Original Articles

THE ROLE OF DEVELOPMENTAL STIMULATION IN NUTRITIONAL REHABILITATION

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Objective: To evaluate the role of developmental stimulation and nutritional supplementation in rehabilitation of malnourished children in the hospital and community settings. Design: Prospective follow up study. Settings: (i) Nutrition clinic of a teaching hospital; and (ii) Community Nutrition Project in coastal Kerala. Subjects: (i) Hospital study: 100 children aged 6-24 months with moderate and severe Protein Energy Malnutrition (PEM) constituted the study group. The control group consisted of well nourished children matched for age and sex, 50 from high (Control I) and 50 from low socioeconomic (SE) status (Control II). The study group was randomized into two subgroups to administer the interventions namely composite stimulation package (STIM) or nutritional management (NUT), (ii) Community study: A cohort of 332 children aged 6-24 months with varying grades of PEM were studied. As per the area of residence, they were divided into three subgroups; 2 study groups to administer the two interventions namely STIM or NUT and a control group. Methods: In both the hospital and community studies, environmental parameters, growth and development were assessed initially. After two years, the study groups were reassessed in comparison with the control groups. A final IQ assessment was done in each subgroup by a tester blinded to the grouping. Results: (i) Hospital study: Control children from high SE status (Control I) had the highest overall scores compared to those from low SE status (Control II) as well as the study groups with PEM even after administering either STIM or NUT. Both the interventions produced a significant positive impact on growth and development, but STIM was found superior to NUT. (ii) Community study: There was a high prevalence of PEM in the community, which reduced significantly after the interventions. STIM was found superior in its positive impact on growth and development. In both studies, direct correlation was observed between environmental parameters and anthropometric scores and between anthropometic scores and IQ. Conclusions: The benefit of developmental stimulation in nutritional rehabilitation and the need for providing better environment for deprived children are brought out in this study.

Key words: *Community rehabilitation, Developmental stimulation, Intelligence quotient, Nutritional supplementation, Protein energy malnutrition.*

NEARLY 80 million (63%) of under five children are estimated to suffer from varying grades of protein energy malnutrition (PEM) in India(l). Majority of these children live in an environment of multideprivation. Growth retardation and

developmental impairments are the sequelae of such multideprivation and malnutrition(2,3). Even though Kerala stands apart in vital statistics with better health and nutritional status, there are certain backward pockets with deplorable conditions mostly in slums, coastal and tribal settlements. Various interventions have been initiated to tackle the problem of malnutrition. Although nutritional intervention trials have shown a positive impact on growth and development(4-6), a stimulating environment is said to further augment child development(7). However, factors like the site of intervention, curriculum, duration and cost effectiveness need to be worked out. For this purpose, two pilot projects were initiated, one in the hospital setting and another in a backward coastal area near Thiruvananthapuram city.

Subjects and Methods

Hospital Study

The study sample consisted of 100 children aged 6-24 months, 50 with moderate and 50 with severe PEM from low socioeconomic (SE) status who attended the Nutrition Clinic of the Department of Pediatrics, SAT Hospital, Medical College, Thiruvananthapuram. Grading of PEM was done according to the LAP classification(8). Grade II (weight 61-70%) was considered as moderate and Grades III and IV (weight <60%) were considered as severe PEM. Children with kwashiorkor were included as severe PEM irrespective of weight. Children with congenital malformations or chromosomal, genetic, metabolic and neurologic disorders were excluded. The study group was randomized into two groups in order to administer the two types of intervention namely composite stimulation package (STIM) and nutritional management (NUT). The control group comprised of age and sex matched well nourished children, 50 from high (Control I) and 50 from low SE status (Control II). They were selected from the Immunization Clinic of the hospital and from the well nourished children in a community nutrition project run by the department.

Community Study

The study was conducted in a backward coastal area, Poonthura, inhabited by traditional fisherfolk. With the help of the local church, the area was divided into 10 wards and 10 community volunteers were selected from the local area. They were given information regarding primary health care and nutrition and were utilized to motivate the parents and to help the health team in implementing the programme. There were 540 children aged 6-24 months in the community. After excluding the well nourished children, a cohort of 332 children from low SE status with mild to severe PEM according to the IAP classification were included in the study. Children with congenital malformations or chromosomal, genetic, metabolic and neurologic disorders were excluded. A group of 127 malnourished children residing in 5 wards close to the Corporation Child Welfare Center were given the benefit of STIM and 118 malnourished children residing in 5 wards away from the center were given the benefit of NUT. A sample of 87 malnourished children residing in the outskirts and new colony served as the controls.

Initial Assessment

Assessement was done using a proforma *(Table I)* and the respondent was the mother or a responsible family member. The SE status was assessed using the Kuppuswami scale(9) taking into account education and occupation of parents and per capital income which was modified to suit the study after pretest. As the family income ranges in the scale were low and

TABLE I- *Proforma Utilized*

I. Sociodemographic factors

1. Name & Address 2. Age in months 3. Sex
4. No. of Children 5. Spacing of birth 6. FP Methods

II. Environmental Factor

A. *Socio-economic Data*

1. Education of parents 2. Occupation of Parents 3. Family Income 4. Percapita Income
SE Status Score 26-27/16-25/1 M5/5-10/<5

B. *Standards of Sanitation*

1. Water for drinking and other purposes and storage of water
2. Defecation of children below 5 yrs.
3. Hand washing by mother before handling/eating food and after defecation
4. Appearance of mother's hands and cloth
Sanitary score 18-21/13-17/7-12.

C. *Microenvironment*

1. Maternal attitude (4 items) 2. Supportive system (4 items)
Microenvironmental score 19-24/15-18/8-4.

III. Dietary Factors

1. Breastfeeding and weaning
2. Present calories and protein intake 3. Diet during illness

IV. Clinical Assessment

1. General examination 2. System examination
3. Associated infections and immunization status

V. Anthropometric Assessment

1. Weight Weight for age
2. Height Height for age
3. Weight for Height 4. Head circumference

VI. Developmental Assessment

1. Gross motor 2. Fine Motor Adaptive 3. Language
4. Personal Social 5. DQ

VII. Intervention and Follow up

A *Medical*

1. Primary Health care 2. Immunization
3. Medical care (OP & IP) 4. Deworming B

Nutrition

1. Dietary evaluation 2. Nutritional assessment and growth monitoring
3. Nutritional supplements; Food, Oil, Vitamin, Minerals 4. Nutrition education C

Stimulation

1. Developmental evaluation and developmental information
2. Individualized stimulation for catch up: Visual, Auditory, Tactile, Vestibular
3. Play therapy 4. Motor coordination tasks: hand and feet exercise and skills
5. Training of ADL

D *Psychosocial*

1. Social interview 2. Counselling
3. Help in decision making 4. Psychosocial support
5. Child rearing skills

VIII. Outcome

Final assessement of environmental, anthropometric and developmental scores, IQ

outdated, per capita income was scored in the study instead of family income. Upper class I (score 26-27) was regarded as high and lower middle class III (score 11-15) as well as lower classes IV and V (score < 10) were ragarded as low SE status. Standards of sanitation were scored as per the scale of Briscoe(10), taking into account the source of water supply, sanitary habits and cleanliness and categorized into good (score 18-21), fair (score 13-17) and poor (score 7-12). Microenvironment was scored using pretested items selected from the "Handbook of Parental Acceptance and Rejection"(11) and a supportive system scale(12,13) and categorized into good (score 19-24), fair (score 15-18) and poor (score 8-14). Growth was assessed using standardized anthropometric measurements(14) like weight, height, head circumference and by computing weight for age, height for age and weight for height in comparison with NCHS reference standards(15). Weight for age was classified according to the IAP classification(8). The degree of stunting and wasting were catagorized as per Waterlow's classification(16) using height for age and weight for height, respectively. Developmental evaluation was done using the Denver Developmental Reference Chart(17) to understand deviation and delay in areas like gross motor, fine motor adaptive, language and personal social development and an overall developmental quotient (DQ) was calculated for comparison. A mean score of 100.4 obtained in well nourished children with high SE status justified the use of this scale in the study population.

Interventions

The children in the study groups were given the benefit of either NUT or STIM. *NUT* included nutritional inputs like dietary evaluation by 24 hour recall(18), breast-feeding and weaning practices and diet during illness, assessment by clinical and anthropometric parameters, food supplementation and nutrition education and also medical inputs like primary health care, immunization, deworming and medical care during illness. *STIM* included in addition to NUT, developmental inputs like assessment, information about milestones, individualized stimulation(19), play therapy, motor coordination tasks(12) and training of activities of daily living (ADL) and also psychosocial inputs directed to the parents like social interview, counselling, help in decision making and education on child rearing skills. *Inputs for the child* included food supplementation; medical check up, immunization, medical care, developmental stimulation and play therapy. *Inputs for the parents* included health and nutrition education, counselling, child rearing skills, psychosocial support, information about milestones, training in developmental stimulation, motor coordination tasks and ADL.

Health Team

The investigators, postgraduate students, public health nurse, helper, developmental tester and social scientist constituted the health team in the hospital study. The services of the public health nurse, helper and preschool teacher in the corporation center and 10 community volunteers were utilized in the community study. A team of doctors including the investigators, postgraduate students, developmental tester and social scientist visited the area, conducted weekly clinics and implemented the programme.

Follow-up

Both NUT and STIM groups were followed up for two years. They were given a palatable precooked ready to mix cereal pulse mixture (SAT mix) as a supple-

ment(20), iron and folk acid tablets/drops, vitamin A concentrate, multivitamins, zinc and also coconut oil 3 tsf per day to bridge the calorie gap. In the hospital study, the malnourished children were given 150-200 Calories/Kg body weight. This was found to approximate the Recommended Dietary Allowances (RDA} for age(21) and hence the RDA for age was given to each child in the community study. Follow up was ensured by good rapport, positive suggestions, food and vitamin supplements, by sending reminders and organizing home visits when necessary. They were given appointments once a week during the first three months, once in two weeks in the next three months and once a month during the rest of the period. Individualized developmental tasks(19) were taught to the mothers and they were advised to train the child.

Final Assessment

Outcome was assessed by reevaluating the environmental, anthropometric and developmental parameters in the two study groups treated with either NUT or STIM in comparison with the well nourished control group who were not given any special intervention. In the hospital study, a final IQ assessment was done in all the children in the study and control groups by a tester blinded to the grouping, a clinical psychologist, to overcome observer bias and to evaluate cognitive development. In the community study final IQ assessment was done in 30% of children selected at random from all the subgroups. The Indian adaptation of Stanford Binet Intelligence test was utilized to assess IQ(22) and the scores were categorized into normal, borderline and mild to profound retardation. IQ assessment was not undertaken initially because the children were below the age of three years at the beginning of the study. The preset goals in catch up were more than 20%, 5% and 15 scores, respectively in weight, height and DQ.

Analysis

Catch up in the various scores (X posttest — X pretest) was computed and assessed using ANOVA with IQ done by the tester blinded to grouping as a controlling factor to overcome observer bias. As ANOVA showed statistically significant positive effect with both the interventions, an 'effect size' was computed(23) to rate the two interventions as

$$\frac{\text{X posttest — X pretest}}{\text{SD pretest}}$$

Correlations between the various environmental and anthropometric parameters and between anthropometric scores and IQ were computed using the Pearson's correlation coefficient. Analysis was also done incorporating significant variables using a logistic regression to identify the determinants of anthropometric parameters and IQ.

Results

I. Hospital Study

Seventy eight per cent of the children with PEM were above one year of age. In the study and control groups, the male to female ratio was comparable. The initial and final percentage distribution of children according to nutritional status is given in *Table II.* In the study groups 50% had moderate and 50% had severe PEM and 9% were severely stunted. Among those with severe PEM, three children (6%) had Kwashiorkor, six (12%) had Marasmic Kwashiorkor and 41 (82%) had Marasmus. With regard to wasting 6, 37 and 57%, respectively had mild, moderate and severe wasting. Half (52%) had head circumference below the 5th centile. After the interventions, there was no one with severe

TABLE II-*Percentage Distribution of Children According to Nutritional Status in the Two Studies.*

Parameter		Groups					
		SUM		NUT		Control	
		Initial	Final	Initial	Final	Initial	Final
I. Hospital		(n = 50)	(n = 47)	(n = 50)	(n = 44)	(n = 100)	(n = 96)
Grade of PEM							
0-Normal		-	96**	-	85**	100**	97**
I-Mild		-	2	-	4	-	3
II-Moderate		50	-	2	50	11	-
III & IV-Severe		50	-	-	50	-	-
Grade of Stunting (S) and Wasting (W)							
0-Normal	-S	18	96**	19	70**	100**	99**
	-W		98**		83**	100**	99**
I-Mild	-S	39	4	38	17	-	1
	-W	6	2	6	17	-	1
II Moderate	-S	34	-	35	13	-	-
	-W	38	-	36	-	-	-
Ill-Severe	-S	9	-	-	-	**8**	**-**
	-W	5	-	-	58	-	-
II. Community		(n-127)	(n=108)	(n=118)	(n=103)	(n=87)	(n=76)
Grade ofPEM							
0-Normal		-	54**	-	53**	-	22*
I-Mild		43	39	48	37	47	41
II-Moderate		44	7	40	10	37	33
III & IV-Severe		13	-	12	-	15	4
Grade of Stunting (S) and Wasting (W)							
0-Normal	-S	45	64*	47	61*	45	57
	-W	-	66*	-	57**	-	15
I-Mild	-S	37	28	36	26	37	29
	-W	62	34	63	43	61	41
II-Moderate	-S	16	8	15	12	16	12
	-W	25	-	36	-	25	32
Ill-Severe	-8	2	-	2	1	2	2
	-W	13	-	11	-	14	4

*p <0.05, ** p < 0.01

PEM, severe stunting or severe wasting in either groups (p <0.001). Thirteen percent in NUT group continued to have moderate stunting as against none in the STIM group. Ninety six per cent in STIM came upto normal nutritional status with regard to weight and height as against 85% and 70%, respectively in NUT group (p <0.05).

TABLE III-*Percentage Distribution of Children According to Environmental and Growth Parameters in the Two Studies.*

Parameter	Groups																	
	STIM						NUT						Control:					
I. Hospital Study																		
	Initial			Final			Initial			Final			Initial			Final		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
SES	–	–	100	–	3	97	–	–	100	–	2	98	50*	–	50	50	2	48
SS	2	26	72	56*	44*	–	6	22	72	44*	54*	2	58*	17	25	62	18	20
MES	4	22	74	58*	42*	–	2	24	74	36*	54*	10	36*	38	26	44	32	24
DQ	10	86	4	96*	4	–	14	18	6	74*	26	–	100*	–	–	100	–	–
IQ	–	–	–	–	96*	4	–	–	–	72	28	–	100*	–	–	100	–	–
II. **Community Study**																		
	Initial			Final			Initial			Final			Initial			Final		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
SES	–	–	100	–	3	97	–	–	100	–	2	98	–	–	100	–	1	99
SS	2	62	36	44*	56	–	3	58	39	36*	59	5	2	60	38	4	66	30
MES	4	6	70	51*	41*	–	3	32	65	25*	67*	8	4	31	65	8	43	49
DQ	57	31	12	84*	16	–	58	30	12	79*	18	3	56	32	12	57	34	9
IQ	–	–	–	94	6	–	–	–	81	19	–	–	–	–	–	59	28	12

* $p<0.01$

1. Good/Normal 2. Fair/Borderline 3. Poor/Retarded

SES-Socioeconorrtic score; SS-Sanitary score; MES—Microenvironment score;
DQ—Developmental quotient; IQ—Intelligence quotient.

The initial and final percentage distribution of children according to environmental and developmental parameters is given in *Table III*. All the children in the study groups had low SE status compared to 50% in the control group. This status remained comparable at the end of the study. A total of 72% and 74%, respectively had poor sanitary and microenvironment scores compared to 25% and 26%, respectively in the controls ($p < 0.01$). After the interventions, 56% and 58%, respectively in STIM and 44% and 36%, respectively in NUT group improved to good scores ($p < 0.05$). Even among the controls only 36% had good microenvironment score. Initially developmental delay was observed in STIM and NUT groups which markedly improved by the end of the intervention. Children from control II with low SE status also had slight delay compared to children from control I with high SE status. IQ assessment done at the end of the study showed that 96% in STIM had normal IQ compared to 72% in NUT group ($p < 0.05$). The mean initial and final environmental and development scores are given in *Table IV*. All the initial scores were significantly lower in the study groups compared to the controls ($p < 0.05$). Among the controls, control I from high SE status had the highest overall scores initially and at the end of the study. Catch up in weight for age, weight for height and DQ in both STIM and NUT groups were significant ($p < 0.01$). Significant catch up in gross motor development was noted in both STIM and NUT group, but catch up in other areas of development was more in STIM group. Catch up in height was 3.2% in STIM compared to 0.5% in NUT group. Height velocity was higher in the first year of follow up compared to the second year and was more in STIM than in NUT group. The mean IQ was more in STIM (91.1) than in NUT group (82.8). In the final assessment all the mean values were higher in STIM than in NUT group. There were 5 drop outs and 4 deaths in the study groups and 4 drop outs in the control groups. The drop outs were due to change of residence or illness of parents.

II. Community Study

There was a high prevalence of PEM among the children aged 6-24 months in the community. Out of the 540 children in this age group, only 18% had normal nutritional status. The rest (n=332) had varying grades of PEM and they were included in the study. Seventy three per cent of the children with PEM were above one year of age. In the study and control groups, the male to female ratio was comparable. The initial and final percentage distribution of children according to nutritional status is given in *Table II*. In the study groups 42% had moderate and 13% had severe PEM and 2% were severely stunted. Among those with severe PEM no one had Kwashiorkor, three (1%) had Marasmic Kwashiorkor and 34 (99%) had Marasmus. With regard to wasting, 62%, 26% and 12%, respectively had mild, moderate and severe wasting while 39% had head circumference below the 5th centile. After the interventions, there was no one with severe PEM, severe stunting or severe wasting in STIM but 1% in NUT group and 2% in control group, continued to have severe stunting. 12% in NUT group continued to have moderate stunting as against 8% in STIM group. With regard to weight and height, 54% and 64%, respectively in STIM came upto normal nutritional status as against 53% and 61%, respectively in NUT group. At the end of the study in the control group, 22% came upto normal nutritional status compared to the initial observation ($p < 0.05$). All the other parameters evaluated did not show any significant improvement in the control group at the end of the study. The percentage distribution of chil-

TABLE IV-*Mean* Scores *of Initial and Final Environmental and Growth Parameters in the Two Studies.*

Parameter	Groups Mean (SD)								
	STIM			NUT			Control		
	Initial	Final	Difference	Initial	Final	Difference	Initial	Final	Difference
I. Hospital Study									
SES	8.9 (1.7)	10.8 (1.6)	1.9 (1.5)	9.2 (1.6)	10.2 (1.7)	1.0 (1.5)	18.3* (1.3)	18.9* (1.6)	0.6 (1.4)
SS	12.0 (1.7)	14.3 (1.4)	2.3 (1.1)	12.9 (1.9)	12.8 (1.6)	0.1 (1.7)	17.1* (1.7)	20.4* (0.6)	3.3 (1.2)
MES	14.7 (1.8)	17.2* (1.6)	3.5 (1.7)	14.6 (2.0)	15.8 (1.8)	1.2 (1.9)	18.9* (2.0)	21.5* (1.2)	2.6 (1.8)
W/A	62.0 (3.9)	92.6** (4.6)	30.6** (4.4)	62.2 (2.4)	88.6** (5.2)	26.6** (3.8)	96.5* (4.5)	92.9 (4.9)	3.6 (4.7)
H/A	92.2 (3.8)	95.0 (3.1)	3.2* (3.4)	93.1 (3.0)	93.6 (2.9)	0.5 (2.9)	97.8* (2.0)	97.4* (2.0)	0.4 (2.0)
DQ	76.4 (6.7)	93.9* (3.1)	17.5** (5.3)	75.4 (6.3)	83.4* (2.9)	13.8** (5.1)	97.2* (7.5)	96.4 (4.4)	0.8 (6.0)
IQ	-	91.1* (3.2)	-	-	82.8 (3.1)	-	-	96.5* (4.3)	-
II. Community Study									
SES	9.1 (1.6)	10.4 (1.4)	1.3 (1.5)	9.4 (1.2)	10.2 (1.8)	1.2 (1.5)	9.6 (1.3)	9.8 (1.5)	0.2 (1.4)
SS	12.2 (1.7)	14.8 (2.1)	2.6 (1.9)	12.7 (1.2)	13.8 (2.3)	1.1 (1.7)	12.2 (1.4)	12.4 (1.8)	0.2 (1.6)
MES	14.9 (1.2)	18.2* (1.6)	4.7* (1.4)	14.8 (1.8)	16.4 (2.3)	2.4 (2.1)	14.9 (1.4)	15.2 (1.6)	1.7 (1.5)
W/A	76.8 (15.4)	89.7* (7.4)	12.9** (10.7)	78.7 (14.9)	89.9* (8.4)	11.2** (11.5)	73.1 (10.8)	78.3 (9.6)	5.2 (10.2)
H/A	94.7 (4.8)	97.9 (2.8)	3.2* (3.8)	95.2 (4.9)	96.7 (3.5)	1.5 (4.2)	93.5 (4.5)	93.8 (4.3)	0.3 (4.4)
DQ	83.3 (12.0)	93.1* (7.2)	10.2 (9.6)	82.8 (13.9)	91.3* (8.9)	9.5* (11.4)	82.5 (11.2)	84.6 (10.3)	2.1 (10.8)
IQ	-	95.1* (10.2)	-	-	91.3 (8.9)	-	-	88.6* (10.3)	-

*p<0.05; **p< 0.001; W/A-Weight for age%; H/A-Height for age %;
SES-Socioeconomic score; SS-Sanitary score; MES-Microenvironment score;
DQ—Developmental quotient; IQ-lntelligence quotient.

dren according to environmental and developmental parameters is given in *Table III.* All the children in the study groups and control group had low SE status. This status remained comparable at the end of the study. A total of 38% and 68%,

respectively had poor sanitary and microenvironment scores in the study groups and 38% and 65%, respectively in the controls. After the interventions, 44% and 51%, respectively in STIM and 36% and 25%, respectively in NUT group improved to good scroes. These differences were statistically significant compared to the initial observation ($p < 0.05$). Initially developmental delay was observed in STIM and NUT groups which markedly improved by the end of the intervention. IQ assessment done at the end of the study showed that 94% in STIM had normal IQ compared to 81% in NUT group ($p < 0.05$). 9% in the control group continued to be retarded. The mean initial and final environmental and development scores are given in *Table IV*. All the initial scores were comparable in the study groups and the controls ($p < 0.05$). Catch up in weight for age, weight for height and DQ in both STIM and NUT groups were significant ($p < 0.01$). Significant catch up in gross motor development was noted in both STIM and NUT groups, but catch up in other areas of development was more in STIM group. Catch up in height was 3.2% in STIM compared to 1.5% in NUT group. Height velocity was found to be higher in the first year of follow up and was more in STIM than in NUT group. The mean IQ was 95.1 in STIM and 91.3 in NUT group. These were 19 (15%) dropouts in STIM group, 15 (13%) dropouts in NUT group and 11 (13%) dropouts in the control group. These dropouts were due to change of residence or illness of parents. Flood and erosion of seashore were the reasons for increased drop out rate in STIM than in NUT group due to location of this area nearer to the sea.

In the hospital and community studies, ANOVA done with IQ as a controlling factor showed that both the interventions produced a significant positive impact on catch up in weight ($p < 0.01$) and DQ ($p < 0.05$). The effect size on catch up in weight ($p < 0.001$) and DQ ($p < 0.05$) was significant in both STIM and NUT groups; but catch up in height was significant only in STIM ($p < 0.05$). Among the preset goals in the hospital study, catch up in weight was optimum with both STIM and NUT but it was optimum in DQ only with STIM. In the community study, catch up in weight, height and DQ was less than in the hospital study. Catch up in height was the lowest.

Correlations

Correlations between the various parameters revealed that in the hospital study, weight had a linear correlation with microenvironment score (r - 0.65), sanitary score (r=0.62) and SE score (r=0.59) and in both hospital and community studies with maternal education (r=0.59 and 0.6, respectively). In the hospital study, height correlated with SE score (r=0.51) and microenvironmental score (r=0.5) and with sanitary score (r=0.48) in both the studies. In the community study, IQ had a linear correlation with SE score (r=0.5) and maternal education (r=0.2) and in both the hospital and community studies with weight (r=0.47 and 0.3, respectively), height (r=0.56 and 0.3, respectively) and head circumference (r=0.54 and 0.2, respectively).

In the pooled data, by multiple regression analysis *(Table V),* microenvironment score, maternal education and sanitary score were identified as important determinants of weight in the hospital study where as height alone was noted significant in the community study. In the hospital study, SE score and in the community study sanitary score were noted as determinants of height. Weight and SE score were observed as determinants of IQ in both the studies. In addition, in the hospital study maternal education and head circumference and in

TABLE V-*Multiple Regression of Significant Environmental and Growth Parameters in the Two Studies.*

Independent Variables	P	T	p value
I. Hospital Study			
	Weight		
	(R - 0.65, R square - 0.42, Adjusted R square - 0.41)		
Microenvironment score	- 0.29	-2.74	0.006
Maternal education	-0.18	-2.36	0.019
Sanitary score	-0.24	-2.27	0.024
	Height		
	(R - 0.43, R square - 0.19, Adjusted R square - 0.15)		
Scoioeconomic score	0.54	3.09	0.003
	IQ		
	(R - 0.92, R square - 0.84, Adjusted R square - 0.85)		
Maternal education	-0.13	-3.56	0.001
Socioeconomic score	-0.32	—8.35	0.001
Weight	-0.58	-16.37	0.001
Head circumference	-0.08	-2.80	0.005
II. Community Study			
	Weight		
	(R - 0.65, R square - 0.3, Adjusted R square - 0.31)		
Height	0.44	7.8	0.001
	Height		
	(R - 0.45, R square - 0.23, Adjusted R square - 0.26)		
Sanitary score	0.13	-2.8	0.006
	1Q		
	(R - 0.50, R square - 0.25, Adjusted R square - 0.25)		
Socioeconomic score	-0.39	10.2	0.001
Weight	-0.18	4.3	0.001
Height	-0.16	4.0	0.001

the community study height were noted to determine IQ. None of the variables studied were noted to determine head circumference.

Discussion

As the first two years of life is a period of rapid brain growth and myelination(3) and as PEM is more prevalent in the weaning and post weaning phase(24), this age group of 6-24 months was selected for the study. Any intervention aimed at the growing brain should be initiated early. The need for a multidisciplinary approach in nutritional rehabilitation has been suggested and hence nutritional supplementation and composite stimulation package were tried. Micronutrient and oil supplementation(25,26), a combined approach with nutritional supplementation and education(5)

as well as stimulation(7) have been found beneficial. As observed in previous studies, majority of the children with PEM were above one year of age(2,27). The comparable male to female ratio noted in the present study brings out the non existence of neglect of the female child in Kerala unlike other parts of India(28).

Severe PEM is on a downward trend, but the high prevalence of PEM and stunting in the coastal community shows that there are backward pockets in Kerala that need immediate attention. As the hospital study was conducted in a tertiary referral center, there were florid cases of severe PEM. There was also a high prevalence of wasting and stunting indicating acute as well as chronic PEM. The very high prevalence of moderate and severe stunting among children in India(l), is attributed to low birth weight, chronic PEM, micronutrient deficiency, genetic short stature and psychosocial dysfunction(29). The head circumference of the children in the study group was low as noted in poor communities(30). Early malnutrition and genetic causes(31) are responsible for this.

All the environmental scores were significantly lower in the study groups with PEM as well as in the control groups from low SE status. An association between sanitary facilities and height has been demonstrated(32). The low standards of sanitation noted in the coastal community is an eye opener to the importance of providing safe drinking water and sanitary facilities to the underprivileged people. As maternal health and attitude are important determinants of child development(33), the low microenvironment score noted in the study stresses the need for- giving better status and support to the mothers. After interventions, the mean sanitary and microenvironment scores in STIM group were better than in the NUT group as an effect of counselling and psychosocial support given to the mothers.

After the interventions, there was catch up in all the anthropometric and developmental scores in both STIM and NUT groups. However, this fell short of that observed in the control group I with high SE status. In the community study, 9% among the controls with PEM continued to be retarded at the end of the study. This brings out the need for developmental stimulation in children belonging to deprived communities. Developmental delay was marked in the study groups. Motor delay and poor competitive skills in school children have been attributed to PEM(34) and delay in language and personal social development in preschool children have been attributed to lack of stimulation(12,35). Biologic and social factors are also known to influence cognitive development(36). Catch up in gross motor development with nutritional supplementation and overall catch up with stimulation noted in the present study point to the need for stimulation along with nutritional supplementation. Twenty two per cent among the controls improved to normal nutritional status possibly due to mass media communication, adult literacy campaign and general uplift of the community. Following the interventions, catch up in weight was maximum followed by catch up in DQ. Catch up in height was less than the preset goal. This was due to the short span of follow up in the present study. Catch up in height will take longer periods. On rating, the 'effect size' STIM was superior to NUT. Effect size which is equated to Z score(23), is useful in intervention trials. Better catch up in growth and development noted in STIM group is supported by earlier studies(37) from Guatemala, Mexico, Spain, Beirut, Chile, South Africa, Louisiana (USA), Columbia and Jamaica. Various stimulation models were found useful, but

home based, age appropriate and individualized stimulation was most effective(38) as children with PEM functionally isolate themselves. Community participation, focus on the family, information regarding milestones, warm relationships, structured play and stimulation as utilized in the earlier studies(37,38) have been tried in this study. Psychosocial inputs in STIM benefited the parents and the effect was noted in growth and development of the children.

The direct correlation observed between anthropometric parameters and the various environmental scores and between IQ and anthropometric parameters stresses the need for improving both nutritional and environmental status for optimum growth and development. The need for improving both environmental and nutritional status is again stressed by the observations of the multiple regression analysis. However, head circumference is said to be more genetically determined(31).

The role of developmental surveillance and stimulation in the comprehensive rehabilitation of children with PEM and multideprivation are emphsized in the study. Children from deprived communities need nutritional supplementation and a developmental boost in the early years of life to obtain optimum development. This can be made a reality by utilizing the package of services in the existing Child Welfare Programme like ICDS and by including discussion on developmental milestones during mothers' meetings, by providing simplified developmental observation charts and by appropriate stimulation. Resident community volunteers (RCVs) can be utilized to focus on children below three years of age, who do not generally get the benefit of growth monitoring, nutritional supplementation and stimulation(39). This is highly important in order to improve the quality of survival.

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