 1.90; p<0.05). Women in this study with higher consumption of ‘sweets’ were less likely to experience large weight loss (OR 0.67, 95% CI 0.49 to 0.92; p<0.05).

The inverse relationship seen in these 2 studies in women may to some extent reflect reverse causality (those prone to weight gain may be more likely to avoid sweets), or biased reporting. The reason for the association between high 'sweets' intake and both weight gain and weight loss in men in one study is unclear. The weight loss could be due to an increased risk of diabetes associated with increased sweets (and therefore sugar) intake, or result from a change in diet in those with a previously high sweet intake.

Children and young people

The 1 relevant cohort study identified (n=811) found no significant association between maternally reported frequency of 'sweets' intake (candy and desserts) at baseline and risk of being overweight at 10 year follow-up (figures NR). The small size of the study and the lack of assessment of confectionery alone means that no firm conclusions can be drawn.

Evidence Statement 58: Relationship between confectionery and weight related outcomes

Adults: There was inconclusive evidence from 1 high quality review[1] of cohort studies on the relationship between confectionery and weight related outcomes.

The 4 cohort studies in the review had mixed results, with some finding no significant association (2 studies), and the others finding significant associations with both positive and inverse directions of effect. The effect of higher intake of confectionery and other 'sweets' ranged from a 26% reduction in risk for gaining over 10 pounds in women with higher intake (OR 0.74, 95% CI 0.6 to 0.91) to a 48% increase in the risk of large weight gain (not defined) in men (OR 1.48, 95% CI 1.03 to 2.13).

Children and young people: There was inconclusive evidence from 1 high quality review[1] of 2 cohort studies on the relationship between confectionery and weight related outcomes. The 1 relevant study in the review found no

association between consumption of candy and desserts and risk of being overweight at 10 year follow-up (figures NR).

Applicability to the UK: The results are applicable to the UK.

[1] Summerbell et al. 2009 [++]

6.4 Search details

The following searches for systematic reviews on confectionery and obesity were carried out by NICE. They yielded 48 systematic reviews, none of which met inclusion criteria for the current review

Strategies

HealthEvidence.ca, DOPHER

sweets OR confectionery OR candy OR candies OR chocolate* OR pastr* OR cake* OR biscuit*

HealthEvidence.ca - **10 results**

DoPHER – **1 result** (not relevant – picked up due to author name (Candy), subject was educational interventions for asthmatics).

CDSR/DARE/HTA/NHS EED

ID	Search
#1	MeSH descriptor: [Candy] explode all trees
#2	MeSH descriptor: [Cacao] explode all trees
#3	confectionery:ti,ab
#4	sweets:ti,ab
#5	(candy or candies):ti,ab
#6	chocolate*:ti,ab
#7	pastr*:ti,ab
#8	cake*:ti,ab
#9	((sugar* or glucose or fructose or syrup) adj3 snack*):ti,ab
#10	biscuit*:ti,ab

#11 #1 or #2 or #3 or #4 or #5 or #6 or #7 or #8 or #9 or #10
#12 MeSH descriptor: [Obesity] explode all trees
#13 MeSH descriptor: [Overweight] this term only
#14 MeSH descriptor: [Weight Gain] this term only
#15 MeSH descriptor: [Ideal Body Weight] this term only
#16 ((prevent* or reduc* or tackl* or address*) next/6 (obes* or "weight gain" or "excess weight" or overweight)):ti,ab
#17 ((maintain* or maintenance or prevent* or reduc* or control* or manag* or monitor* or healthy or normal or average) and (weight or bmi or body mass index or body fat or waist circumference or adiposity)):ti,ab
#18 (non obese or nonobese or non overweight or nonoverweight):ti,ab
#19 #12 or #13 or #14 or #15 or #16 or #17 or #18
#20 #11 and #19

Medline & Medline in-process

Database: Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations and Ovid MEDLINE(R) <1946 to Present>
Search Strategy:
---
1 exp Obesity/ (138494)
2 Overweight/ (11618)
3 Weight Gain/ (22408)
4 Ideal Body Weight/ (121)
5 ((prevent* or reduc* or tackl* or address*) adj5 (obes* or "weight gain" or "excess weight" or overweight)).ti,ab. (19729)
6 ((maintain* or maintenance or prevent* or reduc* or control* or manag* or monitor* or healthy or normal or average) and (weight or bmi or body mass index or body fat or waist circumference or adiposity)).ti,ab. (409895)
7 (non obese or nonobese or non overweight or nonoverweight).ti,ab. (13585)
8 or/1-7 (520231)
9 Meta-Analysis as Topic/ (13686)
10 meta analy$.tw. (62225)
11 metaanaly$.tw. (1306)
12 Meta-Analysis/ (47281)
13 (systematic adj (review$1 or overview$1)).tw. (53162)
14 exp "Review Literature as Topic"/ (7493)
15 or/9-14 (121384)

16 exp Candy/ (3033)
17 Cacao/ (2224)
18 confectionery.ti,ab. (431)
19 sweets.ti,ab. (2593)
20 (candy or candies).ti,ab. (1094)
21 chocolate*.ti,ab. (3298)
22 pastr*.ti,ab. (414)
23 cake*.ti,ab. (2921)
24 ((sugar* or glucose or fructose or syrup) adj3 snack*).ti,ab. (187)
25 biscuit*.ti,ab. (813)
26 or/16-25 (14231)
27 8 and 15 and 26 (9)

Embase

Database: Embase <1974 to 2014 May 01>
Search Strategy:
---
1 exp Obesity/ (289317)
2 Weight Gain/ (64215)
3 ((prevent* or reduc* or tackl* or address*) adj5 (obes* or "weight gain" or "excess weight" or overweight)).ti,ab. (25564)
4 ((maintain* or maintenance or prevent* or reduc* or control* or manag* or monitor* or healthy or normal or average) and (weight or bmi or body mass index or body fat or waist circumference or adiposity)).ti,ab. (537745)
5 (non obese or nonobese or non overweight or nonoverweight).ti,ab. (16962)
6 or/1-5 (766393)
7 "systematic review"/ (73750)
8 meta analy$.tw. (77428)
9 metaanaly$.tw. (4020)
10 Meta-Analysis/ (78051)
11 (systematic adj (review$1 or overview$1)).tw. (63940)
12 or/7-11 (166923)
13 Cacao/ (4378)
14 confectionery.ti,ab. (551)
15 sweets.ti,ab. (3323)
16 (candy or candies).ti,ab. (1349)
17 chocolate*.ti,ab. (4269)
18 pastr*.ti,ab. (554)

19 cake*.ti,ab. (4693)
20 ((sugar* or glucose or fructose or syrup) adj3 snack*).ti,ab. (226)
21 biscuit*.ti,ab. (1035)
22 or/13-21 (16728)
23 6 and 12 and 22 (27)

ASSIA

(SU.EXACT("Obesity") OR SU.EXACT("Weight gain") OR TI,AB(((prevent* OR reduc* OR tackl* OR address*) NEAR/5 (obes* OR "weight gain" OR "excess weight" OR overweight)) OR ((maintain* OR maintenance OR prevent* OR reduc* OR control* OR manag* OR monitor* OR healthy OR normal OR average) AND (weight OR bmi OR body mass index OR body fat OR waist circumference OR adiposity)) OR (non obese OR nonobese OR non overweight OR nonoverweight)))

AND

(SU.EXACT("Confectionery") OR SU.EXACT("Cakes") OR SU.EXACT("Biscuits") OR TI,AB(confectionery OR sweets OR candy OR candies OR chocolate* OR pastr* OR cake* OR biscuit* OR (sugar* OR glucose OR fructose OR syrup NEAR/5 snack*)))

AND

(SU.EXACT("Systematic reviews") OR SU.EXACT("Meta-analysis") OR TI,AB((meta NEAR/1 analy*) OR metaanaly* OR (systematic NEAR/1 (review* OR overview*))))

7 results

Search date: 2nd May 2014

7 Reference list

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8 Additional Appendices in separate documents

Appendix A: Individually modifiable behaviours considered by the evidence review

Appendix B: Methods

Appendix C: Excluded study bibliography

Appendix D: Quality appraisal templates

Appendix E: Summary table of non-prioritised reviews

Appendix F: Evidence tables for prioritised reviews