

**ICH&HPSY 2020****5<sup>th</sup> International Conference on Health and Health Psychology****COGNITIVE IMPACT OF BREAKFAST CONSUMPTION ON  
SCHOOL AGE CHILDREN AND YOUTH**

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**Abstract**

The literature has shown a positive impact of breakfast on cognitive performance of school-age children and youth, although this meal is often omitted by young people. This study reviews 30 previous studies, focusing on this population, published in PubMed and MEDLINE databases until September 2019. To allow the integration of the largest possible number of published studies in this analysis, the search terms had to be as comprehensive as possible. Breakfast, cognitive impact, children, and youth were the terms chosen. The main conclusions are that the differentiated effects on the several dimensions of cognition (attention, memory, aptitudes and school performance, among others) also depend on the variables and instruments used, on the population background and characteristics, and on the study conditions. Evidence also shows the difficult to isolate the direct effects due to the confounding variables. Despite some results where the relationship between breakfast and cognition is far from obvious, the existence of this effect (often mediated by individual and contextual variables) is clearly more evident than the mechanisms by which it manifests itself. So, scientific evidence plays a crucial role in the search for the ideal breakfast and to prove the importance of making breakfast a vital daily habit. Studies point to a greater visibility of consequences in processes that are more likely to trigger short-term influences.

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*Keywords:* Breakfast, cognition, school performance, children/youth



## 1. Introduction

The increasing attention that the literature has been giving to food, specially to food consumption, as an element of people's quality of life, justifies increasingly specific and detailed scientific incursions. Thus, research proliferates looking for effects beyond the usual patterns as the impact of the specific characteristics of the food ingested, in terms of macro and micronutrients.

This is the framework of this review about the cognitive impact of breakfast on children and youth. Nowadays, there are no doubts about the beneficial effect of the first morning meal to restore people's metabolic levels after a long fasting period. On the other hand, there are several references that associate the positive influences of such meal with cognitive growth and development, improvements in information processing skills (attention/concentration, memory, etc.) and school learning (Chitra & Reddy, 2007). Nevertheless, current data show an increase in people who skip or seldom have breakfast (Alexy et al., 2010; Chitra & Reddy, 2007; Lien, 2007), meaning an urgent need for social measures and for policies meant to raise awareness and promote a healthy breakfast consumption that will adequately respond to the specific needs of any person, at any time.

The objectives of eating habits and food consumption, associated with the differentiated effects they have on each age group, that may influence the composition and nutritional value of the ingested food, and the conviction that they will have a lifelong effect on children and youth development, justify the growing concern in studying the importance of breakfast intake. The literature gives greater prevalence to studies conducted on children and youth, particularly on the former. This interest can be understood and justified by the associated factors to the characteristics of child development (faster and more intense physical and cognitive transformations), by the knowledge about the early acquisition of long-lasting habits, and also by the availability of school population.

The complexity of cognitive performance, given the diversity of the associated constructs, hinders the analysis in this field. Besides, the efforts to successfully achieve a synthesis process give rise to even bigger difficulties. Thus, given the diversity of cognitive processes involved, we chose a classification that would facilitate the presentation/organization of information and that includes the attention/concentration, memory, cognitive aptitudes, and school performance dimensions. Those dimensions are bound together by a common, unifying element that focuses on relevant aspects to the main activity of the selected population, i.e., on activities such as information processing and school learning that play a crucial part in any student's life.

The studies reviewed refer to the breakfast consumption effect on cognition in school-age children (aged 6 or older), regardless of their education level, nationality, or socio-cultural background. In fact, diversity may be useful to ensure the results consistency through limited methodological processes based on the use of non-representative samples or when other experimental research conditions are not totally ensured.

The search was conducted using the PubMed and MEDLINE databases, until September 2019, and used the following search terms: breakfast, cognitive impact, children, and youth. A total of 228 references was extracted. The amount of references dropped to 115 once duplicate publications were removed. After the application of the exclusion criteria, namely papers on school-based breakfast programs, review papers that did not involve school-age population, or variables related to conditions that did not include the

Glycemic Index (GI), or the presence/absence of breakfast consumption, the results fell to 46 references. The review ended up including the 30 papers that were available at the time and could be accessed).

## **2. Problem Statement**

The literature has shown the positive impact of breakfast on the cognitive performance of school-age children and youth. It is interesting to know the cognitive dimensions that were pointed out.

## **3. Research Questions**

What are the cognitive dimensions that the literature relates to the breakfast regular consumption? What are the mechanisms by which it manifests itself? There is an ideal breakfast?

## **4. Purpose of the Study**

This revision study aims to identify the relationship between daily breakfast consumption and the cognitive dimensions (attention, memory, aptitudes, and school performance) in school age children and youth. Additionally, we reflect about the composition of the breakfast and the time (short or long) of this effect.

## **5. Research Methods**

This study reviews 30 previous papers focusing on children and youth, published in PubMed and MEDLINE databases. We considered all the documents published until September 2019. To allow the largest possible number of published studies in this analysis, the search terms laid out had to be as comprehensive as possible. Breakfast, cognitive impact, children, and youth were the terms chosen.

## **6. Findings**

### **6.1. Metabolic effects of breakfast and cognitive functions**

Data on the breakfast consumption effects on cognitive performance contrast with the limited information available about the processes that will cause such effects. Nevertheless, there is a general awareness of the metabolic mechanisms triggered by macro and micronutrients and of the nutritional impact on the individual's healthy growth and development (Benton, 2010) and on the proper brain functioning, a prerequisite for an efficient cognition. It is known, for example, that the extension of fasting has metabolic consequences associated with the gradual decline in blood glucose and insulin concentration, among others, that may interfere with cognitive function (Lien, 2007; Rampersaud et al., 2005). This means that glucose is considered the first substrate of brain activity (Bellisle, 2004). In fact, there is evidence of compensatory benefits from the consequences of the breakfast omission, through carbohydrate supplements (Morris & Sarll, 2001). Moreover, the study of the grazing effect (small and frequent meals) has shown the positive impact of this eating condition on verbal reasoning (Hewlett et al., 2009), a finding that may reinforce that argument. On the other hand, some studies have shown that foods that have low Glycemic Index (GI) are

better for cognitive performance than high GI foods (Brindal et al., 2012; Cooper et al., 2012; Ingwersen et al., 2007; Micha et al., 2010; Micha et al., 2011; Wesnes et al., 2003). In the United Kingdom, for instance, 64 children (age 6 to 11) assessed after a breakfast with low GI, showed improvements in attention, while there was a decrease in the secondary memory of those who had a high GI breakfast when compared to those who had a low GI breakfast (Ingwersen et al., 2007). The explanation, according to the authors, may have to do with the fluctuations in blood glucose concentration caused by high-GI foods. Wesnes et al. (2003) obtained identical results with 22 British children and youth aged 9-16 years. The same happened in a study carried out by Mahoney et al. (2005) on short-term memory, in American children aged 9 through 11 years.

Cooper and collaborators (2012) have also found cognitive benefits provided by breakfasts with low GI (vs. high GI breakfasts and skipping breakfast) to improve cognitive tasks that involve attention, working memory and Stroop effect (the ability to inhibit the cognitive interference of a specific stimulus while simultaneously processing a second stimulus). However, a study with 39 Australian children, mean age of  $11.6 \pm 0.7$  years, found no significant differences in the cognitive function caused by the level of GI of the ingested breakfast. The study conducted by Micha et al. (2011), that involved 74 children from the United Kingdom aged 11-14 years, showed a higher predictive value for declarative verbal memory in a breakfast with low GI. The literature also points out the mediating role of the interaction between individual differences in glucose tolerance and the glycemic load contained in breakfasts (Nabb & Benton, 2006).

The brain is also sensitive to variations in other nutrients, especially iron, iodine, vitamins A and C, and folic acid, whose ideal levels are associated with breakfast consumption. The brain won't be able to replace those nutrients throughout the day, if children or youth choose to skip breakfast (Micha et al., 2010). Having breakfast daily is therefore essential to ensure healthy nutritional status that is responsible for a better cognitive performance, despite malnutrition often appear associated with multiple socioeconomic and demographic parasitic variables. However, the adverse effects of nutritional deficit are more visible in developing than in industrialized and developed countries (4).

There is large evidence that the blood glucose value (glycemia) influences memory and that, on the other hand, macronutrients affect the release of glucose into the blood stream. However, very few studies have focused on the effects of the different macronutrients on glucose removal rates. Consequently, little is known about the composition of the breakfast one would recommend improving a child's memory performance. One of the most important conclusions of the literature (Rampersaud et al., 2005) establishes a link between better memory and low glucose levels and better blood glucose tolerance. In addition, the increased memory capacity has been shown to be related to the consumption of low-calorie meals (low in protein, fat, and carbohydrates) that produce small increases in blood glucose.

The previously research highlight the heterogeneity of breakfast conditions, often influenced by the food industry and that implies the use of industrial nutrient complexes instead of other food sources (fruit, bread, milk, etc.). There are also different situations, in which breakfast is qualitatively (variety in nutritional composition) and quantitatively operationalized (presence or absence). This also contributes, together with contradictory or inconclusive results and the individuals' specific needs (e.g., gender and age) that have a mediating power over the metabolic effect of breakfast (Mahoney et al., 2005) to the no

consensual opinion of the composition and quantity of the ideal breakfast (although some sources of nutrients are recommended).

## **6.2. Effects of breakfast on attention/concentration**

Over the years, many studies have been developed to prove the positive effect of breakfast on attention/concentration. Despite that tendency, other interactive and mediating variables are emerging. A Germany study by Widenhorn-Muller et al. (2008), involving 104 subjects aged 13-20 years, shows the existence of higher concentration levels among male students who have breakfast daily. In another study, involving 30 Americans aged 9 -11, skipping breakfast had an impact on the decrease of the students' auditory attention but had no significant effect on their visual attention (Mahoney et al., 2005). Gajre et al. (2008), with 379 Indian children (11-13 years old), concluded that there is evidence of better attention/concentration performance among those who have breakfast on a regular daily basis, compared to those who have breakfast from time to time or skip it. In the United Kingdom, among 1386 children and youth aged between 6 and 16, those who had breakfast did better in their attention span tests (Wesnes et al., 2012). Still in the United Kingdom (Fulford et al., 2016), but with opposing results, 22 children, aged 12-14, did not show any significant improvement in their attention span, before and after they had breakfast.

Generally, the diversity of study conditions may explain the heterogeneous results obtained, however there seems to be a tendency to come across differences associated with other variables beyond having or not breakfast.

## **6.3. Effects of breakfast on memory**

Memory emerges as one of the most frequently used dependent variables in research studies focusing on this sort of topic, while exploring its different contents (visual memory, semantic memory, episodic memory, spatial memory, short-term and long-term memory) specifically assessed. The evidence shown the breakfast protective effect in this cognitive variable, as well as the negative consequences of fasting in children and young people (Mahoney et al., 2005; Wesnes et al., 2003).

Widenhorn-Müller et al. (2008), in a German study including male youth and young adults (aged 13-20), showed the positive effect of having breakfast daily and the negative effects of skipping breakfast on short-time memory (visual and verbal). A research conducted with 30 American children (9-11 years old) points out worse results in children's memory span tests when they had skipped breakfast. Those findings were influenced by gender (breakfast intake seemed to benefit both genders' spatial memory; breakfast consumption improved girls' short-term memory but not boys') and by age (better the younger in children's spatial memory) (Mahoney et al., 2005).

Wesnes et al. (2012) concluded that memory span results were better among British children and youth who have breakfast daily. Another finding in a study conducted with 434 students (5-9 years old) who were attending a public school in Jordan evidenced a significant 2.53 increment in a standardized memory test, as a consequence of eating breakfast daily (Almomani et al., 2018).

On the other hand, Fulford et al. (2016) found no breakfast impact on memory. The same happened in another research, where the students' short-term memory was not affected by the breakfast consumption habits (Iovino et al., 2016).

#### **6.4. Effects of breakfast on aptitudes**

Despite the progressive increase (qualitative and quantitative) of research, the influence of breakfast on aptitudes remains unclear and sometimes evidences mixed or conflicting results. This may be due to the diversity of cognitive tasks contents (numerical, figurative, abstract, verbal and spatial) and with the achievement processes (understanding, perception, reasoning, etc.) that help the development of someone's aptitudes. However, most evidence seem to confirm the beneficial effect of breakfast consumption on the different aptitudes (mostly verbal and numerical), visual perception and reasoning. Additionally, those that refer to null or even negative effects are quite scarce.

In Venezuela, a study involving 68 children aged 9-10 years who were attending a private school concluded that breakfast consumption has a positive impact on logical reasoning (Marquez Acosta et al., 2001). Mahoney et al. (2005) conducted a research with two groups of American children (n=30 per group) of different ages (6-8 years and 9-11 years), and three different breakfast conditions (oat flakes and skimmed milk, ready-to-eat cereals and no breakfast). The children who did not have breakfast obtained worse results in visual perception tests, assessed four times a week, while Pollitt et al. (1982) concluded that 34 American children (aged 9-11 years) who had their breakfast daily perform better than those who skip it.

In the United Kingdom, Cooper et al. (2011) concluded that breakfast consumption had a positive impact on the simple and complex visual-motor aptitudes, working memory and Stroop effect of 96 adolescents aged between 12 and 15, compared with students who tend to skip breakfast. On the other hand, a study with 468 children (6-12 years), developed in Jordan, revealed a positive influence of breakfast regular consumption on the increase of cognitive skills (temporal and spatial orientation and visual and spatial perception), compared to those who do not have breakfast daily (Almomani et al., 2014).

In contrast, a study involving 292 school-age children (11-13 years) conducted in the United Kingdom (Adolphus et al., 2015) found no positive predictive value of frequent breakfast consumption (5-7 times a week) for verbal or nonverbal reasoning. Once again in the United Kingdom, a research with 128 children (8-10 years) points out no differences in cognitive processing speed and verbal learning in those who have or have not breakfast (Iovino et al., 2016).

Concluding, the cognitive aptitudes content tends to be positively affected by regular breakfast consumption, although sometimes the effect is mediated by the global nutritional status rather than by breakfast consumption alone. We should stress that this cognitive process has a longer developmental period, and therefore the effects may not be noticed in short-term situations.

Generally, this set of studies stresses the existence of positive results that will be obtained over longer interventions and that will foster more solid and lasting cognitive contents and that are less susceptible to be influenced by temporary agents or variables.

#### **6.5. Effects of breakfast on school performance**

The objective dimension of school performance (school grades) hides a multifaceted reality where interact factors relating to students (individual, family, and social background) and to school (school community and education system). So, isolating the breakfast consumption variable and understanding its impact on students' school performance is a task that requires some caution. However, we believe that the

positive relationships between these variables are mediated by the positive impact of breakfast on the children's cognitive skills, deemed crucial for their learning. Once again, the evidences are carried out under different conditions, but, mainly included in one of three groups: breakfast consumption frequency (how often they have breakfast a week, breakfast or no breakfast), breakfast nutritional quality (its composition and energy value) and the children's participation in school breakfast programs. We are interested in those into the first group.

A study carried out in Jeddah, Saudi Arabia (Abalkhail & Shawky, 2002), with 800 students (47.0% male), aged 9 to 21 years ( $M=14.0\pm 2.6$ ), found out that the highest percentage of students with the lowest school results was found among those who didn't have breakfast. Lien(3) conducted another research that involved 7305 Norwegian students who were between 5 and 16, over 2 school years and showed highest school results in students who have breakfast daily. Likewise, Gajre et al. (2008) concluded that regular breakfast consumption has a positive effect on school results. His study involved 379 Indian students (aged between 11 and 13 years), in an ex post facto design, whose assessment on a single day was based on regular, irregular breakfast consumption and no breakfast. Again, in Thailand (Ho et al., 2015), daily breakfast consumption was a differentiating factor of school performance among 2401 elementary school children. Another study conducted in the United Kingdom (Littlecott et al., 2016) that involved children between 9 and 11 years who were assessed twice (3093 - base and 3055 - follow-up - 6 to 18 months later) in Mathematics, Science and English tests, found significant associations between these performances and regular breakfast consumption, stronger in the follow-up assessment.

## 7. Conclusion

The positive impact of breakfast consumption on cognitive and school performance is provide by scientific evidence. Most of the studies are conducted with children and youth and the most significantly improve is in populations with nutritional deficiency (Benton, 2010).

This review led us to conclude that many of the beneficial effects of breakfast consumption on cognition are more consistently observed in variables that are most likely to be influenced in the short term, such as immediate memory and attention span. It is also true that these are basic processes that can have an impact on other performances (aptitudes, school results, etc.). These results reflect a greater quantitative investment of research in these studies, since other processes would require longer assessments that would lead to solid cognitive changes. In fact, talking about performance or cognitive development is quite different. The former is mostly related to circumstantial performances, although it depends on the latter.

Cognitive complexity, which hinders the isolated effects and the comparison between studies, together with the diversity of study conditions (construct, variable control, forms of assessment, designs, samples, statistical techniques, etc.) explain the multiplicity of results. However, the accuracy and considerable size of some samples lend the positive results of regular breakfast consumption a large degree of reliability and consistency.

Regardless of the unquestionable need for replication, methodological improvements, long-term impact studies or of the clarification of the procedures through which the effects are felt, and taking advantage of the huge development of statistical software, there is no doubt about the importance of promotional, political, social and educational measures that would make breakfast consumption a

generalized habit among children and youth. Additionally, this revision provides scientific data to inform nutrition education strategies.

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