

# The Role of Breakfast in Brain Development and Function

The common expression “brain food” underscores the important role of nutrition in the formation and fueling of the brain.

The human brain is a remarkable organ – it represents 2% of adult body weight, yet is the most metabolically active

body organ. The brain has limited capacity to store energy and therefore relies on energy and nutrients from the food we eat to help it develop and function. Interestingly, research on cognitive performance in school children suggests that an adequate diet – more specifically, a diet including breakfast – may also improve brain function.



# Energy and Nutrient Needs of the Growing Brain

The brain develops rapidly during the first two years of life and reaches its adult size between six and 14 years of age. The brain of a child is larger relative to total body size and utilizes more energy than that of an adult. The rapid growth of the brain supports the notion that adequate nutrition is important throughout childhood.

An early study investigated the relationship between glucose utilization and structural development in the brain.<sup>1</sup> The study hypothesis was that cerebral glucose utilization would be elevated in areas where the brain is actively growing, and could thus indirectly identify areas of structural development. Using positron emission tomography, results showed that cerebral glucose utilization is elevated in neonatal brains, but it is also high in children from the age of four to 10 years; and levels do not decline to adult values until 16 to 18 years. Based on this evidence, it was concluded that the brain continues to grow with heightened energy needs well into adolescence.

In addition to the vital role of food energy, several nutrients have important roles in developing the brain, including protein, iron, zinc, selenium, iodine, folate, vitamin A, vitamin B12, vitamin D, choline and long-chain polyunsaturated fatty acids. In review papers on this topic, experts conclude there is strong evidence for the role of nutrition and brain development from studies of preterm infants or children in developing countries.<sup>2,3</sup> Protein-energy malnutrition sustained beyond the first year of life or deficiency of specific nutrients at critical periods of brain growth may also have lasting effects on brain development, and ultimately cognitive function.<sup>3</sup> The evidence in industrialized countries is not as clear because severe malnutrition is uncommon and any effects of poor nutrition on brain development may be less apparent.<sup>3</sup> However, diet can have potential influence. In industrialized countries, research is on the role of nutrition and brain function rather than development. In this area of work, there is specific focus on breakfast and cognitive performance.

## Breakfast is “Brain Food”

Given that breakfast provides immediate fuel and nutrients for utilization by the brain after an overnight fast, it is not surprising that this meal has been widely studied in an effort to understand the relationship between nutrition and brain function. The bulk of this research has focused on the effect of breakfast on cognitive function using outcome measurements such as academic performance, school attendance and mood in children or adolescents, primarily in schools and other institutional settings. The reasoning is that breakfast skippers would have lower blood glucose and insulin concentrations (along with other metabolic differences) than breakfast consumers during the morning hours; and these differences could thus interfere with certain brain functions. A landmark review of this topic concluded that the available data suggest cognitive function is sensitive to short-term variations in the availability of nutrient supplies.<sup>4</sup> It has also been summarized that skipping breakfast interferes with cognition and learning, and effects are more pronounced in nutritionally at-risk children than in well-nourished children.<sup>5</sup>



### Food for thought...

Breakfast contributes to immediate and long-term nutritional status.

Research in children and adolescents has shown that nutrients missed by skipping breakfast are not made up over the day, and breakfast skippers are more likely to fail to meet recommended intake levels of vitamins A, B6, and D, calcium, magnesium, riboflavin, folacin, zinc, phosphorus and iron.<sup>6</sup> Some of these nutrients – vitamins A and D, zinc and iron – have also been identified as having a key role in brain development.

Almost 20% of children under 18 skipped breakfast in Canada in the past two years.<sup>7</sup>

## Some Key Studies on Breakfast and School Performance

- In an early randomized control trial, Vaisman and colleagues measured the effect of breakfast timing on cognitive function in school children (n=569, 11-13yr).<sup>8</sup> In a first test, children were classified as breakfast eaters or skippers and underwent learning, memory and retention testing two hours after school arrival. Results showed that breakfast eaters scored significantly higher on immediate recall tests than breakfast skippers. Two-thirds of the subjects were then provided cereal and milk at school for 15 consecutive days, while the remaining subjects continued with their usual breakfast behaviour (breakfast at home 1-2hr before school or breakfast skipping). Results of this second test showed that children tested 30 minutes after eating breakfast at school scored significantly higher on most cognitive function modules compared with children who ate breakfast earlier at home or skipped breakfast. The researchers concluded that breakfast may enhance performance in cognitive testing; however, the timing of the meal must also be considered.
- More recently, Wesnes and colleagues tested 29 children (9-16yr) on four successive mornings of different breakfast treatments (cereal A with milk, cereal B with milk, glucose drink or no breakfast).<sup>9</sup> Computerized testing of attention and memory, as well as mood and satiety scores were conducted immediately before breakfast and four times afterward at hourly intervals. Results showed that attention and episodic memory were significantly improved in the cereal groups, and cereal intake had the strongest effect on immediate word recall (a component of episodic memory). By midday, the ability of the children to recall words was decreased in both the glucose drink and no breakfast groups, but slightly increased in the cereal groups. Breakfast eaters also had better mood scores related to alertness and contentment.
- Using similar cognitive testing methods as Wesnes' group, Ingwersen and colleagues investigated the effect of the glycemic index (GI) of breakfast on cognitive performance in children (n=64, 5-11yr).<sup>10</sup> Results showed that some test scores of attention and memory (accuracy of attention and secondary memory) decreased more substantially following a high GI versus low GI breakfast. The researchers concluded that breakfast composition may play a role in cognitive function, but that further study of the meal composition is required, including looking at nutrients such as protein.

**Skipping breakfast interferes with cognition and learning, and effects are more pronounced in nutritionally at-risk children than in well-nourished children.**



Subsequent reviews of breakfast and school or cognitive performance support these specific study findings. Positive benefits on cognitive function (particularly memory, academic performance and school attendance rates), psychosocial function and mood have been demonstrated in children who consume breakfast.<sup>11</sup> A positive effect of breakfast programs has also been shown in children and adolescents.<sup>12</sup> However, both of these reviews suggest that the lack of a consistent approach and multiple confounding variables such as meal timing, breakfast composition and nutritional status have hindered accurate measurement of the true magnitude of the relationship between breakfast and cognition. To better understand this relationship, further investigations controlling for such confounding variables are required.

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## Benefits of breakfast on school performance

- memory
- school attendance
- mood
- academic performance

## The Bottom Line

Brain growth continues well into adolescence and energy and key nutrients from food are vital to this development. Breakfast and cognitive performance studies have demonstrated that children who consume breakfast may have improved ability to learn in the morning school hours as evidenced by improved memory and more accurate performance on mental tasks. Research has also shown that children who consume breakfast are more likely to be alert and content. To date, a more definitive relationship between breakfast and cognitive function has yet to be determined; however, it appears that eating a healthy breakfast can help to fuel a better brain.

### Health Canada recommends...

Enjoy breakfast everyday. It may help control your hunger later in the day. Children who eat breakfast are more alert. Be a role model – if adults eat breakfast, it is likely children will too.

Health Canada, *Eating Well with Canada's Food Guide: A Resource for Educators and Communicators*

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