Parental Education, Children's Nutritional Status and Non-verbal Intelligence in Rural School-children

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Objective: To assess non-verbal intelligence and its relationship with nutritional status, nutrient intakes and parents' education in school-children. **Methods:** A cross-sectional, observational study was conducted in children between 6-11 years, without any known chronic disorder or intellectual disability. Data were collected regarding parents' education, anthropometry and dietary intakes. Non-verbal intelligence was assessed by Raven's Coloured Progressive Matrices (RCPM). **Results:** In 323 enrolled children (52.9% boys), a significant positive association was observed between RCPM scores and parents' education (father's r_s=0.14, mother's r_s=0.22), height Z-scores (r_s=0.14) and dietary intakes of zinc (r_s=0.14), iron (r_s=0.12) and folate (r_s=0.14). **Conclusion**: Height in normal range, higher zinc, iron and folate intakes, and parental higher educational levels were associated with higher non-verbal intelligence scores.

Keywords: *Cognitive function, Micronutrients, Raven's Coloured Progressive Matrices.*

Parental education and child's nutritional status are hypothesized to be major factors that affect a child's cognitive abilities [1,2]. Majority of the Indian population (70%) resides in rural areas where literacy rates are as low as 68.9% [3]. The nutritional status of children in rural areas has been reported to be poor with high prevalence of micronutrient deficiencies [4]. Indian studies suggest that poor cognitive development is related to poor growth and low socio-economic status [2]. However, there are few reports that have studied the relationship between cognitive development of Indian children with micronutrient intake and their parents' education.

Non-verbal intelligence indicates the ability to learn, analyze, comprehend, and solve novel, complex problems without the use of words [5]. Assessment tools like the Raven's Coloured Progressive Matrices (RCPM) are preferred in multicultural settings or rural areas where poor language skills are a barrier [5].

The objectives of this study were to assess the non-verbal intelligence in school-children from a rural setting and to study the relationship of nutritional status, nutrient (zinc, iron and folate) intakes and parents' education with children's non-verbal intelligence.

METHODS

This cross-sectional study was carried out in 6-11 year old children from a randomly selected primary school in Karegaon, a rural area in Western Maharashtra, from mid June 2014 to end of July 2014. Children with known chronic disorders like diabetes, thalassemia and intellectual disability were excluded [6]. According to earlier reports of RCPM scores (70.65% children below average), considering a 4% margin of error and 5% significance level, sample size of 313 was computed [2]. Ethical approval was obtained from the Ethics Committee, Jehangir Clinical Development Centre. Written informed consent was obtained from parents.

Demographic data, socioeconomic status (SES) and parents' education were elicited by structured questionnaires [7]. Height, weight and hemoglobin concentrations were assessed by standard techniques [8,9]. Anemia was categorized as mild (hemoglobin 11-11.4 g/dL) and moderate (hemoglobin 8.0-10.9 g/dL) [9].

Clinical psychologists administered the RCPM test. This measures the general ability of children aged 4 to 11 years, by 3 sets of "diagrammatic puzzles" (12 items in each), with increasing levels of difficulty [5]. It takes about 15 minutes to administer the test. Categorization of RCPM scores is as follows: Superior and High Average (111-130), Average (91-110), Low Average (81-90), Borderline (71-80) and Extremely Low (≤70) [5].

Dietary intake was assessed by 24-hour dietary recall taken over three non-consecutive days. Nutrient intakes were estimated by the C-Diet software (a cooked foods

database software) and were compared to the Indian recommended dietary allowances (RDA) [10,11]. Dietary adequacy was computed based on Indian RDA.

SPSS for Windows (version 21.0.2012) was used for statistical analyses. Normality of variables was tested using one-sample Kolmogorov-Smirnov test. Chi-square test was used to test the relationship between the categorical variables. Spearman's Rank correlation coefficient (r_s) was used to denote correlation between variables.

RESULTS

The study population comprised of 323 children (52.9% boys) with mean age of 8 (1.1) years and 89% belonging to middle SES. Anthropometric parameters and nutritional intakes were comparable and diets were deficient in both macronutrients and micronutrients. Mild anemia was detected in 2.3% and moderate anemia in 4.5% children. *Table* **I** depicts the distribution of RCPM scores and inter-category comparison of demographics.

Children, whose parents had completed high school education or more, attained significantly better scores compared to children whose parents had lower education levels. Significant positive associations, but with low correlation coefficients, were found between both father's (r_s=0.14) and mother's (r_s=0.22) education and children's RCPM score categories.

A significantly greater proportion of children (30%) with normal heights (HAZ ≥–1.0) attained 'Average'

RCPM scores compared to children (20%) with mild to moderate stunting (HAZ<–1.0). The percentage of children with 'Extremely Low' scores was lower among children with normal heights (19%) compared to those with mild to moderate stunting (28%) (*Fig.* **1**). Similar trends, which were non-significant (*P*>0.05), were noted between WAZ and RCPM scores.

Significant, positive though weak correlations were obtained for zinc (*r*=0.14), iron (*r*=0.12) and folate (*r*=0.14) intakes with RCPM scores. These correlations were investigated further by categorizing micronutrient intakes according to tertiles generated from the data into 3 groups: substantially inadequate intakes (<35% of RDA), marginally inadequate intakes (35 to 44% of RDA) and marginally adequate intakes (≥45% of RDA); and exploring their associations with RCPM categories. A greater percentage of children, who had marginally adequate intakes of zinc (38%), iron (37%) and folate (31%) separately, scored 'Average' RCPM scores compared to children who had substantially inadequate intakes of zinc (23%), iron (21%) and folate (22%) (*Fig.* **2a**). Also, among the children with marginally adequate intakes, the percentage of children who scored 'Extremely Low' RCPM scores were lesser compared to children with substantially inadequate intakes of zinc, iron and folate (*Fig.* **2b**).

DISCUSSION

This observational study in 6-11 year old children from a single school in a rural area reveals that majority of

TABLE I DEMOGRAPHIC CHARACTERISTICS OF CHILDREN ACCORDING TO THE RCPM SCORES

Parameters	Superior and High Average (111 to 130)	Average (91 to 110)	Low Average (81 to 90)	Borderline (71 to 80)	Extremely Low(≤70)
n	11	81	77	79	75
Gender					
Male	73%	49%	53%	54%	52%
Female	27%	51%	47%	46%	48%
Socio-Economic Status					
Low SES	-	3%	6%	8%	8%
Middle SES	82%	92%	90%	86%	92%
High SES	18%#	5%	4%	6%	-
Father's Education					
High School and Above	73%	80%	78%	65%*	63%*
Lesser than High School	27%	20%	22%	35%*	37%*
Mother's Education					
High School and Above	55%	56%	42%	44%	24%#
Lesser than High School	45%	44%	57%	56%	76%#

*Significantly different from 'Average' RCPM score; #Significantly different from other score categories.

Significantly higher than in subjects with HAZ <-1.0;

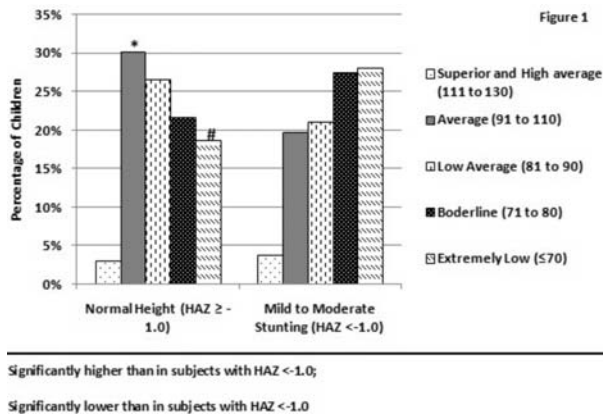Significantly lower than in subjects with HAZ <-1.0

**FIG. 1** *Association of height-for-age z-scores with RCPM standard scores.*

children had below average scores (≤90) in non-verbal intelligence measured by RCPM. Significant positive associations were found between parents' education, children's height (indicator of nutritional status) and intakes of iron, zinc and folate with RCPM scores.

Comparably, in a study of Santal tribal children, RCPM scores of well-nourished children as well as of those from upper SES were found to be significantly higher than that of the poorly nourished children and those from lower SES, respectively [2]. The absence of association of RCPM scores with SES in our study can be explained by the relatively homogeneous socio-economic status distribution. However, we did observe positive though weak associations of paternal and maternal education with RCPM scores, with the latter demonstrating a stronger association. Schooling, more

than household wealth, has been proposed to be a reliable assessment of SES and maternal schooling has been demonstrated to exert a strong influence on children's cognitive functions [1]. The weak associations obtained between parental education and RCPM scores may be because other than parental education level, data related to important factors like parenting style and family interactions, which also have an influence on cognitive outcomes, was not collected by us.

It has also been demonstrated in previous studies in children that micronutrient intakes are positively associated with cognitive test scores. We observed that though diets of the study children were overall deficient in micronutrients, those whose diets had relatively higher amounts of zinc, iron and folate performed better in RCPM test. Sen, *et al.* [12] demonstrated that anemia negatively affected cognition in Indian adolescent girls and demonstrated an improvement in assessment scores with iron-folic acid supplementation. Serum folate levels have shown weak significant positive associations with cognitive test scores in the NHANES III data on 6-16 year olds [13]. Supplementation studies with zinc-rich foods have demonstrated positive effects on cognition in young, undernourished Indian adolescent girls [14]. However, we found poor associations of micronutrient intakes with RCPM scores in our study; this may possibly be because current dietary intakes may not have an association with long-term outcomes such as cognition.

This study being an observational study, only provides an insight into limited factors that are associated with non-verbal intelligence in school-children from a rural setting. Further studies are required to elucidate the
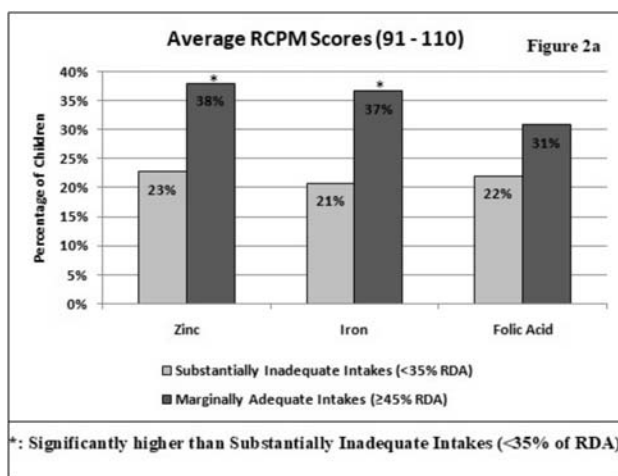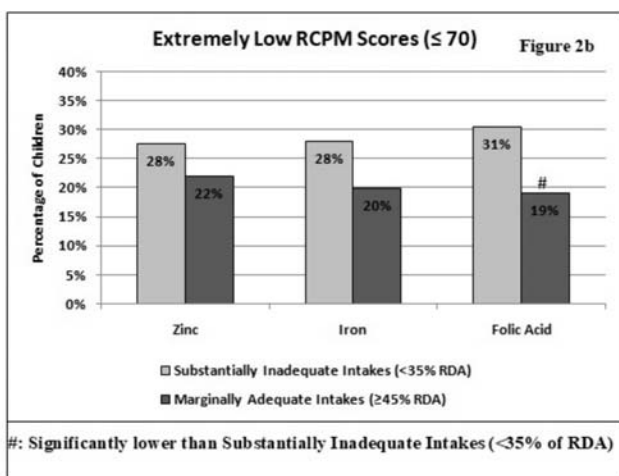
FIG. 2 *Comparison of percentage of children with 'Average' (a), and extremely low (b) RCPM Scores among micronutrient intake categories.*

WHAT THIS STUDY ADDS?

• Majority (72%) of the 6-11 year-old children from rural setting had 'Low Average' or lower scores (*i.e.*<90) in non-verbal intelligence tests.

• Maternal education status, child's linear growth and dietary intakes of iron, zinc and folic acid demonstrated significant, positive but weak associations with children's RCPM scores.

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mechanisms of association of different variables observed in this study with non-verbal intelligence in school-children. Also, long-term supplementation studies which consider factors such as parenting and family interactions are required.

Thus, in rural school-children, parent's, especially mother's education, children's linear growth and dietary intakes of zinc, iron and folate may be important influencers of outcomes in non-verbal tests of intelligence.

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