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EFFECTS OF NUTRITIONAL INTERVENTION AND COGNITIVE FUNCTIONING OF SCHOOL CHILDREN'S

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ABSTRACT

The purpose of this paper was to review existing literature about past research that highlighted studies concerning nutrition and its relationship to brain function, cognition, learning, and social behaviors. There is evidence that school breakfast and lunch programs are not up to par with current Indian nutritional norms and standards and that USDA standards may not be utilizing the latest research about nutrition. Studies have shown that proper nutrition has a direct effect on student performance and behavior in school. Much of the literature reviewed in this article confirmed that nutrition has a direct effect on neurotransmitters which are important in sending messages from the body to the brain. Specific dietary components were shown to have negative effects on this system, many of which are commonplace in school-aged children's daily eating. Unfortunately, school breakfast and lunch programs, in many cases, inhibit the body's cognitive and energy potentials by not providing proper nutrition. The problem has also added to the obesity rate amongst Indian students, which also has added to the lower achievement in school. In many studies, cases of socioeconomic status seem to be an indicator of food insufficiency, which is simply the lack of available food to a household. Food insufficiency has been shown to directly affect children's cognitive development. What schools can do to improve upon existing nutritional conditions is a focus of the latter section of the paper. Many schools across the nation have invested in nutrition by way of enhanced breakfast and lunch programs. Some have even gone so far as to grow fresh produce in school gardens. Finally, recommendations are explored and given for ways schools can help improve the nutrition of their food programs, thus taking steps to ensure students are given the energy needed for normal cognitive development and social skills.

Key Words: - Nutrition, Cognition, Development, School,Skills, Children, Health.

1. INTRODUCTION:

In an educational world filled with failing schools and apathetic students, state boards of education have searched for answers on how to increase test scores and create school systems where all students receive the best education possible. Amongst the plethora of possible solutions, perhaps they should look first at the nutritional substance of what our school-aged

children are eating each day as they struggle through a day of learning. There is a correlation between nutrition and cognition as well as psychosocial behavior; this relationship has been highly under-researched, but there exists many studies that look at the nutritional benefits of many proteins, vitamins, and food substances as they affect learning and brain function. Our schools have the potential to play a vital role in preparing and sustaining our students' potential learning abilities and benefitting their social behaviors by supplying nutritious breakfasts and lunches during school days.

Providing the nation's low-income youth with nutritious food has been a concern for over a hundred years.

Thus in this backdrop the current research study is entitled to investigate "**Correlation between Nutritional Intervention and Cognitive Functioning of School Children's**" with the objective of finding out various factors which influence significance and importance of nutritional intervention on various facets of cognitive development of school children in Jaipur (Rajasthan).

2. STATEMENT OF THE PROBLEM

This research paper attempts to look at research that addresses the relevance of nutrition and its effects on brain development, cognition, and social behaviors. It will use the research to help develop possible steps that schools can take to ensure that their food programs adhere to the high standards of federal nutrition guidelines that are based upon the latest research. The question remains concerning the nutritional guidelines closely follow the latest research in nutritional health and its effects on brain development and cognition. The same concern for school breakfast and lunch programs exists; schools need to ensure that their programs follow the state and national guidelines.

Parents need to make sure that their students are eating school program breakfasts and lunches if they are up to par with standards and guidelines. It is hoped that adequate research exists that is readily available to schools and parents so that children have the opportunity to be as nutritionally healthy as possible for optimal brain function, cognitive development, positive social behaviors, and energy to carry out school activities.

3. RESEARCH QUESTIONS

This research paper is based upon and attempts to answer the following questions:

a. *What role does nutrition play in students' cognitive development, learning, academic performance, and social behaviors in the school setting?*

b) What can our schools do to improve their school breakfast and lunch programs to ensure that students are receiving the best nutritional diet available?

4. REVIEW OF LITERATURE

A detailed Literature has been reviewed to make the study relevant. Few key observations obtained from Literature cited are elaborated below:

Table 1. Summary of the roles of key macro and micro nutrients in brain function and its impact on cognitive domains

Nutrients	Role in brain function	Effects of deficiency on cognitive domains
Glucose	provides energy for the brain	depression affects overall mood state and psychological wellbeing
n-3 PUFA	• may influence neural functioning through its effects on proteins/ enzymes that play a role in brain membranes • neuronal gene expression	delayed information processing
B vitamins Thiamin, folate and vitamin B-12	• propagates nerve impulses • maintains the nerve's membrane potential • helps in proper nerve conductance • maintains integrity of the myelin sheath	depression episodic memory and language ability
Iron	proper development of oligodendrocytes (the brain cells that produce myelin) 5 cofactor for several enzymes that synthesize neurotransmitters	lack of memory and learning impairment lower cognitive scores, poorer motor development altered social emotional development loss of brain iron compromises cognitive development.
Iodine	Neurocellular proliferation, synapse and dendritic formation	lower IQ scores poor cognitive abilities – verbal knowledge16, non-verbal and verbal abstract reasoning, visualspatial perception and executive functioning tremendous drop in intellectual ability lack of coordination and hearing impairment
Zinc	•essential to the central nervous system and zinc containing neurons are concentrated in the forebrain 20 •zinc-dependent neurotransmitters in the mossy fibers system of the hippocampus are involved in memory	deficits in attention, learning, memory, and neuropsychological behavior 9-11

Table2. Characteristics of the micronutrient intervention studies on cognitive performance of children: supplement-based

Reference	Study location	n	Age (years)	Sample Characteristics	Intervention
Sungthong *et al* (2004)	Southern Thailand	397	7-13	Rural, low socioeconomic status, high prevalence of underweight Excluded severe IDA (Hb < 80 g/L and SF < 20 g/L), severe malnutrition (WHZ < 3rd percentile of Thai reference)	Baseline Hb used to identify anemic children at Hb ≤ 115 g/L for < 12 ≥ 12 years old. Interventions assigned randomly within each anemic and non-anemic stratum to 1 of the 3 treatment groups: 1) daily iron; 2) weekly iron; 3) placebo. Ferrous sulfate 300 mg (60 mg elemental Fe) tablets. Duration : 16 weeks
Rico *et al* (2006)	Northern Mexico; main source of lead exposure was a metal foundry	602	6-8 Boys and girls	Baseline: mean blood lead 11.5 ± 6.1 g/dL, and 51% had levels ≥10 µg/dL. Overall prevalence of children with depleted iron stores (SF<15 µg/L) and zinc deficiency (SZn ≤ 65 µg/dL) were 21.7% and 28.9%, respectively.	4 groups: 1) Fe only; 2) Zn only; 3) Fe+Zn; 4) placebo Each tablet 30 mg ferrous fumarate and/or 30 mg ZnO; Distributed daily in school and at home during school holidays Duration: 147±15 days
Christian *et al* (2010)	Rural Nepal	676	7-9 boys and girls low socio-economic status	In 1999-2001, mothers received micronutrient supplements daily from early pregnancy through 3 months postpartum. 4 groups: 1) Fe, folic acid, vit A; 2) Fe, folic acid, Zn, vit A; 3) Fe, folic acid, Zn, vit A +	Out of 3,351 live births in 2000-2001 among the 4 study groups, this cross-sectional follow-up on 676 children aged 7 to 9 years in June 2007-April 2009. The children were not given additional

				11 other micronutrients; 4) placebo+ vit A only; Folic acid (400 µg), Fe (60 mg), Zn (30 mg), vitamins D (10 µg), E (10 mg), B-1 (1.6 mg), B-2 (1.8 mg), B-6 (2.2 mg), B-12 (2.6 µg), C (100 mg), and K (65 µg); niacin (20 mg); copper (2.0 mg); and magnesium (100 mg), 1000 µg retinol vit A.	micronutrients other than biannual vitamin A, in accordance with the Nepalese government policy, whereby children received 200 000 IU of vitamin A biannually from 6 to 60 months of age.
Pongcharoen *et al* (2011)	Northeast Thailand	560	9 Boys & girls Rural, low socioeconomic status	In 1998-1999, 609 infants (4-6 months) were randomly assigned to 1 of 4 groups: 10 mg Fe ($FeSO_4$), 10 mg Zn ($ZnSO_4$), 10 mg Fe plus 10 mg Zn, or a placebo. Infants received supplements daily for 6 months.	560 children (92% of original sample) participated in the follow-up cross-sectional study in 2007-8 when the children were 9 years of age.

Hb: haemoglobin; SF: serum ferritin; SZn: serum zinc; IDA: iron deficiency anaemia; WHZ: weight-for-height z score

Table 3. Main cognitive performance outcomes according to type of intervention

Type of intervention	Reference	Cognitive functions assessed	Main cognitive outcomes
Food-based	Gewa et al. (2009)	7 memory tests, test for attention, concentration & intelligence (Ravens CPM)	Groups that received animal source foods (meat, milk) had higher available Fe, Zn, B12 and B2 and they showed significantly better scores for RCPM (problemsolving abilities) and short term memory and concentration

			tests than other groups.
	Nga et al (2011)	Raven's Colored Progressive Matrices test (CPM); Wechsler Intelligence Scale (WISC III)	Children anaemic at baseline receiving fortified biscuits had significantly higher Raven's scores than children given non-fortified biscuits; no statistical effect of consuming fortified biscuits on Raven's scores in children non-anaemic at baseline.
	Lien et al (2009)	4 tests: 1) Raven's CPM; 2) verbal meaning test; 3) arithmetic test; 4) Digital Span tests	Milk drinking children showed significantly better results for mental tests than control group; fortified milk children showed superior performance for short term memory than regular milk group
	Kumar and Rajagopalan (2010)	7 memory tests, test for attention, concentration & intelligence (Ravens CPM)	In the memory tests and test for attention, the mean change in scores in experimental group was significantly better than control group. No significant improvement in the overall intelligence between the two groups
	Vazir et al. (2006)	Malin's Intelligence Scale (Indian adaptation of WISC III); PGI Memory Scale; tests on attention and concentration; academic	Fortified group showed significant improvement for tests on attention and concentration; other tests on IQ,

		scores	memory and school exam scores did not show significant differences between the 2 groups.
	Manger et al. (2008)	Test for short-term learning, memory and attention span: WISC-III),Visual Recall test and school grades	Significant differences between groups for visual recall scores (visual memory)
	Osendarp et al (2007) (NEMO Study Group)	(WISC-III): verbal and performance; Rey Auditory Verbal Learning Test (RAVLT) Visual attention (NEPSY);	No significant treatment effects observed on any cognitive test outcomes after 12 months of intervention. Significant effect for verbal learning and memory in girls only.
	Solon et al. (2003)	Written Primary Mental Abilities Test (PMAT-FC) consisting of verbal, nonverbal test; quantitative assessment	Significant changes for Fe def. anemia and I2 def. children for verbal and non-verbal ability. Fortified groups showed no significant changes in total cognitive performance at 0 and 16 weeks
	Muthayya et al (2009)	11 subtests comprising 6 KABC II, 2 WISC-R and 3 RAVLT tests; tests conducted at baseline, 6 and 12 months	All groups had a significant improvement; high MN more beneficial than low MN at 6 months but not at 12 months; no significant differences between high and low n-3 fatty acids treatment. Overall, high MN as effective as low MN on cognitive performance
Supplement-based	Sungthong et al. (2004)	Test of Nonverbal Intelligence (TONI-2);	IQ score increased in all groups compared to

		school exam marks	baseline; however, IQ change in daily Fe group was sig less than weekly Fe and placebo groups.
	Rico et al (2006)	Wechsler Intelligence Scale for Children-Revised Mexican version [WISC-RM] and Peabody Picture. Vocabulary Test	Performance on all tasks improved significantly over time but not related to the supplementation.
	Christian et al (2010)	Universal Nonverbal Intelligence Test (UNIT); tests of executive function; motor functions using the Movement Assessment Battery for Children (MABC), finger tapping test	Intellectual functioning memory, motor functioning positively associated with prenatal Fe & folic acid supplementation in Nepal; ; no sig differences between control and groups given (Fe, folic acid & Zn) or multiple micronutrients
	Pongcharoen et al (2011)	WISC III (verbal & nonverbal abilities); Raven's Colored Progressive Matrices (CPM) (nonverbal); school performance scores	No significant differences in any of the cognitive outcomes between the 4 groups. Supplementation Fe or Zn or both during infancy does not lead to long-term cognitive improvement.

4. RECOMMENDATIONS AND CONCLUSION

Research increasingly supports the important link between nutrition and learning potential. Healthy eating is essential for students to achieve their full academic potential, mental growth, and lifelong health and well-being. When children are not receiving proper nutrition they are unable to reach their full potential. Schools need to educate parents and children on how to live a healthy lifestyle that includes proper nutrition. Schools can help school-aged children

develop healthy eating habits by emitting a consistent health message by ensuring that healthy food choices are offered at school. School administrators need to provide opportunities for staffs to receive education on good nutrition and health in the school environment. Schools should establish committees that include parents and community members to promote a healthy school atmosphere by focusing on nutrition and vending policies.

Schools need to make the commitment to offer quality meals that provide the energy and nutrients students need to achieve their maximum potential. Many schools sell low-nutrient, energy-dense items through a la carte in the cafeteria and vending machines. Due to budget cuts schools have come to rely on the profits made through these venues. Unfortunately, federal regulations do not apply to competitive food offerings, items that are not part of the reimbursable USDA meals (Finkelstein et al., 2008), so until school policy addresses this issue there will continue to be unhealthy foods available in the school environment. By offering a variety of healthy foods in the school meal program children will learn to enjoy many different foods and develop healthy eating habits. Schools can show they are committed by ensuring that food staff is properly trained, and the menu meets or exceeds the nutrition standards set forth by the Nutritional Standards of India.

Students should be asked for their input before planning school meals so that a variety of food can be offered that is not only nutritious but appealing to the students. One way to appeal to students is to get them involved with hands-on experience in producing some of their own food.

Nutrition should be taken off the back-burner and place front and center to help students reach their full learning potential. Our goal must be to teach all children the meaning and importance of good nutrition so they are able to develop good eating habits that will support a lifetime of maximizing their full potential

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