Effects of eating breakfast and school breakfast programmes on children and adolescents: a systematic review

Martina Lundqvist, Nicklas Ennab Vogel, Lars-Åke Levin

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Address:
CMT
Department of Medical and Health Sciences
Linköping University
581 83 LINKÖPING

Visiting Address:
CMT
Building 511-001, Entrance 76, level 13
Campus US
Linköping

Tel.: 013-28 10 00

Website: http://www.cmt.liu.se/
ABBREVIATIONS

AD ACL – Activation-Deactivation Adjective Check List
ASC – After School Club
BC – Breakfast Consumption
BIC – Breakfast in Classroom
BMI – Body Mass Index
BP – Breakfast Programme
BW – Body Weight
CAT – Cognitive Ability Test
CDR – Cognitive Drug Research
CF – Cognitive Function
CL – Cognitive Load
CPT – Continuous Performance Test
CSHQ – Children’s Sleep Habits Questionnaire
CRF – Cardiorespiratory Fitness
CT – Controlled Trial
CVD – Cardiovascular Disease
d2 — Aufmerksamkeits-Belastungs-Test
DABS – The Diet and Behaviour Scale
DiaBP – Diastolic Blood Pressure
EB – Eating Breakfast
ECLS-K – Early Childhood Longitudinal Study-Kindergarten Class
ELA – English Language Arts
FRP – Free and Reduced Price
HDL – High-Density Lipoprotein
HDL-C – High-Density Lipoprotein-Cholesterol
HEI – Healthy Eating Index
HOMA-IR – Homeostasis Model Assessment-Insulin Resistance Index
HSCL-10 – Hopkins Symptoms Checklist (10-Item Version)
LDL – Low-Density Lipoprotein
LDL-C – Low-Density Lipoprotein-Cholesterol
LGT-3 — Lern- und Gedachtnistest
MetS – Metabolic Syndrome
N/A – Not Available
NAEP – National Assessment of Educational Process
NAPLAN – National Assessment Program-Literacy and Numeracy
PA – Physical Activity
PBF – Percent Body Fat
PSID-CDS – Panel Study of Income Dynamics-Child Development Supplement
QALY – Quality Adjusted Life Years
RCT – Randomized Controlled Trial
RVIP – Rapid Visual Information Processing task
SAT – Scholastic Assessment Test
SBP – School Breakfast Programme
SysBP – Systolic Blood Pressure
SES – Socioeconomic Status
TAG – Triacylglycerol
TC – Total Cholesterol
TG – TriGlyceride
USBP - Universal School Breakfast Programme
VAS – Visual Analogue Scale
VGZ – Verfahren zur Erfassung des Gefühlszustandes
WIAT(III) – Wechsler Individual Achievement Test (3-Components)
WPQ – Well-being Process Questionnaire
(A+PAAC) – Physical Activity and Academic Achievement Across the Curriculum
ABSTRACT

Background: Breakfast is often described as the most important meal of the day. The regularity of wholesome, daily meal patterns comprised of healthy foods is important for the physical and mental development of children and adolescents. One way to make sure that children and adolescents eat breakfast on a regular basis is to serve it at school. Several published reviews have examined the effects of eating breakfast and studied effects of school breakfast programmes on children and adolescents. Informed decisions of whether to promote eating breakfast or to introduce a school breakfast programme require a broader perspective.

The aim was to conduct a systematic review of scientific publications that study the effects potentially relevant for economic evaluations of eating breakfast or implementing school breakfast programmes for children and adolescents.

Method: In the systematic literature review, studies were identified by searching the electronic databases PubMed, CINAHL, Web of Science and PsycINFO from January 2000 through October 2017. The following inclusion criteria guided the selection of the identified studies: published articles from peer-reviewed journals with full text in English, studies collecting primary data, quantitative studies, studies performed in countries comparable to Sweden in terms of access and quality of nutrients, economic and social conditions and publications studying at least one of the topics; academic achievement, quality of life and wellbeing, risk factors/morbidity or cognitive performance.

Results: Twenty-six studies on eating breakfast and eleven studies on school breakfast programmes fulfilled the inclusion criteria and were judged to be of at least moderate quality were included in the analysis. The results of the review of studies on eating breakfast showed positive and conclusive effects on cognitive performance, academic achievement, quality of life, well-being and risk factors/morbidity. This indicates that eating breakfast is important. The results of the studies on school breakfast varied. Minor positive effects were seen on cognitive performance and academic achievement. Most studies showed no effects and all studies suffered from different methodological weaknesses.

Conclusions: The overall assessment of the studies on eating breakfast indicated positive effects. The studies on school breakfast programmes showed minor positive effects, but the majority of the studies showed no
effects and all studies suffered from different methodological weaknesses. In order to assess the cost-effectiveness of eating breakfast and of school breakfast programmes we need to know more about how the identified effects influence the societal cost and the individuals gain in quality-adjusted life years both in the short and the long term.
Bakgrund: Frukost beskrivs ofta som dagens viktigaste måltid och flera studier har visat att kostintag har en positiv effekt på barn och ungdomars såväl fysiska som mentala utveckling. Ett sätt att öka barn och ungdomars frukostintag är att servera frukost på skoltid. Idag finns flera publicerade översiktsatiklar som har granskat effekterna av att äta frukost såväl som effekterna av skolfrukostprogram. För att kunna fatta ett beslut om huruvida man ska lägga resurser på att främja frukostätande eller servera frukost på skoltid krävs dock ytterligare information.

Syftet med rapporten är att systematiskt granska de vetenskapliga publikationer som studerar effekter av att äta frukost eller effekter av implementering av skolfrukostprogram potentiellt relevanta att inkludera i en ekonomisk utvärdering.


Resultat: Tjugosex artiklar som studerade effekter av att äta frukost samt elva studier som studerade effekter av skolfrukostprogram uppfyllde de uppsatta inklusionskriterierna och bedömdes vara av minst mättlig kvalitet inkluderas i analysen. Studierna som studerade effekter av att äta frukost var samstämmiga. De visade att frukostätande hade positiva effekter på kognitiv prestanda, akademisk prestation, livskvalitet och välbefinnande samt på morbida riskfaktorer. Artiklar som studerade effekter av skolfrukostprogram visade på varierande resultat. Ett fåtal studier fann att skolfrukostprogram hade positiva effekter på kognitiv prestanda och akademisk prestation men majoriteten av studierna kunde inte påvisa några effekter. Flertalet av studierna var dock behäftade med metodologiska svagheter.

Slutsats: Åta frukost har överlag positiva effekter på de studerade utfallsmåten. Skolfrukostprogram har små till måttliga effekter på de studerade utfallsmåten. Majoriteten av studierna som undersökte skolfrukostprogram visade dock inga effekter och alla studier var
behäftade med metodologiska svagheter. För att kunna bedöma kostnadseffektiviteten av att äta frukost och skolfrukostprogram, behöver vi mer kunskap om hur de identifierade effekterna påverkar samhällets kostnader och en individs livskvalitet och levnadsår, på såväl kort som lång sikt.
1. BACKGROUND

Breakfast is often described as the most important meal of the day. Overall, eating breakfast on a regular basis is linked to a range of beneficial health outcomes in adults, including improved cognition, physical activity, and lower risk of hypertension [2-4]. Moreover, several studies have focused on examining if breakfast habits have any bearing on school attendance, academic achievement and general health in children and adolescents. Research findings indicate that the regularity of wholesome, daily meal patterns comprised of healthy foods is important for the physical and mental development of children and adolescents [5]. The quality and regularity of breakfast consumption have also shown to be associated with mental performance, academic achievement, physical activity and quality of life [6-12]. Despite this, young people often skip breakfast [13], and the prevalence of children and adolescents skipping breakfast is increasing [14]. In addition, it has been shown that breakfast skipping is particularly common amongst children of lower socioeconomic status [15].

One way to make sure that children and adolescents eat breakfast on a regular basis is to serve it at school. A School Breakfast Programme (SBP) aims to provide a healthy breakfast in school, to improve e.g. nutrition and academic performance [16]. SBP is commonly supervised by staff, offering school children a nutritious breakfast at school before going to class [17]. A variant of SBP is Breakfast in Classroom (BIC). With BIC, students get breakfast in their classroom at the beginning of the school day, rather than in the cafeteria before school start.

In addition to research studying the effects of eating breakfast (EB), there is a growing body of literature that aims to measure the effects of School Breakfast Programmes (SBP). Several published reviews have examined the effects of EB and SBP on children and adolescents [18-21]. Informed decisions of whether to promote eating breakfast or to introduce a school breakfast programme require a broader perspective. Since societal resources are scarce, and the needs are endless, choices between health interventions must be made. Economic evaluation of different interventions seeks to identify and quantify the costs and consequences of each alternative for well-founded and informed decision-making.
Economic evaluations are comparative analyses of alternative courses of action in terms of both costs and consequences. The costs are weighed against the health effects measured in such a way that it corresponds to a value, usually quality adjusted life-years (QALYs). This measure should ideally encapsulate the impact of an intervention on a person’s length of life, and the impact on their health-related quality of life which is recognized as an important indicator of treatment outcomes. To our knowledge there are no published economic evaluations of EB and SBP. In the absence of cost-effectiveness studies, and as a starting point for future economic assessments, this review will focus on studies that measure outcomes that directly or indirectly can be transformed into QALYs that are traditionally used in cost-effectiveness analysis.

The aim was to conduct a systematic review of scientific publications that study the effects potentially relevant for economic evaluations of eating breakfast or implementing school breakfast programmes for children and adolescents.
2. METHOD

Studies were identified by searching the electronic databases PubMed, CINAHL, Web of Science and PsycINFO between January 2000 and October 2017.

To capture all relevant articles published in the field, two different search strategies were constructed. See table 1.

Table 1. Search strategies.

<table>
<thead>
<tr>
<th>Search strategy 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakfast AND Children OR Adolescents OR Teen OR Youth OR students OR kids OR pupils AND Behavior OR Mental OR Learning OR Effect OR Cognitive OR Academic OR Achievement OR Performance OR Well-being OR Quality of life OR Health</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Search strategy 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>School AND Breakfast AND Children OR Adolescents OR Teen OR Youth OR students OR kids OR pupils AND Behavior OR Mental OR Learning OR Effect OR Cognitive OR Academic OR Achievement OR Performance OR Well-being OR Quality of life OR Health</td>
</tr>
</tbody>
</table>

2.1 Selection of studies

The overall inclusion criteria applied were:

- Published articles from peer-reviewed journals with full text in English.
- Studies collecting primary data.
- Quantitative studies.
- Studies performed in countries comparable to Sweden in terms of access and quality of nutrients, economic and social conditions.
- Studies using well defined and valid measures of breakfast consumption.
- Publications studying at least one of the following topics:
  - Academic achievement
  - Quality of life and Well-being
The association between eating breakfast and weight-related outcomes is a thoroughly studied topic with broad coverage in previous literature [22-24]. The established links for utilizing weight-related outcome measurements in cost-effectiveness analysis highlight the redundancy of further examinations of this association. Weight-related outcomes are therefore omitted from the EB section of this review [25, 26]. The review of SBP studies included studies using weight/obesity as outcome.

One of the authors (ML) conducted the search in October 2017. Initially, two of the authors (ML, NEV) read all titles and abstracts of the identified studies to determine the relevance of each article. If title and abstract met with the inclusion criteria, the study proceeded to the next stage of the review process. Studies with insufficient information in title and abstract also proceeded to the next stage of the review process. After this selection, all authors (ML, L-ÅL, NEV) read the remaining studies in full text, in order to confirm inclusion eligibility and to conduct the quality assessment.

### 2.2 Quality assessment

In pairs, the authors read the articles in full to assess both eligibility and scientific quality. If the two authors who made the initial assessment did not agree, the third author also read the article. The scientific quality assessment was based on the following criteria: adequate control group(s), randomization, sufficient statistical power, control of confounders, sufficient descriptions of experimental design, relevance of outcome measures and consistency between reported results and conclusions [27, 28]. In order not to let the results of the study affect the quality assessment, this was done separately without, as far as possible, reading the study results. The criteria for quality assessment varied with different study types. The quality of the studies was rated as high, moderate or low. A study rated 'high quality' had to fulfill all the quality criteria. Studies of moderate quality fulfilled several of the criteria. Finally, low-quality studies either failed to meet several of the criteria or had major shortcomings in certain criteria. Studies rated as being of high or moderate quality were included in the further analysis. The low-
quality studies were excluded. They are presented with a comment in Appendix 1. Tables 2 and 3 contain the following information from the included studies: reference, participant characteristics (number, age, gender), study design, study purpose, outcomes, authors conclusions and the scientific quality assessment.

2.3 Result compilation

A compilation of the study results based on statistical inference is presented in tables 4 and 5. A study was deemed positive if it had at least one statistically significant positive outcome measure; a study was deemed negative if it had at least one statistically significant negative outcome and a study was deemed ‘no effect’ if it showed no statistically significant results. A two-tailed p-value of 0.05 was considered statistically significant.
3. RESULTS

The flow chart in figure 1 illustrates the work process. Database searches identified 5,200 articles. No articles were identified through other types of article sources. After removal of duplicates, 2,958 unique articles remained. Exclusion based on information given in title and abstract resulted in the removal of 2,830 articles. Full-text articles were categorized as “Effect of Eating Breakfast” (EB) or “Effect of School Breakfast Programmes” (SBP). The full-text reading of the EB articles resulted in the additional exclusion of sixteen articles that did not meet the inclusion criteria, and eight were excluded due to low quality. Full-text reading of the SBP articles excluded 63 articles that did not meet the inclusion criteria, and three were excluded due to low quality. Finally, 26 EB articles and 11 SBP articles met the inclusion criteria and remained for further analysis. The 26 EB studies included in the analysis are summarized in table 2, and the 11 SBP studies included in the analysis are presented in table 3.

Figure 1. Flow chart of the work process. PRISMA 2009 Flow Diagram [1].
<table>
<thead>
<tr>
<th>First author (year), Country</th>
<th>Participants</th>
<th>Study design</th>
<th>Study purpose</th>
<th>Outcomes</th>
<th>Author conclusion</th>
<th>Scientific quality assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Age</td>
<td>Gender (female)</td>
<td>Morbidity risk factors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hallstrom et al. (2013), SWE, ESP, BEL, DEU, FRA GRC, ITA, AUT [29]</td>
<td>2929</td>
<td>14.7 years</td>
<td>53% Cross-sectional, observational</td>
<td>To examine the association between breakfast consumption and CVD risk factors in European adolescents.</td>
<td>Findings regarding European adolescents confirm previous data indications: adolescents who consume breakfast regularly have lower body fat content than other peers. Results also show that regular BC is associated with higher cardio-respiratory fitness and (especially in male adolescents) with a healthier cardiovascular profile and negation of the effect of excess adiposity on TC and LDL-C.</td>
<td>Moderate</td>
</tr>
<tr>
<td>Marlatt et al. (2016), USA [30]</td>
<td>367</td>
<td>14.7 years</td>
<td>49% Observational</td>
<td>To evaluate the relationship between both breakfast and fast food consumption on selected biomarkers and important cardiovascular and metabolic risk factors among healthy adolescents, and further examine the relationship</td>
<td>The finding suggests that fast food and BC are associated with some metabolically important chronic disease risk factors in healthy adolescents.</td>
<td>Moderate</td>
</tr>
</tbody>
</table>
between these dietary behaviors and the known risk factor clustering that occurs with the metabolic syndrome.

<table>
<thead>
<tr>
<th>Study</th>
<th>n</th>
<th>Age Range</th>
<th>Design</th>
<th>Objective</th>
<th>Biomarkers</th>
<th>Evidence</th>
<th>Methodological Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moschiano et al. (2012), ITA [31]</td>
<td>800</td>
<td>10 ≤ years</td>
<td>Observational</td>
<td>To assess the possible association between headache and specific habits and lifestyle factors.</td>
<td>Headache</td>
<td>Evidence of clear association between headache and irregular intake of meals (especially irregular breakfast) and sleep disturbance with significant differences when comparing subjects with and without headache.</td>
<td>Moderate</td>
</tr>
<tr>
<td>Papoutsiou et al. (2014), CYP, GRC, DEU, ITA, SWE, EST, BEL, ESP [32]</td>
<td>8863</td>
<td>2 &lt; 10 years</td>
<td>Cross-sectional Observational</td>
<td>To investigate the relationship between breakfast routine and CVD risk factors in a multinational sample.</td>
<td>Blood glucose TC, LDL-C, HDL-C, TG, PA</td>
<td>Daily BC contributes to controlling school-aged children's weight and lipid profile. It promotes higher PA.</td>
<td>Moderate</td>
</tr>
<tr>
<td>Sese et al. (2012), ESP, GBR, FRA, BEL, DEU, AUT, HUN, GRC [33]</td>
<td>826</td>
<td>14.8 years</td>
<td>Observational</td>
<td>To examine the associations of food behaviors and preferences with markers of insulin resistance and clustered metabolic risk factors score after controlling for potential confounders, including body fat in European adolescents.</td>
<td>TG, TC, HDL-C, Blood glucose, SBP, HOMA-IR</td>
<td>The results of this study indicate that insulin resistance and a clustered metabolic risk factors score are positively associated with food behaviors and preferences. Skipping breakfast explains part of the insulin resistance</td>
<td>Moderate</td>
</tr>
<tr>
<td>Study (Year, Location)</td>
<td>N/A</td>
<td>Variance</td>
<td>Study Design</td>
<td>Study Objective</td>
<td>Measures</td>
<td>Key Findings</td>
<td></td>
</tr>
<tr>
<td>------------------------</td>
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<td></td>
</tr>
<tr>
<td>Smith et al. (2010), AUS [34]</td>
<td>2184</td>
<td>53.3%</td>
<td>Longitudinal, Observational</td>
<td>To examine longitudinal associations of breakfast skipping in childhood and adulthood with cardiometabolic risk factors in adulthood.</td>
<td>Mean Weight Circumference Cardiometabolic Risk factors</td>
<td>Participants skipping breakfast in both childhood and adulthood had larger waist circumferences, higher BMIs, and poorer cardiometabolic profiles than did those who reported eating breakfast at both time points.</td>
<td></td>
</tr>
<tr>
<td>Walter (2014), USA [35]</td>
<td>13,570</td>
<td>51%</td>
<td>Cross-sectional</td>
<td>To study how lifestyle behaviors (skipping meals, water intake, tobacco use, alcohol use, and physical activity) and illness-related factors (depression, somatic complaints, insomnia, and obesity) work together to predict headache in an adolescent population.</td>
<td>Recurrent headache</td>
<td>Lifestyle behaviors and illness-related factors are associated with adolescent headache. Skipping breakfast three or more times was one of them.</td>
<td></td>
</tr>
<tr>
<td>Wennberg et al. (2015), SWE [36]</td>
<td>889</td>
<td>52.2%</td>
<td>Longitudinal, Observational</td>
<td>To analyse whether poor breakfast habits in adolescence predict the metabolic syndrome and its components in adulthood.</td>
<td>Metabolic syndrome: Central Obesity, High Fasting Glucose</td>
<td>Poor breakfast habits in adolescence predicted the metabolic syndrome in adulthood. Of the metabolic syndrome components, poor breakfast habits in adolescence predicted central obesity and high fasting glucose in adulthood.</td>
<td></td>
</tr>
<tr>
<td>Wennberg et al. (2016), SWE [37]</td>
<td>889</td>
<td>52.2%</td>
<td>Longitudinal, Observational</td>
<td>To investigate whether irregular eating of meals in adolescence predicts the metabolic syndrome</td>
<td>Metabolic syndrome</td>
<td>Irregular eating of meals in adolescence predicted the metabolic syndrome.</td>
<td></td>
</tr>
</tbody>
</table>
its components in adulthood, and if any specific meal is of particular importance.

in adulthood, but not independently of BMI and lifestyle in adolescence. Poor breakfast in adolescence was the only specific meal associated with future metabolic syndrome, even after adjustments.

| Cognitive performance | 30.43 |  |  |  |

Cooper et al. (2011), GBR [38] 96 13.3 years 62.5% Randomized crossover design To examine the effects of breakfast consumption on cognitive function, mood and blood glucose concentration in adolescent schoolchildren. Modified AD ACL (mood questionnaire) VAS – hunger, fullness Blood glucose concentration CF tests Visual search (focused attention) Stroop (negative priming) Sternberg paradigm (working memory) BC improved the accuracy of responses on the visual search and Stroop tests. BC also improved response times on the more complex levels of the Sternberg paradigm, but did not have consistent effects on response times on the other tests conducted. BC was particularly beneficial for the more cognitively demanding tasks, whereas the simpler tasks could be performed to a similar level following breakfast omission. Moderate

Defeyter and Russo (2013), GBR [39] 40 14.2 years 52.5% Crossover design To investigate the effect of breakfast consumption on cognitive performance and mood in adolescents, and any interaction that breakfast consumption Bond-Lader (mood scale) VAS - thirst, hunger, satiety Overall, it appeared that after breakfast, participants felt more alert, satiated, and content. Only in the recall task did Moderate
<table>
<thead>
<tr>
<th>Study</th>
<th>Participants</th>
<th>Age</th>
<th>Sample Size</th>
<th>Study Design</th>
<th>Measures</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hjorth et al. (2016), DNK [40]</td>
<td>710-828</td>
<td>9.9</td>
<td>49%</td>
<td>Cluster-randomized crossover design</td>
<td>CL tests: Delayed word recall (memory), Choice reaction time (attention), RVIP (sustained attention), Stroop (negative priming), Serial 3s, 7s (attention, memory)</td>
<td>Performance appears to be significantly modulated by the interactive combination of the effect of BC and task difficulty, with improved performance at time two when the task was harder.</td>
</tr>
<tr>
<td>Wessnes et al. (2003), GBR [41]</td>
<td>29</td>
<td>12</td>
<td>51.7%</td>
<td>Randomized, four-way crossover design</td>
<td>CSHQ, CRF, d2-test (concentration), Sentence reading speed and correctness, Mathematics proficiency</td>
<td>Normal weight children had higher cognitive performance compared to overweight/obese and underweight children. Daily BC was associated with higher cognitive performance in the d2-test, mathematics and/or sentence-reading test.</td>
</tr>
</tbody>
</table>

Skipping breakfast impairs attention and episodic memory, increasing in magnitude over the morning. Ingesting carbohydrates in the form of breakfast cereals reduces attention deficit by more than half and, for some aspects of...
| Wesnes et al. (2012), GBR [42] | 1386 | 10.59 years | 52% | Controlled trial | To determine the extent to which breakfast cereals would help to prevent declines in cognitive function in school children. | Power of attention, Response speed variability, Digit vigilance task, Choice reaction time task, Picture recognition | Power of Attention, a score reflecting the ability to focus attention and avoid distraction, was slowed by 7% in those children who did not have breakfast. The ability to sustain attention was also compromised, 7% less targets being detected in the digit vigilance task while 23% more false alarms were made. The ability to correctly identify pictures was impaired by 9% and speed was slowed by 9%. Finally, the response speed variability was 10% greater in children | Moderate |
who did not have breakfast. These scores reflect every aspect of cognitive performance assessed, showing a comprehensive difference between the two groups.

<table>
<thead>
<tr>
<th>Study</th>
<th>Year</th>
<th>Age (years)</th>
<th>Gender (%)</th>
<th>Design</th>
<th>Primary outcomes measured</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Widenhorn-Müller (2008), DEU[43]</td>
<td>104</td>
<td>17.2</td>
<td>46%</td>
<td>Randomized crossover design</td>
<td>d2-Test (concentration speed and attention), LGT-3 (learning capacity, immediate memory), VGZ (mood assessment scale)</td>
<td>This crossover trial demonstrated positive short-term effects of breakfast on cognitive functioning and self-reported alertness in high school students.</td>
</tr>
<tr>
<td>Page et al. (2009), USA, SVK, HUN, ROU, CZE [44]</td>
<td>3121</td>
<td>16.6</td>
<td>54.7%</td>
<td>Cross-sectional</td>
<td>Self-Rated Health, R-UCLA Loneliness Scale, Beck Hopelessness Scale, Cheek and Buss Shyness Scale, MacArthur Scale of Subjective Social Status – Youth Version, Self-Rated Happiness</td>
<td>Self-related Health appears to be associated with psychosocial functioning and other dimensions of adolescent health in CEE youth. Eating breakfast was one of twelve significant predictors of SRH.</td>
</tr>
<tr>
<td>Richards and Smith (2016), GBR[45]</td>
<td>2307</td>
<td>13.6</td>
<td>51.5%</td>
<td>Longitudinal study with two cross-sections</td>
<td>DABS, Exercise frequency questionnaire, Self-Assessed Mental</td>
<td>The current study has provided evidence to suggest that high stress, anxiety, and depression levels in adolescents are...</td>
</tr>
</tbody>
</table>
school children. Health (WPQ-items) associated with breakfast omission. The relationship is unlikely to be causal in nature and there may be bi-directional mechanisms involved, with mental health also influencing whether or not breakfast is consumed.

<table>
<thead>
<tr>
<th>Study Authors</th>
<th>Year</th>
<th>Age</th>
<th>Gender</th>
<th>Study Design</th>
<th>Objective</th>
<th>Measures</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smith (2010), GBR</td>
<td>2010</td>
<td>8.11 years</td>
<td>50.7% Separate groups design</td>
<td>To examine the effects of consuming different breakfast cereals on parents' perceptions of the alertness, cognitive function and other aspects of the well-being of their children.</td>
<td>Questionnaire measures of well-being (alertness, cognitive difficulties, anxiety, depression, emotional distress, fatigue, somatic symptoms, positive/negative mood, symptoms, bowel problems).</td>
<td>Breakfast cereal consumption by children is associated with greater well-being.</td>
<td></td>
</tr>
<tr>
<td>Boschloo et al. (2012), NLD</td>
<td>2012</td>
<td>14.81 years</td>
<td>56% Cross-sectional</td>
<td>To investigate whether adolescents who habitually skip breakfast have lower end-of-term grades than adolescents who eat breakfast daily.</td>
<td>Breakfast Consumption Attention Problem Scale School performance – arithmetic mean of subjects Dutch, mathematics and English.</td>
<td>Study shows that breakfast skipping and school performance are related, partially mediated by attention. No causal conclusions drawn.</td>
<td></td>
</tr>
<tr>
<td>Burrows et al. (2017), AUS</td>
<td>2017</td>
<td>11.33 years</td>
<td>50-55% Observational</td>
<td>To conduct secondary analysis to examine associations between a range of dietary behaviours Dietary behaviors NAPLAN (reading, writing, spelling).</td>
<td>The findings demonstrate the association between dietary behaviours and Moderate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Study</td>
<td>Country</td>
<td>Sample Size</td>
<td>Age</td>
<td>Sample %</td>
<td>Study Design</td>
<td>Methodology</td>
<td>Academic Achievement</td>
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</tr>
<tr>
<td>Faught et al. (2017), CAN [49]</td>
<td></td>
<td>28 608</td>
<td>14.1 years</td>
<td>50.9%</td>
<td>Observational</td>
<td>Questionnaire (academic achievement, PA, healthy eating habits, sleep, screen time, BW-status, SES)</td>
<td>Breakfast was only significantly associated with the academic domain of writing.</td>
</tr>
<tr>
<td>Faught et al. (2017), CAN [49]</td>
<td></td>
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<td>14.1 years</td>
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<td>Breakfast was only significantly associated with the academic domain of writing.</td>
</tr>
<tr>
<td>Lien (2007), NOR [50]</td>
<td></td>
<td>7305</td>
<td>15-16 years</td>
<td>50.6%</td>
<td>Cross-sectional survey</td>
<td>Average grade for mathematics, written Norwegian, English and social science. HSCL-10 (mental distress)</td>
<td>The implications of skipping breakfast on mental distress and academic performance are stronger for boys than girls and stronger for Norwegians than immigrants.</td>
</tr>
<tr>
<td>Littlecott et al. (2016), GBR [12]</td>
<td></td>
<td>3193 (baseline), 3055 (follow-up)</td>
<td>9-11 years</td>
<td>50.8% (baseline) 49.5% (follow-up)</td>
<td>Observational</td>
<td>Educational outcomes: SAT-scores</td>
<td>Significant positive association between self-reported BC and educational outcomes.</td>
</tr>
<tr>
<td>Prome et al. (2016), USA [51]</td>
<td></td>
<td>698</td>
<td>7.5 years</td>
<td>50.5%</td>
<td>Cluster-randomized controlled trial</td>
<td>WIAT-III</td>
<td>Both BC and breakfast content may be associated with improved standardized test performance in elementary school students.</td>
</tr>
</tbody>
</table>
To investigate the association between breakfast consumption and school connectedness and to extend previous research on the association between breakfast consumption and academic achievement.

School connectedness (questionnaire)
Academic performance (good marks: 70%-100%, poor marks: <70%)

Provides supporting evidence for the association between regular BC and higher school connectedness and academic performance.

Regular meal pattern, intake of healthy food items and being physically active were all associated with increased odds of high academic achievement, whereas the intake of unhealthy food and beverages, smoking cigarettes and snuffing were associated with decreased odds of high academic achievement.

<table>
<thead>
<tr>
<th>First author (year), Country</th>
<th>Participants</th>
<th>Study design</th>
<th>Study purpose</th>
<th>Outcomes</th>
<th>Author conclusion</th>
<th>Scientific quality assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sampasa-Kanyinga &amp; Hamilton (2017), CAN [52]</td>
<td>9912 15-2 years 48.6% Observational</td>
<td>To investigate the association between breakfast consumption and school connectedness and to extend previous research on the association between breakfast consumption and academic achievement.</td>
<td>School connectedness (questionnaire) Academic performance (good marks: 70%-100%, poor marks: &lt;70%)</td>
<td>Provides supporting evidence for the association between regular BC and higher school connectedness and academic performance.</td>
<td>Moderate</td>
<td></td>
</tr>
<tr>
<td>Stea and Torstveit (2014), NOR [53]</td>
<td>2432 15-17 years 51% Cross-sectional study</td>
<td>To examine the associations between several lifestyle habits and academic achievement in adolescent girls and boys.</td>
<td>Self-reporting questionnaire (dietary-, PA-, smoking- and snuffing habits, academic achievement)</td>
<td>Regular meal pattern, intake of healthy food items and being physically active were all associated with increased odds of high academic achievement, whereas the intake of unhealthy food and beverages, smoking cigarettes and snuffing were associated with decreased odds of high academic achievement.</td>
<td>Moderate</td>
<td></td>
</tr>
</tbody>
</table>

N/A – No information Available

Table 3. Summary of included School Breakfast Programme studies.

Cognitive performance

<table>
<thead>
<tr>
<th>First author (year), Country</th>
<th>Participants</th>
<th>Study design</th>
<th>Study purpose</th>
<th>Outcomes</th>
<th>Author conclusion</th>
<th>Scientific quality assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moore et al. (2014), GBR</td>
<td>111 schools (n = 4510) Age range 9-11 years N/A</td>
<td>RCT/ Pre-, post study/ Cross-sectional design</td>
<td>To examine impacts of the Primary School Number of healthy and unhealthy items</td>
<td>Universal breakfast provision may reduce socio-economic</td>
<td>Moderate</td>
<td></td>
</tr>
<tr>
<td>Study</td>
<td>Sample Size</td>
<td>Mean Age</td>
<td>Gender</td>
<td>Methodology</td>
<td>Findings</td>
<td></td>
</tr>
<tr>
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<td></td>
</tr>
<tr>
<td>Shemilt et al. (2004), GBR</td>
<td>6042</td>
<td>9.83</td>
<td>50.2%</td>
<td>RCT/observational analysis</td>
<td>To describe the economics of UK school breakfast clubs, to estimate costs resulting from clubs and to investigate relationships between costs and outcomes.</td>
<td></td>
</tr>
</tbody>
</table>

**Free Breakfast Initiative in Wales on inequalities in children’s dietary behaviors and cognitive functioning.**

- **at breakfast**
  - Fruits + vegetables and unhealthy items during rest of the day
- **Breakfast skipping and attitudes**
  - Episodic memory (group)
  - Hyperactivity

- **inequalities in consumption of healthy breakfast items and breakfast skipping.**

- **Life, Health and School Questionnaire scores**
- **The Strengths and Difficulties Questionnaire scores**
- **The Trail Making Test scores**
- **Family Questionnaire scores**
- **School attendance**
- **Punctuality**
- **Attainment**

**Intention to treat analysis** showed that pupils in intervention group had:
- Improved concentration at 3 months into study
- Fewer reports of skipped classes and skipped days at school within last month at 1 year.

Higher proportion of primary-aged breakfast club attendees reported eating fruit for breakfast and had borderline or abnormal conduct and total difficulties scores (primary-aged) and prosocial score (secondary-aged) compared to non-
<table>
<thead>
<tr>
<th>Study</th>
<th>Observational Design</th>
<th>Observational, Longitudinal Study</th>
<th>Pre-, Post- Study</th>
<th>To Estimate the Impact of a Breakfast in the Classroom (BIC) Programme on School Breakfast Programme Participation, School Attendance, and Academic Achievement.</th>
<th>School Level: Breakfast Participation Rates</th>
<th>Grade Level: Academic Achievement</th>
</tr>
</thead>
</table>
| **Anzman-Fraca et al. (2015), USA [56]** | N/A                  | N/A                               |                  | **School level:** Breakfast participation rates  
Grade level: Academic achievement  
**BIC-program seems to:**  
- Increase school breakfast participation rates  
Improve overall school attendance rates. |
| **Corcoran et al. (2016), USA [57]** | N/A                  | N/A                               | Grades 4 - 8     | **School meals programme participation**  
**BMI and obesity**  
**Student Achievement**  
**Attendance**  
**Offering breakfast in classroom (BIC) increases school breakfast participation. Study provides no evidence of hoped-for gains in academic performance, or of feared increases in BMI and obesity.** |
| **Kleinman et al. (2002) USA [58]** | N/A                  | N/A                               | Grade range 3-5: 82%  
Grade range 6: 18% | **Participation in a school breakfast programme enhanced daily nutrient intake. Improvements in nutrient intake were associated with significant improvements in student academic performance and psychosocial functioning while also reducing** | **Hunger and School breakfast participation**  
**Psychosocial functioning**  
**Academic performance scores** | **Participation in a school breakfast programme enhanced daily nutrient intake. Improvements in nutrient intake were associated with significant improvements in student academic performance and psychosocial functioning while also reducing** |
<table>
<thead>
<tr>
<th>Study Authors</th>
<th>Location</th>
<th>No. of Schools</th>
<th>Grade Range</th>
<th>Student Attendance</th>
<th>Design</th>
<th>Participants</th>
<th>Program</th>
<th>Program Outcomes</th>
<th>Impact on School Attendance</th>
<th>Impact on Academic Achievement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leos-Urbel et al. (2013), USA [59]</td>
<td>Grades 3-8</td>
<td>7238</td>
<td>49.6%</td>
<td>Observational, difference-in-differences design</td>
<td>To examine the impact of the implementation of a universal free school breakfast policy on meals programme participation, attendance, and academic achievement.</td>
<td>Meal programme participation</td>
<td>Student attendance</td>
<td>Standardized math and reading test scores</td>
<td>Universal provision services increase program participation by social rather than economic pricing mechanisms; no evidence of programme participation influence on educational outcomes.</td>
<td>Moderate</td>
</tr>
<tr>
<td>Mhurchu et al. (2013), NZL [60]</td>
<td>424</td>
<td>9.4 years</td>
<td>53%</td>
<td>RCT 1-year stepped wedge-cluster</td>
<td>To investigate the effects of a free school breakfast programme (SBP) in New Zealand on children’s school attendance. Secondary aims were to examine the impact of the breakfast programme on children’s academic achievement, self-reported grades, sense of belonging at school, behavior, short-term hunger, breakfast habits and food security.</td>
<td>School, SBP attendance</td>
<td>Academic achievement</td>
<td>Self-reported reading grade</td>
<td>A free SBP did not have a significant effect on children’s school attendance or academic achievement but had significant positive effects on children’s short-term satiety ratings, i.e. reduced hunger. Higher SBP attendance rates may be required to influence school attendance and/or academic outcomes.</td>
<td>Moderate</td>
</tr>
<tr>
<td>Ribar et al. (2013), USA [61]</td>
<td>N = 10 schools n = 8078 Grade 1-2: n =</td>
<td>Grade range 1-5</td>
<td>Range 47.3 – 50.0%</td>
<td>Pre-, post-change design</td>
<td>To investigate student outcomes associated with changes in the availability of School meal participation</td>
<td>School attendance</td>
<td>Switch from universal free to eligibility-based SBP reduced breakfast participation; largest reduction occurring</td>
<td>Moderate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Study</td>
<td>N</td>
<td>Grade Range</td>
<td>Design Method</td>
<td>Study Object</td>
<td>Findings</td>
<td>Methodological Quality</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>--------------------------------------------</td>
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<td>--------------------------------------------------------------------------</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Universal free breakfasts at elementary schools</td>
<td>4797</td>
<td></td>
<td></td>
<td></td>
<td>Test score performance among students ineligible to free or reduced-price meals did not harm test scores or attendance rates</td>
<td>Moderate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gleason and Dodd (2009), USA [62]</td>
<td>2282</td>
<td>Grades 1-12</td>
<td>Observational, cross-sectional</td>
<td>To estimate the relationship between participation in school meal programmes and children’s body mass index (BMI) and their likelihood of being overweight or obese, testing the hypothesis that school meal participation influences students’ weight status, as measured by their BMI and indicators of overweight and obesity.</td>
<td>No evidence that SBP participation contributes to rising rates of childhood obesity.</td>
<td>Moderate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hofferth and Curtin (2005), USA [63]</td>
<td>1268</td>
<td>Age range 6-12 years</td>
<td>Observational</td>
<td>To examine whether income is linked to overweight in school-age children. Second, it explores whether food programmes contribute to overweight in these children.</td>
<td>No evidence that children from poor families are more likely to be overweight or that food programmes contribute to overweight in these children.</td>
<td>Moderate</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
programs such as the Food Stamp Program, the National School Lunch Program, and the School Breakfast Program are associated with overweight among children in different income groups.

<table>
<thead>
<tr>
<th>Study (Sudharsanan et al. (2016), USA [64])</th>
<th>Grade Level (Grades 5 &amp; 8)</th>
<th>Prevalence (%) (49.7%)</th>
<th>Study Design (Observational, difference-in-differences)</th>
<th>Research Question (To determine whether receiving breakfast at school is related to changes in children’s weight between the fifth and eighth grades, and whether the relationship between school breakfasts and obesity varies for children of different socioeconomic backgrounds.)</th>
<th>Outcome (Obesity)</th>
<th>Findings (For most children, receiving school breakfast is unrelated to obesity. For children from families below the federal poverty line, unhealthy obesity between fifth and eighth grade could be related to the receipt of school breakfast in fifth grade.)</th>
<th>Strength (Moderate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A – No information Available</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
3.1 Studies of Eating Breakfast

In total, 26 studies were included in the analysis. All studies were published between 2003 and 2017. The countries represented were the UK (seven studies), the US (three studies), Canada, Norway, Australia, Sweden (two studies each), and Denmark, Germany, Italy and the Netherlands (one study each). Four studies were multinational. Most of the studies included were observational. Five were randomized controlled trials, one was a non-randomized trial and one used a separate-group design.

The number of participants included in the studies varied from 29 to 28,608. Based on the predetermined inclusion criteria, they all study children and adolescents. The majority studied adolescents [12, 29-31, 33, 35-39, 41-50, 52, 53]. Only four studied children with a mean age below ten years [32, 34, 40, 51].

The studies included a variety of outcome measures and instruments. Based on the applied criteria, studies were divided into four categories. Studies of morbidity risk factors associated with eating or not eating breakfast were most common [29-37]. In addition, studies of links between breakfast and academic achievement were frequent [12, 47-53]. In six studies, the association between breakfast eating and cognitive disorders was analyzed [38-43]. Finally, in three studies the link between breakfast eating and QoL and/or well-being was studied [44-46]. No study concerning the cost-effectiveness of eating breakfast was found. Table 4 shows a compilation of the EB study results.

3.1.1 Morbidity risk factors

All the studies that had morbidity risk factors as outcomes were observational studies. Most of the studies examined the association between breakfast consumption and the metabolic syndrome. Marlatt et al. found that higher levels of breakfast consumption were significantly associated with lower risk for insulin resistance as well as other risk factors for metabolic syndrome [30]. This is in line with what both Sese et al. and Wennberg et al. concluded in their studies [33, 36, 37]. The two studies conducted by Wennberg et al. were longitudinal with 27 years of follow-up. In both studies, they found an association between poor breakfast habits and future risk of developing metabolic syndrome. Hallstrom et al. studied the association between breakfast consumption
and cardiovascular disease risk factors. Their results indicated that adolescents who regularly consumed breakfast had higher cardiorespiratory fitness and lower total adiposity [29]. However, they did not find any significant effect of breakfast consumption on blood lipid levels, blood pressure or insulin resistance, in females. Two studies examined the association between breakfast skipping and headache [31, 35]. Both found that irregular breakfast eating is associated with headache.

3.1.2 Cognitive performance

A various number of instruments and test were used to measure cognitive performance among the studies included. All of them found that eating breakfast has positive effects on cognitive performance. Wesnes et al. concluded in both their studies that breakfast improved children’s attention [41, 42]. Cooper et al. found that eating breakfast had particularly beneficial effects when study participants faced more cognitively demanding tasks [38]. They also measured self-reported tension and calmness between the breakfast and no breakfast groups, but found no difference. In addition, they found that breakfast consumption improved response time measured with Sternberg paradigm, a memory-scanning task for short term memory testing. This effect was not possible to confirm with other similar tests measuring response time. Wesnes et al. also showed that breakfast affects response speed variability. Participants who had breakfast showed lower response speed variability. Hjorth et al. and Widenhorn-Müller used the d2-test to measure selective and sustained attention and visual scanning speed. Hjorth et al. found a positive interaction between breakfast consumption and d2-test results [40]. Widenhorn-Müller showed beneficial effects of breakfast on short-term memory and mood but not on sustained attention [43].

3.1.3 Quality of life and Well-being

All of the included studies used different measurements to study the association between breakfast consumption and QoL and/or well-being. However, the results are consistent. Page et al. found that eating breakfast was one of twelve significant predictors of self-rated health measures [44]. Richards and Smith provided evidence showing that stress, anxiety and depression were associated with skipping breakfast [45]. Nevertheless, they highlighted the possibility that mental health might influence whether a person consumes breakfast or not. Smith et al. also found that breakfast consumption is linked to increased well-being [46].
3.1.4 Academic achievement

All the studies that investigated breakfast consumption and academic achievement found positive associations between breakfast consumption and academic achievement. In a study conducted by Lien in Norway, the implications of skipping breakfast on mental distress and academic achievement were stronger for boys than girls and were stronger for native Norwegians than immigrants [50]. Burrows et al. concluded that dietary behavior overall was associated with higher academic achievement, but that breakfast was only significantly associated with the domain writing [48].

Table 4. Compilation of results from EB studies.

<table>
<thead>
<tr>
<th>First author</th>
<th>Cognitive Performance</th>
<th>Academic Achievement</th>
<th>Morbidity Risk Factors</th>
<th>QoL/Well-being</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hallstrom et al. [29]</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marlatt et al. [30]</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moschiano et al. [31]</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Papoutsou et al. [32]</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sese et al. [33]</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smith et al. [34]</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walter [35]</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wennberg et al. [36]</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wennberg et al. [37]</td>
<td>+</td>
<td></td>
<td></td>
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<tr>
<td>Cooper et al. [38]</td>
<td>+</td>
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<tr>
<td>Defeyter and Russo [39]</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hjorth et al. [40]</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wesnes et al. [41]</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wesnes et al. [42]</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Widemhorn-Müller [43]</td>
<td>+/-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Page et al. [44]</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Richards and Smith [45]</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smith [46]</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boschloo et al. [47]</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
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<tr>
<td>Burrows et al. [48]</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Faught et al. [49]</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lien [50]</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Littlecott et al. [12]</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ptomey et al. [51]</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Sampasa-Kanyinga &amp; Hamilton [52]</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stea and Torstveit [53]</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of studies indicating positive effects</td>
<td>7 (100%)</td>
<td>8 (100%)</td>
<td>9 (100%)</td>
<td>4 (100%)</td>
</tr>
</tbody>
</table>
In total, 11 studies were included in the analysis. The studies were published between 2002 and 2016. The countries that were represented were the US (eight studies), the UK (two studies), and New Zealand (one study). The number of participants included in the studies varied from 97 to 723,843. The age of the participants in the studies varied. Most of them examined children and adolescents in a range of ages using data from different grades. Ribar et al. and Hofferth and Curtin studied children that were a bit younger (between 6-12 years).

Seven studies were observational studies [55-57, 59, 62-64]. Two were randomized controlled trials and the remaining two used pre-post design. Most of the studies compared regular SBP participation with non-participation. However, a few had slightly different approaches. Ribar et al. examined changes from universal free school breakfast programmes to eligibility-based programmes, which is quite different from previous studies which only investigated intervention changes in the opposite direction. The majority of the studies examined the effects of SBP. Corcoran et al. examined BIC. Anzman-Frasca et al. compared BIC with non-BIC schools (where non-BIC schools offered traditional SBP).

The identified outcome measures used in the studies included were cognitive performance, academic achievement and weight/obesity. Studies of academic achievement were most common. No studies of the association between QoL and/or well-being and SBP were identified. Nor did any studies examine the association between SBP and different morbidity risk factors. Furthermore, no study of the cost-effectiveness of SBP was identified. Table 5 shows a compilation of the SBP study results.

### 3.2 Studies of School Breakfast Programmes

| Number of studies indicating negative effects | 1 (14%) | 0 (0%) | 0 (0%) | 0 (0%) |
| Number of studies indicating no effects       | 0 (0%)  | 0 (0%) | 0 (0%) | 0 (0%) |

* = Positive effect, - = Negative effect, 0 = No effect

3.2.1 Cognitive performance

Moore et al. used several different outcomes to study the effect of free SBP compared to non-free SBP [54]. They found that free SBP had no effect on episodic memory but concluded that SPB might reduce socio-economic inequalities in terms of breakfast skipping. Shemilt et al. also studied several outcome measures [55]. They showed that SBP improved
concentration and reduced the number of days the adolescents skipped classes and school.

### 3.2.2 Academic achievement

Studies of the association between SBP and academic achievement showed varied results. Anzman-Frasca et al., Corcoran et al., Leos-Urbel et al. and Mhurchu et al. all concluded that serving breakfast had no effect on educational outcomes. Mhurchu et al. found that SBP had no effects on children's school attendance rates but had significant positive effects on children's short-term satiety ratings [60]. More specifically, Leos-Urbel et al. examined meal programme participation, student attendance and standardized mathematics and reading test scores [59]. They found no impact on educational outcomes from meal programme participation. However, results indicated that universal free SBP increased participation among children previously eligible to free school breakfast. Anzman-Frasca et al. also showed that participation rates were greater in BIC schools compared to non-BIC schools, and found an association between BIC participation and improved overall school attendance rates [56]. However, as stated above, they found no difference regarding performance in mathematics and reading in the group that received BIC versus the group that did not. Kleinman et al. differed from the other studies [58]. They found that students participating in SBP enhanced their daily nutritional intake and found an association with significant improvements in academic performance.

Ribar et al. had a slightly different approach [61]. They studied if switching from a free to an eligibility-based SBP reduced participation. They found that it led to substantially reduced participation rates. However, they found no evidence that the reduced participation harmed test scores or attendance.

### 3.2.3 Weight/Obesity

Three of the studies used weight/obesity as outcome measure. In principle, all three studies agreed. Gleason & Dodd found no evidence that SBP participation contributes to childhood obesity [62]. Hofferth & Curtin also found no evidence that food programmes contribute to overweight in children from poor families [63]. Sudharsanan et al. reported that for most children, receiving school breakfast was unrelated to obesity [64]. However, SBP participation in 5th grade was possibly
associated with weight gain between 5th and 8th grade, for children from families in poverty compared to children of similar socioeconomic status that did not receive breakfast.

The study conducted by Corcoran et al. also used weight/obesity as outcome measure [57]. In line with the other studies, they found no association of excessive weight gains or obesity rates from BIC.

Table 5. Compilation of results from SBP studies.

<table>
<thead>
<tr>
<th>First Author</th>
<th>Cognitive Performance</th>
<th>Academic Achievement</th>
<th>Weight/Obesity</th>
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<tr>
<td>Anzman-Frasca et al. [56]</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Corcoran et al. [57]</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Gleason and Dodd [62]</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Hofferth and Curtin [63]</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Kleinman et al. [58]</td>
<td>+</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>Leos-Urbel et al. [59]</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mhurchu et al. [60]</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Moore et al. [54]</td>
<td>0</td>
<td>0</td>
<td>+</td>
</tr>
<tr>
<td>Ribar et al. [61]</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Shemilt et al. [55]</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Sudharsanan et al. [64]</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Number of studies indicating positive effects:
1 (50%) 2 (29%) 2 (33%)
Number of studies indicating negative effects:
0 (0%) 0 (0%) 1 (14%)
Number of studies indicating no effects:
1 (50%) 5 (71%) 3 (50%)

+ = Positive effect, - = Negative effect, 0 = No effect
4. DISCUSSION

This review searched for studies examining the effects of eating breakfast (EB) and of school breakfast programmes (SBP) respectively. Throughout the review, the results of the two searches were handled separately. The EB studies included focused mainly on studying the effects of eating breakfast versus not eating breakfast; divided into four categories of study outcomes. Similarly, the range of study outcomes in the SBP studies were divided into three outcome categories. All studies included in the analysis met the inclusion criteria of this review and were judged to be of at least moderate quality. Consequently, the excluded studies either failed to meet the inclusion criteria or had a low study quality rating.

There was a notable variation in study design across the studies. In general, studies were either of observational or experimental design. The strongest study design for drawing causal relationship is the randomized controlled trial. Observational studies are important and common but also vitiated by several limitations. This is important to keep in mind when interpreting and assessing the value of the results presented in observational studies. For instance, it is problematic to assign the effects of eating breakfast to its sole nutritional value. Whether children eat breakfast or not and whether it has any substantial effect on study outcomes might very well be derived from a large number of unobserved influential factors, such as the children's social environment and parental support.

Variation in the studied type of breakfast intervention also differed. In the SBP category, each intervention had a unique design. The interventions could include Breakfast In Classroom (BIC), universal-free school breakfast programme, extended availability and serving capacity of school breakfast, and the launch of information campaigns to promote breakfast eating to schoolchildren, their parents and staff. It was not possible to draw any definite conclusions regarding the importance of how the breakfast is served. However, possible mechanisms related to the serving of breakfast are discussed below.

The results of the SBP studies varied. A few studies showed that SBP had minor positive effects regarding cognitive performance and academic achievement. Studies examining the association between SBP and weight/obesity showed both positive and negative effects. However, the majority of the studies found no effects at all. In addition, no studies examined the effects of SBP on quality of life, well-being and morbidity
risk factors. Two of eleven SBP studies examined the effects of BIC. Both studies found that BIC improved the overall participation rate compared to SBP [56, 57]. Breakfast access can be facilitated when served in the classroom, reaching students who otherwise are unlikely to participate. However, based on the two studies included in this review it is difficult to draw any firm conclusions regarding this. Moreover, none of these studies showed any effects in any of our outcome topics. Leos-Urbel et al. found that universal-free SBP increased participation rates primarily among those who previously skipped eligibility-based school breakfast. The increased participation rates were driven by social mechanisms, as the stigma of receiving eligibility-based SBP vanished. These studies highlight reasons for introducing universal-free SBP interventions. Eligibility-based SBPs that target individual schoolchildren in need of interventional support may therefore prove unsuccessful. This supports the conclusion of Moore et al., that universal-free SBP might reduce socio-economic inequalities among schoolchildren. Many of the SBP studies included suffered from methodological weaknesses. This could potentially explain the thin set of observable effects. Whether the detected associations were of a causal nature remains unanswered, since few studies were randomized controlled trials. The most common shortcoming among the SBP studies was the lack of confounder control. For example, the recurring lack of control for whether the children had breakfast at home or elsewhere.

The review of EB studies showed positive and conclusive effects on cognitive performance, academic achievement, quality of life, well-being, and morbidity risk factors. This is clear evidence that eating breakfast is important. The consistently positive results may indicate different forms of bias. There is always a risk of publication bias that could contaminate this type of review, which could have overestimated the strength of the evidence [65]. In addition, it is also possible that authors facing non-significant results can tweak the hypothesis to better suit data. This is known as HARKing – hypothesizing after the results are known [66]. Also, the lack of control for confounders in the EB studies may have affected the results. As it is not possible to adjust for all confounders, it is difficult to establish a clear causal link between intervention and outcome [67]. EB studies that examine the association between breakfast and weight/obesity has been thoroughly studied and reviewed before. Therefore, such studies were excluded from this review. However, despite the exclusion of the weight/obesity effects of eating breakfast in this review, it should be noted that it is relevant to include weight/obesity in economic evaluations of breakfast.
To conduct this review, several considerations and restrictions had to be applied. Including only studies from regions comparable to Sweden restricted the study catchment area to Europe and North America, plus Australia and New Zealand. The potential exclusion of relevant studies from other nations is one limitation. In the assessment of study quality, the risk of incorrect classification is contingent. Although, by proactively disregarding the study results in the articles included when performing quality assessment, the authors took measures to limit the risk of study quality misclassification.

Studies of breakfast attract researchers from different discipline. In part, this explain the high diversity in designs of SBP interventions, the multiple definitions and the measurement methods used in studying EB. Often, systematic reviews include a meta-analysis component. Meta-analysis uses statistical methods to synthesis data from the systematic review into a single quantitative outcome. Pooling results from different instruments and outcomes may lead to between-study heterogeneity and biased meta-analysis [68]. Therefore, meta-analysis of this research area is currently unwarranted.

Our interest in finding and valuing the effects that can be attributed to breakfast eating and SBP emanates from the question of the cost-effectiveness of breakfast interventions. Our study cannot answer that question, but shows that breakfast eating and SBP do have effects that could be used in economic evaluations, especially when using decision analytic modeling, calculating the long-term cost and effects of intervention. For instance, improved cognitive performance and academic achievements may influence long-term effects on an individual’s productivity through improved school results, grades, higher education. Further, this gives higher human capital, which can be reflected in higher income, both for the individual and for society. Improvements in quality of life and well-being will have an immediate effect on the child’s/adolescent’s QALY weight but also, if the effects are sustained, on the long-term QALY gain. Finally, the health effects mediated by a reduction of long-term morbidity risk factors such as obesity, will contribute to lower morbidity/mortality and a reduction in health care costs. In order to answer the questions regarding cost-effectiveness of breakfast and interventions promoting breakfast, we need to know more about how the identified effects influence the societal cost and the individual’s QALY gain. There is also a need to develop models that can simulate breakfast interventions long-term costs and effects. In this study, we have started that work by identifying important model parameters.
5. CONCLUSIONS

- The overall assessment of the eating breakfast studies indicated positive effects in cognitive performance, academic achievement, quality of life and well-being, and reduced long-term morbidity risk factors.
- The school breakfast programmes studied showed minor positive effects regarding cognitive performance, academic achievement, with mixed impact on weight/obesity. However, most studies showed no effects, and all studies suffered from different methodological weaknesses.
- Universal-free SBP, such as BIC, may lead to increasing participation rates. Uncertainty remains whether it has any impact on school attendance rates and socio-economic inequalities.
- In order to answer the questions regarding cost-effectiveness of breakfast and breakfast interventions, we need to know more about the long-term effects of the interventions.
CONFLICT OF INTEREST

Financial support for conducting this review has been provided from Arla Foods. The authors have collected data and performed all analyses independently, and without unwarranted involvement from the funder.
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52. Sampasa-Kanyinga, H. and H.A. Hamilton, Eating breakfast regularly is related to higher school connectedness and academic performance in Canadian middle- and high-school students. Public Health, 2017. 145: p. 120-123.


60. Mhurchu, C.N., et al., Effects of a free school breakfast programme on children’s attendance, academic achievement and short-term hunger: results from a stepped-wedge, cluster randomised


APPENDIX 1

Presented in table 6 are studies that were excluded due to low quality and reasons for exclusion.

Table 6. Excluded studies due to low quality, with reasons for exclusion

<table>
<thead>
<tr>
<th>Exclusion no.</th>
<th>First author (year)</th>
<th>Title</th>
<th>Reason for low quality rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eating Breakfast studies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Adolphus et al. (2015) [69]</td>
<td>The Relationship between Habitual Breakfast Consumption Frequency and Academic Performance in British Adolescents</td>
<td>1, 6</td>
</tr>
<tr>
<td>2</td>
<td>Benton and Jarvis (2007) [70]</td>
<td>The role of breakfast and a mid-morning snack on the ability of children to concentrate at school</td>
<td>1, 3, 5</td>
</tr>
<tr>
<td>3</td>
<td>Karatzi et al. (2014) [71]</td>
<td>Dietary patterns and breakfast consumption in relation to insulin resistance in children. The Healthy Growth Study</td>
<td>1, 7</td>
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<tr>
<td>4</td>
<td>Kral et al. (2012) [72]</td>
<td>Effects on cognitive performance of eating compared with omitting breakfast in elementary schoolchildren</td>
<td>1, 3, 5</td>
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<tr>
<td>5</td>
<td>López-Sobaler et al. (2003) [73]</td>
<td>Relationship between habitual breakfast and intellectual performance (logical reasoning) in well-nourished schoolchildren of Madrid (Spain)</td>
<td>2</td>
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<tr>
<td>6</td>
<td>Maffeis et al. (2012) [74]</td>
<td>Breakfast skipping in prepubertal obese children: hormonal, metabolic and cognitive consequences</td>
<td>5</td>
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<tr>
<td>8</td>
<td>Overby et al. (2013) [76]</td>
<td>Self-reported learning difficulties and dietary intake in Norwegian adolescents</td>
<td>1, 3</td>
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<tr>
<td>School Breakfast Programs studies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Ask et al. (2006) [77]</td>
<td>Changes in dietary pattern in 15 year old adolescents following a 4 month dietary intervention with school breakfast—a pilot study</td>
<td>1, 3, 5, 6, 7</td>
</tr>
<tr>
<td>11</td>
<td>Paxton et al. (2012) [79]</td>
<td>Nonsignificant relationship between participation in school-provided meals and body mass index during the fourth-grade school year</td>
<td>1</td>
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</tbody>
</table>

Matters causing low quality rating: 1) No RCT, 2) Lack of adequate control group(s), 3) Lack of control for confounders, 4) Insufficiently described experimental design, 5) Insufficient statistical power, 6) Non-relevant outcome measures, 7) Non-consistency between reported results and conclusions.
CMT RAPPORTSERIE/CMT DISCUSSION PAPERS

(Reports with titles in English in brackets are only available in Swedish)

1986:1 P Carlsson, B Jönsson: Makroekonomisk utvärdering av medicinsk teknologi - En studie av introduktionen av cimetidin för behandling av magsär (Medical technology assessment in a macroeconomic perspective - A study of the introduction of cimetidine for treatment of ulcers)

1986:2 L-Å Levin: Betablockerear som profilaktisk behandling efter akut hjärtinfarkt - en samhällsekonomisk analys (Beta-blockers as prophylaxis after acute myocardial infarction - a cost-effectiveness study)

1986:3 B Jönsson: Prevention som medicinsk teknologi - hälsoekonomiska aspekter (Prevention as a medical technology - economic aspects)

1986:4 B Jönsson: Economic aspects of health care provision - is there a current crisis?

1986:5 B Jönsson: The economics of drug regulation


1986:7 S Björk, A Bonair: Att mäta livskvalitet (Quality of life measurements)


1987:5 B Jönsson: Ekonomiska konsekvenser av de nya behandlingsriktlinjerna för hypertoni (Economic consequences of new guidelines of hypertension


1987:7 J Persson, L Borgquist & C Debourg: Medicinsk teknik i primärvården. En enkätstudie riktad till vårcentraler och medicintekniska avdelningar (Medical devices in primary health care)
1988:1 J Persson (ed.): Innovation assessment in rehabilitation. Workshop proceedings
1988:2 C Debourg, L Borgquist & J Persson: Fördelning av hjälpmedel och kostnad på sjukdomsgrupp (Aids for disabled and costs related to groups of diagnoses)
1988:3 BJönsson, G Karlsson & R Maller: Ekonomisk utvärdering av antibiotika (Economic evaluation of antibiotics)
1988:4 Carlsson, P: Stötvågsbehandling av gallsten (ESVL-G) En konsekvensanalys av att införa ESLV-G i den sydöstra sjukvårdsregionen (Extracorporeal shock Wave lithotripsy treatment of biliary stones - A consequence analysis of an introduction of the technology in the south-east health care region)
1988:5 Carlsson, P: Extrakorporal stötvågslitotripsi vid behandling av njursten och gallsten (Extracorporeal shock wave lithotripsy in treatment of renal and biliary stones)
1988:7 Bonair, A: Spridning av medicinsk teknologi - en internationell jämförelse (Diffusion of medical technology - an international comparison)
1989:1 Persson J: Ethical codes in biomedical and clinical engineering - an international comparison
1989:2 Gerdtham U: Läkemedelsförsörjningen i Sverige (The Provision of Pharmaceuticals in Sweden)
1989:9 Jönsson, B: Medicinsk teknologi - utveckling, utnyttjande och utvärdering (Medical technology - development, utilization and assessment)

1990:1 Johannesson, M, Borgquist, L, Elenstål, A, Jönsson, B, Tilling, B: Läkemedels- och konsultationskostnad för hypertoni vid en vårdcentral (Hypertension treatment in an out-patient setting: the costs of drugs and physician visits)

1990:2 Johannesson, M, Jönsson, B, & Gerdtham, U-G: Kostnads-effektanalys av behandling mot högt blodtryck - en metodstudie (Cost-effectiveness analysis of hypertension treatment - methodological issues)

1990:3 Gerdtham, U-G: Den förändrade åldersstrukturens effekt på sjukvårdskostnaderna (Implications of the changing age structure on the health care costs)

1990:4 Jönsson, B: The cost of diabetes and the cost-effectiveness of interventions

1990:5 Johannesson, M & Jönsson, B: Cost-effectiveness analysis of hypertension treatment - methodological issues


1990:7 Johannesson, M, Borgquist, L, Jönsson, B & Råstam, L: Kostnaderna för behandling av hypertoni i Sverige - en analys av olika interventionsgränser och behandlingsmix (The costs of hypertension treatment in Sweden - an analysis of various intervention strategies and mix of treatment)


1991:4 Nordenfelt, L: Quality of Life and Health Promotion. Two Essays in the Theory of Health Care


1991:8 Rehnberg, C: Primärvård i privat entreprenad - En sammanfattning av ett års verksamhet i Norrköping. (Primary Care on contract - a summary of the first year in Norrköping)


1992:2 Persson, J (ed.): Advancing the role of biomedical engineering in health care technology assessment. Proceedings of a joint session organized by IFMBE (International Federation for Medical and Biological Engineering) and ISTAHC (International Society of Technology Assessment in Health Care), at the ISTAHC Eighth Annual Meeting, Vancouver, June 14-20, 1992


1992:7 Chowdhury, S, Persson, J. Videophones for Surgeon - Pathologist Consultations: A Pre-implementation Study

1993:1 Johannesson M, Jönsson B. Ekonomisk utvärdering av osteoporos prevention


1993:4 Karlsson G. Att mäta behandlingsresultat inom sjukvården. En teoretisk jämförelse mellan QALYs och HYEs. Arbetsskisse

1994:1 Garpenby P. Introduktion av metoder inom psykiatri in Blekinge, Västmanland och Östergötland - en jämförande studie


1994:4 Lindvall P, Karlsson G. Primärvård under kommunalt huvudmannaskap. En första bild av försöksverksamheten i Katrineholms kommun

1994:5 Rahmqvist M, Carlsson P. Ålder och andra faktors betydelse för ohälsa och vårdutnyttjande

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<td>De äldre östgötarnas levnadsförhållanden, hälsa och erfarenheter av hälso- och sjukvård</td>
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<td>Sambandet mellan kostnader för hjälpmedel och andra insatser för personer med funktionsnedsättningar</td>
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<td>Andersson A, Brodin H.</td>
<td>Rehabilitering/habilitering av döva och dövblinda med ytterligare funktionsnedsättningar - en ekonomisk pilotstudie</td>
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<td>1995:8</td>
<td>Jonsson D, Husberg M.</td>
<td>Hälsoekonomisk utvärdering av rehabilitering för personer sjukkrivna mer än 30 dagar. En jämförande studie i Östergötland</td>
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<td>Samhällsekonomiska aspekter på reumatisk sjukdom</td>
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<td>Holmberg H, Carlsson P.</td>
<td>Primärvård i privat och offentlig regi - En uppföljning av primärvårdsverksamheten i Norrköping</td>
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<td>Rahmqvist M, Bäckman K.</td>
<td>Landstingsenkät -95. Osttgöternas erfarenheter av primärvård, sjukhusvård och tandvård</td>
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<td>1996:4</td>
<td>Garpenby P.</td>
<td>Att omsätta psykiatrireformen i handling - en första redovisning från Östergötland</td>
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<td>Konsensusuttalande. God strokevård i Östergötland. Landstinget i Östergötland i samarbete med Centrum för utvärdering av medicinsk tekonologi</td>
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1996:7 Garpenby P, Carlsson P. Nationella kvalitetsregister inom hälso- och sjukvården - en uppföljande studie

1996:8 Lindvall P. Introduktion av nya teknologier vid behandling av schizofreni under perioden 1935 - 1990

1996:9 Bäckman K, Brodin H. Äldres färdjänstutnyttjande - bakgrundsfaktorer med exempel från Norrköping

1996:10 Rahmqvist M, Bäckman K. Östgötarernas hälsa, levnadsvanor och läkemedelsförbrukning


1996:12 Persson J, Brodin H. Prototype tool for assistive technology cost and utility evaluation


1997:1 Jonsson D, Husberg M. Utvärdering av olika vårdalternativ inom mödrahälsovården i Östergötland - Kostnader, vårdkonsumtion och vårdkvalitet


1997:5 Garpenby P, Lindvall P. Primärvård under kommunalt huvudmannaskap. CMTs analys av försöket i Katrineholm

1997:6 Jonsson D, Rahmqvist M, Husberg M. Psykiska besvär bland långtidssjukvård i Östergötland

1997:7 Lindvall P. Interna budgetöverenskommelser vid Lasarettet i Motala - Rationell styrning eller mode?

1997:8 Jonsson D, Husberg M. Samhällsekonomiska aspekter på användning av neuroleptika


1998:1 Lundh U, Sandberg J. De äldre östgötarernas levnadsförhållanden, hälsa och erfarenheter av hälso- och sjukvård


1998:4 Andersson A, Levin L-Å. Sjukvård i hemmet - en litteraturgenomgång
1998:5 Sennfält K. Kostnadsnyttoanalys av behandlingar vid kronisk njursvikt. En pilotstudie
1998:7 Jonsson D, Husberg M, Foldemo A. Hälsoekonomisk utvärdering av psykiatrireformen i Östergötland
1998:8 Garpenby P, Larsson SA. Att genomföra psykiatrireformen i vardagen - en uppföljande studie från Östergötland
1998:11 Öberg B, Funkesson K. En beskrivning av rehabiliteringskedjan mellan kommun och lantning i Östergötland. Patienters, anhörigas och personalens perspektiv
1998:12 Löfström L. Riskfaktorer och Resultat inom Hjärtkirurgin - från data till information och åtgärder. En introduktion till litteratur och metoder
1999:1 Rahmqvist M, Johansson G. Patienttillfredsställelse i öppen och sluten sjukhusvård i Östergötland 1997
1999:2 Hass U, Persson J. Utvärdering av ortoser och ortopedteknisk verksamhet
1999:3 Garpenby P, Larsson SA. Inställningen till vårdprogram bland personal inom barn- och ungdomspsykiatrin – en lägesrapport från Östergötland
1999:5 Jonsson D, Husberg M. Samhällsekonomiska kostnader för reumatiska sjukdomar
1999:6 Garpenby P, Larsson SA. Hälsoinformation via Internet, bibliotek och patientinformationscentraler – en systematisk litteraturgranskning
1999:7 Sennfält K, Carlsson P, Magnusson M. Kostnadsnyttoanalys vid behandling av kronisk njursvikt, med fokus på hämodialys och peritonealdialys
2000:1 Larsson SA, Schmidt A, Persson J. Dövblindas upplevelser och erfarenheter av projektet ”Nya möjligheter i arbetslivet”. Delprojekt för dövblindas inom EU-projektet Horizon
2000:3 Garpenby P, Husberg M. Hälsoinformation idag och i morgen. Östgötarnas användning av och förtroende för olika informationskällor
2000:4 Jonsson D, Husberg M. Samhällsekonomiska kostnader för reumatoid artrit och fibrömyalgia
2001:1 Lundh U. Äldres hälsa. En studie av befolkningen i Östergötland och Kalmar län
2002:1 Henriksson M, Carlsson P. Att mäta hälsorelaterad livskvalitet – en beskrivning av instrumentet EQ-5D
2002:3 Rahmqvist M. Nyttan av hörapparat och erfarenheter av hörselvården i Östergötland
2002:4 Husberg M, Larsson SA, Jonsson D, Persson J. Hälsökostnader för rehabilitering vid Smärt- och Rehabiliteringscentrum, Universitetssjukhuset i Linköping
2003:2 Liss P-E. Metoder för bedömning och rangordning av vårdbehov – En översikt
2003:3 Götherström U-C, Persson J. Instrumentet IPPA för resultatmätning vid arbetslivsrelaterad rehabilitering
2003:4 Bernfort L, Nordfeldt S. AD/HD och relaterade tillstånd hos barn och ungdomar. Epidemiologi, behandling och hälsoeffekter i Sverige, Norge och Danmark samt situationen i Östergötland
2003:5 Schmidt A, Husberg M, Bernfort L. Samhällsekonomiska kostnader för reumatiska sjukdomar
2003:6 Henriksson M, Carlsson P. Att läsa och kvalitetsgranska hälsoekonomiska modellstudier
2003:7 Garpenby P, Götherström U-C, Larsson, SA. Inställningen till vårdprogram bland personal inom barn- och ungdomspsykiatrin i Östergötland
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2004:3 Rahmqvist M. Kvalitet i vården ur patientens perspektiv: Variationer i betyg mellan olika patientgrupper och vårdenheter
2004:4 Henriksson M, Lundgren F. Screening för pulssäderbråck i buken - en hälsoekonomisk utvärdering
2005:1 Bernfort L, Persson J. Mobil videokommunikation för döva. Utvärdering av bruksnyttan
2005:2 Garpenby P, Husberg M. Hälsoinformation i vår tid. Östgötarnas användning av nya och gamla informationskällor

2005:3 Bernfort L, Nordfeldt S. AD / HD i ett samhällsekonomiskt perspektiv

2005:4 Bernfort L, Fernell E. Hur påverkas vardagslivet av ADHD och närliggande funktionsnedsättningar? Analys och sammanfattning av en enkätstudie riktad till riksförbundet Attentions medlemmar

2006:1 Bartha E, Kalman S, Carlsson P. Postoperativ smärtlindring - till vilket pris? En hälsoekonomisk modellanalys av två smärtlindringsmetoder


2006:4 Garpenby P. Procedurraltvisa och praktisk prioritering - tre fall från svensk hälso- och sjukvård

2006:5 Davidson T, Levin L-Å. Kostnaden för förmaksflimmer i Östergötland

2007:1 Garpenby P. Inställningen till vårdprogram bland personal inom barn- och ungdomspsykiatrin i Östergötland - en kompletterande intervjustudie

2007:2 Jacobsson F. Monetära ersättningsprinciper i hälso- och sjukvård

2007:3 Persson J, Husberg M, Hellbom G, Fries A. Kostnader och effekter vid förskrivning av rollatorer

2007:4 Rahmqvist M. Befolkningens hälsa och samhällets kostnader för vård och produktionsbortfall - Resultat från ULF-studien 1996 och 2005


2007:6 Arvidsson E, André M, Borgquist L, Carlsson P, Lindström K. Så resonerar läkare och sjuksköterskor vid prioriteringar av patienter i primärvård

2007:7 Hallert, E, Husberg M, Schmidt A, Jonsson D. Sjukdomsförlopp, kostnader och livskvalitet vid nydebuterad reumatoid artrit

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