An investigation of the effects of breakfast cereals on alertness, cognitive function and other aspects of the reported well-being of children

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Rationale: Previous research has shown that consumption of breakfast cereal improves alertness, cognition and other indicators of reported well-being. Further research is needed to determine whether such effects are observed in children consuming different cereal products. The aim of the present study was 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.

Subjects and methods: Two hundred and thirteen children, (108 female, 105 male; mean age, 8.11 years, SD 2.04 years), recruited from schools in Cardiff, participated in the study. Baseline measures of breakfast consumption and different aspects of reported well-being (mental health, cognitive functioning, alertness, physical health, and digestive problems) were recorded. Following this, children were allowed to try three cereals and selected the one that they found most acceptable (63 chose Cornflakes; 63 Rice Krispies; and 53 Rice Krispies Multigrain). These groups consumed these cereals on a daily basis for 2 weeks. Measures of well-being were recorded on days 7 and 14. The breakfast cereal groups were compared with 34 children who consumed no breakfast.

Results: The baseline results showed that those who consumed breakfast cereal were perceived as having better well-being (fewer mental health problems, a more positive mood, higher alertness and fewer bowel problems) than those who did not consume breakfast. This was confirmed in the intervention study with breakfast cereal consumption being associated with reports of lower depression, emotional distress and fatigue, greater alertness, fewer cognitive problems, and fewer minor symptoms and bowel problems. These effects were apparent after both the first and second week. They were also observed for all cereals.

Conclusions: Overall, the results of this study show that breakfast cereal consumption by children is associated with greater well-being.

Keywords: breakfast cereal, children, cognition, alertness, well-being
Introduction

Smith has discussed the relevance on the concept of well-being in nutrition research. The concept of well-being has become increasingly important since the acknowledgement that there is more to health than the absence of disease. In some areas of research, well-being has been replaced by ‘quality of life’ or some other term that relates to the ability to function well (both physically and mentally) and to have a positive mood state. In the area of nutrition, the term ‘functional food’ is widely used and this refers not only to the beneficial effects related to chronic disease but to potential improved well-being. Consumption of breakfast has been shown to be associated with various aspects of the multidimensional concept of well-being and some examples are given in the following section.

Studies of breakfast consumption and well-being can be sub-divided into three main types. The first type of study has examined the acute effects of breakfast on alertness, other aspects of mood and cognitive functioning. Such research has shown that consumption of breakfast in general, and specifically breakfast cereal, can increase alertness and other positive aspects of mood, and also improve memory. These effects have been demonstrated both in adults and school children. A second set of studies have looked at longer-term interventions (e.g. school breakfast programmes) and shown beneficial effects, especially in children with existing nutritional deficiencies. It should be noted that there have been studies which have failed to demonstrate these effects of breakfast and further research must clarify the underlying conditions that are essential for benefits to occur.

A third group of studies has examined associations between breakfast habit and self-reported measures of well-being. Results from these studies show associations between breakfast consumption and mental well-being (fewer mental health problems, a more positive mood, and better cognitive functioning). These effects have been demonstrated in samples ranging in age from young adults to the elderly. The present study aimed to extend this approach by initially examining associations between breakfast cereal consumption and the well-being of 8-year-old children. This requires adults to report their perceptions of children’s behaviour, a technique which is widely used in other areas and which has been used to demonstrate beneficial effects of breakfast consumption at school. The problem with cross-sectional studies is that it is difficult to infer causality. Intervention studies are now required to examine causality and the methodology has been developed to investigate changes in well-being that can be demonstrated after even a short intervention period. For example, Smith et al. showed that cross-sectional analyses indicated that those individuals with a high fibre diet reported better well-being than those with a lower fibre intake. A subsequent intervention study lasting 2 weeks showed that high fibre breakfast cereal led to report of greater energy. Cross-sectional results may also reflect biases in reporting. An advantage of intervention studies is that they can covary baseline scores which removes any general bias. The second aim of the present study was to conduct an intervention study of a similar length to determine whether high carbohydrate breakfast cereals were also associated with a perceived increase in the well-being of children.

Despite the large literature on associations between breakfast consumption and well-being, and the growing information about general effects of breakfast cereal, there is little information about effects of specific products. The final aim of the present study was to investigate whether children’s breakfast cereal consumption was associated with greater well-being and whether an intervention study with three types of breakfast cereal would lead to perceived improvements in the various dimensions of well-being. One method of achieving this would be to assign children randomly to the no breakfast or one of the breakfast cereal conditions. This method has two potential problems. First, given that evidence suggests that breakfast consumption is beneficial, one might suggest that it would be unethical to stop children consuming breakfast (i.e. allocate consumers to the non-consumption condition for 2 weeks). Second, random allocation does not consider the issue of acceptability of the breakfast product. To address these problems, children in the study were only assigned to the no breakfast condition if they were regular non-consumers. Those in the cereal conditions consisted of consumers and non-consumers who selected their breakfast cereal of choice and consumed this for two weeks. Parents’ perceptions of the children’s behaviour were recorded using similar questionnaires to those used in previous studies of this topic.

Subjects and methods

The present study received ethical approval from the
ethics committee, School of Psychology, Cardiff University.

Participants
The volunteers were recruited from schools in the Cardiff area. The head teacher from each school was contacted personally and their permission to access pupils, via their parents, was requested. The head teacher was asked for informed consent before any approach to parents was made. Parents were invited to contact the Centre if they wished to be considered for the study.

The aim was to recruit approximately 200 child volunteers who were assigned to one of four conditions, namely Cornflakes, Rice Krispies, Rice Krispies Multigrain, and a no breakfast condition. Participants received compensation at a rate of £50 per individual taking part, and each participating school also received a single compensation payment of £150.

Recruitment
Recruitment was in the form of an advertisement for volunteers in the School Newsletter. Those who respond to the advertisement and fulfill the inclusion and exclusion criteria (see below) were recruited consecutively.

Exclusion criteria
Exclusion criteria were: (i) an existing disease or long-term medication; and (ii) relevant food allergies.

Inclusion criteria
Participants had either to: (i) be willing to consume the allocated breakfast cereal every day for 14 days; or (ii) if a non-breakfast consumer, be willing to continue to abstain from eating breakfast for 14 days. In addition, the children had to attend primary school and each participating family had to consist of at least one adult (to complete the questionnaires) and one eligible child.

At the beginning of the study, each child was given an opportunity to try the available cereal at the meeting with the research team prior to the start of the study. Nobody taking part in the study was expected to eat cereal that was not acceptable to them.

The no breakfast condition was made up entirely of children who did not normally eat breakfast. No child who normally ate breakfast was asked to abstain from breakfast. The parents of those children interested in taking part completed a simple screening questionnaire over the telephone to check these exclusion/inclusion criteria before being recruited to the study.

Informed consent
Consent was given by each head teacher who agreed to take part before any parents were approached. Consent was obtained from one adult from each family on behalf of their child or children before commencement of the study.

Design
A 'separate groups' design was used with the volunteers consuming the different breakfast cereals (or no breakfast) for 14 days.

Procedure
One of the problems of studying well-being in young children is that they cannot easily complete questionnaires. A standard method of overcoming this problem is to get parents to observe the children and then complete questionnaires. At the start of the study, adult volunteers completed a baseline questionnaire for their children. Child participants then consumed the chosen breakfast cereal or no breakfast for 14 consecutive days. Adult participants rated their child's well-being by completing questionnaires every 7 days. They also rated their child’s alertness levels before and after breakfast on the first, seventh and last day of the study.

Breakfast cereals
Three high carbohydrate cereals were used in the present study: Cornflakes (372 kcal per 100 g; 84 g carbohydrate, 0.9 g fat, 7 g protein), Rice Krispies (381 kcal per 100 g, 87 g carbohydrate, 1 g fat, 6 g protein), and Rice Krispie Multi-Grain (370 kcal per 100 g, 76 g carbohydrate, 8 g protein, and 3 g fat). A pilot study had shown that at least one of these would be highly acceptable for a child and the products were, therefore, used for this reason. Children were allowed to add milk and sugar to taste (these amounts were not recorded). Similarly, they were not restricted to a specific time of eating the cereal and they were also free to consume the amount they wanted. Previous research has shown that these contextual factors cannot account for the effects of breakfast cereal (e.g. beneficial effects can be seen with cereal bars which rules out a major role of milk or sugar). Variation due to such factors would be added to the between subject error term which, if important, would weaken any effect of the cereal.

Questionnaire measures of well-being
The questionnaire measures of well-being are shown in Table 1. Selection of these measures were based on prior research with young adults. Most of the
breakfast cereals and well-being of children

measures are self-explanatory. In the case of alertness, bi-polar adjectives (e.g. Drowsy–Alert) were used to rate alertness and a total score (the higher the score the more alert the child) used in the analyses. Cognitive difficulties reflected problems of memory, attention and action. Bowel problems measured included constipation, diarrhoea, vomiting and flatulence (these were scored in terms of presence/absence, with higher scores reflecting more problems).

The final sample
In total, 143 families participated in the study (these families were generally middle class, as indicated by the occupation of the parents). Overall, 213 children completed the study (51% were female, and the mean age was 8.11 years, SD 2.04). There were 34 in the no breakfast condition, 63 in the Cornflakes condition, 63 in the Rice Krispies group and 53 in the Rice Krispie Multi-Grain group. There were approximately twice as many in the cereal conditions because it was expected that any differences between the cereals would be smaller than the ‘no breakfast’ versus cereal comparison.

Results

Baseline data
Initial analyses compared the baseline perceptions of well-being data of those who regularly ate breakfast cereal with those who did not regularly consume breakfast. The results of these analyses are shown in Table 2 and it can be seen that regular consumption of breakfast cereal was associated with greater alertness, lower levels of anxiety and depression, a more positive mood and fewer bowel problems (problems of constipation, diarrhoea, vomiting and flatulence). This confirms results obtained from self-report of other age groups.

Intervention data
Analyses of co-variance, with the baseline data as co-variates (to control for the differences observed at baseline), were carried out on the questionnaire data at days 7 and 14. These analyses examined differences between the control and cereal groups at these time points. These results are shown in Tables 3 and 4. One-tailed levels of significance were used if results at day 14 replicated significant findings at day 7.

The day 7 and 14 results were very similar in that breakfast cereal consumption was associated with greater well-being as shown by significant effects on a large number of the measures. These beneficial effects of breakfast cereal was significant for all three products. In summary, breakfast cereal consumption

Table 1 Questionnaire measures of well-being

<table>
<thead>
<tr>
<th>Measure</th>
<th>Questionnaire</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alertness</td>
<td>Bi-polar visual analogue scales</td>
<td>Smith et al.13</td>
</tr>
<tr>
<td>Cognitive difficulties</td>
<td>Profile of fatigue-related symptoms</td>
<td>Ray et al.32</td>
</tr>
<tr>
<td>Anxiety</td>
<td>Hospital Anxiety and Depression Scale</td>
<td>Zigmond &amp; Snaith34</td>
</tr>
<tr>
<td>Depression</td>
<td>Hospital Anxiety and Depression Scale</td>
<td>Zigmond &amp; Snaith34</td>
</tr>
<tr>
<td>Emotional distress</td>
<td>Profile of fatigue-related symptoms</td>
<td>Ray et al.35</td>
</tr>
<tr>
<td>Fatigue</td>
<td>Profile of fatigue-related symptoms</td>
<td>Ray et al.35</td>
</tr>
<tr>
<td>Somatic symptoms</td>
<td>Profile of fatigue-related symptoms</td>
<td>Ray et al.35</td>
</tr>
<tr>
<td>Positive mood</td>
<td>Mood</td>
<td>Zevon &amp; Tellegen35</td>
</tr>
<tr>
<td>Negative mood</td>
<td>Mood</td>
<td>Zevon &amp; Tellegen35</td>
</tr>
<tr>
<td>Symptoms</td>
<td>Symptom check-list</td>
<td>Smith et al.31</td>
</tr>
<tr>
<td>Bowel problems</td>
<td>Digestive function</td>
<td>Smith et al.31</td>
</tr>
</tbody>
</table>

Table 2 Baseline data – breakfast cereal consumption and well-being

<table>
<thead>
<tr>
<th>Measure</th>
<th>Breakfast cereal (n = 83)</th>
<th>No breakfast (n = 57)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alertness before breakfast</td>
<td>450 (17)</td>
<td>419 (22)</td>
</tr>
<tr>
<td>(P &lt; 0.05; Cohen’s d = 0.19)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alertness after breakfast</td>
<td>637 (10)</td>
<td>590 (20)</td>
</tr>
<tr>
<td>(P &lt; 0.05; Cohen’s d = 0.42)</td>
<td></td>
<td></td>
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<tr>
<td>Positive mood</td>
<td>45.4 (0.7)</td>
<td>41.3 (1.1)</td>
</tr>
<tr>
<td>(P &lt; 0.01; Cohen’s d = 0.54)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative mood</td>
<td>9.6 (0.7)</td>
<td>13.0 (1.2)</td>
</tr>
<tr>
<td>(P &lt; 0.01; Cohen’s d = 0.44)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bowel problems</td>
<td>1.7 (0.2)</td>
<td>2.8 (0.4)</td>
</tr>
<tr>
<td>(P &lt; 0.05; Cohen’s d = 0.45)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anxiety</td>
<td>2.9 (0.3)</td>
<td>4.1 (0.4)</td>
</tr>
<tr>
<td>(P &lt; 0.05; Cohen’s d = 0.44)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depression</td>
<td>0.7 (0.1)</td>
<td>1.8 (0.3)</td>
</tr>
<tr>
<td>(P &lt; 0.001; Cohen’s d = 0.64)</td>
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<td></td>
</tr>
</tbody>
</table>

Scores are the mean with SE in parentheses; high scores = greater alertness, a more positive mood, etc. Effect sizes are shown as Cohen’s d statistics.
was associated with perceptions of greater alertness, fewer cognitive failures, lower depression, emotional distress and fatigue, and fewer minor symptoms and bowel problems.

### Discussion

The present study has extended our knowledge of the beneficial effects of breakfast cereal on well-being by...
showing that three different types of cereal increase a number of aspects of well-being. There were no differences between the cereals but all were significantly different from the no breakfast condition. Medium effects sizes were generally present (average Cohen’s d = 0.56 at day 7 and 0.5 at day 14). This has been demonstrated using a sample of young children and the present intervention confirms the association seen in the cross-sectional baseline data. Benefits were seen for perceptions of alertness, cognitive functioning, mental health, mood, and physical health (both general symptoms and specific bowel functioning). These functions are important in every day life and are also linked to the future risk of disease. For example, mental health problems have been shown to be risk factors for cardiovascular disease and cancer in later life. Consumption of breakfast cereal would appear to be a simple method of optimising current well-being which may also reduce the chance of future disease.

It is likely that multiple mechanisms underlie the effects obtained here (see Gomez-Pinilla for a review of the effects of nutrients on brain function). In the short-term, effects of glucose and insulin may be important. Changes in neurotransmitters such as serotonin may also underlie the beneficial effects of high carbohydrate cereals on mental health. In addition, there may be other changes, such as those due to inflammation, that have still to receive further attention. From an applied point of view, the present findings have enormous practical implications. Provision of carbohydrate has been shown to have beneficial effects in extreme real-life situations (e.g. sustained physical activity) and it is now important to extend this research to consider operational efficiency at work, in every day activities such as driving, and in educational settings. It is also important to continue to examine effects across the life span and to look not only at beneficial development in children but also possible reductions in the decline in well-being observed in the elderly.

Acknowledgement

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References


