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ANTHROPOMETRIC MEASURES AND COGNITION IN CHILDREN AGED 7 TO 12

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ABSTRACT Various environmental factors affect neuro development. Among these factors, nutrition plays a vital role. Both poor nutrition and nutrition in excess during childhood can have long-term consequences as an adult. For instance, one's long-term productivity, wages, and health, are significantly influenced by one's nutrition during the early years of life. This study aims to assess the nutrition-cognition nexus among children aged 7–12 years. Anthropometric measurements and calculation of body mass index (BMI) in children who satisfied the selection criteria were done. These children were classified into 3 categories based on their BMI values as Group A (normal BMI) ,Group B (low BMI) and Group C (high BMI) according to the standard age and sex specific growth charts for children aged 5-18 years designed by the Indian Academy of Paediatrics. Cognition was measured in each child using the Mini Mental State Paediatric Examination (MMSPE). The MMSPE scores were compared among the groups. The MMSPE scores in children belonging to Group B and Group C were significantly reduced ($p<0.05$) when compared to children belonging to Group A. The development and maturation of the brain is greatly influenced by one's nutritional status. Both under and over nutrition can lead to cognitive deficiencies which can manifest as memory issues, intellectual sluggishness, or particular learning challenges in reading, writing, or mathematical computation. The reduction in cognitive abilities in these children can be reversed by implementing healthy nutritional habits among them.

KEYWORDS : anthropometric measures, nutrition, cognition

INTRODUCTION

In low- and middle-income nations today, notably in Sub-Saharan Africa and South Asia, malnutrition among children is one of the most important health concerns. A substantial amount of studies have demonstrated that poor nutritional status in childhood can have long-term consequences as an adult. For instance, one's long-term productivity, wages, and health, are significantly influenced by one's nutrition during the early years of life.[1,7,9,26] In the same manner nutrition in excess can lead to being overweight and obese which can have detrimental effects on health, impair the integrity of both grey and white matter in the brain, as well as decrease cognitive functions.[19] Cognitive development is one theory for how dietary status affects long-term wellbeing. Various studies looked at this connection using various measures of cognitive development and nutritional status.[2,5,6,13,14,17,21,25,27] Many of these studies concentrated on the nutritional health of young children under the age of five. This decision is not surprising given the significant impact early nutrition, especially in the first 1,000 days of life, has been shown to have on cognitive development and later educational attainment.[8,11] There is some evidence to suggest that the negative effects of early-life malnutrition on health may be somewhat reversible, supporting the view that efforts to improve child nutrition may be able to reverse or at least lessen some of the adverse effects of malnutrition on cognitive development.[6]

This study examines the nutrition-cognition nexus among children aged 7–12 years. The survey data includes anthropometric information and cognition through Mini Mental State Paediatric Examination (MMSPE). The MMSPE includes measures of reading ability, mathematical ability, and educational attainment. The anthropometric indicator of nutritional status includes Body mass index derived from height and weight of the child.

MATERIALS AND METHODS

This study is a cross sectional survey approved by the Institutional Ethical Committee. In this study, children aged between 7 to 12 years, who attended school on a regular basis, were recruited from areas in and around rural Coimbatore, Tamil nadu. The study group comprised of both the genders. After explaining the procedure and purpose of this study to the parents/legal guardians of these children, informed and written consent was sought from those parents who were willing to allow their children participate in the study. Detailed history was collected from each child's parent/s. Children with any known systemic disease were excluded from the study.

The study population included 150 children. Anthropometric measures namely weight, height and BMI were recorded in each child. The children were requested to wear light clothing. They were asked to stand erect, with both hands by the side and feet together on a portable weighing machine. They were asked to look straight and weight in kilograms was recorded. Weight was measured to the nearest 0.1kg.

Each child was requested to stand erect, with feet together, and both arms relaxed by the side. The height of the child in centimeters was measured using a stadiometer. It was rounded off to the nearest 0.1cm. It was then converted to meters. Quetelet's Index was used to calculate the Body Mass Index. BMI = Weight in Kg / square of height in meters.

The BMI of each child was analyzed using the standard age and sex specific growth charts for children aged 5-18 years designed by the Indian Academy of Paediatrics (IAP).

If BMI of the child fell anywhere above the 5th percentile and below the orange line (23 adult equivalent lines), the child was categorized under Group A (normal BMI/weight for height). If BMI of the child fell below the 5th percentile on the BMI chart, the child was categorized under Group B (underweight). If BMI of the child fell on the middle/orange line (23 adult equivalent lines) or between the middle orange line and uppermost red line (27 adult equivalent lines) or on/above the red line, on the BMI chart, the child was categorized under Group C (overweight or obese).

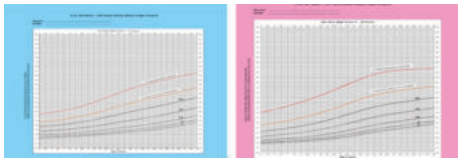

Figure 1- IAP BMI Charts For Girls And Boys
Sources: www.google.com/ iapindia.org

Assessment of cognition was done using the MMSPE (Mini Mental State Pediatric Examination). Jain and Passi have effectively adapted and standardized the MMSE (Mini-Mental State Examination), which is widely used as a cognitive screening test for adults, for children of various nationalities. This method can be employed over a wide age range (3-14 years) and over a brief period of time. Additionally, socioeconomic background and educational level have no bearing on comprehension of instructions. Five areas of cognitive functions namely orientation, attention-concentration, registration, recall and language in a single set of questions were chosen from previously standardized scales used in Indian children. The average time taken for the test was 5-7minutes.The maximum score of this cognitive test is 37. The cut off abnormal scores calculated as 2 standard deviations below the mean in different age groups were 3-5 years – 24, 6-8 years - 28, 9-11 years – 30, 12-14 years – 35.

Statistical Analysis

The results were tabulated and analysed. All parameters were expressed in mean and standard deviation. Paired t test was used as a test of statistical significance between the groups and p-value <0.05 was considered to be statistically significant.

RESULTS

Table 1- General Characteristics Of The Study Population (n=150)

Parameter	Mean	Standard deviation
Age in years	9.18	1.73
Weight in kg	29.86	8.82
Height in cm	127.61	10.54
Body Mass Index in kg/m2	18.16	4.12
MMSPE score (max = 37)	32.73	3.24

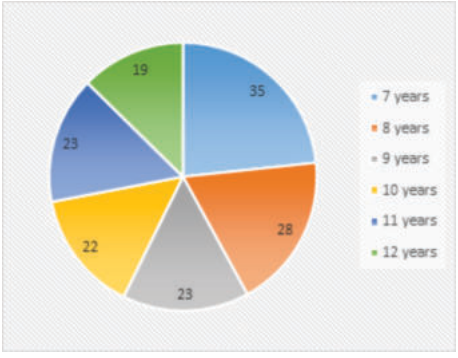

Fig 2- Age Wise Distribution Of The Study Population

Table 2- Distribution Of BMI Among Study Population

Category	BODY MASS INDEX (kg/m2)	
	Mean	Standard deviation
GROUP A	17.9	2.0
GROUP B	13.5	0.9
GROUP C	23.1	1

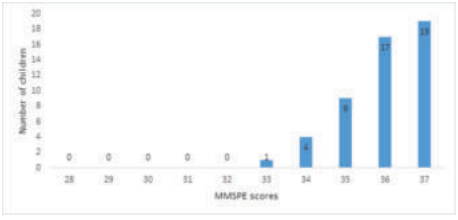

Figure 3- MMSPE Scores Distribution Among Group A Children

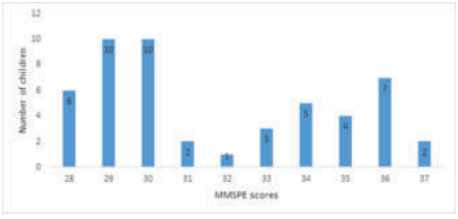

Figure 4- MMSPE Scores Distribution Among Group B Children

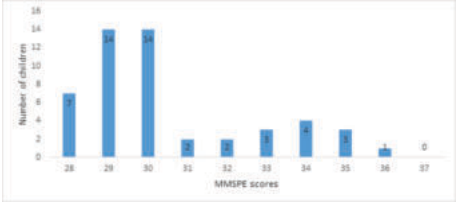

Figure 5- MMSPE Scores Distribution Among Group C Children

Table 3- Relationship Between BMI And MMSPE Scores Among Study Population

Category	MMSPE SCORES		P value
	Mean	Standard deviation	
GROUP A	36	1.03	
GROUP B	31.7	3.0	<0.0001*
GROUP C	30.5	2.2	<0.0001*

*p value <0.05 – statistically significant

The mean MMSPE scores among group B and group C children was significantly less compared to the MMSPE scores of Group A children.

DISCUSSION

From the results furnished above, it is evident that the MMSPE scores of Group B and Group C children were significantly reduced when compared to the scores of Group A children. Malnutrition is characterized by deficiencies, excesses, or imbalances in a person's nutrient- and/or energy-intake. Malnutrition encompasses two primary types of conditions. The first is "undernutrition," which is characterized by stunting (low height for age), wasting (low weight for age) and thinness (low weight for height or low BMI) and micronutrient insufficiencies (a lack of critical vitamins and minerals). The second is overnutrition characterised by overweight and obesity (increase BMI/ weight for height). Evidence from research on both humans and animals suggests that a variety of environmental factors have an impact on neurocognitive development. Among such factors nutrition plays a vital role in neurocognition.

The development and maturation of the brain is greatly influenced by one's nutritional status. The stages of development are numerous and intricate: neural cells must multiply, migrate to the proper location, form connections, form the proper neurotransmitter receptors, and be adequately covered in myelin, a protective material necessary for the proper transmission of nerve signals. This well constructed network of brain cells is susceptible to external stressors, which includes nutrition [4].

The methods through which nutrition affects mental health, nevertheless, are still poorly understood. It has been proposed that cognitive function and synaptic plasticity may be negatively impacted by vitamin B12 and omega-3 fatty acid deficits. Studies show that omega-3 fatty acids and vitamin B12 supplementation are necessary to lower the risk of cognitive decline, while the outcomes of intervention trials utilizing these nutrients alone are inconclusive.[24] Protein insufficiency has been found to cause a reduction in the thickness of the visual cortex, parietal neocortex, dentate gyrus, CA3, and cerebellum.[10,18,22].

Studies have also shown that undernutrition reduces the size of the Paraventricular Hypothalamic Nucleus while increasing the size of the Ventromedial Hypothalamic Nucleus, indicating that developmental disruptions might alter the way the brain is organized.[20].

Poor nutritional status induced cognitive deficiencies manifest as memory issues, intellectual sluggishness, or particular learning challenges in reading, writing, or mathematical computation. The child may struggle with sociability, emotional management, or attention deficit hyperactivity disorder, amid other behavioural issues.[12]

In comparison to children who receive enough nourishment and live in the same environment, it is thought that "survivors" of malnutrition score 5 to 15 points lower on average on standard IQ tests. The severity of malnutrition proportional to the degree of cognitive impairment [3].

In our study, the children of Group B, with lesser than normal BMI scores had a mean MMSPE score of 31.7(3) and children of Group A with normal BMI scores had a mean MMSPE score of 36(1.03). It can be seen that the score among undernourished children is less compared to scores of children with a good nutritional status, and it is also statistically significant. These findings are in accordance with studies conducted by Sandjaja et al,Geetha Kingdon et al, Yubraj Acharya et al and Demewoz Haile et al.

Childhood obesity is an upcoming major and serious concern in many countries.

Speaking of which, according to a review by June Liang et al, of the Center for Healthy Eating and Activity Research at the University of California, San Diego (UCSD), in children, being overweight is linked to a variety of executive function deficits, including weaker working memory, attention, mental flexibility, and decision-making.[16]. Obesity has been linked to lower academic performance, thinner orbitofrontal and anterior cingulate cortices, less white matter integrity, and decreased hippocampal volume, according to research by Antonio Convit at al.[28]

Executive functions like impulse control, decision-making, and postponing gratification in addition to attention and memory are also affected. According to a study by Sussanne Reyes et al, overweight children exhibit poorer inhibitory control compared to normal-weight children, which may make it more difficult for them to say no to unhealthy meals.[23]

Animal experiments conducted by Davidson and colleagues revealed that a high intake of processed carbohydrates and saturated fat can erode the blood-brain barrier, particularly in the hippocampus. Given that the hippocampus is a region crucial to memory and executive function, this renders the brain more susceptible to damaging substances that can compromise its function. According to Davidson's research, a blood-brain barrier breach can also change the levels of brain-derived neurotrophic factor (BDNF) in the hippocampal region. BDNF is a protein which influences appetite, executive function, and decision-making, as well as neuron development and long-term memory. He speculates that obesity in adolescents and kids hampers the blood-brain barrier, though more research is required to confirm this[15].

In our study, the children of Group C, with more than normal BMI scores had a mean MMSPE score of 30.5(2.2) when compared to children of Group A with mean MMSPE score of 36(1.03). It can be seen that the score among overweight and obese children is less compared to scores of children with a good nutritional status, and it is also statistically significant. These findings are in accordance with studies conducted by Yanfeng Li et al.

CONCLUSION

Our study shows that the MMSPE scores, a measure of cognition in children, is significantly reduced in children who are malnourished. It is evident that the nutritional status of a child greatly influences the cognition. But, this reduction in cognitive abilities can be reversed by modifying the nutritional habits of these children. Undernourished children should be encouraged to eat a balanced diet which meets his/her requirements of carbohydrates, protein, fat and other important minor nutrients and vitamins. Programs such as school lunch schemes, improved sanitation, immunization and health services can be implemented to reduce the prevalence of undernutrition. Research suggests incorporating mindfulness practices in children greatly reduces impulsive behaviour. Exercise, specifically aerobic fitness can not only help in weight reduction, may help enhance executive functions in overweight children.

Additionally, parents can best support their children to follow healthy eating habits and avoid poor food choices. Eating together as a family, avoiding screen time while eating are simple measures that can be taken at home. To conclude, strategies to improve nutrition in children can have a promising effect on cognition and in the long run, help in favourable contribution to individual and also towards national development.

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