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Dr. Ram Avtar Kapar
Teacher, Upgraded Middle School, Arnama, Khutauna, Madhubani, Bihar, India

Corresponding Author:
Dr. Ram Avtar Kapar
Teacher, Upgraded Middle School, Arnama, Khutauna, Madhubani, Bihar, India

Effect of nutrition on children cognitive development in India

Dr. Ram Avtar Kapar

Abstract
"The learning environments of home, school and the wider culture therefore enable experience-dependent learning, and lay the basis for the cognitive and emotional functioning of the adult system" Genetic and environmental factors including nutrition interact and provide the basis for physical growth, cognitive and socio-emotional development. Among the multiple early environmental influences, food insecurity and resultant dietary deficiencies, inadequate and poor feeding practices, recurrent and chronic infections, and low levels of infant-caregiver stimulation prevent children from reaching their full potential for growth and development and also increase the risk of poor health due to reduced immunity. Continuing to live in poverty further exacerbates the consequences leading to a perpetual vicious cycle of loss of intellectual, physical and economical potential especially among infants and young children living in low and middle income countries. Brain development during foetal and early postnatal life, is rapid, demonstrating the highest degree of plasticity. The inherent capacity to learn is present, but how and what the infant learns is modulated by the specific determinants in the environment.

Keywords: Cognitive, emotional, development, intellectual and physical

Introduction

The child brain is not different and consist of the same structures and functions as also the mechanisms. Therefore, cognitive development of infants, children until adolescence requires neural enrichment or new stimuli in their environment to build on the existing structure, making it more complex through interaction and learning from the environment. "The learning environments of home, school and the wider culture therefore enable experience-dependent learning, and lay the basis for the cognitive and emotional functioning of the adult system" (Goswami, 2015) [6]. Enrichment or stimulation provided through early caring behaviours of caregivers include feeding of adequate good quality nourishing food and nutrition, verbal interactions and opportunities for learning, and protecting the child from various risks that can obstruct the normal course of development. Genetic and environmental factors including nutrition interact and provide the basis for physical growth, cognitive and socio-emotional development. Among the multiple early environmental influences, food insecurity and resultant dietary deficiencies, inadequate and poor feeding practices, recurrent and chronic infections, and low levels of infant-caregiver stimulation prevent children from reaching their full potential for growth and development and also increase the risk of poor health due to reduced immunity. Continuing to live in poverty further exacerbates the consequences leading to a perpetual vicious cycle of loss of intellectual, physical and economical potential especially among infants and young children living in low and middle income countries.

Brain development during foetal and early postnatal life, is rapid, demonstrating the highest degree of plasticity. The inherent capacity to learn is present, but how and what the infant learns is modulated by the specific determinants in the environment. The genetic expression is modulated by the biological, socioeconomic as well as the psychosocial effects and the timing of these can alter the structure and function of the brain and resultant behaviour. In turn, infant behaviour directly affects the development and 'wiring' of the brain through its interactions with biological and psychosocial influences. 'The risks associated with poverty, such as lack of stimulation or excessive stress, affect brain development, resulting in dis-regulation of the hypothalamic-pituitary-adrenocortical system, and change the electrical activity of the brain related to efficiency of cognitive processing'.

Review of Literature

Review of selected literature is an essential part of every research process. It helps us to examine and evaluate what has been said earlier on the research subject

Spears, D and Lamba, S. (2016) [1] Effects of Early-Life Exposure to Sanitation on Childhood Cognitive Skills: Evidence from India, One hypothesized channel through which nutritional status affects long-term wellbeing is cognitive development. Existing research has examined this relationship using various indicators of nutritional status and cognitive achievement.

Crookston, B.T, Schott, W, Cueto, S, Dearden, K.A, Engle, P and Georgiadis, A, *et al*. (2013) [2] Postinfancy growth, schooling, and cognitive achievement: There is some evidence that the impact of early-life malnutrition on health could be partially reversible supporting the view that efforts to address child nutrition could reverse, or at least mitigate, some of the effects of early-life nutritional deficiencies on cognitive development.

Perignon, M, Fiorentino, M, Kuong, K, Burja, K, Parker, M and Sisokhom, S, *et al*. (2014) [3] Stunting, poor iron status and parasite infection are significant risk factors for lower cognitive performance in Cambodian school-aged children Several recent studies have examined the nutrition-cognition nexus among children older than five years. For example, Perignon and colleagues studied the association between various nutritional deficiencies and cognitive achievement among Cambodian children aged 6-16.

Methodology

The method used in this paper is descriptive-evaluative method. The study is mainly review based. It is purely supported by secondary source of data, i.e. books, journals, papers and articles and internet.

Result and Discussion

Birth Weight and Cognitive development

The Pune Low Birth Weight (LBW) longitudinal study from birth to adulthood in India was conducted in a cohort of 161 LBW infants with birth weights less than 2000g. The cohort divided into three groups according to their gestation- 'preterm and small for gestational age' (SGA, n=61), 'full term but small for gestational age' (full term SGA, n=30) and full term control group, i.e., 'appropriate for gestational age' (AGA, n=70) was followed until age 18 years. At age 18 years, the IQ (Raven's Progressive Matrices) of the LBW groups was significantly lower than controls (P<.002). Preterm SGA subjects had the lowest IQ, though just within normal limits. LBW males had significantly lower IQ than male controls (P<.03). The IQ of pre-term SGA subjects of college educated mothers (P<.004) belonging to higher socioeconomic class was significantly higher (P<.04) than those of lower social class and lesser educated mothers. The 18 year IQ was best predicted by IQ at 6 and 12 years (Chaudhari *et al*., 2013). A South Indian study examined the effect of birth weight and head circumference on cognitive ability of 9-10 year old children. Using the Kaufman Assessment Battery, Memory and Attention-Concentration tests, results adjusted for age, sex, gestation, socio-economic status, parent's education, maternal age, parity, BMI, height, rural/urban residence, and time of testing indicated a small increase in learning ability, long-term storage and retrieval memory and visuospatial ability with increase in birth weight and head circumference. No significant associations were observed between birth weight/head circumference and short-term memory, fluid reasoning, verbal IQ and attention- concentration (Sargoor *et al*., 2010).

Effects of PEM on Growth, Brain and Cognitive Development

Brain development around 24 and 42 weeks of gestation is particularly vulnerable to nutritional deficiencies due to the rapid development of several neurologic processes that include synapse formation and my elimination. However, being highly plastic, the developing brain can be repaired after nutrient repletion. But with severe nutrient deprivation, the plasticity of the vulnerable brain can be challenged and results in brain dysfunction that persists despite later repletion with nutrients. Early severe protein-energy undernutrition leads to growth restriction, and stunting in particular has been found to affect learning and consequent poor cognitive development that may even be irreversible. Globally, 26% or about 165 million children under 5 years of age were stunted in 2011. Information on stunting and education from 79 countries indicated the average prevalence of stunting to be 26·0%. 'For every 10% increase in stunting (Height for age, <-2 SD), the proportion of children reaching the final grade of primary school dropped by 7·9%' (World Health Organization 2006). The Sub-Saharan Africa and South Asia have much higher per cent stunted children compared to global figures. Crookston *et al.* (2013) [2] examined the associations between recovery from early stunting and cognitive abilities using longitudinal data from Ethiopia, India, Peru and Vietnam. They found that improving the growth of children who were stunted in infancy and maintaining nutrition in children who might otherwise falter may significantly benefit their schooling and cognitive achievement (Crookston *et al*., 2013) [2]. The association of early stunting with long term poor likelihood of formal employment at age 20-22 years was observed in the Philippines (Carba *et al*., 2009) and also poorer psychological functioning in Jamaican adolescents (Walker *et al*., 2007). Therefore, the timing of growth faltering due to undernutrition appears to be important. In Guatemala, growth and development were related up to age 24 months but not from 24 to 36 months (Kuklina *et al*., 2006). Pooled data from five longitudinal studies found that a 1 SD increase in height from birth to 2 years was associated with increased schooling and inversely related to grade failures, whereas growth from 2 to 4 years had little effect indicating the importance of early nutrition below the age of 2 years (Martorell *et al*., 2010).

Effect of micronutrients on brain and cognition

Cognitive function depends on the combined activity of billions of neurons and several biochemical pathways, and specific enzymes that require several micronutrients. Therefore in addition to macronutrients, certain micronutrients are implicated in brain functions. Iron deficiency during prenatal and neonatal periods can alter myelination, monoamine neurotransmitter synthesis, and hippocampal energy metabolism. Assessment of these effects utilize tests for speed of processing (myelination), changes in motor and emotional affect (monoamines), and recognition memory. Zinc deficiency affects the regulation of autonomic nervous system as well as the hippocampal and cerebellar development. Iron deficiency anaemia can impede infant and young child's development and iron therapy may not be able to reverse its adverse effects. Preventive measures with iron supplementation to infants and their mothers during pregnancy were found to benefit children's motor, socio-emotional and language development. Maternal iron deficiency anaemia at 6 to 10 weeks post-partum was found to be associated with lack of maternal sensitivity and poor infant responsiveness (Murray-Kolb and Beard, 2009) in South Africa that improved post iron treatment. At 9 months of age these infants were also delayed in their development. The prevalence of iron deficiency due to inadequate intake of iron rich foods can impair brain function. Whenever the diet offers a wide variety of foods and supplies sufficient protein and calories, it is likely that vitamin and mineral intake will also be adequate.

Evidence suggests that subclinical micronutrient deficiency can disrupt psychological function in children (Naismith *et al*., 1988). Micronutrients have also been implicated in attention-concentration deficit hypothesis. In a matched-pair, cluster, randomization study, 6 to 15 year old residential school children in South India received a micronutrient enriched drink or a placebo drink (Vazir *et al*., 2006). Children with lower dietary micronutrient intake have been reported to respond more readily to supplementation (Tofail *et al*., 2008), "responders" being children who showed increased serum micronutrient levels and improvement in mental function after supplementation. In an earlier study, multi-vitamin deficient rural school boys randomly supplemented with B-complex vitamins or placebo for one year found higher biochemical values for riboflavin, pyridoxine and folic acid among those supplemented. However 50% of supplemented boys continued to be deficient in one or more vitamins. Psychomotor benefits of supplements were observed on arm-hand steadiness test. The study concluded that functional impact of vitamin supplements may be seen even in the absence of clear-cut clinical or biochemical change (Bamji *et al*., 1982) [4].

Conclusion

Our study concludes that a major mechanism by which nutritional deficiencies in childhood impact later life is likely through poor cognition and low educational attainment. The negative associations between measures of malnutrition and cognitive ability and educational attainment that we uncovered suggest that policies need to address both early and middle childhood and both acute and chronic malnutrition. Our findings speak to the merits of malnutrition mitigation programs, such as school lunch schemes and improved sanitation and health services. The benefits achieved need to be sustained and protected from new stressors such as climate change calamities, humanitarian crises, food price volatility, violence in the current war-like scenario in parts of the world that have far reaching consequences worldwide. From the nutritional point, innovations need to be encouraged in design and delivery of nutrition specific interventions, to make them more affordable and available. In parts of the world that are presently torn with violence, acute food shortage and difficulty in reaching children and adults trapped in far flung areas poses a major hurdle to prevent starvation deaths. The long-term consequences will need special efforts at rehabilitation.

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