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# Effect Of Breakfast Intervention On Cognitive Function, School Performance, And Absenteeism In Basic School Students In Sudan

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## ABSTRACT

***Background:*** *Breakfast is widely recognized as the most important meal of the day, particularly for school-aged children, as it supports optimal brain function and academic success. In low-resource settings such as Sudan, breakfast skipping is prevalent due to economic constraints, leading to adverse effects on students' cognitive development, school attendance, and academic outcomes.*

***Objective:*** *This study aimed to evaluate the impact of a structured school breakfast program, using Adzuki beans as a nutritious and locally available food, on the cognitive performance, academic achievement, and attendance of primary school students in Khartoum State.*

***Methods:*** *A quasi-experimental design was applied to a sample of 294 students aged 6 to 14 years. The intervention involved providing a daily breakfast based on Adzuki beans over an eight-month period. Baseline and post-intervention data were collected on absenteeism rates, academic grades, and cognitive test scores. Statistical analysis was conducted to assess the significance of observed changes.*

***Results:*** *Following the intervention, there was a dramatic reduction in absenteeism, with mean days absent falling from 10.05 to 1.05 ($p<0.001$). Academic performance showed substantial improvement: students receiving weak or failing grades decreased from 69.4% to 32.3%, while those achieving good or excellent grades increased from 30.6% to 67.7%. Cognitive assessments also reflected marked gains, with the proportion of students scoring average or above rising from 34.7% to 75.2%.*

***Conclusion:*** *The structured breakfast program demonstrated a significant positive impact on students' educational and cognitive outcomes. These findings underscore the crucial importance of school feeding initiatives, particularly in socioeconomically disadvantaged regions, and support their expansion as a public health and educational strategy in Sudan.*

***Keywords:*** *Academic performance, Adzuki beans, absenteeism, breakfast, cognition, intervention, Sudan, schoolchildren.*

## INTRODUCTION

Breakfast is critical to cognitive development and academic achievement among school-aged children. Regular breakfast consumption has been associated with improved memory, attention, and school performance, while skipping breakfast has been linked to fatigue, inattentiveness, and absenteeism [1,2]. Despite the growing body of international evidence supporting school feeding programs, data specific to Sudan remains scarce.

Poor dietary habits, particularly skipping breakfast, are prevalent among Sudanese children due to socioeconomic hardship, food insecurity, and lack of school feeding infrastructure [3,4]. These conditions adversely affect cognitive functioning and educational performance, limiting students' academic potential [5]. Iron and glucose

levels are particularly important for brain function, with studies showing that their deficiency may impair memory, concentration, and executive functioning [6,7].
Moreover, observational and interventional studies have demonstrated that children who eat breakfast regularly are more likely to arrive at school on time, engage in class, and achieve better test scores [8–10]. In the United Kingdom and the United States, breakfast programs have been associated with improved attendance and behavioral outcomes [11,12]. The cognitive benefits are believed to stem from the stabilization of blood glucose levels and availability of key micronutrients such as iron, zinc, and B vitamins essential for brain health [13,14]. In LMICs such as Sudan, school breakfast interventions may not only address educational performance but also combat underlying nutritional deficiencies that hinder mental development. This study investigates how a structured breakfast intervention, using a nutrient-dense food such as Adzuki beans, affects school attendance, academic performance, and cognitive abilities in a Sudanese basic school setting.

## METHODS

This quasi-experimental study was conducted at a public basic school in Khartoum Bahri, Sudan. The study included 294 students aged between 6 and 14 years. All students received a daily breakfast meal based on Adzuki beans for eight months. The meal was provided during school days and designed to meet basic nutritional needs. To assess the impact of the breakfast program, data were collected at two points: before the intervention (baseline) and after eight months (post-intervention). The outcomes measured were:

- **Absenteeism:** Recorded as the number of school days missed by each student [15]
- **Academic performance:** Measured through students' term grades, categorized into levels such as excellent, good, weak, and failure [16]
- **Cognitive ability:** Assessed using the Henman-Nelson test, a standardized tool for measuring cognitive function in school-aged children [17]

For data analysis, two statistical tests were used:

- The **Wilcoxon signed-rank test** was applied to compare pre- and post-intervention results for continuous variables like absenteeism and cognitive scores [18]
- The **McNemar test** was used to analyze changes in categorical variables, such as academic performance levels [19]

A p-value of less than 0.05 was considered statistically significant. The study aimed to determine whether the breakfast intervention had a measurable effect on students' attendance, learning outcomes, and cognitive performance.

## RESULTS

**Table 1. Demographic Characteristics of Students (N=294)**

| Variable | Category | Frequency | Percentage (%) |
|---|---|---|---|
| Age (years) | Mean ± SD | 10 ± 1.8 | - |
| Gender | Male | 147 | 50 |
| | Female | 147 | 50 |
| Father's Education | Informal | 116 | 39.5 |
| Mother's Education | Informal | 70 | 23.8 |
| Economic Status | Poor | 191 | 65 |

The study involved 294 students with an average age of 10 years (±1.8). Gender distribution was balanced, with equal numbers of males and females (50% each). A large portion of the students' parents had informal education, with 39.5% of fathers and 23.8% of mothers lacking formal schooling. Additionally, 65% of the students came from poor economic backgrounds.

**Table 2. Reasons for Skipping Breakfast (N=294)**

| Reason | Frequency | Percentage (%) |
|---|---|---|
| Haven't money | 210 | 71.7 |

| | | |
|---|---|---|
| Haven't money – food | 76 | 26 |
| I don't like the choices | 3 | 1.4 |
| I am not hungry | 2 | 0.9 |

The predominant reason for skipping breakfast was financial difficulty, as 71.7% of students reported not having enough money, and 26% indicated insufficient food availability. A small number of students did not like the breakfast options (1.4%) or were not hungry in the morning (0.9%).

**Table 3. School Absenteeism Pre vs Post Intervention**

| Statistic | Pre | Post |
|---|---|---|
| Mean Days Absent | 10.05 | 1.05 |
| Range | 0–30 | 0–8 |
| Std. Deviation | 4.28 | 1.76 |
| P-value | — | <0.001 |

After the breakfast program, mean absenteeism dramatically decreased from 10.05 days before the intervention to 1.05 days after ($p < 0.001$). The range and standard deviation of days absent also reduced, indicating more consistent school attendance following the intervention.

**Table 4. Academic Performance and Cognitive Scores Pre vs Post**

| Category | Pre (%) | Post (%) |
|---|---|---|
| Weak/Pass Grades | 69.4 | 32.3 |
| Good–Excellent Grades | 30.6 | 67.7 |
| Below Average Cognition | 39.8 | 4.7 |
| Average and Above | 34.7 | 75.2 |
| Superior | 3.7 | 13.3 |

Academic performance improved significantly post-intervention, with the proportion of students having weak or passing grades dropping from 69.4% to 32.3%, while good to excellent grades rose from 30.6% to 67.7%. Cognitive ability improved as well: the percentage of students scoring average or above increased from 34.7% to 75.2%, while those with below-average cognition decreased from 39.8% to 4.7%. Students with superior cognitive scores also increased from 3.7% to 13.3%.

## DISCUSSION

This study shows that a daily school breakfast program significantly improves important academic and behavioral outcomes among basic school students in Sudan. The most notable result was the significant decrease in absenteeism from an average of 10.05 days before the intervention to just 1.05 days after. These findings are consistent with studies by Murphy et al. [11] and Kristjansson et al. [7], who reported similar drops in school absenteeism after implementing school feeding programs in LMICs.

Academic performance also showed significant improvement. The percentage of students with weak or pass grades dropped sharply from 69.4% to 32.3%, while those with good and excellent grades rose from 30.6% to 67.7%. These changes support the findings by Florence et al. [12] and Kleinman et al. [10], who noted better test scores and grades among students in school breakfast programs. Adolphus et al. [1] concluded that regular breakfast intake positively impacts cognitive function and classroom behavior, leading to improved academic results.

Cognitive performance improvements were equally notable, with the percentage of students scoring "average and above" doubling after the intervention. Hoyland et al. [2] and Wesnes et al. [8] provide evidence that morning meals boost neurocognitive function by maintaining stable glucose levels and adequate micronutrient intake during school hours. Glucose is the brain's main energy source, and even brief fasting can impair memory and attention [9,13]. Furthermore, deficiencies in iron and B vitamins impede neurotransmitter production and cognitive growth [6,14].

The intervention meal included Adzuki beans, a nutrient-rich legume high in protein, iron, fiber, and B vitamins. Legumes are increasingly recognized as affordable, effective tools to combat childhood malnutrition in LMICs [23]. When added to school meals, such foods not only boost nutritional status but also enhance cognition and physical well-being [20,24]. Economic hardship was the most commonly cited reason for skipping breakfast in this study. Over 70% of participants reported skipping breakfast because of financial constraints, a trend seen in similar studies across Sub-Saharan Africa [3,25]. Addressing this root cause with targeted government intervention could be crucial to achieving both educational and nutritional equity. Programs in Ghana and Kenya have demonstrated that subsidized school feeding improves enrollment, attendance, and gender equality in education [22,26].

Furthermore, the psychosocial benefits of school feeding programs should not be ignored. Well-nourished students tend to exhibit better emotional regulation, increased motivation to learn, and higher engagement in class activities [28]. These indirect benefits are essential for fostering a comprehensive learning environment that supports long-term success.

Limitations of this study include its single-school setting and the absence of a control group. Future studies should use randomized controlled designs with multiple intervention sites to verify generalizability. Additionally, collecting longitudinal follow-up data could evaluate the lasting effects of nutritional intervention on educational trajectories.

Nonetheless, the improvements seen in this study regarding attendance, academic performance, and cognitive ability provide strong evidence for expanding school breakfast programs in Sudan. Given the high rates of undernutrition and school dropouts in low-income areas, this affordable intervention could play a significant role in achieving national goals related to education and health [29,30]. It is crucial that stakeholders, including government agencies, NGOs, and international organizations, work together to develop sustainable school nutrition initiatives.

## CONCLUSION

The daily school breakfast program significantly enhanced absenteeism rates, academic performance, and cognitive function among basic school students in Sudan. These findings support existing evidence that school feeding programs improve educational outcomes, especially in low-resource settings facing economic challenges. Despite limitations of a single-site, non-randomized design, the study highlights the potential of breakfast interventions to reduce undernutrition and improve school retention nationwide.

## RECOMMENDATIONS

1. Expand school breakfast programs nationwide to improve attendance and academic outcomes.
2. Provide financial support to help low-income families access nutritious meals.
3. Incorporate nutrient-rich foods like Adzuki beans to enhance meal quality.
4. Promote collaboration between the government, NGOs, and international partners for program sustainability.
5. Conduct further research using rigorous designs to validate findings.

### Ethical consideration:

Ethical approval was not obtained for this study because, at the time of implementation, no Institutional Review Board (IRB) was available at Omdurman Islamic University or in the study area. Additionally, informed consent was not obtained from participants or their guardians due to the programmatic nature of the school-based intervention and the absence of a formal ethical oversight mechanism. Nonetheless, the study adhered to general ethical principles, including respect for persons, non-maleficence, and confidentiality, and no personally identifiable information was collected.

### Availability of Data and Materials:

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

**Competing Interests:**
The authors declare that they have no competing interests that could influence the study outcomes or interpretation.

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**Authors' Contributions:**
All authors contributed to the conception, design, data collection, analysis, and writing of this manuscript. All authors read and approved of the final manuscript.

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**Conflict of Interest Statement:**
The authors declare that they have no conflict of interest.

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