

Significance of Breakfast on Intelligence Quotient (IQ) Level of School Children: A Systematic Review

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Abstract:

Breakfast refers to the first meal which is taken in the morning and taken before the start of daily activities. Researchers have demonstrated a link between eating breakfast and positive performance of children. The present study was undertaken to evaluate the effects of breakfast on IQ level of school going children. Effect of breakfast and nutrient on IQ and studies of habitual breakfast intake between regular breakfast intake and skipper has been reviewed on the school children. There are twenty-five studies reviewed which were published between 2003 and 2017. The evidence indicates that regular breakfast consumption is more beneficial than skipping, but this effect is more noticeable in children whose nutritional status is low. Studies of school breakfast programmes suggest that intake of regular breakfast have positive effects on academic performance. Therefore, regular breakfast consumption is correlated with higher intake of essential nutrients eventually positive effect on IQ.

Keywords: Breakfast significance, Intelligence quotient, School performance.

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I. INTRODUCTION

Breakfast refers to the first meal which is taken in the morning and taken before the start of daily activities and considered as the most important meal of the day. Breakfast means breaking-the-fast of the night. Several observational studies have demonstrated an association between eating breakfast and positive performance in school (Liu 2013). According to a recent study based on children and how breakfast affects the school performance and behaviour observed that eating breakfast every day is positively associated with the improved school performance (Adolphus et al, 2013). In addition, various studies have been suggested that the quality of the breakfast have a positive effect in the school performance. Intelligence quotient (IQ) is a number representing a person's reasoning ability. IQ of school going children is affected by many factors including diet, socioeconomic factors, parental education, eating behaviours etc. Experts have been studying the relationship between breakfast and IQ over the past three decades, and suggested that skipping breakfast may have negative impact on school performance of children (Karagounis et al, 2018).

Since 1960's it has been pretty well-known and documented that hunger and lack of nutrition have adverse effects on children's learning ability. Children who skip their breakfast are more likely to feel tired and irritable, face troubles on concentrating their morning lessons and find complex mental tasks more difficult (Karagounis et al, 2018). Several studies showed a significant relationship between eating breakfast and improved IQ levels or academic performance (Hoyland et al, 2009). Comparatively, children who ate unhealthy foods such as sweets or chips for breakfast had no positive impact on educational outcomes (Hoyland et al, 2009).

The Importance of Breakfast

Research findings indicate that children who eat breakfast

make fewer errors on standardized achievement tests and exhibit improved vigilance, attention and school attendance and reduced tardiness, while missing breakfast reduces children's speed and accuracy of information retrieval and memory.

Theoretically, there are two biological mechanisms by which breakfast affects brain function and cognitive test performance. One involves the metabolic changes associated with essentially an extended overnight fast during which the brain is fuelled by glucose stored in the form of muscle glycogen. A child's muscle mass is significantly smaller than an adult's and children tend to sleep for longer periods thus their stored glycogen are more likely to be depleted by morning, leaving their brains hungry for energy (Datar et al, 2012). The other mechanism involves the long-term salutary changes that breakfast may have on nutrient intake as well as nutritional status which in turn could affect cognition (Datar et al, 2012). In a study investigator observed that repletion of iron stores and rehabilitation from anaemia results in improved school performance in tests of memory and visual attention (Matsui et al, 2011). Childhood and adolescence are crucial period that requires adequate nutrition especially children at the age of 6-12 years need sufficient amount of protein and calories for proper development (Hoyland et al, 2009). Therefore, what children are actually eating at breakfast time is also important. Carbohydrates intake by mean of cereal and bread in the morning provides glucose for proper functioning of brain, however, eating carbohydrates rich food alone results a drop in blood sugar level along up to lunch time. Including protein rich food in children's breakfasts slows down the absorption of carbohydrates and keep blood sugar levels steady throughout the morning (Pollitt 1995).

Worldwide studies regarding the effect of breakfast on IQ level suggested a positive association between regular

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intakes of breakfast that is rich in protein and fat improved IQ level (performance) (Taha et al, 2017). Therefore, the present study has been undertaken to systematically evaluate the latest published research articles to observe the significance of breakfast on IQ level of school children.

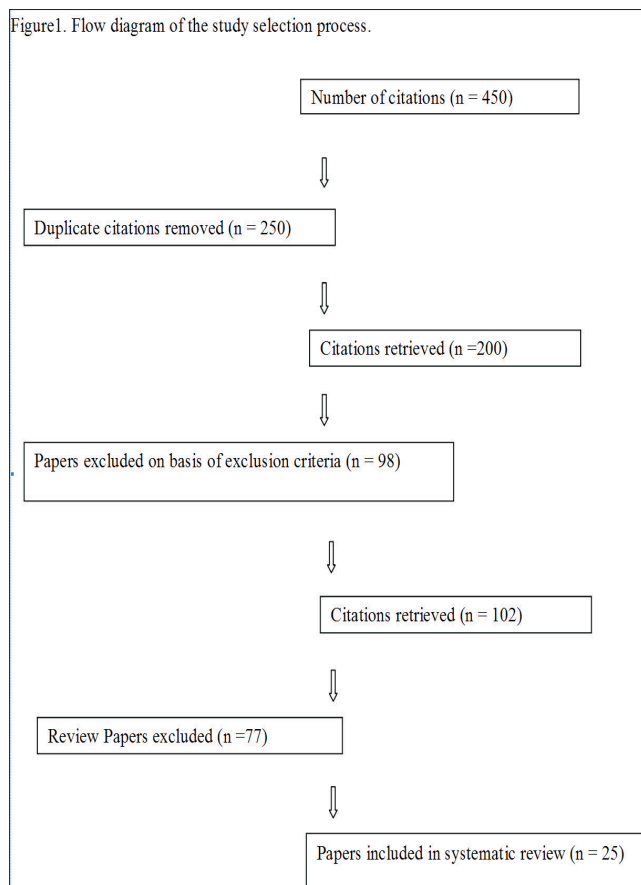
Materials and methods

Electronic databases were searched on 10 Aug 2018. The electronic databases including MedLine, pubmed, ScienceDirect, Embase, and Google Scholar, were searched to retrieve relevant published research articles using various keywords including 'breakfast', 'intelligence quotient', 'IQ', 'effect of breakfast', 'nutrients', 'protein', 'fat', up to the last 10 August 2018. Additional search strategies involved scanning of reference lists of the retrieved research articles identified for identifying other relevant articles. Following removal of duplicates (n=250), 200 citations were retrieved for possible inclusion in the present review. The search was limited to the studies conducted on human subjects and the articles published in English language. Class presentation was excluded since these do not provide an objective measure of cognitive function.

Study Selection Process

Figure 1 details the study selection process and the number of papers retrieved and excluded at each stage. Of the 450 studies retrieved, 425 exclusions were made, most commonly because the studies examined adult or elderly samples; measured breakfast behaviours only; took measures of appetite only. Some papers contained multiple studies. Therefore, twenty-five articles were extracted.

Figure1. Flow diagram of the study selection process.



Inclusion and Exclusion Criteria

Papers were included or excluded according to the following criteria.

Participants - Studies of children or adolescents (aged 8–18 years) of either sex were included. Studies were excluded if they examined adult, elderly or patient samples. Only cross sectional and collaborative studies were included in this systematic review paper.

Planning

Any type of breakfast planning, including studies comparing breakfast with no breakfast, and studies of different breakfast types were included. Breakfast was defined according to the descriptions of the meals or foods consumed provided in the papers reviewed. These varied but generally considered breakfast to be the first food consumed that day although this was not the case for some interventions where prior intake was not controlled. Studies were not excluded on the basis of the content of the meal; for example, studies that included interventions using drinks and/or snacks were included.

Quality assessment

Each study was rated for quality using pre-defined assessment criteria by two of the authors independently. The inter-rater correlation for ratings was $r = 0.86$ and discrepancies were discussed as a panel with the third author to reach consensus. Therefore, we devised an fifteen-item tool which covered key elements of study aims and design, sample selection, breakfast manipulation, controls, analysis and outcomes are as given below.

Paper:

Rater:

Score 0 if criterion not satisfied. Score 1 if criterion Satisfied:

No. Criterion	Score
1. Clear aims and objectives stated	
2. Clear description of locale/environment, e.g. place, laboratory/classroom	
3. Clear description of sample, e.g. age (mean, SD, range), sex, number	
4. Clear description of study design	
5. Clear description of data collection	
6. Provision of recruitment data and strategy	
7. Provision of compliance data, i.e. performance testing and breakfast intake	
8. Clear description of planning, e.g. composition	
9. Appropriateness of planning, e.g. food style/quality	
10. Valid and reliable outcomes, e.g. appropriateness of cognitive test	
11. Clear description of data analysis	
12. Appropriateness of data analysis	
13. Clear description of findings	
14. Strengths of study and suggestions for future work	
15. Limitations of study	

Table1. Chronological studies showing association between breakfast and IQ among school going children

Reference	year	QA	Sample Size	Age (years)	Country	Study Design	Cognitive Measures	Findings	Comments
Taha and Rashed	2017	14	130 Female student	15-19	Abu Dhabi, UAE	Cross sectional	Self-administered questionnaire to correlate the breakfast intake, frequency of intake, anthropometric measurements and demographic factors.	Correlation was significant at the $p = 0.01$ level. Breakfast consumption is associated with increased academic performance among high school female students	Breakfast consumption increases, the school scores increase too. The results were found to be highly significant $p < 0.001$
Hisam et al.	2015	14	120 students	16-18	Pakistan	Cross sectional	Wechsler Intelligence Scale for Children was used for IQ assessment.	Significant association found between gender and breakfast consumption ($p=0.047$) as well as compared RBC and IBC	Better IQ was observed among teenagers who consumed breakfast daily as compared to those who irregularly take breakfast.
Ghazi et al.	2013	13	529 children	10-14	Baghdad, Iraq	Cross sectional	Raven's Colored Progressive Matrices (CPM) tool was used to obtain an IQ score for each child.	Malnourished children are 11.6 times more at risk of having low IQ as compared with normal children, and children who skip breakfast in the morning have a 7.4 times higher risk of low intelligence compared to those who eat breakfast every day.	There was a 7.3 point decrease in IQ score associated with malnutrition, a 4.69 point decrease in children who skip breakfast, and a 3.2 point decrease when children's nutritional habits were poor.
Pandey and Vora	2015	14	213 students	15-17	Bangalore, India	Cross sectional	Pre-structured questionnaire	27% of the subjects were breakfast skippers, and 73% of them were Regular breakfast eaters and showed to interfere with cognition, with a significant difference (p value 0.026).	Breakfast intake is said to have a positive effect on IQ though a very small difference between regular breakfast eaters and skippers.

Lien et al.	2007	13	7343 students	15-16	Oslo, Norway	Cross sectional	Questionnaire	The odds ratio (OR) for being mentally distressed when eating breakfast seldom/ never compared with every day was 3.0 (2.0-4.5) for boys, 1.6 (1.2-2.1) for girls and 1.6 (1.5-2.6) for the immigrant group. The comparable OR for having low school grades was similar for boys and girls, 2.0 (1.3-3.0), and 1.6 (1.5-2.6) for the immigrant groups.	Skipping breakfast is a common feature among students. The implications of skipping breakfast on academic performance are stronger for boys than girls and stronger for Norwegian students compared with immigrants.
Herrero et al.	2006	15	141 students	12-13	Saragosa, Spain	Cross sectional	Breakfast quality has been assessed according to criteria of the kid study	When pooled quality of breakfast and mid-morning snack is analyzed, the average mark systematically increases as breakfast-snack quality increases. The outcome was that there exist global significant differences between groups (p -value = 0.0004).	Average mark systematically increases as breakfast quality increases from an average score of 5.63 in the group with poor quality breakfast to 7.73 average score in the group with a good quality breakfast
Florence et al.	2008	14	5200 students	10-13	Nova Scotia, Canada	Cross sectional	Modified version of Harvard youth/Adolescence Food Frequency Questionnaire (YAQ)	The diet quality scores ranged from 26.0 to 86.0, with an average score of 62.4. Students reporting increased diet quality were significantly less likely to fail in literacy assessment.	Across various indicators of diet quality, an association with academic performance was observed.
Kleinman et al.	2012	15	227 students	8-11	Boston Washington	collaborative study (Cohort)	Child Hunger Index Report (CHIC)	Prior to the USBP (universal-free school breakfast program), 33% of all study children	Improvements in nutrient intake were associated with significant improvement

								were classified as being at nutritional risk and had significantly poorer attendance, punctuality, grades at school, behaviour problems and were less likely to eat breakfast at school.	nts in student academic performance.
Fernández et al.	2008	13	467 children	12-17	Spain	Cross-sectional	questionnaires of seven-day consumption frequency	Girls aged 15-17 years including 8.33% take poorest quality due to skipping meal while 68.29% take breakfasts and have good quality.	The population studied consumes a poor breakfast, which may affect the academic outcomes
Matthys et.al. (8)	2007	13	341 students	13-18	Ghent, Belgium	Cross-sectional	7-day estimated food record method (semi-structured diary)	The energy contribution of breakfast to daily energy intake was on average 15.7% in boys and 14.9% in girls.	Overall, individual breakfast score was 3. In boys, 18% ate a low quality breakfast score 3, 56% ate a moderate-to good-quality breakfast score 4, while only 13% ate a full value breakfast score 5. In girls 27% had an individual breakfast score 3, 45% had a score 4 and only 10% had an individual breakfast score 5.
Keith et al.	2003	14	29 students	8-12	UK	Cross sectional	A computerised test of attention, working memory and episodic memory, but memory was conducted prior to breakfast and again 30, 90, 150 and 210 minutes later.	The glucose drink and no breakfast conditions were followed by declines in attention and memory, but the declines were significantly reduced in the two cereal conditions.	This study provides objective evidence that a typical breakfast of cereal rich in complex carbohydrates can help maintain mental performance over the morning.

II. RESULTS & DISCUSSION

All the retrieved studies has been summarised in Table 1. Based on the findings of the last two decades of research, overall evidence suggests that breakfast consumption has generally positive effects on IQ in comparison with breakfast skipping. The association of breakfast consumption patterns with academic performance of girls observed that skipping breakfast was shown to interfere with cognition, being observed when the cognitive abilities of regular breakfast eaters was compared to that of skippers. According to (Taha and Rashed 2017) regular breakfast eaters had a high average IQ level as compared to a much lower to breakfast skippers. However, subjects consume breakfast regularly follow a similar pattern of having normal/average IQ levels as compared to breakfast skippers (Pandey and Vora 2015) hence, possess a clear advantage over skippers, when compared in terms of academic performance and IQ levels. Skipping Breakfast has shown to interfere with cognition.

In addition, accordingly (Lien et al. 2007) skipping breakfast is a common feature among students and implications of skipping breakfast on academic performance are stronger for boys than girls. Compared with normal children and children who skip breakfast in the morning have a higher risk of low intelligence compared to those who eat breakfast every day (Ghazi et al. 2013). This effect appears to be pervasive in both short term and long-term studies based on school breakfast programmes consequently the apparent beneficial effects of school breakfast programmes may be linked to breakfast and cognition increased attendance, and effects of such provision in older children are not known (Ghazi et al. 2013). It was also observed by (Taha and Rashed 2017; Kleinman et al. 2002) that the Breakfast consumption is associated with increased academic performance among school students consumed increased amount of breakfast, in addition, the school scores increase too. In addition, breakfast effects are more easily demonstrable in nutritionally vulnerable children. According to (Hisam et al. 2015) it is difficult to recommend an optimal breakfast for cognitive function based on the currently available research and found no significant association found between breakfast intake and IQ level among students having regular breakfast. However the IQ score was more among RBC (regular breakfast consumer) as compared to IBC (irregular breakfast consumer). Some studies like (Herrero et al. 2006; Matthys et al. 2007) observed that there exist global significant differences between students having an insufficient quality breakfast obtained an average mark, and if they upgraded to improvable quality obtained high mark compare to students who having insufficient quality breakfast.

Across various indicators of diet quality, an association with academic performance was observed by (Florence et al. 2008) that students with decreased overall diet quality were significantly more likely to perform poorly on the assessment however girls performed better than boys. According to (Fernández et al. 2008) Student who consumes a poor breakfast may affect the academic outcomes. The glucose drink and no breakfast conditions were followed by declines in attention and memory, but the declines were significantly reduced in the two cereal conditions. Study done by (Keith et al. 2003)

provides objective evidence that a typical breakfast of cereal rich in complex carbohydrates can help maintain mental performance over the morning.

III. EFFECTS OF HABITUAL BREAKFAST QUALITY

There were only few studies (Murphy 2007; Basch 2011; Kleinman et al. 2002; Florence et al. 2008) that observed habitual breakfast intake. These studies suggest a positive effect of breakfast quality on scholastic performance. It was indicated by one study that snack provision could ameliorate the negative effect of a poor-quality or no breakfast. These studies did not include measures of cognitive function other than school performance.

IV. EFFECT OF NUTRIENTS ON IQ LEVEL OF SCHOOL CHILDREN

In contrast to the above finding, studies based on influence of nutrients on children's academic performance and overall diet quality as a force effecting cognitive ability has also been investigated. In a 2003 survey of 5200 fifth grade students conducted in Nova Scotia, (Florence et al. 2008) found that there was an association between diet quality and academic performance. The Diet Quality Index-International by (Giovannini 2010) ranks diet quality based on total daily consumption on a scale of 0-100 (a higher the score indicating a higher diet quality) and was used in a study as a basis to measure the diets of the students surveyed. According to (Florence et al. 2008), this measurement is preferable over measurements of individual nutrients because people do not consume single nutrients but combinations of foods. The DQI-I scale was deemed valuable in this study due to the fact that it takes into account adequacy, moderation, variety, and balance of individuals' diets and gives each factor an individual score (Florence et al. 2008). It is important to understand the characteristics of eating habits graded by each component of the score, since this information is fundamental to correlating what type of nutritional habits had a bearing on academic performance. The dietary adequacy component ranks individual's (Florence et al. 2008) consumption of foods and nutrients essential to a healthy diet such as fruits, vegetables, grains, dietary fibres, protein, iron, calcium, and vitamin C, while the dietary moderation component reflects individuals' intakes of saturated fat, salt and other empty calorie foods (Giovannini 2010). The dietary variety component scores consumed food diversity, and the balance component ranks the ratios of carbohydrate, fat, and protein in the diet. It is interesting to note that increased consumption of fruits, vegetables and moderate fat intake are considered as indicative of a high-quality diet (Giovannini 2010). Approximately six months after students completed dietary surveys, the Elementary Literacy Assessment, which is a standardized test in Nova Scotia, was administered to the same students as a tool to measure academic performance as related to the students' dietary scores (Giovannini 2010). The results of this study conducted by (Florence et al. 2008) demonstrated that there is indeed a connection between overall diet quality and academic performance. Of the 4589 students who submitted complete dietary information, the average score was 62.4 with a range from 26.0 to 86.0. After

the literacy assessment was given, students with higher dietary scores were found to be less likely to fail any portion of the standardized assessment. According to the results, both the variety and adequacy components versus the moderation and balance components seemed to have more bearing on the literacy assessment scores. Also noteworthy fact that students with higher fruit and vegetable intakes as well as lower fat intakes were more likely to do well on the literacy assessment. According to (Florence et al. 2008) their findings highlight the value of consuming a diverse selection of foods in order to meet the recommended number of servings from each food group. Later in their summary, they also asserted that school programs should encourage the consumption of fruits and vegetables and discourage the over-indulgence in foods that are high in dietary fat in order to support improved assessment scores. Although this study neither specifically looked at the impact of breakfast nor analyzed individual micro- and macronutrient consumption, the findings are still significant when applied to the functions of breakfast. Demonstration by (Vishnukumar 2017) observed that the overall diet quality of children does play a role in their academic success. The research findings of (Mathys et al. 2007) helps to support the theory that the overall nutritional quality of breakfast is significant to students' cognitive abilities, since breakfast should be a daily indispensable source of caloric intake according to a study by (Mathys et al. 2007).

V. CONCLUSION

The majority of studies have concentrated on the measurement of memory and attention performance, with less examination of tasks that engage other cognitive domains, processes and aptitudes. School breakfast programmes may be linked to breakfast and cognition increased attendance and reduced absenteeism. The overall findings indicate that breakfast consumption is more beneficial than skipping breakfast, but this effect is more apparent in children whose nutritional status is compromised. There have been few studies based on examinations of problem solving and psychomotor skill. However, from the studies reviewed, it is difficult to conclude which specific cognitive domains are most sensitive to nutritional manipulations at breakfast time, although there is most abundant support for effects on memory. Therefore, regular breakfast consumption is correlated with higher intake of important nutrients which positively influence IQ.

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