

## RESEARCH ARTICLE

## INFLUENCE OF NUTRITION AND SOCIO-ECONOMIC STATUS ON INTELLECTUAL DEVELOPMENT IN SCHOOL CHILDREN

Kashinath D Garkal<sup>1</sup>, Anjali N Shete<sup>2</sup><sup>1</sup> Registrar, Maharashtra University of Health Sciences, Nashik, Maharashtra, India<sup>2</sup> Department of Physiology, Government Medical College, Aurangabad, Maharashtra, India

## Correspondence

Anjali N Shete  
(dranju01@yahoo.com)

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**Background:** The nutritional adequacy is one of the determinants of quality of human resources everywhere. Malnutrition is the root cause for the death of 6 million children each year in developing countries. Nutritional deficiency is correlated with an increased risk of impaired cognitive function in children.

**Aims and Objective:** To assess the role of nutrition and socioeconomic status on the development of IQ in school children.

**Materials and Methods:** A cross-sectional, observational study was carried out in 200 primary school children aged 5–9 years of both the sexes. The children were grouped into five nutritional grades. The IQ was calculated using Kamat's psychological tests for all the children.

**Results:** The degree of malnutrition shows a definite reduction in IQ development, which is statistically significant. The study showed that declined socioeconomic status further decreases the development of IQ in school children.

**Conclusion:** The study concluded that the nutritional status and the socioeconomic status significantly decline the mental and physical growth of children.

## INTRODUCTION

The nutritional adequacy is one of the determinants of quality of human resources everywhere. In fact, it can be stated that "man is what he eats."<sup>[1]</sup> Malnutrition is the root cause for the death of 6 million children each year in developing countries. It accounts for 55% deaths that occur in children.<sup>[2]</sup> Much more than this number is affected because of malnutrition alone. Millions of those who survive are left crippled, vulnerable to illness, and intellectually disabled.

Protein energy malnutrition has been identified as a major health and nutrition problem in India. It not only is an important cause of childhood morbidity and mortality but also leads to permanent impairment of physical and mental growth.<sup>[3]</sup>

The nutritional disorders affect vast population of the Asian region. Intrauterine growth and development is one of the most vulnerable processes in the human life cycle, and its aberrations can result in lasting profound influence in later life. Severe iodine deficiency during the intrauterine life can cause profound mental retardation of children. Until

the year 1990, more than 40 million children in 26 countries born each year were at some risk of mental impairment caused by iodine deficiency in their mother's diet.<sup>[2]</sup> Widespread survey of nutritional status of the population in the backward districts of our states has revealed that the prevalence rate of malnutrition ranges between 54.5% and 57.6% in different groups of socioeconomic status.<sup>[4]</sup> Prevalence of nutritional anemias is widely spread in lower socioeconomic groups of people, particularly in females and children. Nutritional deficiency in children affects physical, mental, and intellectual development.<sup>[5]</sup> In preschool children, anemia is widespread. Different cities in India indicate that 52–60% of children were anemic, with Hb less than 11 g/dL for the age group of 1–6 years.<sup>[1]</sup>

The iron deficiency is strongly correlated with increased risk of impaired cognitive function in children. In infancy and early childhood, it delays psychomotor development and impair cognitive development, lowering IQ by about 9%.<sup>[2]</sup>

Research work so far has established the relationship between the nutritional status of

children and their physical, neural, reproductive, and immune growth. Many factors such as nutrition and socioeconomic status affect IQ development. This study, therefore, was planned to assess the role of nutrition and socioeconomic status on the development of IQ.

## MATERIALS AND METHODS

For the study, 200 primary school children of either sex in the age group 5–9 years were selected. The children were selected from the corporation school. Written permission was taken before the study from the principal of the school. Ethical clearance was taken from the institute. As the participants were children, informed written consent was taken from their parents for the study. The basic demographic measurements such as height and weight were measured. Detailed clinical examination was performed to rule out any major illness. The study was conducted at Government Medical College, Aurangabad, Maharashtra, India, for a period of 6 months.

The information of the parents regarding their employment, education, accommodation, family members, and residential locality was collected by home visits. The socioeconomic classification of the children was made into five classes according to Kumar.<sup>[6]</sup> Information of the child's diet was collected by one day recall method. Children were divided into five nutritional grades: normal nutrition and grades I–IV depending on the weight of the child for his/her age. The nutritional grades were made according to the classification of the Indian Academy of Pediatrics.<sup>[7]</sup>

The IQ was measured by Kamat's psychological tests.<sup>[8]</sup> Each child was asked six questions designed for his/her chronological age. Each question was given 5 min time for answering. If the child answers all six answers correctly, then the questions for higher age were asked until the child fails to answer these questions. The IQ, expressed in percentage, was calculated by using the following formula:  

$$\text{IQ} = \frac{\text{Mental age in months}}{\text{chronological age in months}} \times 100$$

After obtaining the values of IQ, the children were divided into three groups<sup>[9]</sup>: superior IQ = 110–120; average IQ = 90–110; and below average IQ = 80–90.

**Statistical Analysis:** The results obtained were

analyzed by calculating the mean and standard deviation.  $\chi^2$ -Test was used to determine the correlation.

## RESULTS

This study showed a progressive reduction in IQ development as the degree of malnutrition advanced (Table 1). Of 200 students studied, only 26 were found with normal nutritional status. Ninety children were found to be in grade I, 46 children in grade II, 30 children in grade III, and 8 children in grade IV. As far as superior IQ is concerned, a decrease in IQ from  $114.94 \pm 4.10$  to  $110.75 \pm 3.33$  in normal nutrition to grade II nutritional status was noted. It is evident that not a single case was noted in nutritional grades III and IV.

**Table 1:** IQ for students in relation to nutritional status (N = 200)

Nutritional Status	Superior IQ (Mean $\pm$ SD), n = 58	Average IQ (Mean $\pm$ SD), n = 88	Below Average IQ (Mean $\pm$ SD), n = 54
Normal, n = 26	$114.94 \pm 4.10$ , n = 12	$100.86 \pm 4.09$ , n = 11	$79.2 \pm 10.00$ , n = 3
Grade I, n = 90	$114.26 \pm 3.35$ , n = 41	$99.75 \pm 5.92$ , n = 39	$74.36 \pm 11.54$ , n = 10
Grade II, n = 46	$110.75 \pm 3.33^*$ , n = 5	$99.72 \pm 6.28$ , n = 25	$73.33 \pm 15.11$ , n = 16
Grade III, n = 30	n = 0	$91.00 \pm 4.80^*$ , n = 13	$72.75 \pm 11.00$ , n = 17
Grade IV, n = 8	n = 0	n = 0	$66.02 \pm 11.00$ , n = 8**

n, number of students; \*significant; \*\*highly significant.

**Table 2:** IQ for students in relation to socioeconomic status (N = 200)

Socio-economic Status	Superior IQ (Mean $\pm$ SD), n = 58	Average IQ (Mean $\pm$ SD), n = 90	Below Average IQ (Mean $\pm$ SD), n = 52
Class I, n = 6	$116.32 \pm 4.63$ , n = 5	$108 \pm 0.00$ , n = 1	n = 0
Class II, n = 63	$116 \pm 1.73$ , n = 30	$98.97 \pm 6.07$ , n = 30	$76.76 \pm 10.69$ , n = 3
Class III, n = 67	$114.99 \pm 1.88$ , n = 19	$98.34 \pm 6.16$ , n = 30	$77.58 \pm 11.79$ , n = 18
Class IV, n = 57	$112.33 \pm 1.52^*$ , n = 4	$98.00 \pm 0.00$ , n = 28	$75.00 \pm 4.94$ , n = 25
Class V, n = 7	n = 0	$72.00 \pm 0.00^*$ , n = 1	$70.08 \pm 2.65^*$ , n = 6

n, number of students; \*significant; \*\*highly significant.

Of the 200 cases studied, 58 cases were of superior IQ, 88 cases average IQ, and 54 cases below average IQ (Table 1). A decrease in mean value of superior IQ from  $114.94 \pm 4.1$  to  $110.75 \pm 3.33$ ; average IQ from  $100.86 \pm 4.09$  to  $91 \pm 4.8$ ; and below average IQ from  $79.2 \pm 10$  to  $66.02 \pm 11$  was observed as the degree of malnutrition advanced, which shows the influence of malnutrition on the development of IQ. The observations were statistically significant.

Table 2 shows the effect of socioeconomic status on

the development of IQ. The children were divided into five socioeconomic classes. Of 200 children, only 6 cases were noticed in class I socioeconomic status. Of these, 5 cases were noticed to have superior IQ ( $116.32 \pm 4.63$ ) and 1 case to have average IQ ( $108 \pm 0.00$ ). Furthermore, 63 cases were in class II and 67 cases in class III socioeconomic status. Of the 63 children of class II socioeconomic status, 30 cases were recorded to have superior IQ ( $116 \pm 1.73$ ), whereas 30 cases were found in average IQ status ( $98.97 \pm 6.07$ ). The remaining three cases were showing below average IQ with a mean of  $76.76 \pm 10.69$ .

Sixty-seven children fell under the class III socioeconomic group, of which 19 were found to have superior IQ ( $114.99 \pm 1.88$ ), 30 average IQ ( $98.34 \pm 6.16$ ) and 18 below average IQ ( $77.58 \pm 11.79$ ). It is seen that, as the socioeconomic classes goes down from class I to class III, there is a decrease in number of cases with superior IQ. However, the cases with average IQ and below average IQ were seen to increase from class I to class III. This result shows that declined socioeconomic status worsens the development of IQ. The mean value of superior IQ decreases from  $116.32 \pm 4.63$  to  $112.33 \pm 1.52$  as the socioeconomic status declines from classes I to IV. It clearly indicates that the socioeconomic status has its own impacts on the level of IQ in children even though they belong to the same IQ grade.

In class IV, only 4 cases were recorded to have superior IQ ( $112.33 \pm 1.52$ ), 28 cases were having average IQ ( $98 \pm 0.00$ ) and 25 below average IQ ( $75 \pm 4.94$ ). In class V, not a single case was having superior IQ; one case was having average IQ ( $72 \pm 0.00$ ) and six cases were having below average IQ ( $70.08 \pm 2.65$ ). This result shows clearly that there is shifting of cases from superior IQ group to average and below average IQ groups as the socioeconomic status declined. The results in all cases were statistically significant.

## DISCUSSION

In this study, in 200 primary school children, the nutritional and socioeconomic statuses of the children and their IQ level were determined. The obtained results showed that IQ has a definite correlation with nutritional and socioeconomic statuses of the children, which was statistically significant. Our study revealed that the values of IQ

decrease as the nutritional status declines from normal nutrition to grade IV nutrition. Earlier findings of Aboud and Alemu<sup>[10]</sup> are in confirmation with the findings of this study. The findings are also supported by Soewondo,<sup>[11]</sup> who reported that iron deficiency anemia produces alterations in cognitive functions. Lesser intelligence with malnourishment was also reported. The observations of Lozoff et al.<sup>[12]</sup> showed lower mental test scores in children with iron deficiency anemia.

Malnourished children unlike their well-nourished peers have disabilities and weak immune systems. They also lack the capacity of learning than their well-nourished counterparts. Malnutrition reduces motivation, curiosity, and exploratory activities.<sup>[2]</sup> This in turn impairs the mental and cognitive development. Anemic preschoolers have been found to have difficulty in maintaining attention. Poor school achievement among primary school and adolescent children has also been linked to iron deficiency anemia.<sup>[13]</sup> Biochemical estimates of nuclear and myelin constituents have shown a consistent reduction in their rate of accumulation during the period of malnutrition, particularly during brain growth. The rate of DNA accumulation is reduced by malnutrition. In addition, there is reduction in accumulation of cholesterol, phospholipid, and cerebroside, which affects the cerebellar function. These effects are more in the cases of malnourished children, which contribute to their low IQ level.

Majority of low IQ children are at lower end of socioeconomic status, accordingly one is led to the hypothesis that their poor adaptive function is likely to be secondary to adverse sociocultural influence. This theory is in keeping with the observation that children of lower socioeconomic group have gradual decline in IQ. Our study also showed decline in IQ as the socioeconomic group lowers, which was statistically significant.

The obtained results are supported by previous studies. The studies carried out by López et al.<sup>[14]</sup> found that children from low socioeconomic groups significantly have lower score in the attention tests. Lahiri et al.<sup>[15]</sup> also reported similar findings. According to them, socioeconomic status and nutrition have a great influence on the development of IQ. Social, environmental, and psychological factors also influence the physical growth and

intelligence of a child.

Pollitt et al.<sup>[16]</sup> reported that, in low income countries, iron deficiency anemia causes poor performance on mental and motor tests among children. These findings correlate well with our findings. The children with low school performance were characterized by suboptimal energy intakes and mild to moderate undernutrition, and belonged to large families. These characteristics are found in most of the low socioeconomic group families.<sup>[17]</sup> The prior IQ score observed in this study may be because of the outcome of poor nutrition and disadvantageous environment.

Perales et al.<sup>[18]</sup> reported that children who were undernourished during infancy presented lower score in memory and problem solving. Early severe undernutrition has deleterious effects on basic cognitive functions. The findings of our study correlate with the above-mentioned findings. Children and adults in poor families face health risks related to diet. High rate of anemia in children was a characteristic finding in the poor socioeconomic group.

The results of our study indicate an adverse effect of declined socioeconomic condition on the development of IQ. It may be because of the diet in low socioeconomic group, which is found to be low in essential nutrients. The maternal involvement and stimulation is also associated with better behavior, development, and intelligence of children.<sup>[19]</sup> Low-income mothers did not follow a specific sequence for introducing foods, and a trend of greater inadequacy of nutrient intake is associated with severe malnutrition.

## CONCLUSION

This study concluded that nutritional and socioeconomic status significantly affect the development of IQ in school children.

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