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Cover Page Footnote

I would first and foremost like to express my thank Dr. Darren Wraith for his guidance, feedback and support in the completion of this project. I extend my appreciation and thanks to Dr. Reese for his academic support and proofreading of the project to look better. I would also like to thank my family especially my husband and my little daughter for tolerating me during my study years. Lastly, I would like to dedicate this project to my Mom who always supports and encourages me to continue to achieve my dream.

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A Systematic Review of the Effect of Habitual Breakfast for Adolescents Aged 11-19 Years on Academic Performance

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Abstract

Background: Breakfast consumption plays an important role in growth, energy, BMI, and lifestyle. Studies show that it has a positive influence on cognitive and academic outcomes. Despite these benefits, there has been no systematic review of the literature focusing on habitual breakfast consumption on scholastic achievement among adolescent students aged 11-19. Objective: The objective of this systematic review was to evaluate the existing evidence on habitual breakfast consumption and academic performance in adolescents aged 11-19 years. Methods: A systematic review of studies was conducted for relevant articles published between 1990 and 2015 in the PubMed, PsycInfo, and ERIC databases. Results: The search identified 163 articles. Of these, 12 papers met the inclusion criteria. Eight studies showed a positive relationship between habitual breakfast consumption and school grades, while four papers had non-significant results even though two of these studies were of a superior design. According to NHLBI criteria in terms of quality of research design, most of the studies were assessed to be fair, three were deemed to be weak and only one study assessed to be strong. Various breakfast definitions and classifications within three different time frames were used in the studies. Three academic achievement measurements, including school grades, standardized achievement tests and self-report school grades were used. Conclusion: There is mixed evidence to draw firm conclusion of the effect of habitual breakfast on academic performance, and there are some methodological problems with some of the studies which need to be taken into account. An excellent study design, specific definitions and classifications of breakfast within specific time frames of seven days, and objective measurements for breakfast and academic performance are needed in further research.

Keywords: habitual breakfast, adolescents, academic performance.

Introduction

Breakfast provides the necessary nutrients for growth and maintenance of bodily functions (Wurtman, as cited in Al-Oboudi, 2010, p. 106). Children and adolescents who regularly consume breakfast have an appropriate nutrient and micronutrient intake compared to breakfast skippers (Deshmukh-Taskar et al., 2010; Gibson, 2003). Breakfast consumption has a positive influence on children and adolescents' cognitive outcome, memory, concentration and school grades regardless of socioeconomic status (SES) (Cooper Cooper, Bandelow, Nevill, 2011; Kleinman et al., 2002; Rampersaud, Pereira, Girard, Adams, & Metzl, 2005; Widenhorn-Müller et al., 2008; Dolphus, Lawton, & Dye, 2013). The cognitive function improvements from consuming breakfast are short-term and changes may translate to improved scholastic performance (Adolphus, Lawton, & Dye, 2013), such as higher and more accurate scores in the visual search test (more complex levels), the Stroop test (attention skills) and the Sternberg paradigm (working memory), especially at complex levels (Cooper, Bandelow, & Nevill, 2011). Skipping breakfast can result in a depletion of glycogen stores that lead to disturbances in brain function (Pollitt, Leibel, & Greenfield, 1981).

Approximately 20% to 30% of children and adolescents in the developed world habitually skip breakfast (Corder et al., 2011; Deshmukh-Taskar et al., 2010). Currently, no systematic review investigating the effect of habitual breakfast consumption on academic performance has been conducted, despite the increased academic stress affecting adolescents (Cromer, Tarnowski, Stein, Harton, & Thornton, 1990). The aim of this is review to evaluate controlled studies and extract the best evidence of the effects of the habitual breakfast consumption on the academic performance of adolescents aged 11 to 19 years.

Method Search Strategy and Search Terms

To achieve the objectives of the study, three electronic databases were searched for relevant articles published since 1990. Specifically, 2015 records were searched in the PubMed and PsycInfo databases, and 2013 records were searched in the ERIC database. These databases were selected as they are the key sources of information in the fields of health and education research. The exposure search term used was ‘breakfast’, while the outcome search terms used were ‘school grade’, ‘academic performance’, ‘academic achievement’, ‘grade’ and ‘learning difficulties’. The target population terms ‘adolescent’, ‘youth’ and ‘teenage’ were also applied. Literature was searched which used the following terms; (adolescent* OR teen*OR “young adults”) AND ("school grade" OR "academic performance" OR "academic achievement" OR “grade” OR "learning difficulties") AND “breakfast”).

Inclusion and exclusion criteria

Inclusion criteria.

Articles were included in this review if they met the following criteria:

- They needed to be primary studies in humans (either qualitative or quantitative, cross-sectional, prospective or intervention, case-control or cohort studies) and published in peer-reviewed journals.
- Topics included the effect of regular breakfast consumption, with outcomes including average school grades, standardized achievement tests and self-reported school performance.
- Participants were adolescents aged 11 to 19 of either sex.

Exclusion criteria.

Articles were excluded in this review if they were:

- Literature reviews, editorials, presentations, conference papers, or reports.
- Papers were investigating adults of 20 years of age and older, elderly or children under 11 years of age.

Study Selection Process

Figure 1 shows the paper selection process, and the number of papers included and excluded at each stage. This selection process was conducted by an independent reviewer. A total of 163 articles were retrieved according to the search terms and by using indexing in the databases. The articles were then imported into Endnote. Following the removal of duplicates (n=22), the papers were retrieved. Based on the title and abstracts, the author then reviewed and selected the relevant papers according to the inclusion and exclusion criteria. In the end, 121 exclusions were made, mainly for studies that did not measure academic performance; investigated children; did not assess breakfast; assessed breakfast composition, and were not primary paper studies. Of the 20 remaining articles, all were retrieved and full-text copies obtained if it was unclear from the abstract whether the study should be included. After scanning the full text of the papers, only ten relevant articles remained for inclusion. Reference lists of articles selected for review were also scanned for additional relevant reference. Two further papers which met the inclusion criteria were selected for this review.

Tabulation of Studies

The author independently extracted and summarised the main characteristics of the studies included as follows: (a) author's first name, country and year; (b) study design; (c) number of participants, including their sex and age, as well as mean and SD, if details were provided; (d) definition of breakfast; (e) measurement of academic performance; (f) main study findings; (g) study quality; (h) comments are provided for each study in tables, taking into consideration the study quality in terms of design, analysis, bias and confounding factors.

Quality Assessment

The author independently appraised the quality of the studies by using the assessment criteria tools derived from the National Institutes of Health for Observational (NHLBI), Cohort and Cross-Sectional Studies and Controlled Intervention Studies (NHLBI, n.d.). The NHLBI tools have been designed to support reviewers to focus upon the critical appraisal of the internal validity of studies. They have items for assessing potential errors in methods of the study or even in the study implementation, sources of bias, study power, confounders, the power of causality in the relationship, and other factors. The assessment tool included 14 items for both Cohort and Cross-Sectional and Controlled Intervention Studies. Each element in the set of criteria was equally weighted; a score of 1 if the criterion was satisfied or 0 if the criterion was not satisfied. If the answer was not clear a score of 0 was given. The quality assessment rated poor if the score was 5 or under, fair if the score was from 6 to 9 and good if the score was 10 or above. The quality assessment (QA) ratings are shown in Table 1. As the number of studies included in this systematic review was small, the author elected not to exclude studies on the basis of quality assessment. Therefore, a critical quality assessment will be provided for each type of study.

Results

Quality of the Studies

The NHLBI tools used to appraise the quality of the studies included 14 criteria, and the main characteristics of the criteria relevant to breakfast (BF) and academic performance are discussed. In this review, there was one cohort and one randomized controlled trial (RCT) study. Most studies used a cross-sectional design making it difficult to determine cause and effect. There were also potential confounding factors and reversed causality. Four of the 12 studies included over 400 participants, and in eight of the 12 studies, the number of

participants ranged from 600 to 75,000. These relatively large sample sizes may be representative of adolescents. Seven of the 12 included studies used statistical analysis (e.g. logistic regression) to adjust the key potential confounding variables, which were mixed among studies and included age, gender, SES, parent's educational level, smoking, alcohol consumption, physical activity (PA), etc. The quality of assessments in most studies were fair, and had large sample sizes (Boschloo et al., 2012; Edwards, Mauch, & Winkelman, 2011; Kim et al., 2003; Lien, 2007; Miller, Waldfogel, & Han, 2012; Overby, Ludemann, & Hoigaard, 2013; So, 2013). Four studies, however, did not control for confounding variables (Al-Oboudi, 2010; Gajre, Fernandez, Balakrishna, & Vazir, 2008; Kukulu, Sarvan, Muslu, & Yirmibeşoğlu, 2010; Waggoner, 2002), some of these studies had very small sample sizes, and three were poor in quality according to the NHLBI criteria (Al-Oboudi, 2010; Kukulu, et al., 2010; Waggoner, 2002).

The majority of the studies were cross-sectional in design and did not consider the impact that eating breakfast had on academic performance as exposure and outcomes were assessed at the same time. A cohort study by Miller et al. (2012) observed the effect that is eating breakfast had on academic performance over a sufficient timeframe. The timeframe for the RCT study was four months, which is an appropriate period to examine the effect of breakfast on school grades for one semester (Ask, Hernes, Aarek, Johannessen, & Haugen, 2006; Hoyland, 2009).

Blinding of the outcome assessors is vital as it results in no selection bias as assessors had no information about the students' exposure status. Four studies recruited people to collect data from participants; another used trained research assistants (Kukulu et al., 2010), one used two trained psychologists (Boschloo et al., 2012), one assigned ID numbers to students who answered the questions (So, 2013) and one collected data using single way blinding (Gajre et al., 2008). These studies have less detection bias than other studies in

which the outcome assessors were not blinded. Recruitment methods can also influence the generalizability of the results. Two studies were secondary analyses of existing data sets of nationwide studies (So, 2013; Lien, 2007) and six studies recruited participants randomly (Al-Oboudi, 2010; Kukulu et al., 2010; Kim et al., 2003; Miller et al., 2012; Ask et al., 2006; Waggoner, 2002). In addition, four papers were not clear about recruitment procedures (Boschloo et al., 2012; Edwards et al., 2011; Overby et al., 2013; Gajre et al., 2008).

Participation rate ranged from 38% to 100%; six papers had participation rates that of 77% or higher (Kukulu et al., 2010; Lien, 2007; So, 2013; Overby et al., 2013; Edwards et al., 2011; Kim et al., 2003). Three studies did not report information about the participation rate (Al-Oboudi, 2010; Ask et al., 2006; Gajre et al., 2008), and three others had a response rate of 35%, 38 %, and 45% respectively (Waggoner, 2001; Boschloo et al., 2012; Miller et al., 2012).

Interpretation of the results may be complicated by the range of methodologies used to assess both breakfast eating and academic performance. Two studies used a validated breakfast assessment method, while the rest did not report whether the tools they used had been validated.

Eight studies used a validated academic performance assessment method by either obtaining students' grades from the school's administration (Al-Oboudi, 2010; Boschloo et al., 2012; Kim et al., 2003; Gajre et al., 2008; Waggoner, 2002; Kim et al., 2003) or by using standardized achievement testing (Edwards et al., 2011; Miller et al., 2012). While four studies used the student self-reporting method to obtain information about school grades, only three of these studies were validated (Ask et al., 2006; So, 2013; Lien, 2007). One study was not reliable or valid as it only included one question to assess learning difficulty (Overby et al., 2013). Additionally, results of studies assessing school grades by self-reports obtained

from the responders cannot be generalized to other populations. Table 1 shows further details on the main methods used to assess breakfast consumption and academic performance.

Characteristics of the Included Studies

Table 1 summarizes the main characteristics of the 12 studies included in this systematic review to investigate the effect that habitual breakfast consumption had on academic performance measures. The study populations were from different countries: Norway, Korea, the US, the Netherlands, Turkey, Saudi Arabia and India. Study participants ranged from 11 to 19 years of age; represented different SES and were either undernourished or normally-nourished adolescents. Studies were cross-sectional, cohort, or intervention studies. The majority of the studies used a questionnaire to assess breakfast frequency. These studies used a mix of breakfast definitions within various time frames (including or excluding weekends in their measurement) and a range of breakfast classifications ranging from dichotomous classifications to a seven-day classification. All responses were from adolescents, making interpreting results or generalizing the findings difficult.

In this systematic review, results are grouped into three categories based on measures used to assess academic performance: average school grades, standardized achievement tests, and self-reported school grades. Eight of the 12 studies showed that habitual breakfast consumption had a significant effect on adolescents' academic performance (Boschloo et al., 2012; Edwards el al., 2011; Gajre el al., 2008; Kim et al., 2003; Kukulu et al., 2010; Lien, 2007; Overby el al., 2013; So, 2013).

Average School Grades

Six studies examined the effects of habitual breakfast consumption on average school grades (Al-Oboudi, 2010; Boschloo et al., 2012; Gajre el al., 2008; Kim et al., 2003; Kukulu et al., 2010; Waggoner, 2002). Most studies produced a composite score from grades reported by the school based on different subjects. Four studies demonstrated that habitual breakfast

consumption had a significant effect on adolescents' school performance (Boschloo et al., 2012; Gajre el al., 2008; Kim et al., 2003; Kukulu et al., 2010). There was a significant association (P<0.001) between habitual breakfast skipping and school performance (Boschloo et al. 2012). Overall, skipping breakfast (<5 days/week) was linked with a low average for the end of year school grades among 605 Dutch adolescents ranging from 11 to 18 years. The quality of this study was assessed as fair as it adjusted for some potential confounding factors, such as age, sex, parental level of education, and the student's education track, however, did not consider other important confounders important in adolescence, such as smoking and alcohol consumption. Another limitation is that it only considered breakfast consumption on school days. It also used a definition based on the adolescents' understanding of the definition of breakfast skipping, which could be a confounder (Rampersaud, 2009). A study by Kim et al. (2003) gives similar results based on a dietary behaviour questionnaire administered to nearly 6500 Korean participants in two age groups (13–14 and 16–17 years). It found a similar relationship among all of the different age groups. The association was stronger in younger children (13–14 years) with P<0.001 across gender compared to older children (16–17 years) with P <0.01 for boys and P <0.04 for girls. Regular breakfast consumption was associated with higher results in both genders in the 13–14 and 16–17 age ranges. This study adjusted for some important confounders (parental education, physical fitness and physical status), but it did not take into account smoking, alcohol consumption and sleep behaviour as confounding factors in adolescence. It did not control for SES, which may impact breakfast consumption and academic performance results. This study is of fair quality, and results are representative of the general population with a participation rate of 89% of the students.

Similar results are also seen in a comparative study comparing dietary habits of a sample of 737 students, ranging from 10 to 15 years from urban and non-urban areas, with

other variables like academic performance (Kuluku et al., 2010). Although this study did not directly compare the relationship between dietary habits and academic performance, results show that the most successful grades were achieved by students from urban areas with higher breakfast consumption, compared to non-urban students who often skipped breakfast (Kuluku et al., 2010). Results may be influenced by confounding factors, such as SES, which was not measured in the study. Students in urban areas may also have access to higher quality teachers or private tutoring. Due to these reasons, the study quality was considered poor.

Association between breakfast consumption and academic performance appears to be inconsistent in undernourished adolescents (Gajre, Fernandez, Balakrishna, & Vazir, 2008). Gajre et al. (2008) found that in one-third of adolescents aged 11–13 years who were undernourished, consuming BF 4> day/week was associated with significantly higher average grades. Individual subject analysis of regular BF eaters showed significantly higher grades in English and Science ($P<0.05$). No significant differences were found for Math grades, compared with adolescents who skipped BF. Although study quality was fair, it was unclear if it adjusted for confounders, therefore results may be affected by other factors. Overall, the results show an association between grades and other factors, which may account for inconsistent results. Multivariate analysis indicated a significant association between regular BF consumption, mother's education and employment, weight for age, and the nuclear family. Math grades were significantly associated with the mother's occupation ($P<0.01$), while science grades were significantly associated with the type of family, regular breakfast consumption habit and height for age ($P<0.001$). English grades were associated with regular BF consumption and the mother's educational level ($P<0.001$), and total marks were associated with regular BF consumption ($P<0.01$).

Conversely, no significant association was found between school grades and regular BF consumption in two studies (Waggoner, 2002; Al-Oboudi, 2010). These studies did not

adjust for any confounding factors, such as SES, gender, smoking, alcohol consumption, and sleep behaviour among the participants. Waggoner (2002) conducted a study of 1100 students aged 14–19 years and found no significant difference in the grade point average of students who consume or skip BF. The quality of this study was weak and failed to measure confounders, as mentioned above. This study is unlikely to be representative of the target population, as it only had a participation rate of 35%. A study conducted on Saudi Arabian females found that students who had eaten BF daily earned the highest grades. No significant differences were found between the study groups (Al-Oboudi, 2010). The study sample size was small, its quality was poor, and there was no adjustment for any confounding factors.

Standardised Achievement Tests

Standardized achievement tests are used by schools in developed countries to measure the intellectual level of their students (Adolphus, Lawton, & Dye, 2013). These tests measure numeracy-arithmetic, literacy-reading, and reasoning skills. Two of the 12 studies examined the effect of habitual breakfast on school performance using standardized achievement tests (Edwards el al., 2011& Miller el al., 2012). Edwards et al. (2011) found a positive association between regular consumption of breakfast and test scores, particularly math. Overall, this study found that math scores were higher when students consumed BF≥5 days/week, compared to those who consume BF≤5 days/week ($P<0.000$). They found no relationship between regular BF consumption and reading scores ($P<0.86$). Although the quality of this study was fair, it did not provide information about the students who participated. The study is likely to represent the target population as it had a 91.5% participation rate.

A large cohort study found a non-significant association between reading, mathematics, and science scores and regular consumption of BF. The study design was strong, and results were adjusted for an extensive set of confounding factors like family SES, ethnicity, parental education, gender, family income, etc. (Miller et al., 2012). A limitation of

this study is that it focused on the frequency of family BF rather than habitual BF consumption.

Self-reported Academic Performance

In four studies, participants self-reported their school grades. Three of the four studies demonstrated a significant association between habitual BF consumption and self-reported grades in adolescents (Lien, 2007; Overby et al., 2013; So, 2013). Overall, Lien (2007) found that 7,305 adolescents aged 15–16 years were twice as likely to have lower self-reported grades when they did not consume BF, compared to those who consumed BF every day. The quality of this study was fair as it selected data from a nationwide study and is likely to represent the target population with a 88.3% participation rate. Association between academic performance and regular BF consumption may be obscured as other confounders (alcohol consumption and SES) were involved. Results from this study may be limited due to information bias from self-reported participant responses. Self-reporting could lead to negative outcomes if the participants report negative exposures leading to the false association.

The results from Lien (2007) were similar to the findings of So (2013) that showed a positive association between habitual breakfast consumption and self-reported academic performance ($P<0.001$) in over 75,500 adolescents aged 12–18 years. Adolescents had higher ratings of their school performance when they consumed a regular breakfast (7 days/week) compared with those who skipped breakfast (0 day/week). This study controlled for important confounding factors, such as age, BMI, smoking, alcohol, the level of parental education, family SES and PA. For females, there was a significant association between self-reported school grades and consuming breakfast twice a week; this was also clear with males when they consumed breakfast five days per week (So, 2013). This study had a 95.5% response rate and is likely to be representative of the general population. As this study relied

on an Internet-based survey, the responses may be inaccurate or biased, impacting the results. According to the NHLBI tools, the study quality is only fair.

Overby et al. (2013) found that regular breakfast consumption was significantly associated with less self-reported learning difficulties among adolescents with a mean age of 14.5 years. Adolescents who regularly consumed breakfast >5 days per week were significantly associated with a reduced likelihood of writing, reading (P=0.01) and math difficulty ($P \leq 0.001$), compared to those who did not consume breakfast (≤5 times per week). While the quality of this study was relatively fair, it had some limitations. Results were adjusted for weight and gender, but there was no control for other confounders, like alcohol consumption, smoking and sleep behaviour. Convenience samples were used, potentially resulting in selection bias.

In contrast, a four-month RCT conducted on 54, 15-year-old adolescents found no significant association between self-reported school performance and school breakfast consumption (Ask et al., 2006). This study, however, failed to show a positive relationship between breakfast consumption and academic performance due to untrained project implementers, teachers who were unwilling to cooperate with the project and serve food as instructed, and the fact that breakfast was not provided to students in classes at other schools. While the quality of this study was fair, its statistical power was low due to the small sample size (Ask et al., 2006).

Discussion

This systematic review is the first to identify and collect evidence examining the effect of habitual breakfast consumption on the academic performance of adolescents. The review identified 136 papers from three databases relevant to the research question. However only 12 articles were eligible. The majority of the studies were relatively large, fair in quality and representative of adolescents. While one cohort study was strong, eight of the 12 studies

demonstrated a significant association between habitual breakfast consumption and academic performance. This effect was apparent in both well-nourished and undernourished adolescents from different SES backgrounds. Differences were found based on gender: girls were more likely to have higher grades when they consumed breakfast twice a week, while males were more likely to have higher grades when they consumed breakfast five days a week (So, 2013). Evidence suggests that eating breakfast has a positive effect on math scores (Overby et al., 2013; Edwards et al., 2011; Kim et al., 2003; Lien, 2007; Boschloo et al, 2012), science scores (Graire, 2008; Kim et al., 2003) and English scores (Graire, 2008; Kim et al., 2003; Lien, 2007; Boschloo et al. 2012). Gajre et al. (2008) however, found that adolescents that consume breakfast >4 days per week had higher scores for science and English compared with those who did not eat breakfast, while there was no significant result for mathematics scores. On the other hand, total school grades were found to be significantly higher in students who ate breakfast regularly compared with those who did not eat breakfast, although mathematics was included in the total for school grades. Non-significant results were found in four other studies (Ask et al., 2006; Al-Oboudi, 2010; Waggoner, 2002; Miller et al., 2012).

Methodological Issues and Confounding Factors

In observational studies, confounding factors are the most significant threat to the validity of the results (Egger, Smith, & Schneider, 2003). The association between eating breakfast and academic performance is considered to be a problematic difficulty area for research due to the possibility of potentially confounding factors, and studies should make an effort to adjust for these (Adolphus, el al., 2013). In this systematic review, most of the studies that examined the association between habitual breakfast and academic outcomes were cross-sectional, so there is some potential for confounders to affect the findings.

The most common confounding factors during adolescence are SES, including the parent's educational level, income and occupation; physical activity; smoking; sleep behaviour; and alcohol use. These factors should all be considered when investigating the relationship between breakfast consumption and academic performance. While the degree of controlling for potential confounders varies within the included studies, in examining the association between breakfast consumption and academic outcomes, SES is one of the most important potential confounders. There is consistent evidence on the association between a range of different social economic status indicators (e.g. parental level of education, parental occupation and parental income) and habitual breakfast consumption (Delva, O'Malley, & Johnston, 2006; Johansen, Rasmussen, & Madsen, 2006; Keski-Rahkonen, Kaprio, Rissanen, Virkkunen, & Rose, 2003; Timlin, Pereira, Story, & Neumark-Sztainer, 2008) and academic performance (McCulloch & Joshi, 2001; Machin & Vignoles, 2004). Students from low SES backgrounds tend to skip breakfast more than those from higher SES backgrounds (Doku, Koivusilta, Raisamo, & Rimpela, 2013; Delva et al., 2006; Johansen et al., 2006; Keski-Rahkonen et al., 2003; Timlin et al., 2008), whereas students from high SES backgrounds tend to earn higher grades in school due to their increased opportunity to obtain private tutoring (Kukulu et al., 2010). In this systematic review, four of the included studies only adjusted for one SES indicator: parental level of education (Boschloo et al., 2012; Kim et al., 2003; Lien, 2007; Miller et al., 2012; So, 2013). Only Miller et al. (2012) adjusted for the important indicators of SES (parental level of education, parental occupation and parental income). Other studies failed to adjust for any SES factors (Al-Oboudi, 2010; Gajre el al., 2008; Kukulu et al., 2010; Overby el al., 2013; Waggoner, 2002). SES confounders are the most essential confounders to consider when reviewing a studies' analysis i.e. associations may appear to be statistically significant because students have both a high level of breakfast consumption and high grades in school due to their SES background.

Adolescence is described as a period of increased risk and experimentation with smoking, alcohol, and other risky behaviours. Some evidence has been found of a correlation between smoking and breakfast consumption (Cohen, Evers, Manske, Bercovitz, & Edwards et al., 2003; Keski-Rahkonen et al., 2003; Timlin et al., 2008; Vereecken et al., 2009). Adolescents who tend to smoke skip breakfast due to diminished appetite (Keski-Rahkonen et al., 2003). This behaviour has also been linked to academic performance in adolescents (Pennanen, Haukkala, de Vries, & Vartiainen, 2011; Tucker, Martinez, Ellickson, & Edelen, 2008). Evidence suggests that adolescents who smoked more than six times a week had poor grades in school compared to those who did not. This systematic review found that only two studies adjusting for smoking (Lien, 2007; So, 2013). Additionally, skipping breakfast was also associated with alcohol consumption (Keski-Rahkonen et al., 2003; Timlin et al., 2008; Vereecken et al., 2009), and with academic performance (Balsa, Giuliano, & French, 2011; Peleg-Oren, Saint-Jean, Cardenas, Tammara, & Pierre, 2009; Sabia, 2009). Therefore, because these behaviours are typical in adolescents, these confounders should be adjusted to obtain accurate study results. This systematic review found only one study that adjusted for alcohol consumption (So, 2013) in its analysis. If smoking and alcohol consumption are not adjusted in the analysis, those behaviours will not appear to impact the association between breakfast consumption and academic performance because students have been self-selected from skipping breakfast and for earning poor grades due to smoking and alcohol consumption.

Moreover, physical activity has also been correlated with breakfast consumption (Cohen et al., 2003; Corder et al., 2014; Keski-Rahkonen et al., 2003; Timlin et al., 2008; Yang, Wang, Hsieh, & Chen, 2006) and academic performance (Broh, 2002; Dumais, 2008; McNulty Eitle, 2005) in adolescents. Students that engage in more physical activity tend to eat breakfast more regularly than those who are physically inactive; and, students with higher

academic performance are also more physically active. In this systematic review, only two studies adjusted for physical activity (Kim et al., 2003; So, 2013).

Changes in sleep behaviour and shifts in circadian rhythm are very common in adolescence. Adolescents go to bed late, and they might get up late, so they do not have enough time to eat, or they might not feel hungry enough to eat breakfast in the morning (Alexy, Wicher, & Kersting, 2010; Keski-Rahkonen, Viken, Kaprio, Rissanen, & Rose, 2004). This is an important potential confounding factor, which the majority of studies overlooked when they investigated the relationship between breakfast consumption and school performance among adolescents. Academic performance can also be affected by poor sleep and sleepiness (Curcio, Ferrara, & De Gennaro, 2006; Dewald, Meijer, Oort, Kerkhof, & Bögels, 2010). Therefore, the results of some of the studies that did not adjust for these confounding factors might be inaccurate due to sleep behaviours.

While the articles in this review employed and adjusted for a range of confounding factors, the majority did not control for the most important confounding factors when examining the association between habitual breakfast consumption and academic performance in adolescents such as SES, smoking, alcohol consumption, physical activity, and sleep behaviour. Therefore, in order to obtain more accurate results, future studies examining the association between habitual breakfast consumption and academic performance should collect information about these variables and adjust for them in the analysis.

Academic Performance Tests

Studies have used a range of different measures as academic achievement indicators. Some studies employed average school grades (Al-Oboudi, 2010; Boschloo et al., 2012; Gajre, et al, 2008; Kim et al., 2003; Kukulu et al., 2010; Waggoner, 2002). Even though school grades are valid and accurate since they were obtained from the school administration,

there can be a difference in terms of the time period in which the grades were measured. Some studies only obtained student grades from the previous year (Gajre et al., 2008; Boschloo et al., 2012), while other studies obtained the grades from the first and last semester of the same school year (Al-Oboudi, 2010; Kim et al., 2003). Moreover, there were variations in the subjects that were measured in the studies. The subjects obtained from the school ranged from primary subjects to subjects that measured the entire unit's education level. Differences in the measurement times and the subjects make it difficult to compare the results of these studies.

Other studies used self-reported school grades (Ask et al., 2006; Lien, 2007; Overby et al., 2013; So, 2013). Even though self-reported school grades are easy and convenient to obtain, they are less accurate because students are more likely to report a positive response leading to positive results or a negative response leading to negative results; this can lead to an association with a false inflation or deflation, and it might result in information bias (Kristensen, 2005; Kuncel, 2005). Two studies from the US used standardised achievement tests (MAP) (Edwards et al, 2011; Miller et al. 2012). However, MAP tests might not be an effective way to compare the results of the studies because they are only conducted in developed countries due to the availability and cost of the tests.

Therefore, the results can be inconsistent, and lead to differences in interpretation due to the wide range of measurements that were used in the studies that were included in this review. Future work to examine the effectiveness of the achievement tests to measure academic performance is needed.

Design

The majority of studies that considered the effects of habitual breakfast consumption on academic performance have a cross-sectional design. This type of design addresses the association between habitual breakfast consumption and academic performance, but it is

difficult to determine the direction of the association; it is not known if the outcome followed exposure or if the exposure resulted from the outcome. Thus, it is not an appropriate design for understanding the direction of the association in order to provide meaningful results about the effects. To obtain accurate and valid information on these effects, a study should conduct an experiment or use a longitudinal design, which should be at least three months (e.g. one school semester) in duration and select an appropriate timing for the academic performance tests (Hoyland et al., 2009). This timeframe could be sufficient to show some results of the effect that consuming breakfast has on academic performance (school grades). This review only identified one study that was a prospective cohort study (Miller et al., 2012) without a significant association between the variables, and this study investigated breakfast consumed with family rather than breakfast intake. While one intervention study was included in the review (Ask et al., 2006), its quality was fair as there were a number of limitations: subjective assessment of school grades, untrained implementers, uncooperative teachers to implement the project, no serving of food as instructed, and low statistical power.

Breakfast Assessment

The studies included in this review that examined the effect of breakfast consumption on academic performance lacked a commonly agreed upon timeframe for, and definitions and classifications of breakfast. There are seven different definitions of habitual breakfast consumption based on three different time frames of seven days per week, five days (school days) a week, and regular breakfast-eating habits. Within the seven-day time frame, four different definitions were used, ranging from breakfast consumed seven times a week (e.g. Lien, 2007; Miller et al.,2012; So, 2013; Waggoner, 2001), to eating breakfast at least six out of seven days each week (e.g. Overby et al., 2013), to eating breakfast at least five out of seven days each week (e.g. Edwards et al., 2011) and eating breakfast between five to seven days each week (e.g. Al-Oboudi, 2010).

Within the five-day time frame (school days), two different definitions were used, ranging from eating breakfast on five school days (e.g. Boschloo et al., 2012) to eating breakfast at least four out of the five school days (e.g. Gajre et al, 2008). Two studies used time frames of usual breakfast habits using the definition of eating breakfast regularly (e.g. Kim, 2003; Kukulu et al., 2010). As can be seen from these four different definitions within a variety of timeframes, what constitutes habitual breakfast consumption varies greatly across all of the included studies.

Dichotomous classifications were also used in some studies (e.g. ≥5 days/week, <5 days/week) (Boschloo et al., 2012; Edwards et al., 2011; Overby et al., 2013), but this classification was less likely to reflect habitual breakfast consumption (Adolphus et al., 2013). Moreover, some studies used three domain classifications (e.g. always (5-7 days a week), often (2-4 days a week) and never (0-1 times/week) (Al-Oboudi, 2010; Gajre et al., 2008), or five domain classifications (e.g. seldom/never, 1–2 days/week, 3–4 days/week, 5–6 days/week and every day) (Lien, 2007). Some studies used a seven days/week breakfast consumption classification with a score ranging from 0-7 days a week (Miller et al., 2012; So, 2013; Woggoner, 2002). Brief dietary assessments were used to measure specific aspects of diet; for example, one-item questionnaires (e.g., breakfast yes/no) (Kim et al., 2003; Kukulu et al., 2010). This approach is less likely to provide an adequate assessment of habitual breakfast consumption; moreover, a lack of effectiveness has been observed in the studies that examine the accuracy of a brief dietary assessment (Adolphus et al., 2013).

Most of the studies used a self-reported breakfast assessment, which has limitations as the participants interpreted breakfast consumption subjectively and reported positive or negative exposures and outcomes, which allows for information bias, misreporting and inaccurate recall. Thus, the association between breakfast consumption and academic performance will be inflated or deflated (Kristensen, 2005). To minimize this bias, it is

essential to obtain objective information about exposure and outcome (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003), which, in this case, would be to obtain information about habitual breakfast consumption from the students' parents. This is particularly the case for self-reported nutritional assessments in adolescents as they are considered to be challenging and problematic compared to self-reported assessments in younger children. Livingstone (2004) noted that inaccuracy and underreporting of food intake increases with age. Moreover, adolescents tend to under-report food assessment by approximately 20% (Livingstone et al., 1992; Bandini, Cyr, Must, & Dietz, 1997). As adolescent growth is known to occur rapidly and body image becomes more important to them, adolescents are more likely to be independent of their diet, and they change their healthy habits and lifestyle; they might also be influenced by negative peer pressure, and they might be less willing to cooperate with authority, all of which reduces the compliance and accuracy of reporting in adolescents (Livingstone, 2004).

In the studies included in this review, the lack of consensus in using a consistent definition within a specific time frame might lead to difficulties in interpreting and generalizing the results. Therefore, further work should take into account the timeframe of breakfast measurement within seven days and define regular breakfast consumption as eating this meal seven days/week. Using various dichotomous classifications or a brief breakfast assessment is not enough to define habitual breakfast consumption. Moreover, to ensure accurate results, a breakfast assessment should obtain breakfast consumption responses from parents rather than just the adolescents.

Strengths and Limitations

This systematic review has some limitations. Although an appropriate search strategy was used to identify all papers from the fields of nutrition and education, the results might suffer from publication bias, since no effort was made to include any unpublished studies.

The strength of this type of review is that it provides the best evidence for the effect that habitual breakfast consumption has on academic performance among adolescents since adolescents have different characteristics than children, particularly in terms of their metabolic rate. This results from puberty and diet changes, leading to skipping breakfast as a result of peer and media pressure. Therefore, different mechanisms of action might impact the effects that breakfast consumption has on adolescents. While few articles were found in this area, they have been included, regardless of their quality, and their results have been discussed and interpreted. Moreover, one independent author had to extract and evaluate all the research, and this could also be a limitation of this review.

The majority of articles were collected from observational studies. This type of design demonstrates the relationship between variables; therefore, cause and effect cannot be assumed in these results. These types of articles could also suffer from bias and systematic error leading to false or inaccurate results if the studies failed to adjust for potential confounding factors. Some studies adjusted for those factors, but the range of the adjusted confounders was inconsistent, particularly for essential confounders among adolescents such as smoking, alcohol, sleep behaviour and physical activity (Overby et al.,2013; Edwards et al., 2011; Kim, 2003; Boschloo et al., 2012; So, 2013; Lien, 2007). There are very few randomized controlled designs or longitudinal studies that focus on the effect that habitual breakfast consumption has on academic performance among adolescents due to the costs and time required to conduct those types of studies. However, those types of study designs would help increase the validity of the review's findings by reducing random error and bias. Unfortunately, this review only includes one RCT study, and its quality was fair, and its results were non-significant (Ask et al., 2006). While the quality of the one cohort study that was included was strong, it did not show any positive results even though it adjusted for extensive confounders (Miller et al., 2012).

A further limitation of this review stems from the various definitions within different time frames and classifications of breakfast consumption that were used in the included studies; this makes it challenging to interpret and compare the results; for example, most of the studies used a breakfast consumption timeframe of seven days; however, the definition within that time frame varied greatly, e.g. some students defined regular consumption when they ate breakfast every day of the week (Lien, 2007; Miller et al., 2012; So, 2013; Waggoner, 2001), others defined it as eating breakfast at least 6 days per week (Overby et al., 2013) or consuming it at least 5 days a week (Edwards et al., 2011), and in two studies the students had access to breakfast during school days (5 days a week) within two different definition ranges of eating breakfast at least 5 days a week in school (Boschloo et al., 2012) to 4 days per week in school (Gajre et al., 2008). Moreover, various breakfast assessment classifications were used ranging from dichotomous classifications (Boschloo et al., 2012; Edwards et al., 2011; Overby et al., 2013) to three domain classifications (Al-Oboudi, 2010; Gajre et al., 2008) to five domain classifications (Lien, 2007) to 7 days (0-7 days a week) (Miller et al. 2012; So, 2013; Woggoner, 2002) and brief dietary assessments (e.g. eating breakfast yes/no) (Kim et al., 2003; Kukulu et al., 2010). This difference of definitions within different time frames and varied classifications could lead to students being labelled as breakfast consumers even though they had different rates of eating breakfast.

Another limitation that makes it difficult to compare the results is that the studies used different academic performance measurements. Most studies used school grades obtained from the school administration (Al-Oboudi, 2010; Boschloo et al., 2012; Gajre et al., 2008; Kim et al., 2003; Kukulu et al. 2010; Waggoner, 2002). However, the studies varied in terms of the timing of grade measurements; some studies measured grades using previous annual marks (Gajre el al., 2008; Boschloo et al., 2012) while other studies used the first and last semester grades (Al-Oboudi, 2010; Kim et al., 2003). Moreover, some studies also used self-

reported school grades (Ask et al., 2006; Lien, 2007; Overby et al., 2013; So, 2013), which could lead to inaccurate results. Furthermore, standardised achievement tests (MAP) were employed (Edwards et al., 2011; Miller, et al., 2012) even though these tests were more often used in developed countries, which also makes it difficult to compare the results with other achievement measurements

A final limitation of this review was that the studies adjusted for different potential confounders, such as age, gender, SES, BMI, diet, parental level of education, etc. (Overby et al., 2013; Edwards et al., 2011; Kim, 2003; Boschloo et al., 2012, Miller et al., 2012). Only two studies adjusted for important confounders for adolescence, such as smoking, alcohol consumption and physical activity (Lien, 2007; So, 2013), while, other studies failed to adjust for any confounders (Graire et al., 2008; Kukulu et al., 2010; Waggoner, 2002; Al-Oboudi, 2010). This could lead to a positive result, as the results might be related to other confounding factors that were not addressed.

Recommendations

Based on the evidence and results presented in this systematic review, the researchers make the following recommendations:

There is an urgent need to conduct long-term randomized controlled trials and cohort studies to determine the effects of habitual breakfast consumption on academic performance. More research is needed that considers this association by using objective measurements of academic performance, which is assessed as reliable and valid. Data needs to be collected from school administrations, and subjective methods should be avoided (e.g. self-reported school grades). In addition, the timing of assessing the school grades should be considered (e.g. the end of the school semester). There is an urgent need to use objective methods to assess breakfast consumption; in this case, data could be collected from parents rather than adolescents to reduce bias and random error. Using a consistent definition of time frame for

academic performance and a unified classification of 7 days for breakfast consumption would also be helpful. Studies also need to collect and adjust for the potential confounding factors that affect breakfast consumption and school grades that are specifically related to adolescents, such as SES, smoking, alcohol consumption, physical activity and sleep behaviour.

Conclusion

Firm conclusions cannot be drawn about the effect of habitual breakfast consumption on academic performance in adolescence due to mixed evidence. Studies with better study designs (e.g. Miller et al., 2012; Ask et al., 2006) showed non-significant results, even when adjusting for extensive confounders (Miller et al., 2012). Conversely, poor study designs (e.g. cross-sectional studies) showed significant results for the association after adjusting for potential confounders (e.g. Boschloo et al., 2012; Kim et al., 2003; Lien, 2007; Overby et al., 2013; So, 2013; Edwards et al., 2011), whilst other studies that did not adjust for confounders showed non-significant or inconsistent results (e.g. Al-Oboudi, 2010; Gajre, et al., 2008; Waggoner, 2002). Further research is necessary, based on the recommendations outlined in this review.

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Table 1

Tabulation of studies investigating the effects of habitual breakfast on academic performance in adolescents

First author Year Country	**Study Sample**	**Study Design**	**Definition of Breakfast (BF)**	**Outcome Measurement**	**Result**	**Comments**	**Quality assessment**
Overby 2013 Norway	A total of 475 9th and 10th grade students from four different secondary schools in three different municipalities in Vest-Agder County, Norway. The mean age was 14.6 years for both sexes. Males: 49.7% Females: 50.3%	Cross-sectional study	The questionnaire included 1 item to measure BF. BF intake classified as: 1. Often (BF >5 days/week) 2. Never/seldom (BF ≤5 days/per week)	Questionnaire included 1 item to measure learning difficulties. Learning difficulties classified as: 1. Reading and writing difficulties 2. Mathematics difficulties Having difficulties dichotomized as: • Yes • No • Do not know	Significantly associated with decreased odds of both writing and reading difficulties (OR: 0.44 (0.2–0.8), p = 0.01) and mathematical difficulties (OR: 0.33 (0.2–0.6), p ≤ 0.001) to those who consume breakfast regularly.	Adjusted for BMI and gender Not adjusted for SES and parental education	Fair score=6
So 2013 Korea	Korea Youth Risk Behaviour Web-based Korea Youth Risk Behaviour Web-based survey conducted in 2011, in which 75,643 adolescents from	Cross- sectional study	Internet questionnaire, 1 item Internet questionnaire, 1 item to assess BF frequency. The	The self-reported academic performance rating for previous 12 months:	BF eaters (7 days/week) had higher school performance compared with BF skippers (0 day/week). Odds ratios (OR) for	Adjusted for: age, BMI, smoking, alcohol, parental education, family SES, pa (vigorous and moderate), muscular strength, mental stress	Fair score=9

	school grades 7–12 participated. Data for students from 400 middle schools and 400 high schools *n* = 75643 mean age ± *SD*: 15.10 ± 1.75 Males: 51% Females: 49%		possible responses were: [0] No breakfast [1] 1 day [2] 2 days [3] 3 days [4] 4 days [5] 5 days [6] 6 days [7] Every day	The possible responses were: [1] Very high [2] High [3] Average [4] Low [5] Very low Participants were divided into two groups for multivariate logistic regression: [1] Those with below average academic performance (<Average academic performance) [2] Those with average or higher academic performance (≥Average academic performance)	males: 1.7, 95% CI: 1.57–1.83; P < 0.001; OR for females: 1.92, 95% CI: 1.76–2.97; P < 0.001. Academic performance was associated with BF in the female, when they ate BF at least twice per week; while, for males when they consumed BF at least 5 days per week.	Economic status was obtained from the respondents.	

Gajre 2008 India	A total of 379 students, 11 to 13 years old, in the 6th, 7th and 8th grades. Two urban schools catering to middle-class families in Hyderabad, India. Males: ≈55% Females: ≈45% Underweight: 20.8% Stunted: 38.5% 11-year-old students: 44.3%	Cross-sectional study	Questionnaire to assess BF eating frequency. BF defined as first eating occasion during the morning before school. BF intake classified as: 1. Regular: >4 days/week 2. Irregular: Skipping BF 2–3 days/week 3. Never	Previous year's annual examination marks for: 1. Mathematics 2. Sciences 3. English	Students who consumed breakfast regularly had significantly higher marks for science, English and total average grade compared to those who never ate breakfast ($P<0.05$) but not Group 2.	the adjustment was not clear about SES (education and occupation of parents, family type) Height for age Weight for age Regular breakfast habit.	Fair score=6
Edwards 2011 Fargo, ND, US	School children (US) at eight different schools in Fargo, ND *n* = 800; aged 11–13 years *n* = 694 complete data on gender Males: 48% Females: 52% Eligible for free school meal: 13.5% 6.5 % Eligible for reduced price school meals. (indicative of low SES)	Cross- sectional study	Adapted questions from Youth Risk Behaviour Surveillance survey. BF intake classified as: 1. BF ≥ 5 days/week 2. BF < 5 days/week	MAP tests. Standardized computer tests for: 1. Mathematics 2. Reading	Mathematics MAP scores were associated with eating BF ≥ 5 days/week (p value .000∗) compared with <5 days/week (p value .086). No association between BF and MAP reading scores.	Adjusted for: free school meal (This status was used as a surrogate for SES, a potential confounding factor affecting academic performance).	Fair score=7

Kim 2003 Korea	School children (Korea) *n* = 6463 from 14 middle schools and 14 high schools, aged 13–14 and 16–17 years. A total of 2,194 students from grade 8 (age 13–14 years), and 2,334 from grade 11 (age 16–17 years) Males: 53% Females: 47%	Cross- sectional study	FFQ and dietary behaviour questionnaire. BF intake classified as: 1. Regular BF 2. No regular BF	Average grade from prior school semester. Scores ranged from 1–5 (obtained from school records): 1. Korean 2. Mathematics 3. Social studies 4. Science 5. Physical education 6. Music 7. Art 8. Practical course 9. Ethics 10. English (grades 8 and 11)	Regular BF associated with higher average grade in 13–14 year old boys and girls (p value = 0.000). Higher average grade 16–17 year old boys and girls (p value = .001 for boys; .004 for girls).	Adjusted for: Parental education, Physical fitness and Physical status	Fair score=7
Lien 2007 Norway	School children (Norway) *n* = 7305 aged 15–16 years. Males: 49.4% Females: 50.6% 10th grade for all schools in Oslo during the 1999/2000 and 2000/2001 school years	Cross- sectional study	Questionnaire, 1item to assess BF frequency. BF intake classified as: 1. Seldom/never 2. 1–2 days/week 3. 3–4 days/week	Self-reported most recent grade for: 1. Mathematics 2. Norwegian 3. English 4. Social science Grade scale: 1 (lowest) to 6 (highest)	Increased odds of having low school grades (≤3) in children who seldom/never ate BF compared with everyday consumption in boys and girls (AOR: 2.0, 95% CI: 1.3–3.1 and AOR: 2.0 95% CI: 1.3–3.01, respectively).	Adjusted for: Parental education, Family structure, Immigrant status, Smoking, Dieting and Soft drink consumption	Fair score=7

			4. 5–6 days/week 5. Everyday	Total average grade calculated and dichotomized as: ≤3 or >3.			
Boschloo 2012 The Netherlands	School children (The Netherlands) *n* = 605, aged 11–18 years. Students from four secondary schools in the southern part of the Netherlands, grades 7–12. Males: 44% Females: 56%	Cross-sectional study	Questionnaire, 1 item to assess BF frequency on school days. BF classified as: 1. BF eaters: 5 days/week 2. BF skippers: <5 days/week All of the students were placed in advanced educational tracks in secondary schools.	Average end of year school grades: 1. Dutch 2. Mathematics 3. English as a foreign language Grade range: 1(very bad) to 10 (outstanding)	Grades of the BF skippers were 0.15 lower (standard deviation) than the grades of BF eaters. No differences were found by sex.	Adjusted for: Age, sex, Educational track and Parental education.	Fair score=7
Miller 2012 US	US school children *n* = 21400 at baseline, *n* = 9700 at final follow up. Data collected in waves (8th grade). Age: 13–15 years Males: 51% Females: 49%	Prospective cohort study. Part of ECLS-K national study. Data collection in five waves; one of the waves included in this 2007 review (grade 8)	Parental questionnaire, 1 item to assess family BF frequency. BF classified as frequency/week (ranging from 0–7 times/week).	Standardized achievement tests: 1. Reading 2. Mathematics 3. Science (grade 8)	No significant relations between frequency of family BF and test scores ($p < .05$). Fixed-effects models results, which controlled for unchanging aspects of the children and their families.	Adjusted for: Gender, ethnicity, family SES, parental education, family income, parental job prestige, family structure, area of residence, language, maternal employment during preschool, birth weight, teaching quality, school quality, a region of	Strong score=10

						residence, parental working hours, single parent family.	
Ask 2006 Norway	Two classes from 10th grade in one lower secondary school in a rural district of Southern Norway Participants: 54 adolescents Age: 15 Intervention: M 15;F 11 Control: M 14; F 14	RCT (four-months intervention) Clustered by class Small pilot study	Two conditions: □ Free BF at beginning of each school day for four months. BF consisted of low-fat milk, orange juice, whole grain bread, different spreads with fish, meat and cheese and fruit. □ Control: No School Breakfast Program	Self-report questionnaire on school performance occurred four weeks before the study started and one week after the study was completed.	No significant association between school performance and school breakfast program.	samples were randomly assigned to two groups (I & C)	Fair score=8
Kukulu Turkey 2010	n = 737 6th, 7th and 8th grade students aged 10–15 from two schools : 1-Metropolitan area 2- Non-metropolitan area. Males: 53% Females: 46%	cross sectional study (comparative study)	Questionnaire, 1 item to assess BF frequency. BF intake at home classified as: □ Regular BF □ No regular BF	School grades were obtained from school records. Grades were categorized as: 1. Most successful grade (85–100) 2. Successful (70–84) 3. Average (45–69)	Breakfast consumption was associated with academic performance in adolescents living in an urban area. Around 28.7% of the students in the metropolitan area was most successful; they also regularly ate breakfast at home	Not adjusted or controlled for confounders, such as SES.	Weak score=5

				4. Unsuccessful (below 44)	(about 92%). Just 18.2% of students in the non-metropolitan area were most successful; they also regularly ate breakfast at home (87%).		
Oboudi 2010 Riyadh City, Saudi Arabia	120 female students aged 9–13 years This review included 79 students aged 11–13	Cross-sectional study	Questionnaire, 1 item to assess BF frequency. BF intake categorized as: 1. Usual/always (5–7 days/week) 2. Often (2–4 days/week) 3. Rarely/never (0–1 days/week)	School grades collected of the first semester: 1. Math 2. Science 3. Reading	Girls who ate BF regularly had the highest marks with no significant difference as to the frequency of BF eating:	Not adjusted or controlled for confounders, such as SES.	Weak score=5
Waggoner 2001 USA	1100 students aged 14–19 years from the 2000–2001 classes at Tullahoma High School, located in a rural setting (Tullahoma City school system) in Tullahoma, TN most parents students have professional degrees and employed at (AEDC)	Cross-sectional study.	Questionnaire, 2 items to assess BF frequency either at home or school cafeteria, ranging from 0 to 7.	Average grade point.	There was no significant difference in the grade point average of students who eat BF and those who do not eat BF; p value was p=. 0004. There is no significant difference in the GPA of those who consume BF and those who do not eat BF with regard to gender,	Not adjusted or controlled for confounders, such as SES. Students were selected by stratified random sampling.	Weak score=5

	(indicative of high SES)				age, the average number of hours spent studying each week, grade classification and ethnicity.		

Figure 1. *Flow diagram of the review inclusion process according to theQUORUM statement (Liberati et al., 2009).*