Is consuming breakfast important for academic performance, maintaining a healthy body weight, and improving nutrient intake and lifestyle habits in children?

A report prepared by the
Scientific Committee of the
Agencies for Nutrition Action
May 2007

Authors: *Rob Quigley*, NZ Registered Dietitian, Quigley and Watts Ltd
Dr Rachael Taylor, Senior Lecturer, Department of Human Nutrition, University of Otago
Assoc Prof Robert Scragg, Associate Professor of Epidemiology, School of Population Health, University of Auckland

Contents

1 Executive summary

1.1 Background

Breakfast is regarded by many as “the most important meal of the day”, because an adequate food intake at the beginning of the day helps to ensure that nutrient needs by the body for the remainder of the day are more likely to be met. The 2002 National Children’s Nutrition Survey of New Zealand children aged 5–14 years found that 86% of children usually had breakfast (self-defined), as recalled from the previous week. Maori children (22.9%) were 2.5 times more likely, and Pacific children (40.8%) 5.7 times more likely, to not have breakfast than New Zealand European or Other children (7.7%)

It is difficult to compare these percentages with other countries because of different methods used to define breakfast. The most commonly eaten foods by New Zealand children at breakfast are breakfast cereals (57% of children), followed by bread and toast (35%) and then beverages such as Milo (14%) and fruit juices (11%).

1.2 Aims

The aims of the current report are to answer the following questions:

1. What is the national and international context for eating breakfast?
2. Is regular consumption of breakfast associated with academic performance?
3. Is regular consumption of breakfast associated with overweight or obesity?
4. Is regular consumption of breakfast associated with food and nutrient intake?
5. Do regular breakfast eaters differ from non-eaters in other lifestyle factors such as physical activity, alcohol and smoking?

1.3 Methods

Databases of scientific publications and relevant websites were searched, covering January 1998 to September 2006, an arbitrary starting point to make the analyses manageable. Only English-language references and human studies were included in the review. The reference lists from papers selected in the literature search were used to identify earlier publications, and recent publications up to December 2006 were also identified. Considerable attention was paid to study design, with intervention studies and longitudinal studies with appropriate sample sizes and adjustment for confounders considered “stronger” evidence than smaller studies or cross-sectional studies.

1.4 Breakfast and academic performance

Fifteen studies where found which reported on the effect of regular breakfast consumption on academic performance (studies of the acute effects of missing breakfast are not included in this review because they do not address the question of whether regular breakfast consumption is associated with academic performance). Five observational studies (four cross-sectional and one cohort) and four cohort studies of free school breakfast programmes all found significant positive associations

between the frequency of regular breakfast consumption and academic performance. There were three studies of short-term breakfast interventions (less than one month), of which one found a positive association between receiving the breakfast intervention and academic performance and two found no association. Three trials of long-term breakfast interventions (more than one month) all reported improved academic performance in children receiving the breakfast intervention. In total, 13 studies reported a positive association between regular breakfast consumption and academic performance, two studies reported no association, and no studies reported an inverse association.

1.5 Breakfast and overweight or obesity

Nineteen studies were identified that assessed whether breakfast consumption or frequency of intake was related to weight status in children. Twelve of 14 cross-sectional studies reported significant inverse associations, showing that breakfast skipping or less frequent consumption was related to body weight in children, including data from the National Children's Nutrition Survey. However, many of the cross-sectional studies were small, with inappropriate adjustment for confounders. Two of the five cohort studies were also relatively small. Of the remaining three large-scale cohort studies with extensive adjustment for confounders, two found no association between breakfast intake and weight in children and one showed that breakfast skippers had *smaller* gains in body mass index (BMI), but in overweight participants only. Unfortunately, no interventions have been undertaken to demonstrate that increasing breakfast consumption in children or adolescents has positive effects on body weight, and there is limited evidence relating to the pre-pubertal age group.

1.6 Breakfast and nutrient intake

Twelve studies (10 cross-sectional, one cohort, one intervention) were identified that investigated whether consuming breakfast influences total nutrient intake in children, and an additional four studies that assessed breakfast in relation to foods rather than nutrients (two studies), overall nutrient status (one study) and the nutrient content of other meals (one study). Energy was only measured in five studies, but was higher in breakfast eaters compared with non-eaters in four studies, and similar in the remaining study. Macronutrient intake was generally more favourable in those consuming breakfast, with most studies reporting higher intakes of protein, carbohydrate and fibre and lower intakes of total fat. Intake of minerals and vitamins was also generally higher for breakfast eaters. Data from the National Children's Nutrition Survey showed that children who skipped breakfast were less likely to consume fruit/vegetables, cereals and milk and more likely to consume chocolate/sweets, pies/pastries and soft drinks.

Eight studies (seven cross-sectional, one cohort) were identified that assessed whether consumption of breakfast cereal, usually ready-to-eat cereal, was associated with nutrient intake or status in children and adolescents. In general, increased consumption of breakfast cereals was associated with a lower intake of fat and a higher intake of carbohydrates, minerals and vitamins, while the pattern for energy and protein was more variable.

1.7 Breakfast and other lifestyle factors

Ten reports (seven cross-sectional, one case control, two cohort) of breakfast eating and physical activity were identified. Nine studies (including both cohort studies) reported significant positive associations between the frequency of breakfast consumption and physical activity, and one reported no association. Seven studies (all cross-sectional) of breakfast eating and smoking all reported an inverse association between frequency of having breakfast and risk of smoking. Three studies (two cross-sectional, one cohort) of breakfast eating and mental health were identified. All three studies reported inverse associations between frequency of having breakfast and mental health status, with students with poorer mental health (such as depression) having breakfast less frequently than other students. Three studies (all cross-sectional) reported that regular breakfast was associated with healthier food patterns (less dieting and lower alcohol consumption).

1.8 Conclusions

- Overall, 22.9% of Māori, 40.8% of Pacific and 7.7% of New Zealand European and Other children skip breakfast (do not eat or drink at home or on the way to school), which equates nationally to approximately 83,000 children each day.
- Consistent with international literature, inequalities in skipping breakfast are related to deprivation (most deprived more likely than least deprived), urban versus rural residence (urban more likely than rural) and age (older more likely than younger).
- The most commonly eaten foods by New Zealand children at breakfast are breakfast cereals (57% of children), followed by bread and toast (35%) and then beverages such as Milo (14%) and fruit juices (11%).
- Two-thirds of 172 cereals marketed to the general populace and all of the 26 cereals marketed directly to children were not considered to be good nutritious choices for children by *Consumer* magazine.
- Breakfast patterns may differ according to ethnicity and place of residence: rural Maori and Pacific children with stronger links to the Islands are more likely not to eat breakfast or to eat leftovers from the night before, whereas urban Maori and Pacific children born in New Zealand either don’t eat breakfast or consume breakfast cereals (all types) as the most common foods.
- Lack of time and not being hungry are currently the major barriers to children consuming breakfast, but no work appears to have analysed socio-economic gradients in the data or adequately considered poverty as an issue.

Conclusion: Many New Zealand children are not eating breakfast, and those breakfast cereals that are currently marketed to children represent relatively poor nutritious choices.

- Five of five observational, four of four cohort and one of three short-term trials, along with three of three long-term interventions (two of which were randomised), show that consuming breakfast is associated with improvements in academic performance. The two short-term trials that did not show a significant effect in the total group did show benefits in subgroups.

Conclusion: There is considerable evidence that regular breakfast consumption improves academic performance.

- Twelve of fourteen (86%) cross-sectional studies support the view that breakfast skipping is adversely related to weight status in children.
- In contrast, only one of five cohort studies reported that breakfast skipping adversely affects weight, three reported no relationship once adjusted for confounders, and the remaining study showed that skipping breakfast is associated with *smaller* gains in BMI in overweight but not normal weight children.
- Three of four studies examining whether cereal consumption is related to body weight in children support the view that higher cereal intake is associated with more favourable body weights.
- Few studies have been undertaken in young children (up to 10 years of age) investigating the role that breakfast may play in weight management.

Conclusion: Much of the cross-sectional evidence supports the observation that breakfast or breakfast cereal consumption is related to weight status in children. However, such study designs are prone to bias. Larger, well-conducted cohort studies in general do not support the view that skipping breakfast promotes weight gain, and no interventions have been undertaken to determine whether increasing breakfast consumption favourably affects body weight during growth.

- Although the majority of evidence relating breakfast consumption and nutrient intake is from cross-sectional studies, findings very consistently show that children consuming breakfast have a more favourable nutrient profile than children avoiding breakfast or consuming it less regularly.
- Likewise, cereal consumption is favourably associated with nutrient intake.
- Studies investigating the effect of cereal intake on nutritional status have demonstrated that consumption is positively associated with the biochemical status of many nutrients except for iron; results consistently show no benefit of higher intakes on improving iron status.
- New Zealand data show that children who skip breakfast are less likely to eat fruit and vegetables, less likely to eat lunch and more likely to eat chocolate/sweets, pies and soft drinks. They are also more likely to buy food at the dairy or from the school canteen and less likely to bring food to school from home.
- Few studies have adjusted micronutrient intake for energy intake to ascertain whether improved nutrient intakes of children consuming breakfast are due simply to higher energy intakes or because the diets are more nutrient-dense.

Conclusion: There is some evidence to show that eating breakfast, or consuming it more regularly, is related to better overall nutrient profiles in children and adolescents. Although cross-sectional studies are not generally viewed as providing strong evidence, it may be an appropriate design in this instance for assessing whether current consumption of breakfast is beneficial for overall nutrient intake. However, more definitive evidence would be provided by intervention studies demonstrating that increasing breakfast consumption favourably impacts on nutrient status in children.

- Nine of ten reports (seven cross-sectional, one case control, two cohort) reported significant positive associations between the frequency of breakfast consumption and physical activity, and one reported no association.
- Seven of seven studies (all cross-sectional) reported an inverse association between frequency of having breakfast and risk of smoking.
- Three of three studies (two cross-sectional, one cohort) reported inverse associations between frequency of having breakfast and mental health status, with students with poorer mental health, such as depression, having breakfast less frequently than other students.
- Three of three studies (all cross-sectional) reported that regular breakfast was associated with healthier food patterns (less dieting and lower alcohol consumption).

Conclusion: there is reasonable evidence that the overall pattern is for regular breakfast consumption to be associated with optimal lifestyle behaviours and mental health. However, these associations do not prove cause and effect, and it is possible that some other unmeasured variable is influencing choices affecting both breakfast frequency and other lifestyle patterns.

1.9 Recommendations

- Knowledge that eating breakfast is important for achieving educational outcomes should be widely disseminated to parents and schools.
- The Ministries of Education and Health, SPARC and other related government agencies should support schools' efforts to develop resources aimed at improving breakfast intake in schoolchildren.
- Parents should provide nutritionally appropriate foods and encourage children to consume a nutritionally adequate breakfast each day. For those children who will not eat breakfast, suitable foods should be provided for consumption at a later time.
- Schools should promote the benefits of breakfast consumption to children, incorporating the topic into lessons in several curriculum areas. If schools provide breakfast to (some) children, they should ensure healthy options are available.
- Government agencies should adequately promote the benefits and advantages of consuming a nutritious breakfast for children and adolescents.
- Government regulation of breakfast cereal marketing and labelling is required.
- More research is required to fully understand the barriers to consuming breakfast, particularly in certain age (teenagers), ethnic (may be traditional in some families not to eat breakfast) and socio-economic groups (available income).
- The majority of studies in this review were cross-sectional, and intervention studies are required to determine the true effect of consuming breakfast (when none was consumed before) or increasing the regularity of breakfast consumption in relation to weight status, nutrient status and lifestyle factors.
- Interventions targeting increased breakfast consumption should place Maori and Pacific and more socio-economically disadvantaged children first, because that is where the need is greatest.

1.10 Strategies to improve breakfast consumption

- Parents should role-model eating breakfast, and siblings should consume breakfast together and role-model for each other.
- Children should be involved in the preparation of breakfast (either the night before or in the morning).
- Leftovers from the night before, wholegrain breakfast cereals low in sugar with trim milk, wholemeal toast and/or porridge, fruit and trim milk drinks are all good options for breakfast.
- Sugary drinks such as fruit drinks should be limited. If chosen at all, water down sugary drinks such as fruit juice and fruit drinks, and use trim milk in sugary drinks such as Milo.
- Do not add sweeteners such as sugar, syrups or honey to cereals that already have high levels of sugar.
- Encourage the consumption of fruit and milk and milk products, foods that are widely consumed by New Zealand children.
- Parents need to be aware of what foods are available for purchase at the school and discuss with their children what they are buying with pocket money or money provided to buy food.
- If a child will not eat breakfast, a suitable packed breakfast could be provided (leftovers if feasible, fruit, yoghurt, sandwiches).

2 Background

Breakfast is regarded by many as "the most important meal of the day", and this report sets out to answer how breakfast relates to two of our biggest social and health issues: learning outcomes and obesity in children. To answer these questions, the report draws on data from New Zealand and internationally.

The context for the current study is a New Zealand environment in which almost one in three New Zealand children aged 5–14 years are either overweight or obese[1], accompanied by significant public debate and a variety of proposed responses to this epidemic. This attention is not misplaced: the average 14-year-old girl in 2002 weighed 6.3 kg more than the average 14-year-old girl in 1985, while being no taller (N Wilson, personal communication).

The tripling of obesity and overweight in children during the period 1989–2001 is startling[2], but New Zealand is not alone: obesity is widespread throughout the world[3], rates are rising rapidly[4-6] and the health consequences are severe for both children and adults[7]. Despite high energy intakes, many children have inadequate intakes of vitamins and minerals[1]. In addition, education experts have long questioned the role food has in school behaviour, scholastic performance and lifelong educational outcomes.

2.1 Aim of the report

The aims of the current report are to answer the following questions (see Appendix N for a full summary of the methodology):

1. What is the national and international context for eating breakfast?
2. Is regular consumption of breakfast associated with academic performance?
3. Is regular consumption of breakfast associated with overweight or obesity?
4. Is regular consumption of breakfast associated with food and nutrient intake?
5. Do regular breakfast eaters differ from non-eaters in other lifestyle factors such as physical activity, alcohol and smoking?

Before addressing these questions, we review information on the patterns of breakfast consumption in New Zealand and internationally.

2.2 What is breakfast?

This is a surprisingly difficult question to answer, and reports use different definitions to describe breakfast. Some are based on the time of weekday and/or weekend day, others require certain food groups to be eaten, and many provide no definition at all (see Appendix A). For the purposes of this review, and to be as inclusive as possible, we have defined breakfast as:

- self-reported by author but no other details given, and/or
- foods and beverages consumed between 5.00 am and 10.00 am on a weekday
- foods and beverages consumed between 5.00 am and 11.00 am on a weekend day

Table 1 Breakfast consumption in New Zealand children (24-hour dietary recall)

Group	Percentage consuming breakfast	Absolute number not eating breakfast
Total population	84.0	94,800
Rural	90.1	
Urban	82.6	
NZDep01-I (low deprivation)	95.7	
NZDep01-II	84.9	
NZDep01-III	82.5	
NZDep01-IV	79.0	
NZDep01-V (high deprivation)	77.2	
NZ European and Other	87.9	48,184
Maori	77.6	29,903
Pacific	71.0	17,629
Aged 5–6 years	86.8	
Aged 7–10 years	87.3	
Aged 11–14 years	79.3	

Table 2 Proportion of New Zealand children that eat or drink at home before school

Group	Males – usually (%)	Females – usually (%)	Males – do not (%)	Females – do not (%)
Total population	86.2*	79.2*	2.5	5.3
Rural	89.6	84.3#	1.3	3.2
Urban	85.5	78.2#	2.8	5.8
NZDep01-I (low deprivation)	94.5$	90.3@	0.7	3.3
NZDep01-V (high deprivation)	69.1$	66.3@	5.4	8.6
NZ European and Other	94.4~	87.7>	1.3	2.7
Maori	74.7~	66.0>	3.6	9.9
Pacific	53.3~	50.3>	9.8	13.0
Aged 5–6 years	93.4"	90.6^	0.8	2.1
Aged 7–10 years	87.7"	84.3^	2.2	3.3
Aged 11–14 years	81.3"	69.1^	3.7	8.7

Note: Matching symbols (*, #, $, @, ~, >, ", ^) indicate that a statistically significant difference between the values was quoted in the National Children's Nutrition Survey report.

- foods and beverages consumed at home before school
- foods and beverages consumed on the way to school
- some requirement on consumption of specific food groups such as dairy products, cereals
- dietary supplement consumption only

2.3 New Zealand breakfast patterns

The National Children's Nutrition Survey (CNS) interviewed 3275 New Zealand children aged 5–14 years in their homes and provides three types of data about children's breakfast patterns from a 24-hour dietary recall, a food frequency questionnaire and dietary habits questions. These different sources of data mean that there is no single answer to a particular question, and so the method of data collection is mentioned in the headings below.

2.3.1 Proportion of children that consume breakfast (24-hour dietary recall)

Breakfast eaters were defined as those who consumed at least one item between 6 am and 9 am and included 84% of the sample. The results show that female children (80.8%) are less likely to eat breakfast than male children (87.0%). Lower breakfast consumption (79.3%) occurred in the oldest age group (11–14 years), the more deprived geographic areas of New Zealand (77.2%), Pacific children (71.0%) and urban children (82.6%) (see Table 1)[8]. These data show clear patterns of inequalities in a determinant of health (eating breakfast).

2.3.2 Proportion of children that eat or drink at home before school (dietary habits)

The National CNS also assessed the proportion of children that usually eat or drink something at home before school[1]. Gender, rural/urban residence, socio-economic status, ethnicity and age are associated with eating before school, and many of the associations are statistically significant, displaying inequalities between groups (see Table 2). For example:

- more males (86.2%) than females (79.2%) usually eat or drink at home before school
- rural females are more likely to usually eat or drink at home before school than urban females
- children from the lowest socio-economic groups are less likely to usually eat or drink at home before school
- approximately four times more Maori and five times more Pacific children do not usually eat or drink at home before school than New Zealand European and Other (NZEO) children
- children aged five to six years are more likely to usually eat or drink at home before school than children aged 7–10 years, who in turn are more likely to eat or drink before school than those aged 11–14 years
- Pacific (21.8%) and Maori (16.4%) females aged 11–14 years have the highest proportions of not eating or drinking at home before school (NZEO 4.6%)

- overall, 5.3% of females and 2.5% of males do not eat or drink at home before school.

Table 3 Proportion of New Zealand children that eat or drink on the way to school

Group	Males – usually or sometimes (%)	Females – usually or sometimes (%)	Males – do not (%)	Females – do not (%)
Total population	15.6	15.7	84.2	84.2
Rural	10.3#	12.1	89.7	87.9
Urban	16.8#	16.5	83.0	83.2
NZDep01-I (low deprivation)	7.1^	3.9$	92.9	96.1
NZDep01-V (high deprivation)	29.8^	31.8$	70.1	67.8
NZ European and Other	8.8”	8.4<	91.0	91.6
Māori	25.9”	28.0<	74.0	71.4
Pacific	41.3”	39.5<	58.3	59.8
Aged 5–6 years	12.1*	10.7@	87.7	88.8
Aged 7–10 years	15.8	16.5	84.2	83.5
Aged 11–14 years	17.2*	17.3@	82.5	82.6

Note: Matching symbols (*, #, $, @, <, >, ”, ^) indicate that a statistically significant difference between the values was quoted in the National Children’s Nutrition Survey report.

2.3.3 Proportion of children that eat or drink on the way to school (dietary habits)

As with eating and drinking at home before school, similar associations between gender, rural/urban residence, socio-economic status, ethnicity and age were found with eating and drinking on the way to school, and many of the associations are statistically significant, displaying inequalities between groups (see Table 3). For example, urban males (16.8%) are more likely to sometimes or usually eat or drink on the way to school than rural males (10.3%), and eight times more females from the most deprived socio-economic status (SES) quintile (31.8%) eat food or drink on the way to school than females from the least deprived SES quintile (3.9%).

Approximately three times more Maori children and five times more Pacific children sometimes or usually eat or drink on the way to school than NZEO children. Children aged 11–14 years are more likely to eat or drink on the way to school than children aged 5–6 years. Pacific males (47.5%) and Pacific females (45.7%) aged 11–14 years have the highest proportions of sometimes or usually eating or drinking on the way to school (NZEO males 9.4% and females 8.6%).

2.3.4 Proportion of children that skip breakfast (dietary habits)

When dietary habits data for eating or drinking at home before school and eating or drinking on the way to school are aggregated, an analysis of skipping breakfast is possible. Maori children (22.9%) are 2.5 times more likely, and Pacific children (40.8%) 5.7 times more likely, to skip breakfast than NZEO children (7.7%) [9]. When the proportion not consuming breakfast (using dietary habits data) is multiplied by the 2001 Census data for children aged 5–14 years (NZEO 398,216, Maori 133,499 and Pacific 60,790 children), it indicates that 83,248 New Zealand children do not consume breakfast (NZEO 27,875, Maori 30,571 and Pacific 24,802 children). The dietary habits questions are more likely to provide data reflecting regular consumption than the single 24-hour recall data presented earlier.

This proportion is comparable with the earlier presented 24-hour dietary recall data from the same national survey, which reported that 84% of the sample ate between 6 am and 9 am[8]. When that proportion not consuming breakfast (16% using 24-hour dietary recall data) is multiplied by the 2001 Census data for children aged 5–14 years (592,500 children), 94,800 children are defined as not consuming breakfast.

Another New Zealand cross-sectional study of 12,934 year 9–13 adolescents (age range of approximately 13–17 years), called the Youth2000 survey, reported that 11.8% of males and 23.3% of females “never have breakfast”[10]. Again this is a similar proportion to the National CNS data, supporting the notion that a considerable number of children regularly skip breakfast.

Table 4 Adding sugar, honey or syrup to cereal (food frequency questionnaire)

Group	Percent adding sugar, honey or syrup to cereal
NZ children (5–14 years)	67
Males	70
Females	63
NZDep 01-I males	55
NZDep01-V males	85
NZDep 01-I females	42
NZDep01-V females	80
Maori males	85
Maori females	80
Pacific males	80
Pacific females	79
NZ European & Other males	64
NZ European & Other females	55

2.3.5 Foods eaten for breakfast (24-hour dietary recall)

The most commonly eaten breakfast food is breakfast cereal (all types, including ready-to-eat and cooked cereals), which is eaten by 57% of children followed by bread/toast (35%). Beverages are the next most commonly consumed items by children: chocolate- flavoured drinks (e.g. Milo) (14%), juice/fruit drinks (11%), milk (8%) and tea/coffee (5%). Eggs (3%) and other savoury dishes (3%) are eaten by only a small proportion of children[8].

2.3.6 Breakfast cereal consumption (food frequency questionnaire)

The National CNS also asked food frequency questions about the intake of all types of breakfast cereals (muesli, wheat biscuits, porridge, puffed/flakes/extruded cereals)[1]. It is important to realise that breakfast cereals are only one type of food eaten at breakfast, and that the data below reflect consumption throughout the day for these products, not just at "breakfast time".

2.3.6.1 How often breakfast cereals are consumed (food frequency questionnaire)

As a type of food (not necessarily eaten at breakfast time), 40% of children reported eating breakfast cereal at least once per day, 45% weekly and 15% less than weekly. Females (32%) are less likely to eat breakfast cereal on a daily basis than males (47%), and twice as many children aged 11–14 years (22% male; 24% female) eat breakfast cereals less than weekly than 5–6-year-olds (10% male; 8 % females) or 7–10-year-olds (9% male; 12% female). There are no socio-economic gradients for frequency of intake of breakfast cereals. Breakfast cereal consumption on a daily basis is lower for Pacific children (29% male; 20% female) than for Maori (49% male; 39% female) and NZEO children (48% male; 31% female)[1].

2.3.6.2 Type of breakfast cereal eaten (food frequency questionnaire)

Six out of ten New Zealand children aged 5–14 years eat Weetbix-type breakfast cereals at least once per week, followed by 50% eating cornflakes-type, 36% Rice Bubbles, 25% Cocopops, and 25% porridge. Proportions do not change significantly by sex or age group [1].

2.3.6.3 Sweetener added to cereal (food frequency questionnaire)

Two out of three children usually add sugar, honey or syrups to cereal (67%), and this proportion does not differ significantly by sex or age group, but it does differ by socio-economic status and ethnicity. For example, Maori and Pacific children (approximately eight out of ten) and children from the most deprived geographic areas (approximately eight out of ten) are more likely to add sugar, honey or syrups to cereal than NZEO children (approximately six out of ten) and children from the least deprived geographic areas (approximately five out of ten)[1] (see Table 4). Analysis of what type of breakfast cereals have sugar, honey or syrups added to them has not been undertaken with the survey data.

[1] The following data do not relate to other types of foods that may be eaten for breakfast.

2.4 Maori breakfast patterns

Patterns of food choice are different between cultures. New Zealand European and Others are believed to have a different pattern of food habits to Maori, and this is also believed to be reflected in breakfast eating patterns. Descriptive data outlining breakfast habits for Maori were not identified during this review, and so two experienced nutrition workers have provided the following description of Maori breakfast habits (Christina McKerchar and Hiki Pihema, 2007).

In 1985 Ashcroft [11] surveyed 51 adult Maori in the Raukawa tribal area and described a typical breakfast as "Toast with butter or marmalade, porridge with cream and tea with sugar and milk". However, in 1989 Maori dietitian Hiki Pihema[12] described three different eating patterns she had found common in her practice with adult Maori in Gisborne:

- *A cooked protein breakfast is eaten containing large amounts of boiled or fried leftovers (including meat), no lunch then a large meal is consumed at night containing a lot of protein.*
- *No breakfast, cooked lunch with protein, once again a very large dinner is consumed.*
- *Nothing is consumed all day but a large tea meal that is high protein, high fat, supplemented with bread and butter.*

These eating patterns, especially the consumption of leftover meat for breakfast, could reflect the rural background common to many people living in Gisborne. More recently, cereals and toast for breakfast have become more common within Hiki's practice, especially for children but also with some adults. Increasing wholegrain consumption, when breakfast cereals and breads are chosen by Maori, is a focus of work within some Maori communities.

The 2002 National CNS results found 49% of Maori males and 39% of Maori females (aged 5–14) consume breakfast cereals daily, with the most common type being Weetbix, followed by cornflakes and Rice Bubbles. Porridge was consumed by 33% of Maori males and 36% of Maori females at least once a week.

Te Hotu Manawa Maori produce a resource called "Nga kai pai mo nga rangatahi – Choice kai for young Maori", detailing breakfast ideas for young Maori, including sections on good breakfast choices (pages 4, 7 and 16) and many other healthy recipes. This resource can be ordered online from www.tehotumanawa.org.nz

2.5 Pacific breakfast patterns

Descriptive data outlining breakfast habits for Pacific people were not identified during this review, and so an experienced nutrition worker has provided the following description of Pacific breakfast habits (Mafi Funaki-Tahifote, 2007).

Children who have grown up in New Zealand are more likely to regularly choose breakfast cereals. Parents who have grown up in the Pacific Islands are unlikely to eat breakfast cereals and are more likely to choose leftovers from the prior evening meal. Often the meat portion of the evening meal has been eaten and the leftovers are the

vegetables such as taro, pumpkin and green bananas. This, along with bread, is eaten with a hot drink such as tea, orange tea, lemon grass or lemon leaves. Other options at breakfast time include toast with pawpaw and grated coconut, or a fresh drink made from grated watermelon, coconut milk and pineapple juice.

Environmental factors that affect such choices include the large number of Pacific families that work shifts in factories that start very early in the morning (as early as 5.00 am), and trade jobs that start at about 7.30 am. Once travelling times are taken into account, one or both parents may have left the house before children wake up in the morning. Grandma or Aunty/Uncle may also be at home.

Auckland and Porirua are known to have Pacific staple foods such as taro readily available at more affordable prices than in other parts of the country.

2.6 Breakfast cereals marketed to children

Two *Consumer* magazine reports released in 2006 compiled recent data on the types of breakfast cereals available in New Zealand[13,14]. The first focused on all breakfast cereals available and marketed to both adults and children, and the second on those specifically marketed to children. The reports noted that over the last 11 years the number of breakfast cereals available has increased from 57 to 200 varieties. *Consumer* also reported that New Zealanders spent $180 million dollars on cereals in the previous year alone, 8% higher than the year before.

In the first report, *Consumer* magazine was unable to recommend two-thirds of available cereals because they were considered too high in fat, sugar and sodium, or too low in fibre. Just 63 of 172 (37%) available cereals were considered nutritionally appropriate[14]. Two particular types of cereals contained more healthy options: porridge-style, where 57% of the 21 products were recommended; and biscuits and bites, where 88% of the 16 products were recommended. In comparison, *Consumer* recommended just 23% of light flake cereals, 32% of mueslis, 33% of bran-based cereals, 23% of cornflakes and puffs, and 23% of sports cereals.

Consumer also noted that labelling was not consistent across products and some cereals did not meet legislative requirements, making “informed individual choice” much harder for people. Finally, they commented that “breakfast bars and liquid breakfasts do not measure up to a sit-down breakfast with a bowl of cereal, milk and fruit”[13].

The report focusing on breakfast cereals solely marketed to children is revealing. Aptly titled “Kids candy”[14], *Consumer* were unable to recommend any of the 26 cereals specifically marketed to children based on an assessment against criteria for fibre, fat, sugar and sodium. This makes it difficult for parents or children to make an informed individual choice when none of the cereals specifically marketed to children are healthy choices. Over half of the cereals had at least one-third of their contents as sugar, and five contained more than 50%[14]. To counter this, nearly all of the cereals made claims about added vitamins and minerals, creating a “halo effect”, where consumers perceive that the whole product is healthy if there is a claimed healthy nutrient[15].

A New Zealand report collecting People Meter data on what sort of television advertisements young people were exposed to in 1995 and 1996 provides an indication of the level of television advertising of breakfast cereals. The data purchased showed that for every 20 hours of television watched, children aged 9–17 years would see 24 breakfast cereal adverts. Annually, this was 503 adverts and 95 promotions, totalling 598[16]. More recently, the Ministry of Health's Food Monitoring Report [17] details advertising expenditure for categories of foods, showing that over the last five years advertising expenditure for breakfast cereals has remained within the range of $17.6–22.7 million per annum, contributing 11% of all expenditure over all food categories (the highest category in the comparative chart). In comparison, when combining all of the categories that represent the rest of the healthy food pyramid base (vegetables, fruit, rice and grains, pasta and noodles, and bread and bakery products), they sum to just 8.7%.

This same report[17] compared breakfast cereals available in 2003 but not in 2006 (i.e. deleted products) with breakfast cereals available in 2006 but not 2003 (i.e. new products). It showed that, on average, new products had 10% more fibre, 20% more saturated fat, 29% more sugar and 23% less sodium.

2.7 International breakfast patterns

What children are eating for breakfast internationally, the proportions of children skipping breakfast in other countries, and trends over time internationally provide an interesting context for a New Zealand discussion.

The United States (US) has undertaken large nationally representative dietary surveys since the 1960s (sample sizes of 7513, 12,561 and 4289 children aged 1–18 years over three surveys), and Siega-Riz et al[18] recently investigated breakfast consumption patterns and trends over time. The studies are cross-sectional, so different groups of children were interviewed in each of the three time periods, and the methods employed to collect and analyse data were of high quality. Breakfast was defined as all foods eaten between 5 am and 10 am.

The results show that between 1965 and 1991 breakfast consumption declined significantly for all age groups of children (1–18 years), but the rate of decline increased with age and was highest for teenaged girls (from 84.4% in 1965 to 64.7% in 1991)[18]. This pattern of decreasing breakfast consumption over time is seen in other countries that have collected time-series data[19, 20], except a single small cohort study of adolescents from 15 to 21 years in Sweden[21]. Similar patterns across countries are that girls are more likely to skip breakfast than boys[19, 20, 22-24], and older children are more likely to skip breakfast than younger children[19, 23-25].

Also of interest in the US analysis was that in 1965 no racial differences were observed in the proportion eating breakfast, whereas by 1991 Black adolescents were much less likely than Whites to consume breakfast. The same trend was true for analyses by parental education and income. Siega-Riz et al[18] demonstrated that the decline in breakfast consumption was not due to changing socio-demographic patterns in the US (increases in women in the workforce, divorce rates, births outside of marriage), but instead was due to the adoption of new behaviours in subgroups[18]. A similar study design using four sets of NHANES data from 1971 to 2004 reported that

skipping breakfast differed according to the poverty status of families. For example, 21% of 12-year-olds and 33% of 17-year-olds from families not in poverty skipped breakfast, compared with 26.8 % and 47.9% respectively from families in poverty[25].

No other studies appear to have undertaken such detailed analyses as those described above, although other studies from around the world present an inconsistent pattern or trend between socio-economic status, ethnicity and eating breakfast[24, 26, 27], with some studies showing that belonging to the majority ethnic group improves the likelihood of eating breakfast[20, 28], while one study shows the opposite[29]. The US analysis identified other factors predictive of not eating breakfast, and these are supported by many other studies from around the world, such as living in a single-parent household[24] and having parent(s) who are not college educated[19]. There are no independent differences by race or urban/rural residence[18], and there is no consistent pattern across time for female employment status, family size or place of residence.

Changes in breakfast food choices between 1965 and 1991 in the US analysis reflect fewer sources of dietary fat (changing from whole to trim milk and a decline in bacon, butter and margarine), more fruit and wholegrains, and less eggs and white bread. Increases in wholegrain breads and ready-to-eat cereals also occurred. Siega-Riz et al[18] summarised the overall findings by saying that "An improvement in the quality of breakfasts has been offset by the large percentage of adolescents who do not consume breakfast".

In a large cross-sectional survey of over 18,000 adolescents that relied on a single question about breakfast intake (rather than food recall data), Videon et al[29] analysed breakfast intake against whether adolescents were allowed to make their own decisions about the foods they ate. They found that those adolescents who were allowed to make their own food decisions were 25% more likely to skip breakfast than adolescents who reported their parents made decisions as to what they ate. Videon et al[29] found that parental presence when leaving for school had no impact on whether breakfast was eaten, yet number of meals eaten with parental presence at an evening meal (over three meals per week) was positively associated with eating patterns and increased as the number of meals eaten together increased, including eating breakfast.

The US also makes a school breakfast programme (SBP) available to all children at subsidised prices for low-income students, and this programme runs in two-thirds of all schools. The effect of the SBP on nutrient intake of children is discussed in section 5.3. However, the standards established for school meal programmes do not apply to foods and beverages served and sold throughout the school, such as tuck shops and vending machines, and there is growing concern that standards should be applied to food in the entire school environment. Of course not all schools comply with the nutritional guidelines (e.g. providing foods too high in fat and low in fibre), not all children participate, and those who do participate do not necessarily eat everything provided[30]. Within the SBP, the most effective strategies for increasing school breakfast participation were universal free breakfast and breakfast in the classroom[31]. Interestingly, access to an SBP did not appear to influence rates of skipping breakfast in some population studies[18], whereas other population studies have shown it reversed a decline in skipping breakfast[32].

Table 5 Frequency of breakfast eating in children from around the world

Country	Age (years)	Result	Reference
Sweden, urban & rural	14–15 y	20% of boys and 32% of girls "ate breakfast < 3 times per week"	22
Sweden, urban	15, 17, 21 y	4–5% in each age group "ate breakfast < twice per week"	21
Sweden, urban	15–16 yrs	12% boys and 24% girls missed breakfast once a week or more	34
Finland, rural	10–11 y	1% did not "eat breakfast regularly"	38
Norway, urban	15–16 y	16.7% eat breakfast "1–3 times per month"	27
Denmark, urban	14–16 y	19% boys and 32% girls "not eating breakfast every day"	24
Netherlands, nationwide	5–18 y	5% primary and 13% secondary students "did not eat breakfast before going to school"	19
Netherlands	12–14 y	8% "never had breakfast"	43
Spain, urban & rural	2–24 y	9% were "non-consumers of ready to eat cereals"	96
South Africa, urban	12–16 y	22% did not "have breakfast before school"	35
France, urban	2–18 y	0% "omitted breakfast completely (at least 5 times per week)"	91
France, urban & rural	9–11 y	97% of children "eat breakfast"	44
England, urban	9–12 y	6% of girls and 7% of boys (aged 9–10 years), 23% girls and 12% boys (aged 11–12 years) "did not eat and/or drink at home or on the way to school"	23
England, urban	11–16 y	23% girls and 14% boys "did not eat breakfast on the day of school"	41
Australia urban & rural	13 y	5% males and 18% females "did not eat breakfast"	39
Australia, urban	18 y	23.1% men and 21.7% women "missed breakfast on at least 1 of the 2 days"	26
Australia, urban	6–19 y	8–26% girls and boys "regularly skip breakfast"	33
USA, urban	Average 16 y	49% males and 66% females skipped breakfast "at least 3 times in prior week"	112
USA, urban	14–15 y	23% females and 14% males "did not eat breakfast in the last 24 hours"	28
USA, urban	14 y	27% of girls and 20% of boys "did not eat breakfast on a single day"	70
USA, urban	Grades 9–12	37% females and 43% of males "ate a healthy breakfast"	36
USA, urban & rural	Grades 7–12	20% "ate nothing for breakfast on the previous day"	29
USA, urban	9–19 y	23% white girls and 43% African American girls (at 9 years), and 68% white girls and 78% African American girls (at 19 years) "did not eat breakfast on all 3 days"	20
Canada, urban	14–18 y	7% skipped breakfast 1 day, 17% skipped 2 days, 2% skipped 3 days	92
Canada, urban	Grades 4–8	Fewer than 3% "never" had breakfast	113
Canada, urban & rural	Grade 10	51% boys and 64% girls "did not eat breakfast daily"	37

An Australian cross-sectional study of 1126 students aged 6–19 years shows that children of low socio-economic status are more likely to regularly skip breakfast (31%) than older children of mid or high socio-economic status (22%)[33]. Similar results have been reported by some[22, 34] but not all[35] studies from various countries. When a three-way analysis considering gender, weight and age was undertaken in the Australian study, it showed that overweight females are the most likely to regularly skip breakfast (18%) and normal weight males the least likely to skip breakfast (10%)[33]. Similar findings from other US cross-sectional studies show that those most likely to skip breakfast are adolescents who perceive themselves to be overweight[29,36] or who are concerned about gaining weight[37].

Social networks of children were investigated in a large Danish study of 14–15-year–olds, and no relationship was found between the type of social network the child has (isolated, adult oriented or friend oriented) and breakfast consumption[24]. The authors concluded that not eating breakfast was influenced by family circumstances such as type of family and mother's SES status rather than circumstances in the school classes such as social networks.

2.8 Proportion of children eating breakfast internationally

Different studies use different methods (food frequency questionnaire, 24-hour dietary recall, single questions, etc), different breakdowns of data (ate breakfast yesterday, ate breakfast more than five times per week, ate breakfast every day, etc), and different days of week studied (yesterday, weekdays only, weekdays and weekends, etc), which makes comparisons between countries challenging. Breakfast skipping is defined equally diversely (rarely or never eat breakfast, didn't eat breakfast yesterday, eat breakfast less than twice per week, eat breakfast less than three times per week, etc). Comparisons are therefore not worth significant discussion, and so a table presenting data on breakfast skipping (variously defined) in developed countries is presented in Table 5.

What we can take from this international data, especially those studies that have shown very high rates of breakfast intake, is that nutrition issues are still described for the study populations within the published articles, such as low nutrient intake for certain nutrients and overweight/obesity[38]. It confirms a standard lesson in nutrition that no single risk factor explains outcomes fully, and so no single intervention (such as getting children to eat breakfast) will fully provide the outcomes we seek. Nutrition is a holistic discipline, and many risk factors must be targeted by many interventions to attempt to improve a diverse array of outcomes.

2.9 Why do children eat breakfast?

Only a small number of studies have investigated attitudes about why children skip breakfast, and this is a gap in our knowledge in New Zealand. One Australian study of 669 13-year-olds questioned those who skipped breakfast[39]. This led to a small sample size (56 children out of the 82 breakfast skippers were interviewed), but it provides one insight into possible reasons. The "primary reason" offered for skipping was lack of time in the morning (52%), followed by not being hungry (22%) and not feeling like it (14%); in other words, "personal choice and convenience reasons rather than dieting or body shape" [39].

Table 6 Summary of factors associated with eating breakfast[18,29,36]

Increased likelihood to eat breakfast	Reduced likelihood to eat breakfast
Younger age	Older age
Boys	Girls
Living with a female head of household with at least a college education, or parents with a college degree, or father with higher education	Living with a female head of household or male head of household with little or no educational qualifications
Living in a two-parent household	Living in a single-parent household, living with other family members, living in a foster-parent household
Young children whose single mother is not employed	Young children whose single mother is employed
Normal weight adolescents	Overweight adolescents
Eating evening meals with parental presence	Eating evening meals without parental presence
Children attending school in a rural area.	Children attending school in a large city.

From a checklist where more than one reason could be chosen for not eating breakfast, 11 (all female) out of 56 indicated that wanting to lose weight and/or being on a diet was one of the reasons for not eating breakfast, three claimed there was nothing to eat at home and ten did not like the food available.

The author concluded that skipping breakfast was not a poverty issue, and hence free breakfasts may be less of a solution than teaching the importance of eating breakfast, building self-esteem and informing children about sound methods of weight control[39]. Weaknesses in the paper were a lack of control in the analyses for socio-economic status or other confounders, a very small final sample size, lack of information about dietary methods, and the paper did not describe sample characteristics such as ethnicity and the potential for sample bias, so the conclusion should be treated with caution.

An American study of 1442 fourth- to sixth-grade students was undertaken specifically to understand the perceived benefits and barriers to eating breakfast[40]. Students perceived that breakfast provides increased energy and improved ability to pay attention in school. Barriers to eating breakfast were not having enough time to eat breakfast in the morning (41% sometimes or never have time) and not being hungry in the morning (50% sometimes or very often not hungry). Skipping breakfast because it might make them fat was reported sometimes or very often by 14% of the sample. As with the Australian study, it is not possible to tell the socio-economic status of the sample, and there was no control for confounding (21–28% of each school sampled were non-white).

One English cross-sectional study of over 1000 children showed that the females who defined themselves as “dieting to lose weight” were more than three times more likely to skip breakfast than those “not dieting”, but the same did not hold for boys[41]. Similar results were observed in Australian children aged 12–15 years[42].

Netherlands investigators asked 601 children aged 12–14 years “Why do adolescents eat what they eat?” in a school-based cross-sectional survey[43]. One-half of adolescents’ homes had rules about eating breakfast, and breakfast foods were generally perceived to be available and accessible in the home. The authors show that frequent breakfast eaters had a more positive attitude towards eating breakfast than those who ate breakfast rarely. Many factors were not correlated with eating breakfast, including age, perceived normal breakfast behaviours of the mother or father, social support of the mother and father towards breakfast, self efficacy (how confident and easy students thought it was to eat breakfast), intention to change, food rules or food availability.

The authors concluded that any interventions to increase breakfast consumption should at least include strategies to achieve positive attitudes towards eating breakfast. They also suggested that since dietary behaviour was not associated with action in this group, these communications should not rely on traditional healthy diet messages, but instead on more creative ways to increase positive associations with eating breakfast. For example, this could include increased exposure to these products[43].

A French study sponsored by Kellogg's of 1000 children aged 9–11 years who were socio-demographically representative of the French population showed that 97% of the children ate breakfast (high compared with other nations). Sixty-one percent of children viewed breakfast as the most important meal of the day, two-thirds "would like to have more time for breakfast in the morning" and half "prefer to prepare my own breakfast"[44].

A further French study, following nearly 400 families in a cross-sectional analysis within a cohort study, investigated the influence of family members eating breakfast at the same time, showing that when families frequently eat together their energy intakes are more similar[45]. This was true for both adults and children, but was even more pronounced for siblings. The authors concluded that families are a good place for breakfast interventions by attempting to increase the number of shared breakfasts, highlighting parent modelling and especially sibling modelling.

The National CNS[1] indicated that food security is an issue in New Zealand families. For example:

- about 78% of households reported that "they could always afford to eat properly", but 20.1% said they could only sometimes afford to do so
- 40% of households with five or more children reported that "foods runs out in their household because of lack of money" often or sometimes, which was also reported in over half of all Pacific households (53.9%), and over a third of all Maori households (37.5%)
- nearly a quarter (23.9%) of the most deprived households in New Zealand often or sometimes "relied on others to provide food or money for food in their household when the household didn't have enough money".

Although analyses have not been undertaken to link food insecurity and breakfast skipping within the New Zealand context, it is a plausible hypothesis.

3 Is regular consumption of breakfast associated with academic performance?

The studies reported in this section were identified from a number of sources. Besides the initial literature search, several studies were found in recent reviews[46-50]. Individual research papers were also searched for previous studies with results related to the question.

Research on the effect of breakfast on academic performance goes back at least to the early 1980s[51]. Since then, many studies have shown that cognitive function and academic performance are better in children when tested on a morning after eating breakfast compared to mornings when they had fasted[51-55]. These and other studies have been reviewed by Grantham-McGregor[48] and Taras[49]. Extending the overnight fast by missing breakfast is thought to affect cognitive function through decreased blood concentrations of glucose, insulin and other neurotransmitters[47]. These studies of the acute effects of missing breakfast are not included in this review because they

do not address the question of whether *regular* breakfast consumption is associated with academic performance.

Fifteen studies were found that reported on the effect of regular breakfast consumption on academic performance. Drawing on the review by Grantham-McGregor[48], they have been separated into the following categories:

- observational studies (excluding school breakfast programmes)
- cohort studies of free school breakfast programmes
- short-term breakfast interventions (less than one month)
- long-term breakfast interventions (more than one month).

3.1 Observational studies (excluding school breakfast programmes)

Five observational studies (four cross-sectional and one cohort) were identified (see Appendix B). The cross-sectional studies were carried out in Saudi Arabia[56], Malaysia[57], Spain[58] and Denmark[24] (see Table 7). All four studies show significant positive associations between regular breakfast patterns and summary scores of academic performance. The cohort study comprised offspring of women in the Nurses Health Study carried out in the US[59]. This study found that children who missed breakfast performed less well at schoolwork in the following year. Thus, all five studies found positive associations between frequency of regular breakfast consumption and academic performance.

However, there are limitations in some of these studies. A weakness of the cohort study is its reliance on self-rating of academic performance, in contrast with all four cross-sectional studies which used objective measures. Furthermore, there was limited control of confounding variables, particularly of socio-economic status, which was only controlled in two studies[24, 57].

3.2 Cohort studies of free school breakfast programmes

Four studies were identified which compared the academic performance of students participating, with those not participating, in free school breakfast programmes (SBPs) (see Appendix C). Three of these studies were of primary school students at schools in the US, and measured academic performance before and after the introduction of the breakfast programme[60-62]. The other study was of 16-year-old female students entering a rural nursing school in Taiwan, which measured academic performance at the end of the first semester[63].

All four studies had objective measures of academic performance. Two of the studies found that increased attendance in the free SBP was associated with increased scores in a summary comprehensive test[60] or in each subject[63]. The other two studies observed that increased breakfast attendance was associated with increased grades for mathematics but not for other subjects[61, 62]. Thus, as for observational studies above, all cohort studies of participation in free SBPs have shown improved grades in one or more subjects.

Table 7 Summary of studies comparing regular breakfast consumption with academic performance

Type of study	Direction of association			
	Positive	**None**	**Negative**	**Total**
Observational				
X-sectional	4	0	0	4
Reference number	56 57 58 24	0	0	1
Cohort	1			
Reference number	59			
Cohort studies of free school breakfast programmes	4	0	0	4
Reference number	60 61 62 63			
Short-term breakfast interventions (< 1 month)	1	2	0	3
Reference number	66	64 65		
Long-term breakfast interventions (> 1 month)	3	0	0	3
Reference number	67 68 69			
Total	**13**	**2**	**0**	**15**

See Appendices B to E for a description of the magnitude of the relationship for each study.

A limitation of these studies is that students not participating in the free SBP may have had breakfast at home before coming to school, so that the comparison is not truly between breakfast and no breakfast. A further criticism is their limited control of confounding, with only one study controlling for socio-economic variables[60]. It is also possible that participation in the SBP is associated with some other unmeasured variable (e.g. maternal attitudes favourable to education), which was responsible for the increased academic performance in participating children.

3.3 Short-term breakfast trials

Three studies were identified which investigated the effect of short-term breakfast interventions, of less than one month duration, on academic performance (see Appendix D). All these studies were of students at primary schools in Jamaica[64], Peru[65] and Israel[66]. The Jamaican study was a cross-over trial, where each student acted as their own control by receiving both the intervention breakfast and the placebo breakfast (one-quarter of an orange) each for one to three weeks, with a three-week washout period in between[64]. The other two studies were parallel trials with separate intervention and control groups, with the breakfast intervention lasting 15 to 30 days[65] or 14 days[66]. All studies had objective measures of academic performance or cognitive function.

Two of the studies did not find any main effect from the intervention breakfast, with no improvement in academic performance when analysing the total study sample[64, 65]. However, both of these studies did find improved test scores in subgroups. The Jamaican study found a significant increase in the verbal fluency score after breakfast (compared with placebo) only in undernourished children[64], while the Peruvian study found the opposite – a greater increase in the vocabulary score in the breakfast group compared with the control, but only in heavier children[65].

In contrast, the Israeli study found that students receiving the breakfast intervention scored higher for most tests than students in the control group[66]. This finding was in spite of the fact that 66% of children in the control group had breakfast at home. Thus, overall, only one study out of three found a positive association between breakfast and academic performance in the total study sample. Further, two of the studies did not directly measure academic performance, but used tests of cognitive function instead[64, 66].

3.4 Long-term breakfast trials

Three trials of long-term breakfast interventions (over one month) on academic performance were identified (see Appendix E). Two studies in Jamaica[67,68] and the other in South Africa[69] all involved primary school children. Students were randomised by class[67] or individually[68] to receive either the intervention or placebo in the Jamaican studies, while in the South African study the breakfast intervention was implemented at a rural school, with an urban school acting as the control[69]. The breakfast intervention period was longer in the Jamaican studies – 10 weeks[67] or eight months [68] – than the six-week period in the South African study[69]. All three studies used objective measures of academic performance.

Both Jamaican studies found significantly increased scores for arithmetic, but not for reading or spelling, in the breakfast group compared with controls[67,68]. The South African study also found greater increases in the digit span test (for memory and concentration) and a vigilance test (for alertness and arousal) among students at the school that received breakfast than the control school[69]. Thus, all three schools showed improvements in academic performance, particularly with numeric tests, for students receiving breakfast. However, a limitation of the latter study is that the significant result may be explained by differences in another confounding variables between the intervention rural school and the urban control school.

3.5 Summary

Thirteen out of the fifteen studies reported positive associations between regular breakfast consumption and academic performance (see Table 7). Two other studies of short-term interventions failed to find a main effect, and are listed as not finding an association, although each did find a positive association in a subgroup[64,65]. Importantly, no study reported a negative association between regular breakfast consumption and academic performance, although the possibility of publication bias skewing such an observation cannot be discounted. Such findings should have been observed by chance if there was truly no association between regular breakfast consumption and academic performance (on the assumption there is no publication bias). Furthermore, the positive associations reported for randomised trials[67,68] are unlikely to be explained by other confounders (aside from the South African study by Richter et al[69]), which strengthens the evidence.

Thus, there is considerable evidence that regular breakfast consumption improves academic performance. The benefit appears to be greater for mathematics, which was improved in four studies by breakfast, than for other subjects such as reading, spelling or subjects with a knowledge component (science, social studies), which showed no improvement[61,62,67,68].

4 Is regular consumption of breakfast associated with overweight or obesity?

In total, 23 studies were identified that met our criteria for examining the relationship between breakfast consumption and weight status in children. We chose not to restrict these analyses to those consuming “regular” breakfasts, since this would exclude several large and therefore informative studies that had used single-day dietary recalls to assess breakfast consumption, including appropriate New Zealand data[8]. Instead, we included all studies that investigated the relationship between breakfast intake and weight in children, regardless of how breakfast was measured or defined. We also separated the analyses into three main groups:

- those who had assessed breakfast intake either as a categorial variable (yes/no) or in terms of frequency of intake
- studies that used the intake of cereal, usually ready-to-eat (RTE) cereal, as the key variable of interest, rather than breakfast consumption *per se*

- some additional papers that had investigated a variety of issues surrounding breakfast consumption, principally to do with school breakfast programmes.

4.1 Is consumption of breakfast associated with overweight or obesity?

We identified 19 studies that assessed whether breakfast consumption or frequency of intake is related to weight status in children (see Appendix F). Table 8 (page 31) demonstrates that the majority of these studies were cross-sectional by design and thus do not provide a strong evidence base. However, they are reasonably consistent, with 12 of the 14 cross-sectional and one of the five cohort studies reporting an inverse association, demonstrating that breakfast skipping or less frequent consumption is associated with a higher risk of overweight or obesity during growth. Five studies did not demonstrate any relationship between breakfast consumption and weight, and one study reported that breakfast skipping was associated with smaller BMI gains in overweight children.

Several analyses involved large (over 1000 participants) and/or representative samples of children from a variety of countries, with appropriate adjustment for multiple confounders[8,18,20,27,32,34,59,70-76]. Of these 12 studies (14 publications), all but three[8,32,73] reported significant inverse correlations, with children consuming breakfast having significantly lower body weights or a reduced prevalence of obesity compared with those who skip this meal or eat it less frequently (see Table 9). Nationally representative samples of children from the US showed that a one-unit increase in BMI was significantly associated with declining breakfast consumption in 11–18-year-old adolescents. Unfortunately, corresponding analyses did not appear to be undertaken with younger-aged children, despite information presumably being collected[18].

Other analyses from 12–16-year-old participants in NHANES III demonstrate that the odds for being a healthful weight (BMI 15th to 85th percentile) were not significantly different in those consuming breakfast compared with less frequent consumers in the group as a whole. However, in the subgroup with one or more obese parents, children eating breakfast some days or every day were 3.1 to 4 times more likely to be a healthy weight than those rarely eating breakfast, whereas no differences were observed in subjects with two non-obese parents[75]. Other nationally representative samples report considerable differences in mean BMI of approximately one unit between girls classed as irregular or regular breakfast eaters[34], or higher odds ratios for being overweight (1.7–2.0) in less frequent eaters in Norwegian teenagers[72].

It is difficult to determine whether differences in study design or analysis account for the two cross-sectional studies that did not observe any relationship between breakfast consumption and weight status, given that both were reasonably large and collected breakfast intake from a single 24-hour diet recall. Nicklas et al[32] reported that breakfast consumption patterns had changed considerably over time in American children, but showed that skipping breakfast did not increase the possibility of being overweight (odds ratio 1.22, 95% CI 0.87–1.71). The other cross-sectional study was an analysis of the recent National CNS, which reported that the percentage of children in each weight category (normal weight, overweight, obese) was not different for breakfast eaters and non-eaters[8].

Table 8 Summary of studies investigating the relationship between breakfast consumption and body weight or obesity in children

	Positive	None	Inverse	TOTAL
Cross-sectional Reference number	0	2 32 8	12 112 26 18 70 71 34 27 72 92 75 25 76	**14**
Cohort Reference number	1 59	3 77 73 20	1 74	**5**
Intervention	0	0	0	**0**
Total	**1**	**5**	**13**	**19**

See Appendix F for a description of the magnitude of the relationship for each study.

While only Nicklas et al[32] adjusted for energy intake, Wilson et al[8] showed that energy intakes were also not significantly different between breakfast eaters and non-eaters within each weight category.

Somewhat surprisingly, perhaps, analyses from the same data set of New Zealand children, but utilising a different assessment of breakfast consumption, show quite different results[76]. The 24-hour recall data categorised children according to whether they had eaten at least one item between 6 am and 9 am on the day of the recall[8], whereas the food habits questionnaire categorised children into three groups (usually, sometimes, no) based on the question "Over the past week, did you eat or drink something before you left home for school in the morning?"[76]. In the latter analysis, evidence of a dose–response relationship was apparent, with significantly lower mean BMI in children reporting "usually" (72% of sample) having something to eat or drink compared with those indicating "sometimes" (22%) or "no" (6%, mean BMI 18.7, 21.5 and 22.1 in the three groups respectively, $p = 0.002$), even after adjusting for age, sex, ethnicity, SES and physical activity. No adjustment for energy intake was possible given the data were obtained from a food frequency questionnaire.

It is feasible that energy intake differed between these three groups. However, as reported above, the analysis using the 24-hour recall data did not show that energy intake differed according to weight status and breakfast group allocation[8]. It is possible that the food habits analysis is more likely to detect any difference in BMI between groups if it is assumed that asking children about breakfast consumption over the past week rather than just the previous day provides a better indication of "usual" intake for each child. The discrepancy in the results from the National CNS could also be related to the analyses, given that one compared actual BMI[76] whereas the other simply reported whether the percentage of children within each weight category differed according to breakfast consumption[8].

Concern has been expressed that the inverse relationship observed between breakfast consumption and weight status from cross-sectional studies in children may reflect an effect rather than a cause, in that overweight children are skipping breakfast in an effort to control their weight. Thus, in general, cohort studies are considered to provide more rigorous evidence than cross-sectional studies. However, only four cohort studies appear to have investigated whether regular breakfast consumption is related to body weight in children, and two of the three cohort studies (four publications) were relatively small[74,77]. One[77] did not directly relate breakfast consumption to weight status but simply reported that weight regain was occurring at the same time as a decrease in the percentage of energy obtained from breakfast (14.4 cf. 12.2% kJ) in a group of 121 French teenagers who had previously been involved in a weight-loss programme.

Elgar et al[74] were able to demonstrate a significant relationship between frequency of breakfast intake and relative weight status in 652 Welsh year 7 students, which was also found in follow-up data obtained four years later. Moreover, multiple regression analysis showed that breakfast skipping predicted BMI at year 11. However, the large attrition observed in this sample (46%) somewhat limits interpretation of the longitudinal analyses.

Table 9 Large (> 1000 participants) and/or representative studies investigating whether consumption of breakfast is associated with weight status in children

Reference number	18	70	71	34	27	72	75	76	20	74	32	8	73	59
Study design[1]	X	X	X	X	X	X	X	X	C	C	X	X	C	C
Association	Inverse	Inverse	Inverse	Inverse	Inverse	Inverse	Inverse	Inverse	Inverse[6] None	Inverse	None	None	None	Positive
N of participants	24,004	1493	8330	1245	1659	1489	1890	3042	2379	652	1655	3275	2379	> 14,000
Age	0–18 y[4]	Mean 14.1 y	7th–11th grades	15-16y	15–16 y	8–9 y, 12–14 y	12–16 y	5–14 y	10 y	Year 7	10 y	5–14 y	10 y	9–14 y
Country	USA	USA	USA	Sweden	Norway	Norway	USA	NZ	USA	Wales	USA	NZ	USA	USA
Nationally representative	Yes	No	No	Yes	No	Yes	Yes	Yes	No	Yes	No	Yes	No	No
Diet assessment method[2]	1–3 24 hr	Single 24 hr	Question	Diet history	Question	FFQ[5]	Single 24 hr	Question	Annual 3DDR[7]	Question	Single 24 hr	Single 24 hr	Annual 3DDR	Question
Breakfast definition[3]	Time	Subject	Subject	Subject	Subject	Subject	Subject	Subject	Time	Subject	Subject	Time	Time	Subject
Significant in both sexes	Not stated	Not stated	Yes	Boys only	Girls only	Not stated	Not stated	Not stated	N/A	N/A	N/A	N/A	N/A	Yes
Adjust for energy intake	No	No	No	No	No	Yes	No	No	Yes	No	Yes	Yes	Yes	Yes
Adjust for physical activity	No	No	No	No	Yes	Yes (TV)	Yes	Yes	Yes	TV	No	No	Yes	Yes

[1] X refers to cross-sectional and C to cohort.

[2] 24 hr = 24-hour recall; Question = single question containing the word “breakfast; 3DDR = 3-day diet record.

[3] Time = any food consumed during a certain time frame; usually 5–10 am except for NZ paper, which used 6–9 am; Subject = definition provided by subject, or the word “breakfast” used in questionnaire.

[4] Analyses only appear to have been conducted in 11–18-year-old portion of sample.

[5] FFQ = food frequency questionnaire.

[6] Inverse relationship adjusted for age, ethnicity, diet and two-way interactions but no longer significant once also adjusted for parental education, physical activity and energy intake.

Perhaps the most rigorous cohort study followed 2379 9–10-year-old girls for 10 years with annual collection of three-day diet records to investigate breakfast and nutrient consumption[20,73]. Breakfast was also defined from foods eaten within a certain time frame each day rather than a subjective rating by each subject, and multiple confounders were adjusted for. In one analysis, mean BMI was significantly lower (albeit by only 0.1 kg/m^2) in girls eating breakfast compared with those with less frequent consumption, adjusted for age, ethnicity, site and two-way interactions. However, differences were no longer apparent with further adjustment for parental education, energy intake and physical activity[20]. A separate analysis of the same data set that was predominantly concerned with cereal consumption also reported that days eating breakfast was not predictive of weight status[73].

The remaining cohort study investigated breakfast frequency in relation to annual changes in BMI in over 14,000 US children aged 9–14 years at baseline[59]. Cross-sectional analyses were consistent with the majority of studies described above: children who skipped breakfast were heavier than those consuming this meal. However, longitudinal analyses were quite different, and this study appears to be unique in examining the effects on normal-weight children separately from those classified as overweight. In overweight children, skipping breakfast was associated with *smaller* increases in BMI over time, adjusted for a multitude of confounders including physical activity and energy intake. In contrast, skipping breakfast was not associated with BMI gain in children of normal weight[59]. Thus choosing to restrict breakfast was successful for these overweight children in terms of reducing relative BMI gains compared with other overweight children consuming breakfast more frequently.

It is apparent from Table 9 that few studies involved children younger than 12 years of age[8,32,72]. Although the Wilson et al[8] and Andersen et al[72] studies included children as young as five or eight respectively, analyses tended to adjust for age rather than be presented separately to ascertain if the relationship is apparent in younger children. The single study in younger children investigated meal patterns in relation to time and weight status in 1655 10-year-old children from seven cross-sectional surveys from the Bogalusa Heart Study[32]. In this group, skipping breakfast was not related to overweight status (odds ratio 1.22, 95% CI 0.87–1.71).

Although many studies did adjust for various confounders (see Appendix F), few adjusted for energy intake and physical activity, crucial variables when analysing factors in relation to weight status. Section 5.1 highlights how four of the six studies that measured energy reported higher energy intakes in those consuming breakfast. Table 9 demonstrates that six cross-sectional and four cohort studies adjusted for one or both of these confounders. Of these 10 studies, five reported an inverse association[27,72,74,75], three reported no effect[8,32,73], one[20] demonstrated an initially significant relationship that was no longer apparent once adjusted for energy intake and activity, and one[59] reported that skipping breakfast apparently had favourable effects in terms of reducing relative weight gain in overweight children.

Table 10 Summary of studies investigating the relationship between cereal consumption and body weight or obesity in children

	Positive	None	Inverse	TOTAL
Cross-sectional Reference number	0	1 80	2 79 82*	3
Cohort Reference number	0	0	1 73	1
Intervention Reference number	0	0	1 81	1
Total	0	1	4	5

* Study in adults which included participants aged 18 years.

See Appendix G for a description of the magnitude of the relationship for each study.

It appears that physical activity is related to breakfast consumption (see section 6.1), either directly, or perhaps as a marker of another unmeasured or unknown variable. For example, unhealthy weight loss practices have been demonstrated in relation to breakfast avoidance; teenagers participating in the Youth Risk Behavior Survey who skipped breakfast were more likely to perceive themselves as overweight (actual weight status not reported) and to have used inappropriate dietary practices such as fasting, use of laxatives, diet pills and vomiting to control weight than those eating breakfast[78].

In summary, there is some evidence, albeit weak, that breakfast consumption is related to weight status in children. However, although 13 of 18 studies reported significant inverse associations showing that breakfast skipping or less frequent consumption was related to body weight in children, most of this evidence is from cross-sectional studies, many of which were small or did not adjust for confounding variables. Few cohort studies have been undertaken to determine the long-term influence of breakfast consumption in relation to weight. The few existing studies overall have not provided strong evidence that consuming breakfast is important for weight management in children, and the possibility of publication bias cannot be excluded. Unfortunately, no interventions have been undertaken to demonstrate that increasing breakfast consumption in children or adolescents has positive effects on body weight. In addition, there is little evidence for pre-pubertal children, perhaps because the number of breakfast skippers at this age is considerably lower than that observed in teenaged children (see section 1), which may limit appropriate analyses.

4.2 Is consumption of breakfast cereal associated with overweight or obesity?

Four studies have examined the relationship between consumption of breakfast cereal, usually ready-to-eat (RTE) cereal, and body weight in children (see Table 10, and Appendix G). One cross-sectional, one cohort and the single intervention study all support a beneficial role of cereal consumption in relation to weight status. A significant dose–response relationship was observed in 4–12-year-old children when divided according to the number of servings of RTE cereal over a 14-day diet record collection period: children consuming cereal at least eight times had a mean BMI of 16.7 compared with those consuming cereal less frequently (four to seven times: mean BMI 17.9; and less than three times: mean BMI 19.3)[79].

However, information on BMI was obtained from parents, a large proportion of the sample had missing BMI data, and no confounders were adjusted for. It is possible that parents of children who regularly consume RTE cereal would under-report their child's BMI more than parents of children with less frequent consumption, but this seems unlikely, particularly given that reported energy intakes were similar across cereal frequency groups. The only study that did not find any difference in BMI according to cereal intake was also conducted in a representative sample of children (UK) and used diet records (seven-day) to estimate cereal consumption. No differences in mean BMI or in the prevalence of obesity were observed in children according to their percentage of energy intake from cereals, although there was a tendency for cereal consumers to have improved LDL cholesterol concentrations[80].

Stronger evidence is provided by the cohort study of Barton et al[73], who followed 2379 9–10-year-old girls for 10 years. The number of days eating cereal from annual

three-day diet records was predictive of BMI z-score (–0.015) and weight status once adjusted for a myriad of confounders, including physical activity and energy intake. Only one intervention has tested whether increasing the intake of RTE cereals can impact favourably on body weight in children[81]. Families with overweight 8–12-year-old children were recruited to participate in a 14-week intervention which promoted two simple behavioural goals: to eat two servings of RTE cereal, and to increase steps by 2000 each day (measured using pedometers). The analysis reported that cereal consumption was higher in intervention than control children at follow-up (8.1 cf. 3.6 serves/week, $p < 0.05$), and that favourable effects on body composition were observed. Unfortunately, analyses do not appear to have adjusted for baseline differences between intervention and control groups, including cereal consumption, and the study was under-powered (being a feasibility study), which limits its conclusions.

In summary, little work has examined whether increasing cereal consumption *per se* may be an important target for weight management during growth, although three of the four existing studies do support a beneficial role for RTE cereals. An interesting analysis of 18-year-old and over participants from NHANES III demonstrates that *what* you eat for breakfast might be the important determinant in relation to weight rather than *if* you eat breakfast at all[82]. Subjects who ate RTE cereal, cooked cereal or quick breads (e.g. pancakes, French toast, cakes) had lower BMI values than breakfast skippers, but also lower than those who ate a cooked breakfast. Cooked cereal eaters (but not RTE cereal eaters) also had lower BMI values than those who ate breakfasts consisting of fats/sweets (such as candy), dairy, and breads.

4.3 Does participation in school breakfast programmes influence body weight in children?

Only one study appears to have examined the weight implications of participation in school breakfast programmes (SBP)[83]. Analysis of the nationally representative US 1997 Panel Study of Income Dynamics Child Development Supplement was undertaken to examine whether participation in food programmes is related to overweight among children in different income groups. In initial bivariate and multivariate analyses, children who ate a school lunch were more likely to be overweight than children who did not. However, the authors suggest that this relationship is due more to selection: children who eat school meals differ from children who do not in other factors that may predispose them to being overweight. Because considerably fewer children are involved in SBP compared with lunch programmes (about one-third), the results were analysed in terms of having a school breakfast *added* to the effect of a school lunch rather than the effect of school breakfast *per se*, limiting the usefulness of the paper to this topic.

5 Is regular consumption of breakfast associated with food and nutrient intake?

Sixteen studies were identified that met our criteria for examining the relationship between breakfast consumption and nutrient intake in children. As with section 4, these papers were not restricted to those consuming “regular” breakfasts.

5.1 Is consumption of breakfast associated with food and nutrient intake?

Twelve 12 studies investigated whether consuming breakfast influences total nutrient intake in children (see Table 11) and four studies assessed breakfast in relation to foods rather than nutrients[76,84], overall nutritional status[85] or the nutrient content of other meals[70] (see Appendix H). Table 11 describes those studies that compared the nutrient intake of children who skipped breakfast entirely or consumed the meal less regularly with children who were more consistent eaters. The majority of studies were cross-sectional, with few from large and/or representative samples of children[8,34], many studies were limited in the number of nutrients they assessed[20,26,86-90], and a variety of methods were used to assess breakfast consumption and nutrient intake.

However, the studies were reasonably consistent in terms of the effects on most nutrients. Energy was only measured in six, but was higher in breakfast eaters compared with non-eaters in four, and similar in the remaining two. Macronutrient intake was generally more favourable in those consuming breakfast, with most studies reporting higher intakes of protein, carbohydrate and fibre and lower intakes of total fat. However, of the six studies investigating macronutrient intake in relation to breakfast consumption[8,28,34,89,91,92], only half adjusted for energy intake[8,89,91], despite two of the remaining three studies reporting significant differences in energy intake between breakfast eaters and non/less regular eaters[28,34].

Several studies investigated differences in the intakes of calcium, iron and zinc. In general, breakfast eaters had greater intakes of these minerals. Differences in calcium intake were generally less than 200mg[8,20,86,90], except for Sjoberg et al[34], who reported that 15–16-year-old Swedish adolescents consuming breakfast regularly ate 252 mg (girls) to 404 mg (boys) more calcium than less frequent consumers. However, these children reported very high calcium intakes overall as assessed by dietary histories, ranging from 1100 mg/day in females with less regular breakfast consumption to approximately 2000 mg/day in young male breakfast eaters. Iron intakes differed by up to 3 mg/day and breakfast eaters tended to consume 1–2 mg more zinc each day.

Finally, the intakes of most vitamins were also higher in children and adolescents consuming regular breakfasts, although these were examined less frequently than macronutrients or minerals[8,28,91]. Not surprisingly, the intake of the energy-related nutrients thiamin and riboflavin were higher in the two studies that also reported higher total energy intakes in breakfast consumers[8,28]. Intakes of folate, vitamin C and vitamin A were generally higher, whereas the single study that reported intakes of vitamin E showed no differences in intake between breakfast eaters and avoiders[28].

Data from the National CNS clearly demonstrates that New Zealand children aged 5–14 years who consumed breakfast on the day of the survey had considerably improved nutrient intakes than the 16% of children who did not report having anything to eat or drink between 6 am and 9 am that morning, with lower intakes of fat and higher intakes of energy, protein, carbohydrate, fibre, calcium, iron, zinc, thiamin, riboflavin, folate, vitamin A and vitamin D, measured using a 24-hour recall [8].

Table 11 Studies investigating whether consumption of breakfast is associated with nutrient intake

Reference	26	86	91	28	87	34	89	92	90	8	20	88	Total number of differences for those studies that reported each nutrient		
[1]Study design	X	X	X	X	X	X	X	X	X	X	C	I			
[2]Representative sample	No	No	No	No	No	Yes	No	No	No	Yes	Yes	No			
[3]Diet assessment method[3]	2DDR	7DDR	DH	24 hr	FFQ	DH	2 x 24hr	3DDR	FFQ	24hr	3DDR	Observe	↑	↓	⇔
Energy				↑		↑	⇔	⇔		↑		↑	4		2
Fat			↓	⇔		⇔	↓	⇔		↓				3	3
Carbohydrate			↑	↑		⇔		⇔		↑			3		2
Protein			⇔	↑		↑		⇔		↑			3		2
Fibre	↓			↑		↑		⇔		↑	↑		4	1	1
Calcium	⇔	↑	↑	↑	↑	↑		⇔	↑	↑	↑		8		2
Iron	↑		⇔	↑		↑		↑		↑			5		1
Zinc			⇔	↑		↑				↑			3		1
Thiamin			↑	↑						↑			3		
Riboflavin			↑	↑						↑			3		
Folate			⇔	↑						↑			2		1
Vitamin B_6			⇔	↑									1		1
Vitamin A			⇔	↑						↑			2		1
Vitamin C			⇔	↑		↑				↑			3		1
Vitamin E			⇔												1
Adjusted for kJ[4]	Yes	No	No	No	No	No	NA	No	No	No	Yes	N/A			
Adjusted for kJ[5]	N/A	N/A	Yes	No	N/A	No	Yes	No	N/A	Yes	N/A	N/A			

Note: Breakfast eaters had higher (↑), lower (↓) or similar (⇔) intakes of this nutrient compared with non- or less frequent eaters. Blank spaces indicate not measured or reported. Not all nutrients were necessarily significant in both genders but data not reported.

[1] X = cross-sectional; C = cohort; I = intervention.
[2] Was the sample large (> 1000 participants) and/or representative of the population from which it was drawn?
[3] DDR = number days diet record; DH = dietary history; 24hr = 24-hour recall; FFQ = food frequency questionnaire; Observed = experimental observation.
[3] Were micronutrients adjusted for total energy?
[4] Were macronutrients reported as %kJ?

In general, these differences held across ethnic groups: Maori, Pacific and New Zealand European and Other breakfast consumers ate more protein, fibre and folate than non-breakfast eaters. Pacific children who ate breakfast also had higher energy and carbohydrate intakes, and iron and zinc intakes were higher in both Maori and Pacific but not NZEO breakfast eaters compared with children not eating breakfast[8]. Beneficial effects of breakfast consumption on food intake were also observed from the food frequency questionnaire data[76]. Breakfast skippers were less likely to eat appropriate servings of fruit and vegetables (odds ratio 0.63, 95% CI 0.4–0.9), cereals (0.34, 0.2–0.5) and milk (0.6, 0.5–0.9) each day, and were more likely to have higher intakes of less healthy snack options, including chocolate and sweets (1.63, 1.2–2.2), pies and sausage rolls (1.52, 1.1–2.1) and soft drinks (1.62, 1.2–2.3) after adjusting for age, sex, ethnicity and SES[76]. Moreover, children who skipped breakfast were also more likely to skip lunch and to buy food from the dairy or school canteen, and were less likely to bring food from home to school[76].

The findings for soft drink intake appear to contrast with that of New and Livingstone[84], who reported that breakfast eaters drank fizzy drinks more frequently than non-eaters (3.7 cf. 3.0 times per week, $p < 0.01$). However, the former study was a large representative study with appropriate assessment of food intake and adjustment for confounders[76], whereas the latter involved only 500 English teenagers completing an anonymous questionnaire, with no adjustment for confounding variables[84].

One limitation in all but two[20, 26] of the studies included in this section of the review is that micronutrient intakes were expressed only in absolute amounts. Although absolute intake of vitamins and minerals is important and appropriate to measure, it would have been interesting to see if the higher intakes reported in most studies were a result simply of higher energy intakes or whether children who regularly consume breakfast also have more nutrient-dense diets. None of the three studies reporting higher energy and micronutrient intakes in breakfast consumers reported intakes of micronutrients adjusted for energy[8,28,34]. The two studies that did adjust for energy reported lower fibre (males only), higher iron and similar calcium intakes in breakfast eaters compared with breakfast skippers[26], and more calcium and iron-dense diets in a cohort of girls followed annually for 10 years from the age of 9–10[20]. This cohort study contained the most comprehensive assessment of nutrient intake, obtained from annual three-day diet records. However, like most of the other studies in this category, exclusion of under-reporters did not occur, which may skew results in an unknown direction[20].

Only one small short-term intervention has indirectly assessed whether breakfast consumption influences later intake[88]. Thirty-eight children aged 9–12 years were fed three experimental breakfasts differing in their glycaemic index (low GI, low GI plus sucrose, high GI). Energy intake at an *ad libitum* lunch was subsequently monitored unobtrusively. Type of breakfast explained 17% of the variation in lunch intake, with energy intakes after the high GI breakfast being 119–145 kcal higher than after either low GI meal.

Table 12 Studies investigating whether consumption of breakfast cereal is associated with nutrient intake

Reference	[94]	[93]	[91]	[95]	[79]	[80]	[96]	[73]	Total number of differences for those studies that reported each nutrient		
[1]Study design	X	X	X	X	X	X	X	C			
[2]Representative sample	Yes	No	No	Yes	Yes	Yes	Yes	Yes			
[3]Diet assessment method									↑	↓	⇔
Energy	↓	↑		↓	⇔	↑	⇔		2	2	2
Fat		↓	↓	↓	⇔	↓	⇔	↓		5	2
Carbohydrate			↑	↑	⇔	↑	↑		4	1	
Protein			⇔			↑	↓		1	1	1
Fibre	↑				⇔		⇔	↑	2		2
Calcium	↓		↑		↑	↑	↑	↑	5	1	
Iron	↑	↑	↑		↑	↑	↑	↑	7		
Zinc		↑	⇔		↑	↑		↑	4		1
Thiamin			↑		↑	↑	↑		4		
Riboflavin		↑	↑		↑	↑	↑		5		
Niacin		↑			↑	↑	↑		4		
Folate			⇔		↑	↑	↑	↑	4		1
Vitamin B_6			⇔		↑	↑	↑		3		1
Vitamin A			⇔		↑	↑	↑		3		1
Vitamin C	↓		⇔		↑	⇔		↑	2	1	2
Vitamin E			⇔		⇔		⇔				3
[4]Adjusted for kJ	No	No	No	N/A	No	No	No	Yes			
[5]Adjusted for kJ	N/A	Yes	Yes	Yes	No	No	Yes	Yes			

Note: Cereal eaters had higher (↑), lower (↓) or similar (⇔) intakes of this nutrient compared with non/less frequent eaters. Blank spaces indicate nutrient was not measured or reported. Not all nutrients were necessarily significant in both genders but data not reported.

[1] X =cross-sectional; C = cohort; I = intervention.
[2] Was the sample large (> 1000 participants) and/or representative of the population from which it was drawn?
[3] DDR = number days diet record; DH = dietary history; 24hr = 24-hour recall; FFQ = food frequency questionnaire; Observed = experimental observation.
[4] Were micronutrients adjusted for total energy?
[5] Were macronutrients reported as % kJ?

In summary, there is reasonable evidence to show that eating breakfast, or consuming it more regularly, is related to better overall nutrient profiles in children and adolescents. However, the majority of the studies were cross-sectional, and conclusions cannot be drawn regarding the micronutrient density of the diets due to very few analyses being conducted. It may be that the improvement in nutrient intakes in breakfast eaters arises simply as a result of higher energy intakes. No interventions have been conducted to ascertain if encouraging children and adolescents not to skip breakfast or at least to consume breakfast more regularly results in improved nutritional status.

5.2 Is consumption of breakfast cereal associated with food and nutrient intake?

Eight studies were identified that assessed whether consumption of breakfast cereal, usually ready-to-eat (RTE) cereal, was associated with nutrient intake or status in children and adolescents (see Table 12, and Appendix I). Seven were cross-sectional, with only one cohort study and no interventions, although all but two recruited representative and/or large samples of children, which increases the strength of this evidence somewhat. In general, increased consumption of cereals was associated with improved nutrient intakes, although in contrast to section 5.1, the effects on energy intake were more inconsistent. Six of the eight studies showed energy intakes that were evenly spread being between higher[80,93], lower[94,95] or similar to[79,96] children consuming cereal less often. This variation does not seem to be a function of age.

Although both studies reporting lower energy intakes are derived from the same analysis in UK preschool-aged children[94,95], one of the analyses reporting higher energy intakes was also in this age group[93], although it was comparing nutrient availability from menu plans at preschool centres rather than actual intake in this age group. It is feasible that high consumption of cereals, which are often energy-dense foods, could displace other foods from the diet in very small children, but not those who are older. Variation in methodology is also unlikely to explain the energy results given that all the studies except one[96] assessed cereal intake from multiple days of diet records.

In general, the findings for fat and carbohydrate intake were also reasonably consistent, with most reporting lower intakes of fat and higher intakes of carbohydrate (see Table 12). Intake of protein was more variable, with one study each reporting higher[80], lower[96]or similar[91] intakes in high cereal consumers. Most studies adjusted for energy intakes[73,91,93,95,96] or showed that there were no group differences[79], with only one report not doing so, despite there being significant differences between groups[80].

Intakes of calcium, iron and zinc were also higher in cereal consumers, with few exceptions[91,94], and most studies reported higher intakes of all vitamins, with the exception of vitamin E. Three studies reported similar vitamin E intakes regardless of cereal intake[79,91,96], which is perhaps not surprising given fat intakes were also not different in two of these studies[79,96]. Table 12 highlights that it is only the study of Preziosi et al[91] that tends to show similar intakes of most vitamins, except thiamin and riboflavin. This study was the smallest of all conducted in this series, enrolling only

235 children with a wide age range (2–18 years) and assessing dietary intake by dietary history.

Although most studies adjusted macronutrient intake for energy, only one[73] investigated micronutrient density by adjusting micronutrient intake for energy as well. In this cohort of 9–10-year-old girls followed annually for 10 years, total daily intakes of calcium, iron, zinc, folate and vitamin C were significantly higher when girls ate breakfasts containing cereal compared to breakfasts without cereal, even once adjusted for energy intake.

Given the limitations of dietary assessment in accurately assessing nutrient intake, particularly in younger children where proxy measurements may be obtained, three studies evaluated the effect of cereal consumption on biochemical measures of nutrient status[80,91,94]. Preziosi et al[91] only observed improvements in indices of riboflavin and beta-carotene . However, the much larger and representative national survey of UK children and adolescents aged 4–18 years[80] showed that cereal intake was positively related to folate, vitamin B_{12}, riboflavin, thiamin (girls only) and vitamin B_6 (girls only) status.

Interestingly, none of the three studies were able to show that iron status was improved with greater cereal consumption[80,91,94]. This may be partly because the differences in iron intake were relatively small (1–3 mg, or 8% of the corresponding RDA). Alternatively, studies in UK children demonstrate that school-aged high cereal consumers eat less meat and more milk than low cereal consumers[80], and that the small difference in iron intakes in preschool-aged children comes entirely from non-haem iron, with a corresponding decrease in the intakes of meat and vitamin C in high compared with low cereal consumers[94], factors that would contribute to a lack of effect on iron status. None of the three studies[80,91,94] specifically investigated the contribution of iron-fortified versus unfortified cereals.

These findings for improved nutrient intake in children and adolescents consuming larger or more frequent intakes of breakfast cereals is not entirely consistent with one study reporting the top 10 contributors to nutrient intake in 1112 six- to seven-year-old Spanish children[97]. Despite the differences in macro- and micronutrient intake discussed above, breakfast cereals were not in the top 10 contributors to energy, fat, protein, fibre, calcium, vitamin A or vitamin C intakes. They were, however, significant contributors to carbohydrate (ninth, 3.6%), vitamin B6 (second, 11.7%) and folic acid (first, 12.4%) intakes. It may be that cereal consumption is a marker for the intake of other foods that may have a more direct influence on intake of these specific nutrients. However, others[80] report that breakfast cereals make a significant contribution to the intake of B vitamins, vitamin D and iron, compared with how much energy they provide.

In summary, most of the studies in this area have cross-sectional designs and thus provide relatively limited evidence. However, in their favour, the results are reasonably consistent, demonstrating that children consuming breakfast cereals on a more frequent basis (or contributing larger proportions of total energy) have improved nutrient profiles compared with less regular consumers.

5.3 Other studies investigating the relationship between breakfast and food and nutrient intake

Four reports have examined the potential effect of participation in school breakfast programmes (SBP) on nutrient intake in children and adolescents (see Appendix J). Two studies[30,98] showed that attendance at SBP was associated with a poorer nutrient profile, with one study[99] reporting beneficial effects. Diets of 306 US children aged 5–12 years monitored by visual plate waste for eight days showed that attendance at SBPs provided a diet that was too high in total and saturated fat and too low in calcium and vitamin A in relation to US dietary requirements[30]. Analysis of three-day diet records in 59 English children also showed poorer total and saturated fat intakes and lower intakes of carbohydrate compared with 52 control children who did not attend an SBP[98]. Findings from the latter study[98] should not perhaps be surprising given the foods offered at two of the three schools: fried sausage sandwich or cereal bars, sausage rolls, doughnuts, crisps, buttered toast and fruit squash. Only one school provided appropriate breakfast foods such as cereal and toast.

Interestingly, differences in energy intake were not observed between SBP attendees and controls, although the study was very small given final response rates for dietary information were only 11–54%[98]. The remaining study was extremely small (32 participants in year 1, of which 22 participated in year 2), but was the only one to compare dietary intake at home with that consumed at school breakfasts[99]. In this small group of preschoolers, sugar intake was significantly lower at school than at home in both year 1 (59 cf. 155 g, $p < 0.01$) and year 2 (88 cf. 167 g, $p < 0.01$), but no differences were observed in any other macro- or micronutrient. However, a teacher sat with each group of three to four children and encouraged them to eat an adequate diet for the school breakfast, a situation that presumably would not occur all the time in the home environment.

6 Do regular breakfast eaters differ from non-eaters in other lifestyle factors such as physical activity, alcohol and smoking?

The studies reported in this section were identified in the initial literature search. The lifestyle factors studied in relation to breakfast eating were physical activity, smoking, mental health, and food and alcohol patterns.

6.1 Physical activity

Ten publications studying the relationship between breakfast eating and physical activity were identified (see Appendix K). There were six cross-sectional studies carried out in the UK[100], Switzerland[101], Canada[37], Australia[26], and in the US[102,103]; one case control study carried out in Italy[104]; one cohort study from Canada[105]; and one study from Finland, which reported both baseline cross-sectional results[106] and follow-up cohort findings[107]. The study samples were mostly teenagers.

Table 13 Summary of studies of comparing frequency of eating breakfast with other lifestyle factors

Type of study	Direction of association			
	Positive	**None**	**Negative**	**Total**
Physical activity	9	1	0	10
Reference number	102 26 101 107 104 106 37 105 103	100		
Smoking	0	0	7	7
Reference number			22 100 108 37 106 34 109	
Mental health	0	0	3	3
Reference number			61 110 111	
Desirable food & alcohol pattern	3	0	0	3
Reference number	100 106 78			

See Appendices K to M for a description of the magnitude of the relationship for each study.

All studies reported significant positive associations between the frequency of breakfast consumption and physical activity, except for the UK study[100], which had limited statistical power because of its relatively small sample (n = 328) compared with most other studies. The best-quality information comes from the cohort studies that measured physical activity 2–2.5 years later at follow-up, predicted by baseline breakfast patterns[105,107]. However, there was limited control of confounding variables in most of these studies, and it is possible that choices around breakfast patterns and physical activity are both outcomes of some other underlying and unmeasured variable, since no experimental data show that increasing the frequency of breakfast increases physical activity.

6.2 Tobacco smoking

There were seven studies of breakfast eating and smoking (see Appendix L). These were all cross-sectional and carried out in the UK[100], Canada[37], Turkey[108], Estonia[109], Finland[106], and Sweden[22,34]. The study samples were mostly teenagers. All studies found an inverse association between frequency of having breakfast and risk of smoking. Four of the studies had limited control of confounding[22,37,100,109], and it is possible that some other underlying and unmeasured variable, such as rebelling against authority, is the link between choices of breakfast skipping and taking up smoking.

6.3 Mental health

Three studies of breakfast eating and mental health were identified (see Appendix M). Two were cross-sectional studies in the UK[110] and the US[111] and one was a cohort study in the US[61]. Participants came from the full age range of primary and high schools. All three studies reported inverse associations between frequency of having breakfast and mental health status, with students with poorer mental health, such as depression, having breakfast less frequently than other students. The cohort study found that scores for depression, anxiety and psychosocial dysfunction decreased in students who increased their participation over four months in a free SBP[61]. However, this association does not prove cause and effect, and it is very likely that poor mental health status was a cause of breakfast skipping.

6.4 Food and alcohol patterns

Three studies reported the association breakfast patterns had with general food behaviours and alcohol consumption (Appendix M). All were cross-sectional studies of teenagers carried out in the UK[100], US[78] and Finland[106]. The British study found that increased frequency of eating breakfast was associated positively with eating the evening meal with the family, and negatively with frequency of dieting to lose weight[100]. The US study found that fasting to lose weight was associated with increased risk of not eating breakfast[78]. The Finnish study found that breakfast skipping was associated with increased risk of drinking alcohol[106].

6.5 Summary

Table 13 highlights that the overall pattern is for regular breakfast consumption to be associated with optimal lifestyle behaviours and mental health. However, these

associations do not prove cause and effect, and it is possible that some other unmeasured variable, such as rebelling against authority, is influencing choices affecting both breakfast frequency and other lifestyle patterns.

7 Conclusions and Recommendations

7.1 Summary and Conclusions

- Overall, 22.9% of Māori, 40.8% of Pacific and 7.7% of New Zealand European and Other children skip breakfast (do not eat or drink at home or on the way to school), which equates nationally to approximately 83,000 children each day.

- Consistent with international literature, inequalities in skipping breakfast are related to deprivation (most deprived more likely than least deprived), urban versus rural residence (urban more likely than rural) and age (older more likely than younger).

- The most commonly eaten foods by New Zealand children at breakfast are breakfast cereals (57% of children), followed by bread and toast (35%) and then beverages such as Milo (14%) and fruit juices (11%).

- Two-thirds of 172 cereals marketed to the general populace and all of the 26 cereals marketed directly to children were not considered to be good nutritious choices for children by *Consumer* magazine.

- Breakfast patterns may differ according to ethnicity and place of residence: rural Maori and Pacific children with stronger links to the Islands are more likely not to eat breakfast or to eat leftovers from the night before, whereas urban Maori and Pacific children born in New Zealand either don’t eat breakfast or consume breakfast cereals (all types) as the most common foods.

- Lack of time and not being hungry are currently the major barriers to children consuming breakfast, but no work appears to have analysed socio-economic gradients in the data or adequately considered poverty as an issue.

Conclusion: Many New Zealand children are not eating breakfast, and those breakfast cereals that are currently marketed to children represent relatively poor nutritious choices.

- Five of five observational, four of four cohort and one of three short-term trials, along with three of three long-term interventions (two of which were randomised), show that consuming breakfast is associated with improvements in academic performance. The two short-term trials that did not show a significant effect in the total group did show benefits in subgroups.

Conclusion: There is considerable evidence that regular breakfast consumption improves academic performance.

- Twelve of fourteen (86%) cross-sectional studies support the view that breakfast skipping is adversely related to weight status in children.

- In contrast, only one of five cohort studies reported that breakfast skipping adversely affects weight, three reported no relationship once adjusted for confounders, and the remaining study showed that skipping breakfast is associated with *smaller* gains in BMI in overweight but not normal weight children.

- Three of four studies examining whether cereal consumption is related to body weight in children support the view that higher cereal intake is associated with more favourable body weights.

- Few studies have been undertaken in young children (up to 10 years of age) investigating the role that breakfast may play in weight management.

Conclusion: Much of the cross-sectional evidence supports the observation that breakfast or breakfast cereal consumption is related to weight status in children. However, such study designs are prone to bias. Larger, well-conducted cohort studies in general do not support the view that skipping breakfast promotes weight gain, and no interventions have been undertaken to determine whether increasing breakfast consumption favourably affects body weight during growth.

- Although the majority of evidence relating breakfast consumption and nutrient intake is from cross-sectional studies, findings very consistently show that children consuming breakfast have a more favourable nutrient profile than children avoiding breakfast or consuming it less regularly.

- Likewise, cereal consumption is favourably associated with nutrient intake.

- Studies investigating the effect of cereal intake on nutritional status have demonstrated that consumption is positively associated with the biochemical status of many nutrients except for iron; results consistently show no benefit of higher intakes on improving iron status.

- New Zealand data show that children who skip breakfast are less likely to eat fruit and vegetables, less likely to eat lunch and more likely to eat chocolate/sweets, pies and soft drinks. They are also more likely to buy food at the dairy or from the school canteen and less likely to bring food to school from home.

- Few studies have adjusted micronutrient intake for energy intake to ascertain whether improved nutrient intakes of children consuming breakfast are due simply to higher energy intakes or because the diets are more nutrient-dense.

Conclusion: There is some evidence to show that eating breakfast, or consuming it more regularly, is related to better overall nutrient profiles in children and adolescents. Although cross-sectional studies are not generally viewed as providing strong evidence, it may be an appropriate design in this instance for assessing whether current consumption of breakfast is beneficial for overall nutrient intake.

However, more definitive evidence would be provided by intervention studies demonstrating that increasing breakfast consumption favourably impacts on nutrient status in children.

- Nine of ten reports (seven cross-sectional, one case control, two cohort) reported significant positive associations between the frequency of breakfast consumption and physical activity, and one reported no association.

- Seven of seven studies (all cross-sectional) reported an inverse association between frequency of having breakfast and risk of smoking.

- Three of three studies (two cross-sectional, one cohort) reported inverse associations between frequency of having breakfast and mental health status, with students with poorer mental health, such as depression, having breakfast less frequently than other students.

- Three of three studies (all cross-sectional) reported that regular breakfast was associated with healthier food patterns (less dieting and lower alcohol consumption).

Conclusion: there is reasonable evidence that the overall pattern is for regular breakfast consumption to be associated with optimal lifestyle behaviours and mental health. However, these associations do not prove cause and effect, and it is possible that some other unmeasured variable is influencing choices affecting both breakfast frequency and other lifestyle patterns.

7.2 Recommendations

- Knowledge that eating breakfast is important for achieving educational outcomes should be widely disseminated to parents and schools.

- The Ministries of Education and Health, SPARC and other related government agencies should support schools' efforts to develop resources aimed at improving breakfast intake in schoolchildren.

- Parents should provide nutritionally appropriate foods and encourage children to consume a nutritionally adequate breakfast each day. For those children who will not eat breakfast, suitable foods should be provided for consumption at a later time.

- Schools should promote the benefits of breakfast consumption to children, incorporating the topic into lessons in several curriculum areas. If schools provide breakfast to (some) children, they should ensure healthy options are available.

- Government agencies should adequately promote the benefits and advantages of consuming a nutritious breakfast for children and adolescents.

- Government regulation of breakfast cereal marketing and labelling is required.

- More research is required to fully understand the barriers to consuming breakfast, particularly in certain age (teenagers), ethnic (may be traditional in some families not to eat breakfast) and socio-economic groups (available income).

- The majority of studies in this review were cross-sectional, and intervention studies are required to determine the true effect of consuming breakfast (when none was consumed before) or increasing the regularity of breakfast consumption in relation to weight status, nutrient status and lifestyle factors.

- Interventions targeting increased breakfast consumption should place Maori and Pacific and more socio-economically disadvantaged children first, because that is where the need is greatest.

7.3 Strategies to improve breakfast consumption

- Parents should role-model eating breakfast, and siblings should consume breakfast together and role-model for each other.

- Children should be involved in the preparation of breakfast (either the night before or in the morning).

- Leftovers from the night before, wholegrain breakfast cereals low in sugar with trim milk, wholemeal toast and/or porridge, fruit and trim milk drinks are all good options for breakfast.

- Sugary drinks such as fruit drinks should be limited. If chosen at all, water down sugary drinks such as fruit juice and fruit drinks, and use trim milk in sugary drinks such as Milo.

- Do not add sweeteners such as sugar, syrups or honey to cereals that already have high levels of sugar.

- Encourage the consumption of fruit and milk and milk products, foods that are widely consumed by New Zealand children.

- Parents need to be aware of what foods are available for purchase at the school and discuss with their children what they are buying with pocket money or money provided to buy food.

- If a child will not eat breakfast, a suitable packed breakfast could be provided (leftovers if feasible, fruit, yoghurt, sandwiches).

References

1. Parnell W, Scragg R, Wilson N et al, *NZ Food NZ Children: Key results of the 2002 National Children's Nutrition Survey*. Wellington, New Zealand: Ministry of Health. 2003.

2. Turnbull A, Barry D, Wickens K et al, Changes in body mass index in 11-12 year old children in Hawke's Bay, New Zealand (1989-2000). *Journal of Paediatrics & Child Health* 2004;40(1-2):33-37.

3. Lobstein T, Baur L, Uauy R, for the IASO International Obesity Taskforce, Obesity in children and young people: a crisis in public health. *Obesity Reviews* 2004;5:4-85.

4. Chinn S, Rona RJ, Prevalence and trends in overweight and obesity in three cross-sectional studies of British children. *BMJ* 2001;322:24-26.

5. Ogden CL, Flegal KM, Carroll MD, et al, Prevalance and trends in overweight among US children and adolescents, 1999-2000. *JAMA* 2002;288(14):1728-1732.

6. Booth ML, Chey T, Wake M, et al, Change in the prevalence of overweight and obesity among young Australians, 1969-1997. *American Journal of Clinical Nutrition* 2003;77(1):29-36.

7. World Health Organisation. *Obesity: Preventing and managing the global epidemic. Report of a WHO consultation.* Geneva: World Health Organisation. 3-5 June, 1997, 1998.

8. Wilson N, Parnell WR, Wohlers M et al, Eating breakfast and its impact on children's daily diet. *Nutrition & Dietetics* 2006;63(1):15-20.

9. Utter J, Scragg R, Schaaf D et al, Nutrition and physical activity behaviours among Maori, Pacific and NZ European children: identifying opportunities for population-based interventions. *Australian & New Zealand Journal of Public Health* 2006;30(1):50-56.

10. Adolescent Health Research Group, A health profile of New Zealand youth who attend secondary school. *New Zealand Medical Journal* 2003;116(1171):380-388.

11. Ashcroft AS, Nutritional beliefs and practices of selected Raukawa tribal members, *Journal of the New Zealand Dietetic Association* 1985;39(2):42-54.

12. Pihema H, Food and nutrition education for the Maori people. *Proceedings of the Nutrition Society of New Zealand* 1989;14:137-142.

13. Breakfast of champions. *Consumer Magazine* 2006;457:10-16.

14. Kids candy. *Consumer* 2006;458:120.

15. Roe B, Levy AS, Derby BM, The impact of health claims on consumer search and product evaluation outcomes: results from FDA experimental data. *Journal of Public Policy & Marketing* 1999;18(1):89-105.

16. Hammond KM, Wyllie A, Casswell S, The extent and nature of televised food advertising to New Zealand children and adolescents. *Australian & New Zealand Journal of Public Health* 1999;23(1):49-55.

17. Ministry of Health, *Food and Nutrition Monitoring Report 2006.* Wellington, New Zealand: Ministry of Health. 2006.

18. Siega-Riz AM, Popkin BM, Carson T, Trends in breakfast consumption for children in the United States from 1965-1991. *American Journal of Clinical Nutrition* 1998;67(4):748S-756S.

19. Brugman E, Meulmeester JF, Wekke AS-VD et al, Breakfast-skipping in children and young adolescents in The Netherlands. *European Journal of Public Health* 1998;8(4):325-328.

20. Affenito SG, Thompson DR, Barton BA, et al, Breakfast consumption by African-American and white adolescent girls correlates positively with calcium and fiber intake and negatively with body mass index. *Journal of the American Dietetic Association* 2005;105(6):938-945.

21. Von Post-Skagegard M, Samuelson G, Karlstrom B, et al, Changes in food habits in healthy Swedish adolescents during the transition from adolescence to adulthood. *European Journal of Clinical Nutrition* 2002;56(6):532-538.

22. Hoglund D, Samuelson G, Mark A, Food habits in Swedish adolescents in relation to socioeconomic conditions. *European Journal of Clinical Nutrition* 1998;52(11):784-789.

23. Hackett AF, Gibbon M, Sratton G, et al, Dietary intake of 9-10-year-old and 11-12-year-old children in Liverpool. *Public Health Nutrition* 2002;5(3):449-455.

24. Johansen A, Rasmussen S, Madsen M, Health behaviour among adolescents in Denmark: influence of school class and individual risk factors. *Scandinavian Journal of Public Health* 2006;34(1):32-40.

25. Miech RA, Kumanyika SK, Stettler N, et al, Trends in the association of poverty with overweight among US adolescents, 1971-2004. *JAMA* 2006;295(20):2385-2393.

26. Milligan RA, Burke V, Beilin LJ et al, Influence of gender and socio-economic status on dietary patterns and nutrient intakes in 18-year-old Australians. *Australian & New Zealand Journal of Public Health* 1998;22(4):485-493.

27. Kumar BN, Holmboe-Ottesen G, Lien N et al, Ethnic differences in body mass index and associated factors of adolescents from minorities in Oslo, Norway: a cross-sectional study. *Public Health Nutrition* 2004;7(8):999-1008.

28. Nicklas TA, Reger C, Myers L et al, Breakfast consumption with and without vitamin-mineral supplement use favorably impacts daily nutrient intake of ninth-grade students. *Journal of Adolescent Health* 2000;27(5):314-321.

29. Videon TM, Manning CK, Influences on adolescent eating patterns: the importance of family meals. *Journal of Adolescent Health* 2003;32(5):365-373.

30. Friedman BJ, Hurd-Crixell SL, Nutrient intake of children eating school breakfast. *Journal of the American Dietetic Association* 99(2):219-221.

31. Pilant VB, American Dietetic Association, Position of the American Dietetic Association: local support for nutrition integrity in schools. *Journal of the American Dietetic Association* 2006;106(1):122-133.

32. Nicklas TA, Morales M, Linares A, et al. Children's meal patterns have changed over a 21-year period: the Bogalusa Heart Study. *Journal of the American Dietetic Association* 2004;104(5):753-761.

33. O'Dea JA, Caputi P, Association between socioeconomic status, weight, age and gender, and the body image and weight control practices of 6- to 19-year-old children and adolescents. *Health Education Research* 2001;16(5):521-532.

34. Sjoberg A, Hallberg L, Hoglund D et al, Meal pattern, food choice, nutrient intake and lifestyle factors in the Goteborg Adolescence Study. *European Journal of Clinical Nutrition* 2003;57(12):1569-1578.

35. Temple NJ, Steyn NP, Myburgh NG et al, Food items consumed by students attending schools in different socioeconomic areas in Cape Town, South Africa. *Nutrition* 2006;22(3):252-258.

36. Young EM, Fors SW, Factors related to the eating habits of students in grades 9-12. *Journal of School Health* 2001;71(10):483-488.

37. Cohen B, Evers S, Manske S et al, Smoking, physical activity and breakfast consumption among secondary school students in a southwestern Ontario community. *Canadian Journal of Public Health Revue Canadienne de Sante Publique* 2003;94(1):41-44.

38. Haapalahti M, Mykkanen H, Tikkanen S, et al, Meal patterns and food use in 10- to 11-year-old Finnish children. *Public Health Nutrition* 2003;6(4):365-370.

39. Shaw M, Adolescent breakfast skipping: an Australian study. *Adolescence* 1998;33(132):851-862.

40. Reddan J, Wahlstrom K, Reicks M, Children's perceived benefits and barriers in relation to eating breakfast in schools with or without Universal School Breakfast. *Journal of Nutrition Education & Behavior* 2002;34(1):47-52.

41. Lattimore PJ, Halford JCG, Adolescence and the diet-dieting disparity: healthy food choice or risky health behaviour? *British Journal of Health Psychology* 2003;8(Pt 4):451-463.

42. Nowak M, The weight-conscious adolescent: body image, food intake, and weight-related behavior. *Journal of Adolescent Health* 1998;23(6):389-398.

43. Martens MK, van Assema P, Brug J, Why do adolescents eat what they eat? Personal and social environmental predictors of fruit, snack and breakfast consumption among 12-14-year-old Dutch students. *Public Health Nutrition* 2005;8(8):1258-1265.

44. Le Bigot Macaux A, Eat to live or live to eat? Do parents and children agree? *Public Health Nutrition* 2001;4(1A):141-146.

45. Billon S, Lluch A, Gueguen R et al, Family resemblance in breakfast energy intake: the Stanislas Family Study. *European Journal of Clinical Nutrition* 2002;56(10):1011-1019.

46. Pollitt E, Jacoby E, Cueto S, School breakfast and cognition among nutritionally at-risk children in the Peruvian Andes. *Nutrition Reviews* 1996;54(Suppl):S22-S30.

47. Pollitt E, Mathews R, Breakfast and cognition: an integrative summary. *American Journal of Clinical Nutrition*1998;67(Suppl 4):S804-S813.

48. Grantham-McGregor SM, Can the provision of breakfast benefit school performance? *Food & Nutrition Bulletin* 2005;26(Suppl 2):S144-158.

49. Taras H, Nutrition and student performance at school. *Journal of School Health* 2005;75(6):199-213.

50. Rampersaud GC, Pereira MA, Girard BL et al, Breakfast habits, nutritional status, body weight, and academic performance in children and adolescents. *Journal of the American Dietetic Association* 2005;105(5):743-760; quiz 761-742.

51. Pollitt E, Liebel RL, Greenfield D, Brief fasting, stress and cognition in children. *American Journal of Clinical Nutrition* 1981;34:1526-1533.

52. Pollitt E, Lewis NL, Garza C, et al, Fasting and cognitive function. *Journal of Psychiatric Research* 1982-1983;17:169-174.

53. Simeon D, Grantham-McGregor SM, Effects of missing breakfast on the cognitive functions of school children of differing nutritional status. *American Journal of Clinical Nutrition* 1989;49:646-653.

54. Mahoney CR, Taylor HA, Kanarek RB et al, Effect of breakfast composition on cognitive processes in elementary school children. *Physiology & Behavior* 2005;85(5):635-645.

55. Wesnes KA, Pincock C, Richardson D et al, Breakfast reduces declines in attention and memory over the morning in schoolchildren. *Appetite* 2003;41(3):329-331.

56. Abalkhail B, Shawky S, Prevalence of daily breakfast intake, iron deficiency anaemia and awareness of being anaemic among Saudi school students. *International Journal of Food Sciences & Nutrition* 2002;53(6):519-528.

57. Boey CCM, Omar A, Phillips JA, Correlation among academic performance, recurrent abdominal pain and other factors in Year 6 urban primary school children in Malaysia. *Journal of Pediatrics and Child Health* 2003;39:352-357.

58. Lopez-Sobaler AM, Ortega RM, Quintas ME et al, Relationship between habitual breakfast and intellectual performance (logical reasoning) in well-nourished schoolchildren of Madrid (Spain). *European Journal of Clinical Nutrition* 2003;57(Suppl 1):S49-S53.

59. Berkey CS, Rockett HRH, Gillman MW et al, Longitudinal study of skipping breakfast and weight change in adolescents. *International Journal of Obesity* 2003;27(10):1258-1266.

60. Meyers AF, Sampson AE, Weitzman M, et al, School breakfast program and school performance. *American Journal of Diseases in Children* 1989;143(10):1234-1239.

61. Murphy JM, Pagano ME, Nachmani J, et al, The relationship of school breakfast to psychosocial and academic functioning: cross-sectional and longitudinal observations in an inner-city school sample. *Archives of Pediatrics & Adolescent Medicine* 1998;152(9):899-907.

62. Kleinman RE, Hall S, Green H et al, Diet, breakfast, and academic performance in children. *Annals of Nutrition & Metabolism* 2002;46(Suppl 1):S24-S30.

63. Chen M-Y, Liao JC, Relationship between attendance at breakfast and school achievement among nursing students. *Journal of Nursing Research* 2002;10(1):15-21.

64. Chandler AK, Walker SP, Connolly K et al, School breakfast improves verbal fluency in undernourished Jamaican children. *Journal of Nutrition* 1995;125:894-900.

65. Jacoby E, Cueto S, Pollitt E, Benefits of a school breakfast program among Andean children in Huaraz, Peru. *Food and Nutrition Bulletin* 1996;17:54-59.

66. Vaisman N, Voet H, Akivis A et al, Effect of breakfast timing on the cognitive functions of elementary school students. *Archives of Pediatrics & Adolescent Medicine* 1996;150:1089-1092.

67. Powell C, Grantham-McGregor SM, Elston M, An evaluation of giving the Jamaican school meal to a class of children. *Human Nutrition Clinical Nutrition* 1983;37C:381-388.

68. Powell CA, Walker SP, Chang SM et al, Nutrition and education: a randomized trial of the effects of breakfast in rural primary school children. *American Journal of Clinical Nutrition* 1998;68(4):873-879.

69. Richter LM, Rose C, Griesel R, Cognitive and behavioural effects of a school breakfast. *South African Medical Journal* 1997;87(Suppl 1):S93-S100.

70. Dwyer JT, Evans M, Stone EJ et al, Adolescents' eating patterns influence their nutrient intakes. *Journal of the American Dietetic Association* 2001;101(7):798-802.

71. Boutelle K, Neumark-Sztainer D, Story M et al, Weight control behaviors among obese, overweight, and non-overweight adolescents. *Journal of Pediatric Psychology* 2002;27(6):531-540.

72. Andersen LF, Lillegaard ITL, Overby N et al, Overweight and obesity among Norwegian schoolchildren: changes from 1993 to 2000. *Scandinavian Journal of Public Health* 2005;33(2):99-106.

73. Barton BA, Eldridge AL, Thompson D et al. The relationship of breakfast and cereal consumption to nutrient intake and body mass index: the National Heart, Lung, and Blood Institute Growth and Health Study. *Journal of the American Dietetic Association* 2005;105(9):1383-1389.

74. Elgar FJ, Roberts C, Moore L et al, Sedentary behaviour, physical activity and weight problems in adolescents in Wales. *Public Health* 2005;119(6):518-524.

75. Fiore H, Travis S, Whalen A et al, Potentially protective factors associated with healthful body mass index in adolescents with obese and non-obese parents: a secondary data analysis of the third National Health and Nutrition Examination Survey, 1988-1994. *Journal of the American Dietetic Association* 2006;106(1):55-64; quiz 76-59.

76. Utter J, Scragg R, Ni Murchu C et al, At-home breakfast consumption among New Zealand children: associations with body mass index and related nutrition behaviours. *Journal of the American Dietetic Association* 2007;107(4):570-576.

77. Rolland-Cachera MF, Thibault H, Souberbielle JC et al, Massive obesity in adolescents: dietary interventions and behaviours associated with weight regain at 2 y follow-up. *International Journal of Obesity* 2004;28(4):514-519.

78. Zullig K, Ubbes VA, Pyle J, et al, Self-reported weight perceptions, dieting behavior, and breakfast eating among high school adolescents. *Journal of School Health* 2006;76(3):87-92.

79. Albertson AM, Anderson GH, Crockett SJ et al, Ready-to-eat cereal consumption: its relationship with BMI and nutrient intake of children aged 4 to 12 years. *Journal of the American Dietetic Association* 2003;103(12):1613-1619.

80. Gibson S, Micronutrient intakes, micronutrient status and lipid profiles among young people consuming different amounts of breakfast cereals: further analysis of data from the National Diet and Nutrition Survey of Young People aged 4 to 18 years. *Public Health Nutrition* 2003;6(8):815-820.

81. Rodearmel SJ, Wyatt HR, Barry MJ et al. A family-based approach to preventing excessive weight gain. *Obesity* 2006;14:1392-1401.

82. Cho S, Dietrich M, Brown CJP et al, The effect of breakfast type on total daily energy intake and body mass index: results from the Third National Health and Nutrition Examination Survey (NHANES III). *Journal of the American College of Nutrition* 2003;22(4):296-302.

83. Hofferth SL, Curtin S, Poverty, food programs, and childhood obesity. *Journal of Policy Analysis & Management* 2005;24(4):703-726.

84. New SA, Livingstone MBE, An investigation of the association between vending machine confectionery purchase frequency by schoolchildren in the

UK and other dietary and lifestyle factors. *Public Health Nutrition* 2003;6(5):497-504.

85. Serra-Majem L, Ribas L, Perez-Rodrigo C et al, Determinants of nutrient intake among children and adolescents: results from the enKid Study. *Annals of Nutrition & Metabolism* 2002;46(Suppl 1):S31-S38.

86. Ortega RM, Requejo AM, Lopez-Sobaler AM et al, The importance of breakfast in meeting daily recommended calcium intake in a group of schoolchildren [see comment]. *Journal of the American College of Nutrition* 1998;17(1):19-24.

87. Lee S, Reicks M, Environmental and behavioral factors are associated with the calcium intake of low-income adolescent girls [erratum appears in J Am Diet Assoc 2004;104(2):287]. *Journal of the American Dietetic Association* 2003;103(11):1526-1529.

88. Warren JM, Henry CJK, Simonite V, Low glycemic index breakfasts and reduced food intake in preadolescent children. *Pediatrics* 2003;112(5):e414.

89. Cullen KW, Baranowski T, Klesges LM et al. Anthropometric, parental, and psychosocial correlates of dietary intake of African-American girls. *Obesity Research* 2004;12(Suppl):S20-S31.

90. Salamoun MM, Kizirian AS, Tannous RI et al. Low calcium and vitamin D intake in healthy children and adolescents and their correlates. *European Journal of Clinical Nutrition* 2005;59(2):177-184.

91. Preziosi P, Galan P, Deheeger M et al, Breakfast type, daily nutrient intakes and vitamin and mineral status of French children, adolescents and adults. *Journal of the American College of Nutrition* 1999;18(2):171-178.

92. Stockman NKA, Schenkel TC, Brown JN et al, Comparison of energy and nutrient intakes among meals and snacks of adolescent males. *Preventive Medicine* 2005;41(1):203-210.

93. Briley ME, Jastrow S, Vickers J et al, Can ready-to-eat cereal solve common nutritional problems in child-care menus? *Journal of the American Dietetic Association* 1999;99(3):341-343.

94. Gibson SA, Iron intake and iron status of preschool children: associations with breakfast cereals, vitamin C and meat. *Public Health Nutrition* 1999;2(4):521-528.

95. Gibson SA, Breakfast cereal consumption in young children: associations with non-milk extrinsic sugars and caries experience: further analysis of data from the UK National Diet and Nutrition Survey of children aged 1.5-4.5 years. *Public Health Nutrition* 2000;3(2):227-232.

96. van den Boom A, Serra-Majem L, Ribas L et al. The contribution of ready-to-eat cereals to daily nutrient intake and breakfast quality in a Mediterranean setting. *Journal of the American College of Nutrition* 2006;25(2):135-143.

97. Royo-Bordonada MA, Gorgojo L, de Oya M et al. Food sources of nutrients in the diet of Spanish children: the Four Provinces Study. *British Journal of Nutrition* 2003;89(1):105-114.

98. Belderson P, Harvey I, Kimbell R et al, Does breakfast-club attendance affect schoolchildren's nutrient intake? A study of dietary intake at three schools. *British Journal of Nutrition* 2003;90(6):1003-1006.

99. Worobey HS, Worobey J, Efficacy of a preschool breakfast program in reducing refined sugar intake. *International Journal of Food Sciences and Nutrition* 1999;50:391-397.

100. Barker M, Robinson S, Wilman C et al, Behaviour, body composition and diet in adolescent girls. *Appetite* 2000;35(2):161-170.

101. Cavadini C, Decarli B, Grin J et al, Food habits and sport activity during adolescence: differences between athletic and non-athletic teenagers in Switzerland. *European Journal of Clinical Nutrition* 2000;54(Suppl 1):S16-S20.

102. Baumert PW, Jr., Henderson JM, Thompson NJ, Health risk behaviors of adolescent participants in organized sports. *Journal of Adolescent Health* 1998;22(6):460-465.

103. Croll JK, Neumark-Sztainer D, Story M et al, Adolescents involved in weight-related and power team sports have better eating patterns and nutrient intakes than non-sport-involved adolescents [see comment]. *Journal of the American Dietetic Association* 2006;106(5):709-717.

104. Cupisti A, D'Alessandro C, Castrogiovanni S et al, Nutrition knowledge and dietary composition in Italian adolescent female athletes and non-athletes. *International Journal of Sport Nutrition & Exercise Metabolism* 2002;12(2):207-219.

105. Godin G, Anderson D, Lambert L-D et al, Identifying factors associated with regular physical activity in leisure time among Canadian adolescents. *American Journal of Health Promotion* 2005;20(1):20-27.

106. Keski-Rahkonen A, Kaprio J, Rissanen A et al, Breakfast skipping and health-compromising behaviors in adolescents and adults. *European Journal of Clinical Nutrition* 2003;57(7):842-853.

107. Aarnio M, Winter T, Kujala U et al, Associations of health related behaviour, social relationships, and health status with persistent physical activity and inactivity: a study of Finnish adolescent twins. *British Journal of Sports Medicine* 2002;36(5):360-364.

108. Yorulmaz F, Akturk Z, Dagdeviren N et al, Smoking among adolescents: relation to school success, socioeconomic status nutrition and self-esteem. *Swiss Medical Weekly* 2002;132(31-32):449-454.

109. Jarvelaid M, Adolescent tobacco smoking and associated psychosocial health risk factors. *Scandinavian Journal of Primary Health Care* 2004;22(1):50-53.

110. Cartwright M, Wardle J, Steggles N et al, Stress and dietary practices in adolescents. *Health Psychology* 2003;22(4):362-369.

111. Fulkerson JA, Sherwood NE, Perry CL et al, Depressive symptoms and adolescent eating and health behaviors: a multifaceted view in a population-based sample. *Preventive Medicine* 2004;38(6):865-875.

112. Pastore DR, Fisher M, Friedman SB, Abnormalities in weight status, eating attitudes, and eating behaviors among urban high school students: correlations with self-esteem and anxiety. *Journal of Adolescent Health* 1996;18(5):312-319.

113. Evers S, Taylor J, Manske S et al, Eating and smoking behaviours of school children in southwestern Ontario and Charlottetown, PEI. *Canadian Journal of Public Health Revue Canadienne de Sante Publique* 2001;92(6):433-436.

114. Gross SM, Bronner Y, Welch C et al, Breakfast and lunch meal skipping patterns among fourth-grade children from selected public schools in urban, suburban, and rural Maryland. *Journal of the American Dietetic Association* 2004;104(3):420-423.

115. Gonzales EN, Marshall JA, Heimendinger J et al, Home and eating environments are associated with saturated fat intake in children in rural West Virginia. *Journal of the American Dietetic Association* 2002;102(5):657-663.

116. Berg MC, Jonsson I, Conner MT et al, Relation between breakfast food choices and knowledge of dietary fat and fiber among Swedish schoolchildren. *Journal of Adolescent Health* 2002;31(2):199-207.

117. Cunningham-Sabo L, Snyder MP, Anliker J et al. Impact of the Pathways food service intervention on breakfast served in American-Indian schools. *Preventive Medicine* 2003;37:S46-S54.

Appendix A Studies investigating the context of eating breakfast in children

Paper	Subjects	Methods	Definition of breakfast	Confounders adjusted for	Main outcomes
Cross-sectional					
Brugman et al 1998[19]	3138 4–15-year-old Netherlands children.	Part of the regular school health assessments in 20 regions. Nationwide data. Diet assessed by food frequency questionnaire (FFQ) at home and returned by post.	On regular school days only within the last 24 hrs.	Categorised major variables such as sex and age group.	5% of children in primary school and 13% in secondary school skipped breakfast before going to school within the last 24 hrs. 13–17-yr-olds were 2.67 times more likely to skip breakfast than 4–6-year-olds. In a comparable study in 1983, 4% of children skipped breakfast the previous day.
Cohen et al 2003[37]	318 grade 9–12 students in 3 schools in Ontario Canada, rural and small towns.	Diet, physical activity and smoking assessed via questionnaire (no other details provided); included eating behaviour questions such as "whether students ate breakfast every day".	Not defined.	Stratified analyses for age, school, activity, smoking, concern for weight.	42.8% of students ate breakfast every day: 48.8% of boys and 36.1% of girls. Missing breakfast was more common among girls, and this rose from 44.9% in grade 9 to 65.3% in grade 12. For girls, those concerned about gaining weight were more likely to skip breakfast (69.3%) than those not concerned about gaining weight (51.1%).
Evers et al 2001[113]	1293 children in grades 4–8 in Ontario, Canada	Non-random sample of rural and urban schools. FFQ with additional questions to "determine proportion consuming breakfast".	Not defined.	No discussion about controlling for confounders, except stratification of analysis by age, gender and rural area.	> 3% of students across all grades "never" ate breakfast. Girls (60%) were less likely to eat breakfast every day than boys (70%). Boys had relatively stable rates of eating breakfast every day across grades, but in girls, those oldest were least likely to eat breakfast every day.
Gross et al 2004[114]	540 4th grade students from 16 schools – a mix of urban, suburban and rural – in Maryland, USA.	Paper-and-pencil questionnaire, validated. Students were asked "the number of days they ate breakfast per week". Breakfast skippers were defined as those "reporting eating breakfast fewer than 3 times per week".	Not defined.	None.	17% reported skipping breakfast. Urban students (27%) were more likely to skip breakfast than suburban (8%) and rural students (13%).
Haapalahti et al	404 rural 10–11-yr-old	FFQ filled in by parents and child at	Not stated.	Father's	"99% of children ate breakfast

2003[38]	Finnish children from 12 primary schools.	home in weekends and at schools on weekdays.		occupation.	regularly". As the whole sample ate breakfast, the authors stated there was little point analysing between those who didn't and those who did.
Hackett et al 2002[23]	3556 9–10 years and 649 11–12 years in Liverpool, UK.	Food intake questionnaire self-completed in the classroom. Validity and reliability of questionnaire tested.	Not eating and/or not drinking before leaving home for school.	Stratified the analysis by age group and gender.	23% of girls and 12% of boys aged 11–12 years did not eat breakfast. 6% of boys and 7% of girls aged 9–10 years did not eat breakfast.
Hoglund et al 1998[22]	7605 8th grade pupils (14–15-yr-olds) from Sweden, in Goteborg city and Alvsborg county.	FFQ with 29 questions on food consumption, and 27 questions on food habits and patterns.	Not stated.	Controlled for weight, height and body mass index (BMI) as dependent variables, and sex, smoking, physical condition and knowledge as independent variables.	20% of boys and 32% of girls ate breakfast < 3 times per week (sig diff). Girls ate healthier food but meal pattern was more irregular.
Johansen et al 2006[24]	3458 students aged 14–16 years in Copenhagen and Aarhus, Denmark.	Self-completed questionnaires in school and question in school health examination: "How often do you eat breakfast in the course of a school week (Monday to Friday)?"	Not defined.	Controlled for cluster effect of municipalities and school classes. Stratified analysis by gender, age, socio-economic status (SES), type of family, social network and academic proficiency.	Girls 2 times less likely to eat breakfast every day compared with boys (OR = 0.47; 95% CI: 0.39–0.57). As children get older (14, 15, 16 years), they are more likely not to eat breakfast. No consistent pattern or trend between SES status and not eating breakfast, but children who did not eat breakfast every day were more likely to have unemployed mothers (OR = 1.56).
Lattimore & Halford 2003[41]	1019 children aged 11–16 yrs (574 female, 445 male) from 13 secondary schools in Lancashire, UK.	A dieting status question (not dieting, dieting to lose weight, dieting to maintain weight), and a validated food choice and dietary habits questionnaire were self-completed in the classroom. Psychologist and teacher present.	Not defined.	Did not control for confounders such as SES.	19% skipped breakfast on the day of the survey. The dieting to lose weight group was 3.14 times more likely to skip breakfast than the not dieting group. 4 out of 10 females dieting to lose weight skipped breakfast compared with 1.7 out

		School day data only.			of 10 females not dieting. Dieting status and breakfast skipping were not associated for males.
Le Bigot Macaux 2001[44]	1000 children aged 9–11 yrs (and their mothers) who were socio-demographically representative of the French population.	Children interviewed alone and answered structured questionnaires on food consumption and food preferences. Parents also interviewed about child's meals and SES.	Not defined.	Controlled for SES.	97% of children ate breakfast. 61% of children viewed breakfast as the most important meal of the day. Two-thirds of children "would like to have more time for breakfast in the morning'. Half of children "prefer to prepare my own breakfast".
Martens et al 2005[43]	203 12–14-yr-old students in the Netherlands.	Specific school-based self-administered breakfast dietary habit questionnaire: "How many days a week they eat breakfast; purchase and accessibility of breakfast items in the home; table set for breakfast; having breakfast at a table".	Not defined.	Analysis stratified for gender, age and attitude.	Mean breakfast consumption of 4.8 days per week. 8% never had breakfast; 50% always had breakfast. Frequent breakfast eaters had a more positive attitude towards eating breakfast than those who rarely ate breakfast.
Nicklas et al 2000[28]	711 14–15-year-old students from 12 Christian schools in New Orleans.	In-school face-to-face 24h DR using a standardised protocol, food models, product identification notebooks, and collected recipes. Weekdays only.	Self-defined as an eating occasion which the student considered to be his or her breakfast.		19% of adolescents skipped breakfast, 81% had breakfast. More females skipped breakfast than males (23% vs 14%), more non-Whites skipped breakfast than Whites (32% vs 16%), and non-White females (36%). 90% consumed breakfast at home.
Nicklas et al 2004[32]	1585 10-yr-old children (5th grade) in Bogalusa, LA, USA, who were part of the Bogalusa Heart Study.	Data collected from 1973 to 1994 through 7 separate cross-sectional studies in same city involving school-based 1:1 interviews. Only school-day data included. 24-hr dietary recall data analysed for 4 eating occasions: breakfast, lunch, dinner and snacks – reflected reported description of the respondent.	Self-defined.	BMI and meal pattern was controlled for study year, total energy intake, ethnicity, gender and ethnicity.	There was no association between skipping breakfast and being overweight (Table 3 and p 759).
O'Dea & Caputi 2001[33]	1126 students aged 6–19 yrs from 12 primary and secondary schools (1/4 from low	Questionnaire on frequency of meals and snacks, interviewer-administered, with children 1:1 during school hours.	Not defined.	Height, weight and SES controlled for but SES measure was area based, so not an individual	Older children of low SES (31%) more likely to regularly skip breakfast than older children of mid or high SES (22%). Older children more likely to skip breakfast than younger children for

	SES schools) in NSW Australia.			measure. No control for ethnicity.	both genders. 3-way analysis considering gender, weight and age showed that overweight females were the most likely to regularly skip breakfast (18%) and normal weight males the least likely to skip breakfast (10%).
Siega-Riz et al 1998[18]	1–10 years and 11–18 yrs from US households in the 48 conterminous states between 1965 and 1991.	Pooled nationally representative samples of the Nationwide Food Consumption Surveys of 1965 and 1977/78 and the 1989–1991 Continuing Survey of Food Intakes by Individuals. 1 24-HDR in the first survey and 3 consecutive 24-HDRs in the last 2 surveys, with multiple pass and repeat sampling in the later surveys. Statistical analysis to determine trends in breakfast consumption over time and assign changes in breakfast eating to particular characteristics of the population.	Food, beverage or both consumed between 5.00 am and 10.00 am.	Ethnicity, age, gender, SES controlled for.	Breakfast consumption declined for each age group between 1965 and 1991. Predictive factors for eating breakfast were male gender for adolescents, living in the southern states, and living in a female head of household with at least a college education (that likelihood decreases if the female is employed outside the home). Factors predictive of not eating breakfast included living in a single-parent household, in high-income households and in families with fewer than three members. There were no independent differences by race or urban/rural. The decline in breakfast consumption was predominantly associated with adoption of new behaviours rather than changing socio-demographic patterns of the US.
Sjoberg et al 2003[34]	611 boys and 634 girls aged 15–16 yrs from 13 schools and 52 whole classes in Goteberg, Sweden.	A validated diet history method administered at school by a dietitian.	"Intake in the morning before school if it contained a component of cereals and at least a milk product or a fruit/juice or a meat/fish/egg product".	Controlled for gender, smoking, ethnicity, perception of body weight, low SES and BMI. Adjusted for sampling design as well.	88% of boys and 76% of girls were regular breakfast eaters. Irregular breakfast eating was significantly related to all measured socio-demographic and lifestyle variables.

Temple et al 2006[35]	476 students aged 12–16 yrs from 14 schools in Cape Town, South Africa (representative of the population).	Non-validated self-completed questionnaire that asked whether breakfast was consumed, whether food was brought to school and what foods were brought, and whether food was purchased at school and what foods were purchased.	Not stated.	No control for confounding, except for separate analysis by SES (results not shown).	77.8% of students had breakfast before school. Students who attended high SES schools were no more likely to have had breakfast before school.
Utter et al 2006[9]	3275 students aged 5–14 yrs, including 1058 Pacific, 1224 Māori and 993 NZ European & Other (NZEO); nationwide NZ sample.	Pre-tested food habits questionnaire and FFQ administered by interviewers in the children's homes with parental help if the child was < 10 yrs old.	Eating or drinking something before school.	Controlled for age, sex and SES, but only an area-based SES measure was used, not a household level, so some SES confounding may still occur.	Pacific (OR = 5.77; 95% CI: 3.9–8.6) and Maori students (OR = 2.58; 95% CI: 1.8–3.8) were 5.7 times and 2.5 times more likely to skip breakfast compared with NZEO students. More than 40% of Pacific children and 23% of Maori children skipped breakfast either sometimes or always compared with 8% for NZEO.
Van den Boom et al 2006[96]	3534 people comprising children, adolescents and young people aged 2–24 yrs in Spain.	Home-based interviewer-administered 24 HDR (25% of sample underwent second 24 HDR); quantitative FFQ that determined portion size. Breakfast quality score was 3 if the person had a breakfast with a cereal, dairy product and fruit.	Defined as "the first eating occasion involving solid food or a beverage that occurred after waking up and before 10 am on a weekday and 11 am on a weekend".	SES controlled for but no weight or anthropometric data controlled for.	9% of sample were "non consumers" of ready-to-eat breakfast cereals.
Videon & Manning 2003[29]	18,177 adolescents from grades 7–12 from US schools.	Interviewed at home using self-report questions and single measures for breakfast; for whether parents ate main meals with children and how often; and for whether parents let them make their own decisions about the foods they eat – described as adolescent autonomy or parental control.	Not defined.	Analysis by major demographics; parental influence and body weight perception.	20% did not eat breakfast. Compared to White peers, Blacks and Hispanics were less likely to skip breakfast, but girls, older adolescents and adolescents who perceived themselves to be overweight, were more likely to skip breakfast, as were children with parents with a college degree. Adolescents who were allowed to make their own decisions about the foods they ate were 25% more likely to skip

					breakfast than adolescents whose parents made the decision for them. Parental presence when leaving for school had no impact on whether breakfast was eaten, but number of meals eaten with parental presence at an evening meal (> 3 meals per week) was positively associated with eating patterns, including eating breakfast.
Young & Fors 2001[36]	3155 grade 9–12 students (80% white) from all the high schools in a suburban county (higher SES in this county than national averages) in Atlanta Georgia, USA.	Anonymous self-completed questionnaire with 106 attitude and behaviour items – questionnaire based on other studies.	Not defined.	Controlled for demographic (gender, grade, weight, race) and family variables (family context, parental situation, hours spent at home).	Adolescents usually eating a healthy breakfast had higher levels of family communication and parental monitoring. Percentage eating a healthy breakfast decreased as parental living situation changed from a 2-parent (43%) to single-parent (32%) family; other family members (24%); foster family (12%). Percent of adolescents usually eating a healthy breakfast decreased significantly when time at home without an adult was over 2 hours a day. Students who perceive themselves as "overweight" do not report eating a healthy breakfast as often as those who perceive themselves to be "about right".
Cohort					
Billon et al 2002[45]	398 nuclear families with at least 2 children aged 6 yrs and above, from the Stanislas Family Study in France.	3-day diet diary – 2 weekdays and 1 weekend, interviewer administered.	Not defined.	Age, gender, BMI, alcohol, cigarette consumption and physical activity	Frequency of sharing breakfast contributed to increase in family resemblance in breakfast energy intake for both offspring (within children) and spouses (within parents).
Shaw 1998[39]	699 13-year-olds, followed since birth in Queensland, Australia.	University of Queensland Study of Pregnancy. Questionnaires completed by mother and child. Socio-demographic variables came from the mother's questionnaire, and all other items were asked of the child using a "food and eating habits" questionnaire	Not stated.	Only confounders controlled for were those in the stratified analysis – gender and SES.	Females (18.4%) skipped breakfast over 3 times the rate of males (5.3%). 11 (all female) out of 56 indicated that wanting to lose weight and/or being on a diet was 1 of the reasons for not eating breakfast, 3 claimed there was nothing to eat at home, and 10 did not like the food

		(no other information provided). Follow-up phone interview 1 year after questionnaires completed with 68% of the 11% of the sample who were breakfast skippers (56 children interviewed out of a sample of 82 breakfast skippers, from the original sample of 699).			available. The "primary reason" offered for skipping was lack of time (52%) followed by not being hungry (22%) and not feeling like it (14%).
von Post-Skagegard et al 2002[21]	96 males and 112 females aged 15–21 yrs in 2 regions in Sweden.	FFQ with dietary habits questions delivered by trained interviewers.	Not defined.	Height, weight and BMI controlled for.	More than 90% of adolescents ate breakfast 5 times a week or more, and this did not change at 15, 17 or 21 yrs of age. 4–5% of adolescents in all age groups had breakfast twice a week or less.

Appendix B Observational studies investigating the relationship between regular breakfast consumption and academic performance

Paper	Subjects	Methods	Definition of breakfast	Confounders adjusted for	Main outcomes
Cross-sectional					
Abalkhail & Shawky 2002[56]	2850 students, aged 9–21 years, attending 84 schools in Jeddah, Saudi Arabia.	Academic performance assessed by school grades classified as: < 60% = fail; < 60% to < 70% = pass; > 70 to 80% = good; > 80% to 90% = very good; > 90% = excellent.	Information on having a regular daily breakfast collected in interview administered by medical students.	None.	Students who achieved a fail or low pass in school grades (< 70%) were less likely to have regular breakfast compared with students who have excellent grades (73.0% v. 87.8%; $p < 0.05$).
Boey et al 2003[57]	1971 grade 6 students (958 boys, 1013 girls), mean age 12 years, attending 23 primary schools, in city of Petaling Jaya, Malaysia.	Students completed questionnaires, which were checked the following day at interview. Academic performance determined by summing grades for 5 subjects in the Malaysian Primary School Achievement Examination.	Students asked if they were in "the habit of missing breakfast".	Sex, ethnicity, SES, major life events (parental divorce or separation, father losing job, mother starting work, death or hospitalisation of a close relative, hospitalisation of child in previous 12 months).	Students who said they missed breakfast were more likely to have a below-average examination score than those who did not: 44.4% v. 29.6%; adjusted OR = 1.47 (95% CI: 1.07–2.02).
Lopez-Sobaler et al 2003[58]	180 schoolchildren, 103 male and 77 female, aged 9–13 years, from 2 schools in Madrid, Spain.	Diet measured by 7-day weighed food records. Nutrients calculated from Spanish Food Composition Tables. Mental function measured by a Spanish version of the Scholastic Aptitude Test (SAT-1), which has 3 parameters: verbal, reasoning and calculation.	Breakfast defined as adequate if it provided $\geq$ 20% of daily energy intake.	Age, sex and school.	Percentage of energy intake provided by breakfast was a significant ($p < 0.05$) positive predictor of reasoning score and total score, adjusting for age, sex and school.
Johansen et al 2006[24]	3458 students, aged 14 to 16 years, in 244 school classes in Copenhagen and Aarhus, Denmark.	Students completed questionnaires at school. Academic proficiency rated by class teacher.	Students asked "How often do you eat breakfast in the course of a school week (Monday to	Sex, age, SES, type of family, and social network.	Students with poor academic proficiency were more likely not to eat breakfast every day than other students: OR = 1.43 (95%

			Friday)?".		CI: 1.19–1.70).
Cohort					
Berkey et al 2003[59]	14,586 children, aged 9–17 years, offspring of Nurses Health Study II participants, residing in 50 US states. Baseline survey in 1996, with annual follow-up questionnaires mailed in 1997, 1998 and 1999. Analyses restricted to children returning 2 or more consecutive questionnaires.	Questionnaires mailed to homes for completion by children. Children rated their own academic performance, to the question: "Some kids feel like they are very good at their school work", with choosing one of the following – "really true for me, sort of true, not true for me".	1996, 1997 and 1998 surveys: children asked "how times each week (including weekdays and weekends) do you eat breakfast?"	Age, Tanner scale, race, menarche (girls); for each sex.	Within each sex, there was an inverse association between frequency of missing breakfast and relative risk of doing well at school work in the following year, adjusting for confounders.

Appendix C Cohort studies comparing academic performance of participants and non-participants in free school breakfast programmes

Paper	Subjects	Methods	Definition of breakfast	Confounders adjusted for	Main outcomes
Meyers et al 1989[60]	1023 students in grades 3–6 attending 6 schools in the Lawrence school district, Massachusetts, who were eligible to receive the free school breakfast, of whom 696 had cognitive function tests.	Cognitive function measured by change in the Comprehensive Test for Basic Skills, at the end of semester 2, between the year before the breakfast programme and the year the breakfast programme was first administered.	Attenders defined as students who attended breakfast on 60% or more the mornings during the week. Non-attenders were students who did not attend on any days. Other children were excluded from analyses.	School grade, income, number of children in family, ethnicity, sex, baseline test score, and baseline absence rate.	Students who participated in the breakfast programme had a bigger increase in the test score than students who did not (48.13 v. 40.78, p = 0.0049).
Murphy et al 1998[61]	133 students (58 male, 75 female), 83% African-American, mean age 10.3 years, in grades 3–8 at 3 inner-city schools in Philadelphia & Baltimore, with complete before and after information on breakfast participation and academic performance.	Information collected from interviews with students and parents at school. Academic performance measured by student grades in maths, science, social studies and reading.	Attendance at school breakfast recorded for 1 week before start of free breakfast programme, and for 1 week after it had been running for 4 months.	None	Maths score increased in those who increased breakfast participation. Other academic measures unchanged.
Kleinman 2002[62]	97 students in grades 4–6 at 3 inner city Boston schools. No information on age and sex provided.	Participation in the school breakfast service recorded for 1 week before, and 6 months after, start of free breakfast programme. School records of grades in maths, reading, science and social studies.	Single 24-hr diet recalls before and 6 months after the start of the free breakfast programme. Low nutrient group are students who had ≤ 50% of RDA for 2 for more nutrients, and/or for energy.	None.	Children who increased their breakfast attendance were more likely to improve their nutritional status (32%) than other students. Children with an improved nutritional status had increased maths grade ($p < 0.05$) 6 months after the start of the free breakfast programme, but there was no change in other academic measures.
Chen & Liao 2002[63]	690 female first-year students, mean age 16	Final score in 6 compulsory papers at end	Record of attendance for free breakfast at 4	None	Students who attended breakfast ≥ 85% mornings more likely to be

	years, at rural nursing school in Taiwan.	of semester 1.	certified restaurants in first 4 months of semester 1.		in the top 10 students of a paper (45%) than students who attended ≤ 60% of mornings (7%). Significant correlation between percentage of breakfasts attended and score in each of the 6 compulsory subjects.

Appendix D Experimental studies investigating the relationship between short-term breakfast interventions (< 1month) and academic performance

Paper	Subjects	Methods: Design & intervention	Assessment of academic performance	Confounders adjusted for	Main outcomes
Chandler et al 1995[64]	Grade 3–4 children, mean age 9 years, attending 4 rural schools in Jamaica. 100 undernourished children, weight-for-age ≤ 1SD of US reference values, 3 of whom did not complete both tests, leaving 97 in this group. 100 adequately nourished children, weight-for-age > 1SD of US reference values.	Cross-over trial, with each person as their own control. Classes randomised to breakfast or placebo for 1–3 weeks, with an interval of 3 weeks. Intervention breakfast = 2174 kJ; placebo (one-quarter of an orange) = 63 kJ.	Cognitive function tests, administered after receiving the breakfast or placebo, were for visual search, digit span, verbal fluency and speed of information processing.	None. Cross-over design in effect controls for any type of confounding as each child compared with itself.	No significant main effects of nutritional group on any of the cognitive function tests. However, significant increase in verbal fluency score after breakfast (compared with placebo) in undernourished children (23.1 v. 21.6, $p < 0.01$) but no change in adequately nourished children (23.3 v. 23.8, $p > 0.05$).
Jacoby et al 1996[65]	352 grade 4–5 children, mean age 11 years, at 10 rural schools in Peru. Schools randomised to have school breakfast programme (201 students) or not (151 students).	Group randomised study. Intervention for 15–30 days. Intervention breakfast = 600 kcal.	Academic performance measured by tests for digit discrimination, reading comprehension, vocabulary and mathematics	Sex, height, weight, SES, language, school grade, repeating grade, school, entry age to school.	No significant differences in cognitive function between children receiving free school breakfast and controls. However, there was a significant ($p < 0.05$) interaction between treatment and baseline weight. Heavier children had a greater increase in vocabulary score in the breakfast group compared with the control.
Vaisman et al 1996[66]	503 grade 5–6 students in 17 classes at 5 schools in Israel.	Randomised trial, not specified if at the individual or group (class) level. Intervention students given breakfast (30 g cornflakes and 200 ml of milk) at school for 14 days. Control may have had breakfast at home (66% did so).	Cognitive function assessed after 14 days by: Rey Auditory-Verbal Learning Test which measures learning and memory; and 2 versions of each of the Wechsler Memory Scale & Benton Visual Retention Test.	Version of test and gender	Students who had breakfast at school performed better on most scores than the control group.

Appendix E Experimental studies investigating the relationship between long-term (> 1 month) breakfast interventions and academic performance

Paper	Subjects	Methods: Design & intervention	Assessment of academic performance	Confounders adjusted for	Main outcomes
Powell et al 1983[67]	115 students, aged 12 years, in the 3 lowest academic classes of grade 7 at a rural high school in Jamaica.	1 intervention class (n = 44 students), 1 control class given syrup only (n = 33), and 1 control class given no breakfast (n =3 8). All 3 classes monitored for 1 term without any intervention, then for a further term during which interventions were implemented. Intervention breakfast was either milk plus meat patty (730 kcal) or milk plus cake (380 kcal). Control syrup drink was 33 kcal.	Academic performance assessed by the school achievement test, which has 3 components: reading, spelling and arithmetic. Latter 2 administered at the beginning of the 1st and 2nd terms and at end of 2nd term; reading at beginning of 1st and end of 2nd term.	Sex, age, and previous test scores.	No difference in outcome between 2 control groups, which were combined. The breakfast group had a significantly increased score for arithmetic, but not for reading or spelling, compared with the combined control group.
Richter et al 1997[69]	108 children, aged 7–14 years, attending a peri-urban (intervention) school and an urban (control) school in Johannesburg.	Students at the intervention school (n = 55) given free breakfast for at least 6 weeks without interruption. No school breakfast provided to students at control school (n = 53). School breakfast was 30 g cornflakes, 100 ml skim milk and one banana.	Academic performance assessed by the Wechsler Intelligence Scale for children coding and digit span tests, which assesses attention, memory and concentration, and the vigilance test, which assesses arousal. Tests were administered 6 months apart (i.e. before and after the start of the school breakfast programme in the intervention school.	None.	The digit span test and vigilance score were significantly increased in students at the intervention school, compared with those at the control school ($p < 0.01$). There was no difference in the coding score between intervention and control students.
Powell et al	814 children, mean age 108	Individual randomisation	Academic performance	Initial academic score,	Intervention group had

1998[68]	months, attending 16 rural schools in Jamaica. Stratified into underweight and overweight groups (– or + 1SD of US reference weights for age).	within classes to intervention or control. Intervention breakfast was a cheese sandwich or spiced bun and cheese, and flavoured milk, with 2419–2953 kJ. Control students given one-quarter of an orange (76 kJ). For 8 months.	measured with Wide Range Achievement Test, which has 3 subscales: reading, spelling and arithmetic.	sex, grade, under- or well-nourished, school, class, housing rating	significantly increased arithmetic score. However, no treatment effect with spelling and reading.

Appendix F Studies investigating the relationship between breakfast consumption and body weight or obesity in children

Paper	Subjects	Methods	Definition of breakfast	Confounders adjusted for	Main outcomes
Cross-sectional studies reporting an inverse relationship between breakfast consumption and weight status in children					
Pastore et al 1996[112]	743 high school students, mean age 16.1 yrs, 55% female, from 1 school in New York	Height and weight measured by standard techniques. Overweight defined as 110–119% ideal body weight (IBW), obese ≥ 120% IBW.	Asked frequency of skipping breakfast in eating habits questionnaire.	None	72% of obese compared with 30% of underweight skipped breakfast ($p < 0.001$). Other weight-related comparisons not shown but assume were non-significant.
	Comment: From sample of 1500 eligible students, and no data presented on responders compared with non-responders.				
Milligan et al 1998[26]	Cross-sectional analysis of 508 18-yr-old Australians from original cohort study.	Height, weight, waist and hip circumferences by standard techniques. Breakfast intake from 2-day diet records.	Divided into no breakfast, beverages only, continental breakfast, cooked breakfast or convenience foods.	None	Men who didn't eat breakfast either day had higher BMI (23.1 cf. 22.3, $p < 0.05$) and waist-to-hip ratio (0.81 cf. 0.79 $p < 0.05$) than men who ate a continental or cooked breakfast both days. No significant differences were observed for women.
	Comment: Analysis only includes 32% of original cohort (n = 1565), as 28% could not be traced and 33% refused to participate. Some differences in weight and diet were observed between participants and non-participants.				
Siega-Riz et al 1998[18]	Combined data sets of children aged 0–18 yrs from the Nationwide Food Consumption Surveys of 1965/66 (n = 7153), NFCS 1997 (n = 12,561) and 1989–91 Continuing Survey of Food Intake by Individuals (n = 4289).	One 24-hr recall in first survey and 3 consecutive 24-hr recalls in other surveys (with multiple pass and repeat sampling). Statistical analysis to determine trends in breakfast consumption over time and assign changes in breakfast eating to particular characteristics of the population.	Food, beverage or both consumed between 5 am and 10 am.	Age, gender, ethnicity, area, female education and employment, SES, age and sex interactions	A 1-unit increase in BMI was associated with declining breakfast consumption (beta coefficient –0.04, $p < 0.01$) in 11–18-yr-olds. Appears relationship was not tested in younger children.
	Comment: Large representative surveys with clear definition of breakfast.				
Dwyer et al 2001[70]	1493 US children (mean age 14.1 yrs) from follow-	Diet by 24-hr recall. Overweight defined as	As defined by subject from 24-hr recall.	Gender, race, site, intervention group,	Overweight children less likely to eat breakfast on day of recall

	up of CATCH trial participants	BMI ≥ 85th percentile of NHANES I data.		and random inter-school variation	(70% cf. 80%, p = 0.0004).
	Comment: Large sample.				
Boutelle et al 2002[71]	Statewide representative sample of 9097 Connecticut adolescents (7th, 9th, 11th grades) in 1995/96. Excluded 7.5% who were underweight leaving n = 8330.	Self-reported height and weight. Assessed healthful eating behaviour by asking if had eaten certain low-fat foods in previous day (twice or more vs less). Vigorous activity (single question) and demographics by questionnaire.	Asked if usually eat breakfast on school days; dichotomised into yes, usually and no.	Parental SES, race and grade	Obese girls were less likely than normal-weight girls to usually eat breakfast (OR 0.72, 95% CI 0.53–0.97). Both overweight (0.72: 0.60–0.86) and obese (0.68: 0.54–0.86) boys were less likely to usually eat breakfast compared with normal-weight boys.
	Comment: Excellent response rate (83%) using negative consent procedure. Did not adjust for activity even though had (crude) measure and activity differed according to weight status.				
Sjoberg et al 2003[34]	Representative sample of 611 boys and 634 girls aged 15–16 yrs from 13 schools in Goteburg, Sweden.	A diet history consisting of a detailed questionnaire and an individual interview, covering meal pattern, quantity and quality of intake checked by dietitian in subsequent interview	Intake in the morning before school if it contained a component of cereals and at least a milk product or a fruit/juice or a meat/fish/egg product. Breakfast eaters classed as regular (every day before school) or irregular (miss once a week or more)	Gender, smoking, ethnicity, perception of body weight, SES, sampling design	BMI was significantly higher in irregular versus regular breakfast eaters (21.4 cf. 20.5, p = 0.006) in boys but not significant in girls (21.1 cf. 20.9, p > 0.0.05).
	Comment: High participation rates of 86% in boys and 93% in girls. Schools stratified by SES.				
Kumar et al 2004[27]	1659 Norwegian teenagers aged 15–16 yrs from Oslo Health Study in 2000/2001.	Self-reported height and weight. Frequency of breakfast consumption from 1 question. Activity, TV and SES by questionnaire.	Breakfast consumption divided into 3 groups: seldom or 1–3 times per month, weekly or 1–4 times per week, and regularly/daily/5–6 times per week.	Physical activity, ethnicity, fruit and vegetable intake, chocolate/sweets intake, full-fat milk intake, whether had dieted or not	Adjusted odds ratios (OR) for BMI in relation to breakfast frequency was significant in girls; referent group regular, 1.0 (0.6–1.4) up to 4 times per week, 1.7 (1.1–2.8) for seldom group. Not significant in boys.
	Comment: Large representative group with overall excellent response rate.				
Andersen et al 2005[72]	Representative cross-sectional survey in 664 4th and 825 8th graders in 2000 from Norway.	Questionnaire of 277 foods representing typical diet with standard serving sizes. Students indicated	Asked how often they ate breakfast during the week; divided into 3 groups ≤ 2, 3–5, 6–7.	Age, gender, social class, TV viewing, energy, sweets intake.	Odds ratios for being overweight were higher with lower consumption of breakfast (referent 6–7 times): for eating

		whether and when they had consumed each item over a 4-day period. Height and weight self-reported.			breakfast ≤ 2 times per week OR 1.69 (95% CI 0.99–2.89) and 3–5 times 1.99 (1.25–3.18).
	Comment: Good response rates (80–86%). 18–19% height and weight data missing, although authors comment that other information on questionnaire did not differ in those who did and didn't record their weight.				
Stockman et al 2005[92]	180 Canadian adolescent males aged 14–18 yrs, 66% normal weight.	3-day diet records on consecutive days, including 1 weekend day. Height and weight by standard techniques.	Self-categorised by boys. Breakfast eaters divided into consistent eaters (all 3 days) and others.	None	Consistent breakfast eaters had lower BMI (22.1 cf. 24.5, p = 0.0008) than inconsistent eaters, and the prevalence of overweight was also significantly lower (9 cf. 28%, p < 0.05).
	Comment: Saw inverse association between number of eating occasions and BMI, but positive association with energy intake suggesting that under-reporting had occurred. However, under-reporters were not accounted for and no adjustment for any confounders occurred.				
Fiore et al 2006[75]	1890 12–16-yr-olds from NHANES III. Only includes those with BMI ≥ 15th percentile. 51% male, 67% White, 15% African-American, 8.5% Mexican-American.	Diet by single 24-hr recall. Height and weight by standard techniques. Lifestyle factors assessed by questionnaire.	Coded as rarely or never, some days or every day from questionnaire.	Sex, age, race, poverty-to-income ratio, caregiver education, parental weight, maths and reading scores, asthma, water intake, television, exercise	Unadjusted odds ratios for being healthy weight (15th–85th) with rarely/never eating breakfast as referent group were 1.21 (95% CI: 0.83–1.77) for some days and 1.53 (0.95–2.46) for every day (p < 0.10). Adjusted odds ratios were also no longer significant. However, the trend was significant when look at subgroup who had 1 or 2 obese parents (n = 461); OR were 3.1 (1.5–6.2) and 4.0 (1.9–8.6) for some days and every day respectively. No significant trend in those with 2 non-obese parents (n = 631).
	Comment: Analyses only included all those that answered each question, but data not provided for what numbers this represents.				
Miech et al 2006 [25]	2027, 1879, 2173 and 4748 12–17-yr-old adolescents from 4 NHANES surveys.	Diet by 24-hr recall. Height and weight by standard techniques.	Breakfast skipping defined as categorical variable with respondents reporting 0 calories from breakfast compared with all others.	None for this analysis	Reported that breakfast skipping was related to overweight in 1999–2002 NHANES survey (p < 0.001) but further data not shown. Doesn't directly relate breakfast skipping to increases in

					overweight.
	Comment: Was not main focus of analyses so few data actually presented.				
Zullig et al 2006[78]	Statewide representative sample of 4175 American students aged 13–18 yrs from Youth Risk Behavior Survey in South Carolina.	All data from anonymous questionnaires completed in class. Was investigating links with perception of weight and dieting behaviour rather than weight *per se.*	Asked students where had eaten breakfast over past 5 days, then dichotomised answers into no (none) and yes (1–5 times).	Other dieting behaviours in models and analyses conducted with race and gender groups.	White females not eating breakfast were more likely to perceive themselves as overweight (OR 1.4), dieted to lose weight (1.4), fasted to lose weight (3.0) and used laxatives or vomiting to control weight (1.8). Only significant variable in Black females was fasting (1.8). In White males, not eating breakfast was related to overweight perception (1.5), trying to gain weight (0.7), trying to lose weight (1.4), whether had dieted (1.4) or used fasting (2.1) or diet pills (2.4). Results were similar in black males.
	Comment: Reasonable response rate as 82% of schools agreed to participate and 83% of students within these schools did participate, giving an overall response rate of 68%. No data collected (or at least presented) on actual (or self-reported) weight.				
Utter et al 2007[76]	3275 New Zealand children aged 5–14 yrs from national nutrition survey; available data on 3042	Height and weight by standard techniques. Physical activity by 7-day recall questionnaire.	Asked children whether they usually, sometimes or no had something to eat or drink at home before school.	Age, gender, ethnicity, SES and physical activity.	Children who "usually" ate breakfast at home had lower mean BMI (18.7) than those who "sometimes" (21.5) or didn't (22.1) eat breakfast at home ($p = 0.002$).
	Comment: Nationally representative sample with good adjustment for confounders.				
Cross-sectional studies reporting no relationship between breakfast consumption and weight status in children					
Nicklas et al 2004[32]	1655 children from 7 cross-sectional surveys of 10-yr-olds (1973–1994) from Bogalusa, USA. Ethnicity and gender varied in each survey but was approximately 60–65% White, 30–35% African-American.	24-hr recall interviews conducted with the children. Not clear how heights and weights were obtained.	Self-defined by respondent.	Study year, total energy intake, gender, ethnicity, and gender x ethnicity	No significant association between skipping breakfast and overweight (OR 1.22, 95% CI 0.87–1.71).

	Comment: No information on response rates at each time period.				
Wilson et al 2006[8]	3275 New Zealand children aged 5–14 years from national nutrition survey.	3-pass 24-hr recall. Ethnicity self-reported. Height and weight measured by standard techniques. Obesity defined using International Cole criteria.	At least 1 item consumed between 6 am and 9 am	Age, gender, ethnicity, SES, urban vs rural	Energy intakes or percentage eating breakfast did not differ between breakfast eaters and non-eaters for normal weight, overweight or obese.
	Comment: Representative sample with reasonable response rate.				

Cohort studies reporting an inverse relationship between breakfast consumption and weight status in children					
Affenito et al 2005[20]	2379 African-American and White 9–10-yr-old girls followed annually for 10 yrs from 3 areas in USA (National Heart, Lung and Blood Institute growth and health study) – see Barton et al 2005.	Annual 3-day diet records, height and weight by standard techniques, physical activity by questionnaire at 5 time points.	Any eating between 5 and 10 am on weekdays and 5 and 11am on weekend days.	Model 1: age, ethnicity, site and their 2-way interactions. Model 2: plus parental education, energy intake, physical activity	Girls eating breakfast 3 times had significantly lower BMI values (by 0.1) than those with less frequent consumption in model 1, although no longer significant with further adjustment (model 2).
	Comment: Very high retention (82–96% over 10-yr period) and repeated diet records means up to 30 days of nutrient information for each participant. No exclusion of under-reporters, which may be more important given children completed diet records at all ages to ensure confidentiality.				
Elgar et al 2005[74]	Representative sample of 652 Welsh year 7 students, of which 389 were available for follow-up at year 11.	Health behaviours assessed by questionnaire completed by all children who attended class that day. Height and weight measured with clothes and shoes on.	Assessed how many times breakfast (and other meals) were skipped per week from questionnaire.	Sex, age, number of parents, family size, SES, television viewing, lunch and dinner skipping and snacks per day.	Cross-sectional analyses at baseline showed significant relationship between number of breakfasts skipped and weight status (underweight 1 meal, normal weight 1.3, overweight 1.8, obese 2.0, $p < 0.01$). Trend also significant at year 11, although dose–response not as clear (3.9, 2.1, 2.7 and 4.5 meals, $p < 0.01$). Multiple regression showed breakfast skipping was related to BMI (beta 0.19) at year 11 although not once adjusted for BMI at year 7.
	Comment: Large attrition at follow-up (46%) and BMI measurements not corrected for shoes and clothes.				

Cohort studies reporting no relationship between breakfast consumption and weight status in children					
Rolland-Cachera et al 2004[77]	121 French obese children aged 11–16 yrs at baseline in weight loss intervention. Followed up 99 at 9 months, 83 at 1 year and 66 at 2 years.	Used dietary history to assess % kJ from breakfast at home environment at year 1 and 2 compared with 20% provided by live-in intervention. Height and weight by standard techniques	As described	None	Reported that % kJ consumed at breakfast 12.2% at year 2 compared with 14.4% at year 1 occurring at same time as increasing weight, but direct analysis not actually completed.
	Comment: Weak analysis given that did not actually compare energy at breakfast in relation to weight regain, but simply stated they were related because they were occurring over the same time frame.				
Barton et al 2005[73]	2379 African-American and White 9–10-yr-old girls followed annually for 10 yrs from 3 areas in USA (National Heart, Lung and Blood Institute growth and health study) – see Affenito et al 2005.	Annual 3-day diet records, height and weight by standard techniques, physical activity by questionnaire at 5 time points.	Any eating between 5 and 10 am on weekdays and 5 and 11 am on weekend days. Also interested in breakfast cereal consumption at breakfast and other times of the day.	Site, age, number of parents in household, parental education, race, physical activity and energy.	Number of days eating breakfast not predictive of BMI z-score and weight status adjusted for confounders.
	Comment: See Affenito et al 2005				
Cohort studies reporting a positive relationship between breakfast consumption and weight status in children					
Berkey et al 2003[59]	> 14,000 US children from the Growing Up Today cohort (offspring of participants in the Nurses Health Study), aged 9–14 yrs, followed annually for 3 years.	Self-reported height and weight. Physical activity by questionnaire.	Single question on how many times per week child ate breakfast (5 response categories).	Age, Tanner stage, race, girls menstrual status, prior BMI z-score, height growth, activity, inactivity	Overweight children who never ate breakfast had smaller gains in BMI than overweight children who ate breakfast nearly every day (girls: 0.50 kg/m^2; boys: 0.66 kg/m^2). Although tendency for opposite effect in normal weight children, this was not significant.
	Comment: Interesting analysis because it investigated the effect in the different weight status groups.				

Appendix G Studies investigating the relationship between cereal consumption and body weight or obesity in children

Paper	Subjects	Methods	Definition of breakfast	Confounders adjusted for	Main outcomes
Cross-sectional studies reporting an inverse association between cereal consumption and weight status in children					
Albertson et al 2003[79]	Representative sample of 603 children aged 4–12 yrs in US.	14-day household diet record where each food eaten by each household member is recorded. Portion sizes obtained from age- and sex-specific data from the CSFII. Parents reported height and weight (data missing in 170 children).	Consumption of ready-to eat (RTE) cereal.	None	Significant difference in BMI according to number of servings over 14 days: ≤ 3 (19.3), 4–7 (17.9) and ≥ 8 (16.7), all significantly different from each other, suggesting a dose–response effect. Similar relationship if use categories of weight status: 47.4%, 36.7% and 21.3% ($p < 0.01$).
	Comment: 92% had all 14 days diet record data. Did not adjust for any confounders (even though had demographic data) including energy intake (although study shows that mean intake does not differ across frequency groups).				
Cho et al 2003[82]	16,452 individuals aged 18 years and over from NHANES III.	Diet by 24-hr recall; height and weight by standard techniques.	Self-identified by subject. Foods divided into 10 categories: skippers, dairy, meat and eggs, fruit and veges, RTE cereal, cooked cereal, breads, quick breads, fats and sweets, beverages.	Gender, race, age, poverty level, smoking, alcohol, activity	Subjects who ate RTE cereal, cooked cereal or quick breads had significantly lower BMI values than breakfast skippers and meat/egg consumers. Cooked cereal consumers also had significantly lower BMIs than fats/sweets, dairy and breads groups.
	Comment: Although conducted in adults, included here to show it might be actual breakfast content rather than breakfast *per se* that is the important factor.				
Cross-sectional studies reporting no association between cereal consumption and weight status in children					
Gibson 2003[80]	1688 children and adolescents aged 4–18 yrs from UK national survey, of which 1193 gave blood samples (56% of original).	Diet by 7-day diet record. Height and weight by standard techniques.	Divided into tertiles of breakfast cereal intake (as % kJ) for each year of age and gender. Non- and low consumers had to be combined into 1 group as would have been age discrepancy given more older children were non-	Age, gender	No significant differences in mean BMI or prevalence of overweight or obesity according to cereal consumption (but tendency to have slightly better LDL cholesterol profiles).

			consumers.		
	Comment: Rare to have 7-day diet record information from such a large representative group. Analyses adjusted for energy as were expressed as cereal intake as % total kJ but total energy intake did vary between groups, which may account for at least some of the food/nutrient differences.				
Cohort studies reporting an inverse relationship between cereal consumption and weight status in children					
Barton et al 2005[73]	2379 African-American and White 9–10-yr-old girls followed annually for 10 yrs from 3 areas in USA (National Heart, Lung and Blood Institute growth and health study) – see Affenito et al 2005.	Annual 3-day diet records, height and weight by standard techniques, physical activity by questionnaire at 5 time points.	Any eating between 5 and 10 am on weekdays and 5 and 11 am on weekend days. Also interested in breakfast cereal consumption at breakfast and other times of the day.	Site, age, number of parents in household, parental education, race, physical activity and energy.	Number of days eating cereal predictive of BMI z-score and weight status adjusted for confounders, although actual difference small (e.g. –0.015 z-score).
	Comment: See Affenito et al 2005				
Randomised controlled trials reporting a positive effect of breakfast consumption on weight status in children					
Rodearmel et al 2006[81]	105 families with at least 1 overweight 8–12-yr-old child (82 intervention, 23 control). 2 aims: to increase steps by 2000/day and to eat 2 servings of RTE cereal each day.	14-week intervention. Height and weight by standard techniques. 3-day diet records at baseline, middle and study end.	Cereal consumption	None	73–76% of target children completed intervention. Both girls and boys significantly increased number of steps achieved per day. Only follow-up data reported for cereal intake: significant difference between intervention and control children: 8.1 cf. 3.6 serves per week ($p < 0.05$). No differences in energy or nutrient intake at any time point.
	Comment: Baseline cereal intake data not presented. Discussion commented that intake was increased in intervention children but data not shown. Unable to reach target of 14 serves/week despite being provided with cereals. Did report favourable changes in body composition of intervention children. Uneven weighting of intervention relative to control limits power, but authors acknowledge was pilot study to test feasibility. Analyses don't appear to adjust for baseline differences and several sub-analyses were conducted – study possibly not powered to do so. Mentions adult interventions.				

Appendix H Studies investigating the relationship between breakfast consumption and food and nutrient intake in children

Paper	Subjects	Methods	Definition of breakfast	Confounders adjusted for	Main outcomes
Cross-sectional studies reporting a positive relationship between breakfast consumption and nutrient intake in children					
Milligan et al 1998[26]	Cross-sectional analysis of 508 18-yr-old Australians from original cohort study.	Diet by 2-day diet record over consecutive weekdays.	Divided into no breakfast, beverages only, continental breakfast, cooked breakfast or convenience foods.	None	Males who didn't eat breakfast either day had lower intakes of iron (1.3 cf. 1.4 mg/MJ/day, $p < 0.05$) and fibre (20.2 cf. 24.5 g, $p < 0.05$) than males who had a continental or cooked breakfast both days. Only iron was significant for females (1.2 vs 1.4 mg/MJ/day, $p < 0.05$).
	Comment: Analysis only includes 32% of original cohort (n = 1565) as 28% could not be traced and 33% refused to participate. Some differences in weight and diet were observed between participants and non-participants.				
Ortega et al 1998[86]	200 Spanish children (118 boys) aged 9–13 yrs from 2 schools (1 low, 1 middle SES) in Madrid.	Diet by 7-day diet record. Height and weight by standard techniques.	From 7 DDR, but how breakfast measured not defined.	None	Saw significant correlations between intake of calcium (r = 0.72) and milk products (r = 0.76) at breakfast and in the whole diet. Children who consumed < 20% total kJ at breakfast time had significantly lower total calcium (162 mg males and 42 mg females) and milk intakes than children who ate a larger proportion of kJ at breakfast.
	Comment: Analyses restricted to those who ate at school canteen, but information not provided on what proportion this represented. Response rate 59%.				
Preziosi et al 1999[91]	235 children aged 2–18 yrs from 1 region in France.	Diet by dietary history. Vitamin and mineral status by standard biochemical tests on fasting blood samples.	First eating occasion involving solid food or beverage that occurred after waking. Breakfast size (low < 15% RDA kJ, medium 15–25%, high > 25%).	Age	High breakfast consumers had lower intakes of fat and higher intakes of carbohydrate, calcium, phosphorus, magnesium, thiamin and riboflavin. The only differences in the biochemical indices were for thiamin for breakfast size.
	Comment: Recruited from original eligible population of 1.1 million using random sampling, with 62% response rate. Definition of breakfast didn't seem to have a cut-off time – assume a midday meal would not be classified as breakfast				
Nicklas et al 2000[28]	711 15-yr-old students from 12 Christian schools in New Orleans.	Diet by 24-hr recall conducted for weekdays only.	Self-defined as an eating occasion which the student considered to be his or her breakfast. Divided into 3 groups: breakfast skippers, breakfast plus vitamin	Gender, ethnicity, breakfast consumption and all interactions.	Breakfast eaters had higher absolute (gram) daily intakes of kJ, saturated fat, protein, carbohydrate, fibre, starch and sucrose. Significantly higher % of breakfast skippers did not consume 2/3 RDA for all vitamins and minerals except niacin. Those taking supplements (11%) had lower total, SFA and MUFA fat and higher fibre intakes than

			supplement, breakfast no vitamin supplement.		breakfast eaters with no supplement, and lower % consumed less than 2/3 RDA.
	Comment: Did not have sub-sample with repeat 24-hr recall to account for intra-individual variation despite calculating % of sample with intakes less than 2/3 of RDAs.				
Dywer et al 2001[70]	Follow-up of participants from CATCH trial, included 1493 students in 8th grade who completed 24-hr recall (original cohort 2075).	Diet by 24-hr recall. Height and weight by standard techniques, overweight defined as ≥ 85th NHANES I reference data.	Breakfast as defined by student on 24-hr recall.	Gender, race, site (were 4), intervention group and random inter-school variation.	Nutrient content of breakfasts differ considerably from other meals – are generally lowest in energy but relatively higher in protein and sugar compared with other meals.
	Comment: Large sample size.				
Serra-Majem et al 2002[85]	2855 Spanish children/ adults aged 2–24 yrs from representative national survey conducted in 1998–2000.	Single 24-hr dietary recall in 75% of participants, with repeat in 25% to adjust for individual variability. Defined as at low nutritional risk if 0–1 nutrients were below 2/3 RNI, medium (2–3 nutrients), high (≥ 3 nutrients).	Referred to breakfast quality, defined as poor (none of dairy, cereals or fruit consumed), medium (1 consumed) or high (2–3 consumed).	Age, gender, SES	Odds ratios for being at high relative to low nutritional risk not significant when breakfast analysed as a categorial variable (yes/no). However, having high breakfast quality had significantly lower odds of being at high nutritional risk compared with low-quality breakfast (OR 0.58, 95% CI 0.41–0.82).
	Comment: Interesting definition of breakfast quality. Had to exclude 18% of original sample (n = 3534) because of under-reporting of energy intake. See van den Boom 2006.				
Lee & Reicks 2003[87]	105 teenaged girls (mean age 13.4 yrs) recruited from 3 low–income middle schools in Minnesota: Asian-American (58%), White (18%), African-American (14%); 51% from homes with 5 or more children.	Calcium intake by FFQ. Other variables by questionnaire completed by girls in class.	Not clear	None	Significant correlation (p = 0.05) between eating breakfast and calcium intake (r = 0.24).
	Comment: Poor initial response rate of 60%, then excluded large proportion (1/3) with poor FFQ data, which suggests this tool may not be appropriate in this group.				
Sjoberg et al 2003[34]	Representative sample of 611 boys and 634 girls aged 15–16 yrs from 13 schools in Goteburg, Sweden.	A diet history consisting of a detailed questionnaire and an individual interview, covering meal	"Intake in the morning before school if it contained a component of cereals and at least a milk	Gender, smoking, ethnicity, perception of	Regular breakfast eaters consumed more energy, protein, fibre, vitamin C (girls only), calcium, iron (girls only) and zinc and less sucrose and alcohol. No differences were seen for fat or

		pattern, quantity and quality of intake, checked by dietitian in subsequent interview.	product or a fruit/juice or a meat/fish/egg product". Breakfast eaters classified as regular (every day before school) or irregular (missed 1+ /week).	body weight, SES, BMI, sampling design	carbohydrate intake. Energy not consumed at breakfast was not compensated for with higher energy intake at lunch or dinner, but rather from a higher intake of in-between meals and snack foods.
	Comment: High participation rates of 86% in boys and 93% in girls. Schools stratified by SES.				

Stockman et al 2005[92]	180 Canadian adolescent males aged 14–18 yrs, 66% normal weight.	3-day diet records on consecutive days, including 1 weekend day.	Self-categorised by boys. Breakfast eaters divided into consistent eaters (all 3 days) and others.	None	No significant differences in energy or nutrient intakes between consistent and inconsistent breakfast eaters, except for iron, where former had significantly higher intakes (16.4 cf. 13.5 mg/day, $p < 0.05$).
	Comment: 3 DDR appropriate for sample size, although power calculations and response rate not reported.				
Salamoun et al 2005 [90]	385 adolescents (207 girls) from Beirut, 10–16 yrs, half from private (high SES) and half from public (low SES) schools. 8 of 10 schools approached agreed to participate, then students randomly chosen within each school.	Calcium and vitamin D intakes assessed by specific FFQ. SES, physical activity, smoking, alcohol and sun exposure and other variables assessed by questionnaire.	Not clear	Gender, BMI, exercise, pocket money, sun exposure, maternal education, SES, soft-drink consumption, type of school	Breakfast eaters had significantly higher intakes of calcium (858 cf. 656mg, $p < 0.05$) but not vitamin D (135 cf.. 105 IU, $p > 0.05$). Multiple regression analysis showed intake of breakfast significantly associated with log calcium intake (explained 7.9% of variance) and vitamin D (3.9%) once adjusted for confounders.
	Comment: FFQ was validated, but only in a small sample of 10 students. No adjustment for energy intake.				
Wilson et al 2006[8]	Representative sample of 3275 NZ children aged 5–14 years from national nutrition survey.	3-pass 24-hr recall. Ethnicity self-reported.	At least 1 item consumed between 6 am and 9 am	Age, gender, ethnicity, SES, urban vs rural.	Breakfast eaters (84%) had significantly higher intakes of energy, % kJ from total fat, protein (g), carbohydrate (g and % kJ), fibre, vitamins A and C, calcium, iron, zinc, folate, thiamin and riboflavin, but no difference in fat (g) or saturated fat (g) or protein as % kJ. Breakfast only contributed 16.2% kJ but was an important source of calcium (30%), iron (27%), zinc (20%), thiamin (37%), riboflavin (35%) and folate (37%).
	Comment: There were some ethnic differences in intake of various nutrients. Pacific children were the only individual ethnic group where energy intake of breakfast eaters was significantly higher than that of non-eaters (by 1024kJ).				
Utter et al 2007[76]	3275 NZ children aged 5–14 yrs from national nutrition survey; available data on 3042.	Diet by FFQ. Physical activity by 7-day recall questionnaire.	Asked children whether they usually, sometimes or no had something to eat or drink at home before school.	Age, gender, ethnicity and SES	Children who skip breakfast (sometimes or no category combined) were less likely to eat appropriate servings of fruit and vegetables (OR 0.63, 95% CI 0.4–0.9), cereals (0.34, 0.2–0.5) and milk (0.6, 0.5–0.9) each day and more likely to have higher intakes of less healthy snack options, including chocolate and sweets (1.63, 1.2–2.2), pies and sausage rolls (1.52, 1.1–2.1) and soft drinks (1.62, 1.2–2.3). Moreover, children who skipped breakfast were also more likely to skip

					lunch, or to buy food from the dairy or school canteen, and were less likely to bring food from home to school.
Cross-sectional studies reporting no relationship or an inverse relationship between breakfast consumption and nutrient intake					
New & Livingstone 2003[84]	504 English children aged 11–15 years from 3 schools.	Anonymous questionnaire primarily assessing intake of snack foods, especially confectionary.	Not stated	None	Breakfast eaters reported a similar frequency of eating snacks and confectionary as non-eaters of breakfast. However, breakfast eaters drank more fizzy (3.7 cf. 3.0 times per week, $p \leq 0.01$).
	Comment: A fairly crude analysis of breakfast and much of the data in relation to breakfast was not shown.				
Cullen et al 2004[89]	150 African-American girls from 3 of the 4 GEMS studies, aged 8–10 years.	Diet by 2 x 24-hr recalls completed by girls.	Not clear	Age, income, highest household education, material possessions, field centre, number of meals and snacks	No correlation between eating breakfast both days and energy intake, but the former was associated with % kJ from fat (although no longer significant once adjusted for confounders).
	Comment: 8–10-yr-old girls completed 24-hour recalls by themselves, which may reflect the low reliability for most nutrients (intra-class correlations ranging from 0.04 to 0.38). Also, a small sample size with no power statements.				
Cohort studies reporting a positive relationship between breakfast consumption and nutrient intake					
Affenito et al 2005[20]	2379 African-American and White 9–10-yr-old girls followed annually for 10 yrs from 3 areas in USA (National Heart, Lung and Blood Institute growth and health study) – see Barton et al 2005.	Annual 3-day diet records, height and weight by standard techniques, physical activity by questionnaire at 5 time points.	Any eating between 5 and 10 am on weekdays and 5 and 11 am on weekend days.	Age, ethnicity, site and their 2-way interactions, parental education, energy intake, physical activity	Girls eating breakfast 3 times ate 76 mg more calcium and 1.3 g more fibre than girls who didn't eat breakfast during 3 days of recording. Some evidence of a dose–response relationship.
	Comment: Very high retention (82–96% over a 10-year period) and repeated diet records mean up to 30 days of nutrient information for each participant. No exclusion of under-reporters, which may be more important given children completed diet records at all ages to ensure confidentiality. Adjusted for energy intake so can assess nutrient density rather than total nutrient intake.				

Intervention studies reporting a positive relationship between breakfast consumption and nutrient intake				
Warren et al 2003[88]	38 White children from Oxford aged 9–12 years recruited from one school with existing breakfast club; 70% normal weight; 23 girls, 15 boys.	Fed children 3 different breakfasts (low glycaemic index [GI], low GI + 10% sucrose, high GI), measured satiation and palatability, then monitored food intake unobtrusively at *ad libitum* lunch. Also collected 24-hr recall and diet history of habitual breakfast consumption.	Gender and weight status	Type of breakfast explained 17% of variation in lunch intake. Energy intake at lunch significantly higher after high GI breakfast than after both low GI (145 kcal) and low GI + sucrose (119 kcal) breakfasts. Energy intake at lunch after both low GI breakfasts was also significantly lower than after habitual breakfast, which was high GI.
	Comment: Each child ate each breakfast 3 times so had multiple comparisons. Power statement showed could detect lunch differences of 54 kcal.			

Appendix I Studies investigating the relationship between cereal consumption (ready-to-eat cereal) and food and nutrient intake in children

Paper	Subjects	Methods	Definition of breakfast	Confounders adjusted for	Main outcomes
Cross-sectional studies reporting a positive relationship between cereal consumption and nutrient intake in children					
Gibson 1999[94]	904 children aged 1.5–4.5 years from 1995 UK National Diet and Nutrition Survey.	Diet by 4-day diet record (2 weekend days). Iron status from blood sampling.	Divided into 6 age and gender groups, then divided into tertiles of breakfast cereal as % kJ (so 18 groups in total) then all "low" consumers grouped together etc.	Age, sex. Also showed that % of parents in manual occupations did not differ between groups.	Low, medium and high consumers obtained 1.6, 5.4 and 10.6% kJ from breakfast cereals. High consumers had significantly greater intakes of iron and fibre but lower intakes of vitamin C, calcium and energy. However, there were no differences in iron status between cereal consumer groups – possibly because although total iron intakes were higher, they were from non-haem iron. Meat and vitamin C intakes were lower.
	Comment: A relatively small proportion of the eligible group was used for these analyses: 2102 were in initial sample; 1859 were interviewed, 1675 completed 4 DDR, 1003 gave blood; 904 of these had both haemoglobin and ferritin measured and were not taking iron supplements, so the final number was 904 of the possible 2101 (or 43%).				
Briley et al 1999[93]	Menu plans from 117 Texan preschool full-day childcare centres that provided breakfast and/or snacks and lunch.	Compared nutrients provided in menu plans from centres who provided RTE cereal at least 4 times over 10 days compared with those who offered cereal < 4 times. Collected 10-day menu plans from centres over 3 time periods (48 centres, remainder gave at least 1 block of menus).		None, although tried to collect 3 sets of menus from each centre to account for season.	Centres that offered more cereal had menu plans with higher energy, lower fat, and higher niacin, riboflavin, iron and zinc levels. A greater proportions of these centres also met federal guidelines for intakes of these nutrients (e.g. 57% cf. 37% met iron guideline).
	Comment: The factor of interest was cereal rather than breakfast, and therefore could have included some centres that did not offer breakfast.				
Preziosi et al 1999[91]	235 children aged 2–18 yrs from 1 region in France.	Diet by dietary history. Vitamin and mineral status by standard biochemical tests on fasting blood samples.	Compared consumers and non-consumers of RTE cereal.	Age	RTE cereal consumers ate less fat and more carbohydrate, calcium, phosphorus, iron, thiamin and riboflavin. The only differences in the biochemical indices were riboflavin and beta-carotene for RTE cereal intake.
	Comment: Recruited from original eligible population of 1.1 million using random sampling; 62% response rate.				
Gibson 2000[95]	1450 children aged 1.5–4.5 yrs from 1995 UK National Diet and Nutrition Survey.	Diet by 4-day diet record, including 2 weekend days and FFQ.	Divided into 6 age and gender groups, then divided into tertiles of breakfast cereal as % kJ (so 18 groups in total), then all "low" consumers	Age, gender. Also showed that % of parents in manual occupations did not differ across	High cereal consumers ate less energy, fat, non-milk extrinsic sugars, biscuits, cakes, bread, confectionary, total fat, meat and meat products, soft drinks and savoury snacks; and more carbohydrate, sugar and jam. However, actual differences were relatively small (e.g. difference

			grouped together, etc.	groups.	in biscuit/cake intake between 1st and 3rd tertiles only 26 g/week in total).
	Comment: Rare to have 4-day diet records from a large representative study.				
Albertson et al 2003[79]	Representative sample of 603 children aged 4–12 yrs in US.	14-day household diet record where each food eaten by each household member is recorded. Portion sizes obtained from age- and sex-specific data from the Continuing Survey of Food Intakes by Individuals.	Consumption of RTE cereal.	None	Higher intakes of RTE cereal associated with higher intakes of vitamins A, C, B_6, thiamin, riboflavin, niacin, folate, calcium, magnesium, iron and zinc and lower intakes of total fat and cholesterol. No significant differences were observed for energy, carbohydrate, sugar, saturated fat, sodium, fibre or vitamin E. Also no significant differences for the % of children not meeting estimated average requirement for vitamins A, C, magnesium and zinc.
	Comment: 92% had all 14 days diet record data. The study did not adjust for any confounders (even though they had demographic data) including energy intake (although they showed that mean intake does not differ across frequency groups).				
Cho et al 2003 [82]	16,452 individuals aged 18 years and over from NHANES III.	Diet by 24-hr recall; height and weight by standard techniques.	Self-identified by subject. Foods divided into 10 categories: skippers, dairy, meat and eggs, fruit and veges, RTE cereal, cooked cereal, breads, quick breads, fats and sweets, beverages.	Gender, race, age, poverty level, smoking, alcohol, activity.	Breakfast skippers and fruit and vege group had lower energy intakes than all other groups except fats/sweets and beverages. Energy was significantly higher in meat/eggs group than in all other groups except dairy, quick breads and cooked cereal
	Comment: Although conducted in adults, this study has been included to show that it might be actual breakfast content rather than breakfast *per se* that is the important factor.				
Gibson 2003[80]	1688 children and adolescents aged 4–18 years from UK national survey, of whom 1193 gave blood samples (56% of original).	Diet by 7-day diet record. Blood analyses by standard techniques.	Divided into tertiles of breakfast cereal intake (as % kJ) for each years of age and by gender. Non-consumers and low consumers had to be combined into one group, as there would have been an age discrepancy given more older children were non-consumers.	Age, gender	A significant dose–response relationship showing high cereal consumers had high iron, thiamin, riboflavin, vitamin B_6 (boys only) and niacin (girls only) intakes, whereas no difference in retinol, carotene or vitamin C. Also ate less fat and more carbohydrate. Energy intakes varied, but not consistently between genders. Intakes of various foods were quite different. Cereal intake was positively related to folate, vitamin B_{12}, riboflavin, thiamin (girls only) and vitamin B_6 status (girls only), but was not related to iron status.

	Comment: A large representative survey with excellent dietary info. Also completed analyses excluding potential under-reporters – this didn't change the significance of the findings, although actual intakes varied. There was some adjustment for confounders but the study did not seem to adjust for others (e.g. SES) even though they had collected quite a lot of data.				
Royo-Bordonada et al 2003[97]	1112 Spanish children aged 6–7 years from 4 cities, 50.1% boys.	77-item FFQ completed by mothers.	Investigated the contribution of different food groups, including breakfast cereals, to nutrient intake. Results expressed as 10 most important foods/food groups for each nutrient of interest.	Analyses conducted separately in boys and girls.	Breakfast cereals were not in top 10 for energy, total fat, fat type, protein, fibre, calcium, vitamin A, vitamin C or vitamin E, but did feature for carbohydrate (9th 3.6%), sodium (10th, 3,3%), vitamin D (3rd, 8.7%), vitamin B_6 (2nd, 11.7%) and folic acid (1st, 12.4%). Few gender differences except for folic acid.
	Comment: FFQ validated for use in adults, but it was unclear if it was appropriate for use in children. Excellent response rate of 85%.				
van den Boom et al 2006[96]	2852 Spanish participants aged 2–24 yrs.	Food and nutrient intakes by 24-hr recall (25% of sample had repeat recall). RTE cereal consumption by quantitative FFQ (non-consumers, 1–20 g daily, 21–40 g, and > 40 g daily).	First eating occasion involving solid food or a beverage that occurred after waking and before 10 am on a weekday and 11 am on a weekend.	Age, gender, SES	As RTE cereal consumption increased, saw improvements in macronutrient profile. Intakes of thiamin, riboflavin and B_6 increased in all age–sex groups, niacin and folate in almost all groups, and calcium, iron and vitamin D in at least half the groups. Energy was not related to RTE cereal intake. Higher RTE cereal intake was associated with a higher dairy intake and better dietary quality.
	Comment: See Serra-Majem et al 2002				
Cohort studies reporting a positive relationship between cereal consumption and nutrient intake in children					
Barton et al 2005[73]	2379 African-American and White 9–10-yr-old girls followed annually for 10 yrs from 3 areas in USA (National Heart, Lung and Blood Institute growth and health study) – see Affenito et al 2005	Annual 3-day diet records, height and weight by standard techniques, physical activity by questionnaire at 5 time points.	Any eating between 5 and 10 am on weekdays and 5 and 11 am on weekend days. Also interested in breakfast cereal consumption at breakfast and other times of the day.	Site, age, number of parents in household, parental education, race, physical activity and energy	Compared with breakfasts without cereal, those with cereal associated with more nutrient-dense diet (less fat, cholesterol, more fibre, calcium, iron, folic acid, vitamin C, zinc. A similar pattern seen if compare days with and without cereal.
	Comment: See Affenito et al 2005.				

Appendix J Other studies investigating the relationship between breakfast and food and nutrient intake in children

Paper	Subjects	Methods	Definition of breakfast	Confounders adjusted for	Main outcomes
Cross-sectional studies reporting adverse effects of participation in school breakfast programmes on nutrient intake in children					
Friedman & Hurd-Crixell 1999[30]	Average of 306 children aged 5–12 years monitored each day for 8 days who participated in a breakfast programme from 3 schools in Texas; 44% white, 55% Mexican-American.	Assessed dietary intake by visual plate waste. Gave standard serving sizes, then recorded leftovers as all, 3/4, 1/2, 1/4 or none left. Compared intakes with US dietary requirements.	Not applicable	None	Intake was too high in fat and saturated fat and too low in calcium and vitamin A.
	Comment: Study was investigating what children in a school breakfast programme actually ate rather than what was served, to show that actual nutrient intake can differ considerably from provided nutrients.				
Belderson et al 2003 [98]	111 children (52 controls) from 2 secondary schools and 1 primary school in England; 45% males; 60–70% White; average age 11–12 yrs.	Diet assessed by 3-day diet record completed by children over 3 consecutive days. Height and weight by standard techniques.	Recruited children who attended a breakfast club at least 3 days per week for most of the term.	School, breakfast club attendance, ethnicity, gender, eligibility for free school lunches, age	Attendance at school breakfast club associated with poorer nutrient intake – consumed significantly more total and saturated fat (% kJ) and sodium and less carbohydrate overall. No significant differences in energy or other nutrients.
	Comment: Very low response rates for dietary information (38–54% for attendees and 11–54% for controls), so initial sample much larger. Nutrient results perhaps not surprising given school food available – cereal and white toast/spreads at school 1; fried sausage sandwich at school 2; snacks including cereal bars, sausage rolls, doughnuts, crisps, buttered toast and fruit squash at school 3.				
Cross-sectional studies examining effect of location of breakfast or nutrition knowledge of children with regard to breakfast					
Gonzales et al 2002[115]	301 5th grade children from 3 counties in West Virginia, USA, predominantly white, with high % living in poverty.	Saturated fatty acid (SFA) intake measured by youth/adolescent FFQ; all other items by questionnaire completed by children in class.	Not clear but were interested in breakfast consumed other than that from home or school.	Gender, energy intake, frequency of breakfast/lunch/ dinner prepared away from home and usual breakfast location	No difference in SFA intake in children according to location of breakfast ($p = 0.08$), but significant correlation between kJ-adjusted SFA intake and frequency of breakfast prepared away from home ($p = 0.04$). No longer significant in multiple regression analyses when adjusted for confounders.
	Comment: Very poor response rate overall as only 36% of eligible children completed the FFQ. Authors also unsure about variation in the way children interpreted foods “prepared away from home”.				

Berg et al 2002[116]	181 Swedish children aged 11–15 yrs recruited from larger population-based survey.	Used "stacking box" methodology in interviews with children to assess what children were currently eating for breakfast, how they would construct a healthy breakfast, and what changes they could make to increase the fat and fibre contents of model breakfasts.		None, although did separate by age.	Big differences in knowledge according to age. Fat was considered an important issue when choosing a breakfast, but high-fat foods were also viewed as favourable by a large portion of the group (25%). Belief that fat intake should be limited predicted intake of reduced fat milk products. Knowledge of fibre and ability to swap high-fibre foods predicted bread and cereal intakes.
	Comment: Excellent response rates (98%).				
Cohort studies reporting a positive relationship between school breakfast programme participation and nutrient intake in children					
Worobey & Worobey 1999[99]	32 3- and 4-yr-old children attending a university laboratory demonstration school, middle class, well educated.	7-day diet record of home breakfast intake. School breakfast programme (SBP) intake monitored for 6 days in 4-yr-olds and 4 days in 3-yr-olds over a 2-week period.	Compared breakfast eaten at home with what the children ate when provided with an SBP meal.	None	Sugar intake significantly lower in SBP versus home in year 1 (59 cf. 155 g, $p < 0.01$) and year 2 (88 cf. 167 g, $p < 0.01$), but no differences in any other macro- or micronutrient.
	Comment: Poor participation rates: only 32/55 children in year 1 and 26/55 children in year 2. Also had teacher who sat down with groups of 3–4 children and encouraged them to eat an adequate meal – would this represent a normal situation in schools that provide breakfast?				
Intervention studies investigating changing nutrient content of school breakfast programme meals					
Cunningham-Sabo et al 2003[117]	39 schools participating in Pathways obesity prevention study (19 intervention, 20 control) who served school breakfast (of 41 total).	Collected menus, recipes, product information on pre-packaged food for 5-day periods each year for 3 years from each school. Calculated weighted nutrient intakes to account for student choices where more than 1 food from each food group was offered.		Treatment, time, school and all interactions	Reduced fat content of intervention school breakfasts by 3.2% kJ ($p = 0.03$) but no change to energy or other nutrients. Primarily from reduced-fat options in bread/cereals and meat/alternatives groups.
	Comment: Comprehensive analysis given repeated data and careful collection procedures.				

Appendix K Studies investigating the relationship between breakfast consumption and physical activity

Paper	Subjects	Methods	Definition of breakfast	Confounders adjusted for	Main outcomes
Cross-sectional					
Barker et al 2000[100]	328 girls aged 14–16 yrs, from 5 Southampton (UK) schools, interviewed in 1995/96.	Girls answered self-administered questionnaire. Physical activity assessed by question: frequency in an average week of exercising to the point of sweating.	Frequency of eating breakfast in the past month.	None	No association between frequency of breakfast and exercising vigorously ($r = 0.06$; $p > 0.01$).
Baumert et al 1998[102]	Analyses restricted to 6489 students in grades 9–12 at 7 public high schools in US state of Georgia.	Students answered anonymous self-administered questionnaire. Students categorised as athletes (or non-athletes) based on question: "In the last year, have you participated in organised sports outside of the gym class?"	No information provided, although questions came from the US Youth Risk Behavior Survey.	Age, sex and ethnicity	Athletes more likely than non-athletes to have had breakfast on a daily basis: 45% v. 34%, $p < 0.0005$.
Cavadini et al 2000[101]	1283 students (boys 661, girls 622), aged 14–19 yrs, in grades 10 & 11 at secondary schools in the canton of Vaud, Switzerland, during 1996/97.	Students answered anonymous self-administered questionnaire. Students divided into athletic = doing sports activities "nearly every day or every day", and non-athletic = doing sports activities "never or almost never".	Information provided only on ready-to-eat (RTE) breakfast cereals.	None. Sex-specific analyses.	"Athletic" students more likely to eat RTE cereals than "non-athletic": girls 37% v. 15% ($p < 0.05$); boys 32% v. 25% ($p > 0.05$).
Croll et al 2006[103] (same sample as Fulkerson et al 2004[111])	Following groups selected from 4746 students aged 11–18 yrs attending 31 middle and high schools in	Students answered self-administered questionnaire. Students asked about 33 specific	Number of days ate breakfast in the last week.	Ethnicity and SES	Females: students doing weight-based sports had a higher mean frequency of breakfast in last week (3.6) than those doing

	Minneapolis/St Paul, Minnesota: weight-related sports (e.g. dancing, cheer-leading) 218 female, 32male; power team sports (e.g. basketball, baseball) 511 female, 954 male; no consistent sport activity (i.e. < 4 months out of last 12 months) 474 female, 364 male.	activities, and included either weight-related or power team sport groups if they did either of those activities for more than 3 months over a 12-month period.			power team sports (3.2), or who were non-sport involved (3.2). ($p < 0.001$). For males, the non-sport involved group had a lower mean frequency of breakfast (2.7) than those doing power team sports (4.2) or weight-related sports (4.7) ($p < 0.001$).
Keski-Rahkonen et al 2003[106] (same sample as Aarnio et al 2002[107])	5448 twins (2822 girls, 2626 boys), aged 16 years, from national Finnish twin register.	Mailed questionnaires completed at home by twins. Frequency of physical exercise recorded; however, no details provided in report on type of activity. Baseline data collected in cohort study.	Frequency of eating breakfast, with following responses: every morning (reference category in logistic regression), a few times a week, about once a week or less often.	A wide range, including parental breakfast patterns, and student smoking, alcohol, education, behavioural disinhibition, sex and BMI	Breakfast skipping (having it once a week or less often) was associated with an increased risk of never exercising (OR 2.46, 95% CI: 1.61–3.76), adjusting for confounders.
Milligan et al 1998[26]	508 18-yr-olds, who had been previously enrolled in a cohort study, recruited from Perth (Western Australia) schools at age 9 years.	Information collected at interview. Physical fitness measured on bicycle ergometers.	Breakfast recorded as part of a 2-day diet record.	None reported.	Males who did not eat breakfast on one of the 2 days had lower fitness levels than men who had a continental or cooked breakfast on both days; there was no difference in women.
Cohen et al 2003[37]	318 grade 9–12 students in 3 rural schools in Ontario, Canada.	Students completed questionnaires at school. Students reported the number of times per week they did moderate or vigorous activity of at least 30 minutes.	Students were asked whether they had breakfast every day.	Sex-specific analyses.	Students who ate breakfast daily were more likely to participate in physical activity ≥ 3 times per week than other students (boys: 85% v. 69%, $p < 0.001$; girls: 77% v. 60%, $p < 0.05$).
Case control					
Cupisti et al 2002[104]	Female high school students, aged 14–18 yrs, in Italy. *Cases*: élite national-	3-day diet record, collected by registered dieticians; nutrients and	Not described, although probably determined by dieticians.	None	Athletes had a higher percentage of daily energy intake from breakfast than inactive students.

	level athletes (n = 60). *Controls*: students who spent less than 3 hours/week doing competitive physical activity (n = 59).	energy calculated using Italian national food tables.			The latter had a higher intake from snacks. Athletes also ate a more healthy breakfast (mainly toast, corn flakes, jam, sugar and milk) compared with non-athletes (biscuits, brioches, chips, energy-dense packed snacks). Total daily energy intake (per kg body weight) was similar for athletes and controls (Table 2).
Cohort					
Aarnio et al 2002[107] (same as Keski-Rahkonen et al 2003)[106]	4906 twins (26,522 girls, 22,54 boys) aged 16 years, from national Finnish twin register; followed for 2.5 years.	Mailed questionnaires completed at home by twins. Breakfast frequency collected at age 16 yrs. Physical activity collected at each survey: age 16, 17 and 18.5 years. Analyses restricted to twins who replied to all 3 questionnaires. *Persistent exercisers* = those who answered doing physical activity ≥ 4–5 times per week in all 3 questionnaires. *Persistently inactive* = doing physical activity ≤ 1–2 times per month in all 3 questionnaires.	Frequency of eating breakfast: every morning, 3–4 times per week, once a week.	Smoking, alcohol, school type, school grade, father's SES, mother's SES, perception of current health, and BMI.	Compared to twins having breakfast every morning, those having breakfast once a week were less likely to be persistent exercisers: OR = 0.39 (95% CI 0.23–0.67) in boys and 0.62 (0.40–0.96) in girls; and more likely to be persistently inactive: OR = 2.55 (1.64–3.97) in boys and 1.34 (0.0.78–2.30) in girls.
Godin et al 2005[105]	740 students (352 girls, 388 boys) at a French-language school in Quebec City, in grades 7, 8 and 9 at baseline (aged 11–16 yrs) followed for 2 years.	Information was collected from annual self-administered questionnaire. Outcome variable was being a regular exerciser, defined as participating in leisure-time physical activity almost every day over the	Single question with 2 responses (not exhaustive): I never or almost never eat breakfast; I have the habit of eating a healthy breakfast every morning.	A range of attitudinal variables controlled for, plus sex	Students who had a daily healthy breakfast were more likely to be regular exercisers than those who never or rarely ate breakfast (OR = 1.68, 95% CI: 1.09–2.60) adjusting for sex and attitudinal covariates. It is unclear if the analysis compared baseline

		previous school year.			breakfast behaviour with follow-up activity, or compared behaviours cross-sectionally at each interview.

Appendix L Cross-sectional studies investigating the relationship between breakfast consumption and smoking

Paper	Subjects	Methods	Definition of breakfast	Confounders adjusted for	Main outcomes
Barker et al 2000[100]	328 girls aged 14–16 yrs, from 5 Southampton (UK) schools, interviewed in 1995/96.	Girls answered self-administered questionnaire asking whether they smoked and how often.	Frequency of eating breakfast in the past month.	None	Frequency of eating breakfast was associated negatively with frequency of smoking ($r = -0.18$; $p < 0.01$).
Jarvelaid 2004[109]	977 high school students (579 female, 398 male), aged 14–18 years, at 4 high schools in Tartu, Estonia.	Students answered questionnaires anonymously. Smokers defined as students smoking at least one cigarette per day.	No information provided on breakfast question.	No information provided.	Frequent breakfast skipping associated with an increased odds of smoking (OR = 1.3, 95% CI: 1.1–1.5).
Keski-Rahkonen et al 2003[106] (same sample as Aarnio et al 2002[107])	5448 twins (2822 girls, 2626 boys), aged 16 yrs, from national Finnish twin register.	Mailed questionnaires completed at home by twins. Smoking status recorded; however, no details provided. Baseline data collected in cohort study.	Frequency of eating breakfast, with following responses: every morning (reference category in logistic regression), a few times a week, about once a week or less often.	A wide range, including parental breakfast patterns, and student alcohol, education, behavioural disinhibition, sex and BMI.	Breakfast skipping (having it once a week or less often) associated with increased odds of smoking (OR 1.40, 95% CI: 1.11–1.77), adjusting for confounders.
Yorulmaz et al 2002[108]	883 students, mean age 15 yrs (selected from 12,923) attending 28 middle and high schools in Edirne, Turkey.	Students answered a 32-item questionnaire with questions on smoking and breakfast. Smokers (current and occasional) were compared with never smokers.	Single question on breakfast, but no details provided.	Age, sex, SES, studying time, school grade, living with family, food intake, parental smoking, TV watching, number of siblings, family type, separation of parents, and self-esteem	Students who ate breakfast had one 3rd of the odds of being a smoker, compared to those who did not eat breakfast (OR = 0.34, 95% CI: 0.14–0.85).
Cohen et al 2003[37]	318 grade 9–12 students in 3 rural schools in Ontario, Canada.	Students completed questionnaires at school. Students reported whether they were currently smoking cigarettes.	Students were asked whether they had breakfast every day.	Sex-specific analyses	Male students who smoked were more likely to eat breakfast daily than non-smokers (60.4% v. 31.9%, $p < 0.001$); but there was no differences between female smokers and non-smokers (30.4%

					v. 38.2%, p > 0.05).
Hoglund et al 1998[22]	7605 children, aged 14–15 years, selected from schools in Goteburg city and Alvsborg County, Sweden.	Students completed questionnaires at school. Students reported whether they were currently smoking cigarettes.	Students reported how many times a week they ate breakfast.	Sex-specific analyses.	Smokers were less likely to eat breakfast daily than non-smokers (p < 0.001): boys 65% v. 83%; girls 38% v. 73%.
Sjoberg et al 2003[34]	611 boys and 634 girls, aged 15–16 years, from 13 schools in Goteburg, Sweden.	Students completed questionnaires at schools supervised by dietitians. Students reported whether they were currently smoking cigarettes.	Students reported frequency of eating breakfast.	Gender, ethnicity, perception of body weight, SES	Current smokers were more likely to have missed breakfast (once or more often per week) than non-smokers: OR 3.76 (95% CI: 2.64–5.36).

Appendix M Cross-sectional and cohort studies investigating the relationship between breakfast consumption and other lifestyle factors

Paper	Subjects	Methods	Definition of breakfast	Confounders adjusted for	Main outcomes
Mental health					
Cartwright et al 2003[110]	4320 year 7 students (aged 11–12 years) from 36 high schools in South London.	Information on breakfast and other variables collected in self-reported questionnaire. Stress measured by the Perceived Stress Scale (4 items with 5-point Likert scale).	Frequency of breakfast reported.	Gender, weight, ethnicity and SES	The most-stressed students had reduced odds of having breakfast every day compared with the least-stressed students; OR = 0.60; 95% CI 0.60–0.88).
Fulkerson et al 2004[111] (same sample as Croll et al 2006[103])	4734 students (2377 male, 2357 female) aged 11–18 years (mean 14.9) attending 31 middle and high schools in Minneapolis/St Paul, Minnesota	Students answered self-administered questionnaires: food behaviours (including breakfast); depression measured with 6-item scale asking about symptoms (e.g. feeling tired, not sleeping etc).	Number of days ate breakfast in the last week.	Race and school grade controlled for, within each sex.	Students with high depression scores had lower mean frequency of breakfast in the last week compared to those with moderate and low depression scores, within each sex, respectively: Boys: 3.0, 3.3, 3.5, $p < 0.001$; Girls: 2.7, 3.1, 3.1, $p < 0.001$.
Murphy et al 1998[61] Cohort study	85 students in grades 3–8 at 3 inner-city schools in Philadelphia and Baltimore, with complete psychosocial information before and 4 months after start of free school breakfast programme.	Information collected from interviews with students and parents at school. Children answered the Children's Depression Inventory and the Revised Children's Manifest Anxiety Scale. Parents reported symptom checklist which measures psychosocial dysfunction.	Attendance at school breakfast recorded for 1 week before start of free breakfast programme, and for 1 week after it had been running for 4 months.	None	Psychosocial adjustment scores (depression, anxiety and psychosocial dysfunction) decreased in students who increased participation in the free breakfast programme ($p < 0.05$).
Diet and alcohol					
Barker et al 2000[100]	328 girls aged 14–16 years, from 5 Southampton (UK) schools, interviewed in	Girls answered self-administered questionnaire. Includes	Frequency of eating breakfast in the past month.	None	Frequency of eating breakfast was associated: *positively* with frequency of eating evening meal

	1995/96.	questions on food behaviour, such as: frequency of eating evening meal with family, and dieting to lose weight.			with family ($r = 0.35$; $p < 0.001$); and *negatively* with frequency of dieting to lose weight ($r = –0.15$; $p < 0.01$)
Zullig et al 2006[78]	4175 students in grades 9–12 at 241 US public high schools (Youth Risk Factor Behavior Survey).	Students completed anonymous questionnaires at school. Questions asked about weight perceptions and dieting behaviour.	Students were asked where they mostly ate breakfast in the last 5 school days.	Sex- and ethnic-specific analyses.	Fasting to loose weight was associated with increased odds of not eating breakfast in the last 5 school days in all sex/ethnic groups ($p < 0.01$).
Keski-Rahkonen et al 2003[106] (same sample as Aarnio 2002 [107])	5448 twins (2822 girls, 2626 boys), aged 16 years, from national Finnish twin register.	Mailed questionnaires completed at home by twins. Smoking status recorded, but no details provided. Baseline data collected in cohort study.	Frequency of eating breakfast, with following responses: every morning (reference category in logistic regression), a few times a week, about once a week or less often.	A wide range, including parental breakfast patterns, and student smoking, education, behavioural disinhibition, sex and BMI.	Breakfast skipping (having it once a week or less often) was associated with increased odds of drinking alcohol weekly (OR 1.37, 95% CI: 1.12–1.69), adjusting for confounders.

Appendix N Methods

Goal of the Scientific Committee

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

Topic identification

Three initial topics were proposed by the Scientific Committee, in consultation with the Chair and the Executive Officer of ANA. The proposed topics are of relevance to ANA and its member organisations, and reflect the professional expertise of members of the Scientific Committee. The proposed topics were submitted to the Board of the ANA for discussion and approval, and this is one of those topics. Discussion was also held with the Ministry of Health and other agencies about suitable topics, and a topic exploring breakfast was endorsed.

Literature identification

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

A precise and specific search of the literature was conducted using key words such as: child, adolescent, breakfast, morning meal, food habits/preferences, eating, obesity or overweight, BMI, skinfold, academic performance/achievement, educational status, truancy, physical activity. A full list of search terms is available on request. Searches were conducted using the following electronic databases and websites: (i) Medline, (ii) Cochrane Library, (iii) DARE database (includes a database of abstracts of reviews of effects, an National Health Service economic evaluation database and the Health Technology Assessment database), (iv) HDA evidence base, (v) Ministry of Health website, (vi) NHMRC website, (vii) NICE website, (viii) Research Findings Register and (ix) the Campbell Collaboration. All databases and websites were searched for papers published from January 1998 to September 2006, an arbitrary starting point to make the analyses manageable. Only English-language references and human studies were included.

Data handling process

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

1. What is the national and international context for eating breakfast?
2. Is regular consumption of breakfast associated with food and nutrient intake?
3. Is regular consumption of breakfast associated with academic performance?
4. Is regular consumption of breakfast associated with overweight or obesity?
5. Do regular breakfast eaters differ from non-eaters in other lifestyle factors such as physical activity, smoking etc?

Of the 180 article abstracts, 72 were found to be potentially relevant by all three members of the Scientific Committee. A further 80 were identified by only one or two members of the steering group. Further discussion was held on the 80 documents, and a final decision for inclusion/exclusion was made by the group to include a further 62 documents (a total of 134 were included for further consideration).

Due to the extended period of this project, a number of other strategies were used to identify potentially relevant papers while the work was ongoing. Consideration of papers up until December 2006 from reference lists, specific literature searches for papers recommended by colleagues and new research released were rich sources of new information. The initial search strategy was narrow in its year range and a number of papers were therefore not picked up. It is good practice to source literature using as many methods as possible, and this was reflected in the extra papers that were included for further consideration using this mix of methods.

Assessment of papers

The initial 134 papers were separated into three groups based on the research question addressed by the paper. Scientific Committee members were allocated specific research questions (RQ – question 1; RS – questions 2 and 4; RT – questions 3 and 5), and so relevant groups of papers were sent to each member to critically appraise for relevance and quality. Where a paper was found to be equally relevant to multiple questions, the paper and critical appraisal were shared with the other relevant member(s). There was no blinding of authorship of retrieved papers.

A critical appraisal form based on the Scientific Advisory Committee's form used in the television review[2] was further amended for use in this review. The original form was based on the NHMRC tools for assessing individual studies and the Health Development Agency tool for assessing reviews and systematic reviews. The appraisal form included questions relating to the type of study, populations studied, methods used, and the strengths and weaknesses of each study type. Each member made a sole decision about whether a document should inform the report or be discarded.

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

Writing the report

An initial draft of the report was produced by all three members, with members taking specific research questions to write. The appraisal form recorded which questions of interest each article covered, allowing the writing of the report to be easily split up in this way. Drafts of each section and subsequent amendments were circulated among all members, and written and verbal comments (at teleconferences) were incorporated into subsequent drafts. Wording in the final summary statements was informed by the World Cancer Research Fund's evidence judgement criteria and the members' judgement. The words, in order of significance, which have been chosen to reflect the consistency, strength and quality of evidence, and the number of studies for each research question are: considerable, reasonable, possible, insufficient. The report was sent for external review.

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

The Scientific Committee acknowledges the following people for kindly contributing components to the report: Christina McKerchar, Hiki Pihema and Mafi Funaki-Tahifote; and the following people for the peer review of this report and for providing useful feedback: Dr Cliona Ni Murchu, Senior Research Fellow, Clinical Trials Unit, University of Auckland, Dr

[2] Scragg R, Quigley R, Taylor R (2006). Does watching TV contribute to increased body weight and obesity in children? Wellington: Agencies for Nutrition Action

Jennifer Utter, Senior Research Fellow, School of Population Health, University of Auckland and Mrs Primrose Appleby, Education Consultant. Finally, thanks to Nikki Chilcott for expertly managing the contract and ensuring the authors kept to their deadlines.