

The Impact of Nutrition on Child Development at 3 Years in a Rural Community of India

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ABSTRACT

Background: In India, child malnutrition is mostly the result of high levels of exposure to infection and inappropriate infant and young child feeding and caring practices and has its origins almost entirely during the first 2 to 3 years of life. This study aims in assessing the impact of breast feeding on child development of children at 3 years.

Methods: About 530 children at 3 years were assessed for developmental delay by Ages and Stages Questionnaire (ASQ). Growth measurements and hemoglobin estimation were carried out at the time of developmental evaluation. Physical growth was assessed by using World Health Organization growth charts. Children were assessed for their duration of breast feeding and weaning period. They were analyzed for the feeding practices versus developmental outcome. Chi-square test was used to compare the categorical variables. Differences were considered significant at $P < 0.05$ level.

Results: Children who were exclusively breastfed for at least 6 or more months had significantly higher ASQ scores with P value for communication (0.003), gross motor (0.004), fine motor (0.007) and problem solving (0.013) except personal social (0.059) compared with children who had exclusively breastfed for less than 6 months. Children, who were weaned beyond 12th month, had significantly higher ASQ scores with P value for communication (0.004), gross motor (0.091), fine motor (0.044), problem solving (0.001) and personal social (0.012) as against those who were weaned at 6th month or earlier in all domains.

Conclusion: Breast feeding has a positive effect on the overall development of the child and should be promoted in the present generation. In India, child malnutrition is responsible for a higher percentage of the country's burden of disease. Undernutrition also affects cognitive and motor development and undermines educational attainment; and ultimately impacts on productivity at work and at home, with adverse implications for income and economic growth.

Keywords: Breast feeding, child development, undernutrition

INTRODUCTION

There has been great concern within the public health community over a perceived decline in the incidence and duration of breastfeeding in developing countries even after numerous beneficial effects of breast milk have been demonstrated for the term and near-term infants, including improved cognitive skills, improved behavior ratings and decreased rates of infection. Improved neurodevelopment has been related to the presence of long-chain polyunsaturated fatty acids (LCPUFA; arachidonic and docosahexaenoic), which are found in human milk, but not bovine milk.^[1,2]

The prevalence of child undernutrition in India is among the highest in the world; nearly double that of sub-Saharan Africa, with dire consequences for morbidity, mortality, productivity and economic growth. Although levels of undernutrition in India declined modestly during the 1990s, the reductions lagged far behind that achieved by other countries with similar economic growth rates.^[3]

The global community has designated halving the prevalence of underweight children by 2015 as a key indicator of progress toward the millennium development goal of eradicating extreme poverty and hunger.^[3]

Why invest in combatting undernutrition?

Failing to deal effectively with the undernutrition problem in India has dire consequences for children's development. It retards their physical growth and increases their susceptibility to disease in childhood and adulthood. It also affects cognitive and motor development, limits educational attainment and productivity and ultimately perpetuates poverty. In India, child malnutrition is mostly the result of high levels of exposure to infection and inappropriate infant and young child feeding and caring practices and has its origins almost entirely during the first 2-3 years of life.^[3]

Breast feeding and child development

Normal development in a child is a complex process and has a multitude of facets. However, it is convenient to understand and assess development under following domains:^[4]

- Gross motor,
- Fine motor,
- Personal and social development and a general understanding,

- Language and,
- Vision and hearing.

Breast feeding enhances development and intelligence.^[4-9]

Gross motor

Motor development progresses in an orderly sequence to ultimate attainment of locomotion and more complex motor tasks thereafter.

In Ages and Stages Questionnaire (ASQ), gross motor movements were assessed, e.g., locomotor movements of the child such as running, walking, climbing upstairs, jumping and kicking a ball by swinging her leg forward.

The axial (proximal) muscles are concerned with postural adjustments and gross motor movements. The ventral corticospinal and medial descending pathways from brainstem (tectospinal, reticulospinal and vestibulospinal) control the proximal muscles.

Fine motor

This primarily involves the development of fine manipulation skills and co-ordination with age.

In ASQ, fine motor movements were assessed, e.g., fine movements of the child such as drawing a circle, drawing a line from one end of paper to the other end, dressing, using scissors to cut a paper and threading the shoelace.

The distal limb muscles mediate fine, skilled motor movements and are under the control of lateral corticospinal and rubrospinal tracts.

Higher intelligence quotient

Children who had consumed mother's milk by tube in early weeks of life had a significantly higher IQ at 7.5-8 year than those who received no maternal milk, even after adjustment for differences between groups and mother's educational and social class.

Cognitive development

Supplementary regression analysis examining the strength of relationship between duration of breastfeeding and cognitive development show a small, but significant relationship between duration of breastfeeding and scores on the mental development index (MDI) of the Bayley Scales at 1 and 2 years.

Social development

The psychomotor and social development of breastfed babies clearly differs from that of bottle-fed ones and leads at the age of 12 months to significant advantages of the psychomotor and social capabilities.

METHODS

The present study was conducted under the auspices of the Department of Physiology among children aged 3 years and residing in consigned Primary Health Centre area attached to the J. N Medical College, Belgaum, India.

The study was approved by Institutional Ethics Committee for Human Subjects Research.

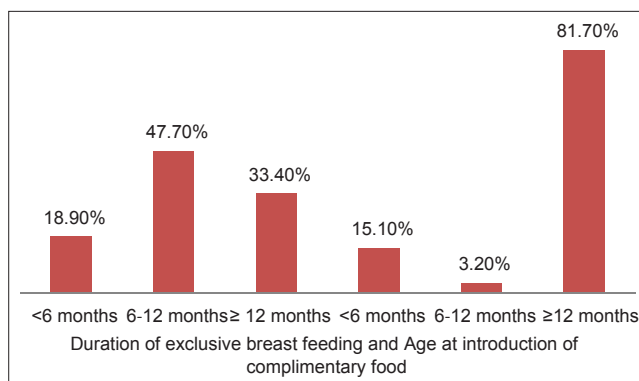
The sample size was estimated to be 530 by allowing 20% error on account of mortality during the 2nd and 3rd year, missed out cases, refusal to participate and treatment initiated before 3 years.

About 530 children at 3 years were assessed for developmental delay by ASQ.^[9] Growth measurements and hemoglobin estimation were carried out at the time of developmental evaluation. Physical growth was assessed by using World Health Organization (WHO) growth charts for weight for age, height for age and weight for height. Children were assessed for their duration of breast feeding and weaning period. They were analyzed for the number of infections acquired versus developmental outcome. Chi-square test was used to compare categorical variables. Differences were considered significant at $P < 0.05$ level.

RESULTS

Feeding practice of children

A higher proportion of the children, 253 (47.7%) were exclusively breastfeeding for 6-12 months. Majority 433 (81.7%) of mothers had started weaning their children at 12 months and later. Majority 514 (97%) of children had received the nutritional supplements [Graph 1].



Graph 1: Feeding practices of children

Feeding practices versus developmental outcome

Tables 1 and 2 summarize the comparison of feeding practices of children with developmental outcomes. Children who were exclusively breastfed for at least 6 or more months had significantly higher ASQ scores compared to children who had exclusively breastfed for less than 6 months [Table 1]. The P value for communication (0.003), gross motor (0.004), fine motor (0.007) and problem solving (0.013) except personal social (0.059) were statistically significant.

Children, who were weaned beyond 12th month, had significantly higher ASQ scores as against those who were weaned at 6th month or earlier in all domains except gross motor [Table 2]. The P value for communication (0.004), gross motor (0.091), fine motor (0.044), problem solving (0.001) and personal social (0.012) were statistically significant. All children had received nutritional supplements.

Table 1: Duration of exclusive breastfeeding versus developmental outcome

Domain	<6 months*	6-12 months*	≥12 months*	χ^2	P
Communication	48	33.2	27.7	11.922	0.003
Gross motor	49	39.9	29.4	11.101	0.004
Fine motor	39	27.7	21.5	9.799	0.007
Problem solving	45	36	27.7	8.673	0.013
Personal social	49	44.7	35.6	5.670	0.059

*Number of children with developmental delay in percentage

Table 2: Time of introduction of complementary food versus developmental outcome

Domain	<6 months*	6-12 months*	≥12 months*	χ^2	P
Communication	42.5	64.7	31.4	10.985**	0.004
Gross motor	43.8	58.8	36.3	4.800	0.091
Fine motor	35	47.1	25.6	6.226	0.044
Problem solving	40	76.5	32.3	14.222	0.001
Personal social	45	76.5	40.6	8.843	0.012

*Number of children with developmental delay in percentage, **(χ^2)

Hemoglobin estimation versus development outcome

A majority of children (367 [69.2%]) had hemoglobin percentage more than 11 g% and children with better hemoglobin concentration showed a higher score with ASQ. These findings were found statistically significant in all domains of ASQ [Table 3].

DISCUSSION

India is facing a grave challenge of having very high rates of child undernutrition with high morbidity and mortality. Undernutrition is an underlying cause of an estimated 53% of all under-five deaths. Those who survive may get locked in a vicious cycle of recurring sickness and faltering growth, often with irreversible damage to their motor, cognitive and social development.^[10]

According to results of animal research and clinical studies, several nutrients and other components present in breast milk could contribute to the enhancement of mental development. LCPUFAs in human milk have an effect on the chemical composition of the brain and enhance retinal and cortical function. These agents can act directly, influencing brain biochemistry and functional development or indirectly, modifying sensory systems that affect brain development.^[11]

Exclusive breastfeeding stands out as a single most effective intervention for child survival. Universalizing early (within 1 h) and exclusive breastfeeding (for 0-6 month), is viewed as a major public health intervention to reduce the child mortality, particularly, in neonates and infants. Improving the complementary feeding is viewed as a major contributor to reduce anemia and stunting as well.^[10]

Table 3: Assessment of hemoglobin estimation and developmental outcome

Domain	Hemoglobin (g %)			χ^2	P
	<10*	10-11*	≥11*		
Communication	69.4	52.8	24.3	55.485	0.000
Gross motor	72.2	53.5	29.4	42.314	0.000
Fine motor	55.6	46.5	18.5	51.630	0.000
Problem solving	58.3	58.3	24.5	56.613	0.000
Personal social	75.0	54.3	35.1	30.956	0.000

*Number of children with developmental delay in percentage. DF=Degrees of freedom

Majority of the mothers who participated in our study had breastfed exclusively for 6 months or slightly more. WHO recommends for a minimum 6 months of exclusive breastfeeding.^[12] The results of the present study show that exclusive breastfeeding had a positive effect on the child's developmental outcomes.

In our study, it was found that increasing duration of breast feeding was associated with consistent and statistically significant increase in ASQ scores assessed at 3 years of age. Similar findings were obtained in a study showing with consistent and statistically significant increases in IQ assessed at ages 8 and 9 years and reading comprehension, mathematical ability and scholastic ability assessed during the period from 10 years to 13 years.^[13]

Breastfeeding is associated with small, but detectable increases in child cognitive ability and educational achievement. A strong positive relationship was demonstrated between breastfeeding and the Peabody Picture Vocabulary Test Revised (PPVT-R) scores with increased duration of breastfeeding. The PPVT-R is a standardized test of receptive language, which has been extensively validated against other standardized tests of intelligence in children and is indicative of verbal intelligence.^[14]

Majority of children had started with weaning after 12 months. WHO recommends that weaning should be started after 6 months along with continued breastfeeding.^[12] In our study, we found a significant association between the time of weaning period and the neurobehavioral development of the child. The present study shows that weaning after 6 months had a positive impact on the child's developmental outcomes in all the skills except gross motor. Children, who were weaned beyond 12th month, had significantly higher ASQ scores with very high significant change in communication skills compared to other skills.

The relation between breastfeeding and childhood cognitive development was examined in 1991-1993 among 439 school-age children weighing < 1,500 g when born. After covariate adjustment for the home environment, maternal verbal ability, a composite measure of parental education and occupation, and length of hospitalization, the authors found that breastfed children evidenced an advantage only for measures specific to visual-motor integration (5.1

IQ points). Differences in test scores between breastfed children and those who did not receive any breast milk feedings were 3.6 IQ points for overall intellectual functioning and 2.3 IQ points for verbal ability.^[15] In 345 Scandinavian children, data on breast feeding were prospectively recorded during the 1st year of life and neuromotor development was assessed at 1 year and 5 years of age. Main outcome measures were Bayley's Scales of Infant Development at age 13 months (Mental Index, MDI; Psychomotor Index, PDI), Wechsler Preschool and Primary Scales of Intelligence (WPPSI-R), and Peabody Developmental Scales at age five. Children breast fed for less than 3 months had an increased risk, compared with children breast fed for at least 6 months, of a test score below the median value of MDI at 13 months and of WPPSI-R at 5 years.^[16] Similar findings were observed in other studies.^[17-20]

Limitations of the study

- Covariate analysis to assess different causes of under nutrition has not been carried out in our study
- At the screening level, estimation of hemoglobin would have been carried out using more accurate methods than Sahli's method.

Suggestions

- Measuring nutrition is challenging owing to the numerous difficulties in assessing diet. However, this type of research is important as diet is a potentially modifiable factor and nutritional interventions may help improve children's cognitive development
- Effects of employment on feeding practices and comparative study of feeding practices among mothers of rural and urban setting
- Our study has concerned on children with age group of 3 years keeping in consideration to school age in a rural setting. It will be better if, the study group of up to 2 years will be chosen as this will give us the prevalence of highly vulnerable group including urban setting with hope of reversible normal neural development following an early intervention
- Assessment of Growth and development of children using screening tools along with metabolic parameters will provide variable etiological factors for developmental delay

and strengthen up the association of child development with specific etiologies in all the domains.

CONCLUSION

Breast feeding has a positive effect on the overall development of the child and should be promoted in the present generation. In India, child malnutrition is responsible for a higher percentage of the country's burden of disease. Undernutrition also affects cognitive and motor development and undermines educational attainment; and ultimately impacts on productivity at work and at home, with adverse implications for income and economic growth. The concerned authorities should provide health education to all productive females and update the benefits of Breast feeding economic growth.

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