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RISK FACTORS FOR MALNUTRITION IN SOUTH INDIAN CHILDREN

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Summary. Protein energy malnutrition is a major health problem in India and it affects the growth and development of young children. This study investigated the impact of hygiene, housing and sociodemographic variables on acute malnutrition in children aged 5–7, living in urban and rural areas. Ordinal logistic regression analysis showed that the overall prevalence of severe malnutrition was 8·2%. Older age, male sex, mother's poor education, lower family income, higher birth order of the child, use of dung or fire wood as fuel and defecation within the premises were significantly associated with malnutrition. Appropriate intervention programmes should be formulated to educate and support these families.

Introduction

Malnutrition and infection are the major causes of morbidity in South Indian children. The synergistic interactions between these factors have an adverse effect on growth and development. The World Health Organization (1981) recommended that methods to identify individuals at high risk should be developed. In rural Tamil Nadu severe malnutrition was found in 9·6% of pre-school children (Steinhoff *et al*., 1986). In slum settlements of Visakapatnam, India, the prevalence of severe malnutrition was 1·1% in 0–5-year-olds (Asthana, 1995). Van Loon *et al*. (1987) reported that the prevalence of marasmus was 2·1% and 2·3% in Zaire and Asia respectively. The prevalence in Bengal, India, was reported to be 3·5%. The information available on risk factors was based on case control studies (Henry *et al*., 1992, 1993). There are few studies on the prevalence of different levels of malnutrition and the risk factors (Steinhoff *et al*., 1986; Bhuiya, Zimicki & D'Souza, 1986; Dixit, Govil & Patel, 1992; Vella *et al*., 1994). A 5-year longitudinal study was carried out to determine the influence of early malnutrition on subsequent physical growth and psychological development in children aged 5–10 years. The children aged 5–7 years were followed up once every 6 months for anthropometry. This study evaluates the role of demographic, economic, biological, hygienic and household variables as risk factors for developing malnutrition in these children aged 5–7 years.

Materials and methods

The urban unit of this study is Vellore town, the headquarters of North Arcot Ambedkar District, whose population was 174,000 in 1981. It is an important business centre, with a large section of the population engaged in trade and commerce or government services. It is well connected with the neighbouring cities of Madras and Bangalore by road and by railway. In the town 89% of the population were Hindus, about 8% were Muslims; 2% were Christians and roughly 1% others.

The rural unit, K.V. Kuppam block, consists of 48 revenue villages with 84 hamlets. This block enjoys a tropical climate with an average yearly rain fall of 830 mm. Electricity is the prime source of power for lift irrigation, the principal crops being paddy, sugar cane, plantain and vegetables. Other crops include peanuts, sorgum, millet and ragi. The total population was 96,000 in 1981, of whom 97·9% were Hindus, 1·4% Muslims, and 0·6% Christians. Of the total work force, about 47·2% were engaged in agriculture, 4·7% in unskilled work, 8·1% in skilled work and only 3·1% in business. Through a sample survey it was estimated that more than 75% of the total population were living below the poverty line, set at Rs 650 per capita annual income.

The populations of the two study areas distinctly reflect rural and urban characteristics, and are expected to show differentials due to their socioeconomic status, food habits, sanitation and living environment. The rural and urban areas are homogeneous as far as social variables are concerned.

During 1982 seven localities and 22 villages were selected from the Vellore town and K.V. Kuppam development block sampling frames, respectively. All children aged 5–7 years were screened for signs of malnutrition by consultant paediatricians. Children with neurological disorders and gross physical deformities were excluded. A total of 1197 and 1299 children from the rural and urban areas respectively were recruited for this study.

The anthropometic data were collected by two anthropologists, and care was taken to reduce inter and intra observer variation by standardising the procedure. The US National Center for Health Statistics reference values of age- and sex-specific body weights were used to assess the nutritional status of the children. Although there are other criteria to detect children with stunting and wasting (chronic malnutrition), the objective of the present study was to identify children with acute malnutrition using weight-for-age criteria and to follow them up for subsequent growth faltering. A child was graded as mildly, moderately or severely malnourished when the measured weight for age was 70–80%, 60–70% and $<60\%$ of the age- and sex-specific reference values, respectively. A child was classified as normal if its body weight was $>80\%$ of the reference value, following the Indian Council of Medical Research's recommendation.

Sociodemographic variables included locality, age, sex, birth order, parental education, yearly family income and expenditure, type of family and marriage of parents, and religion. Also studied were household variables such as type of wall, floor and roof, presence of a separate kitchen, and the fuel used for cooking. Hygiene variables such as waste disposal, source of drinking water and defecating facilities were studied. The variables which were significant in the bivariate analysis were considered for multiple regression analysis and ordinal logistic regression analysis. In regression analysis, Z score was considered as dependent variable. However, although yearly family expenditure was significantly associated with malnutrition, it was not included in the multivariate analysis as it was significantly associated with yearly family income.

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Table 1. Percentage distribution of children by nutritional status, area, sex and age

		Nutritional status			
			Malnourished		
	No.	Normal	Mild	Moderate	Severe
Overall	2496	22·8	39·1	30·0	8·2
Rural	1197	20·6	39·8	32·2	7·4
Boys	595	18·2	39·8	33·9	8·1
Age (years)					
5	381	19·4	41·2	32·5	6·8
6	197	16·8	38·6	35·0	9·6
7	17	5·9	23·5	52·9	17·6
Girls	602	22·9	39·9	30·6	6·6
Age (years)					
5	366	24·9	40·4	30·1	4·6
6	221	20·4	39·8	29·9	10·0
7	15	13·3	26·7	53·3	6·7
Urban	1299	24·8	38·4	27·9	8·9
Boys	674	21·7	39·3	28·6	10·4
Age (years)					
5	373	25·7	38·1	29·2	7·0
6	277	17·0	41·2	28·2	13·7
7	24	12·5	37·5	25·0	25·0
Girls	615	28·1	37·7	26·7	7·5
Age (years)					
5	316	31·0	40·8	22·2	6·0
6	284	25·7	33·8	32·0	8·5
7	15	13·3	46·7	20·0	20·0

The codes used for the multiple regression analysis were: sex (1 male, 2 female); religion (1 Muslim, 2 Christian, 3 Hindu); mother's education (1 illiterate or literate, 2 primary or middle, 3 secondary or college); family annual income (actual); birth order (actual); roof (1 thatched, 2 tiled, 3 RCC or pukka); fuel (1 dung or fire wood, 2 gas or kerosene); defecation (1 within the premises, 2 open field) and age (actual).

As nutritional status of the child has four categories, ordinal logistic regression (cumulative odds) was applied using the polychotomous logistic regression module in BMDP PC90 software (Dixon, 1992). The attributable risk was calculated following Lilienfeld & Lilienfeld (1980).

Results

The distribution of the study children by nutritional status, age and sex is presented in Table 1. The overall prevalence of moderate and severe malnutrition was 30% and 8·2%

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Table 2. Mean weight (and SD) of children by area, sex and age

	Weight (kg)			
	Rural		Urban	
	Mean	SD	Mean	SD
Overall	14·5	2·1	14·8	2·1
Male	14·7	2·1	14·9	2·2
Age (years)				
5	14·3	1·9	14·4	1·9
6	15·5	2·1	15·5	2·3
7	15·0	2·1	15·6	2·3
Female	14·3	2·1	14·6	2·1
Age (years)				
5	13·8	1·8	14·1	2·0
6	15·2	2·2	15·1	2·1
7	15·4	1·5	15·5	2·0

respectively. The prevalence of severe malnutrition was 7·4% and 8·9% in rural and urban areas respectively. As age increased the prevalence of severe malnutrition also increased significantly ($p < 0{\cdot}001$).

Mean weight (and SD) of children according to area, age and sex is presented in Table 2. The mean weight (SD) of urban children was significantly ($p < 0{\cdot}01$) more than that for rural children: 14·8 (2·1) versus 14·5 (2·1). Boys had a significantly ($p < 0{\cdot}001$) higher mean weight than their female counterparts at ages 5 and 6, and mean weight increased significantly ($p < 0{\cdot}001$) with increasing age in both sexes.

The results of the ordinal regression analysis (Table 3) shows that the risk of malnutrition was nearly two and five times significantly ($p < 0{\cdot}001$) more for 6- and 7-year-olds, respectively, as compared to 5-year-old children. Children whose mothers had studied only up to middle school had significantly ($p < 0{\cdot}01$) one and a half times more risk for developing malnutrition as compared to children whose mothers studied up to secondary school or college level. The risk of malnutrition was one and a half times more ($p < 0{\cdot}01$) for children whose yearly family income was less than Rs 4000 as compared to those with income over Rs 8000. The interaction between maternal education and family income showed that the illiterate or literate mothers had similar risk at various categories of income and did not show any synergistic or antagonistic effect. Boys were 1·3 times more likely to be malnourished as compared to girls ($p < 0{\cdot}05$). The risk of malnutrition was 1·2 times higher for children living in thatched roof houses as compared to those living in pukka houses ($p < 0{\cdot}05$). Children whose family used dung or fire wood for fuel had nearly one and a half times significantly higher risk as compared to children whose family used liquid petroleum gas (LPG) or kerosene ($p < 0{\cdot}05$). Birth order of a child was positively ($p < 0{\cdot}05$) associated with malnutrition. Children defecating within the premises of the house were nearly one and

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Table 3. Results of ordinal logistic regression for nutritional status

	Odds ratio	95% CI	Significance *p*
Age (years)			
5	1·0		
6	1·4	1·2–1·7	<0·001
7	3·0	1·9–4·7	<0·001
Sex			
Male	1·3	1·1–1·4	<0·01
Female	1·0		
Religion			
Muslim	1·3	1·0–1·7	<0·06
Christian	1·3	0·6–2·7	
Hindu	1·0		
Mother's education			
Illiterate or literate	1·3	1·1–1·7	<0·05
Primary or middle	1·5	1·1–2·0	<0·01
Secondary or college	1·0		
Yearly family income (Rs)			
≤2000	1·7	1·3–2·4	<0·01
2001–4000	1·6	1·2–2·0	<0·01
4001–6000	1·2	0·9–1·5	
6001–8000	1·2	0·8–1·6	
≥8001	1·0		
Birth order			
1	1·0		
2–3	1·2	1·1–1·5	<0·05
4+	1·1	0·9–1·4	
Roof			
Thatched	1·2	1·0–1·5	<0·06
Tiled	1·2	0·9–1·5	
RCC or pukka	1·0		
Fuel			
Dung or fire wood	1·4	1·1–1·8	<0·05
Gas or kerosene	1·0		
Defecation			
Within the premises	1·3	1·1–1·6	<0·05
Open field	1·0		

a half times ($p<0·05$) more likely to be malnourished as compared to children defecating in the open fields away from the house. Seventy-seven per cent of the children were correctly classified by the above model.

Results of the multiple regression analysis are shown in Table 4. Older age, male sex, Hindu religion, lower family income, mother's literacy (illiterate or literate), fuel

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Table 4. Unstandardised regression coefficients and standard error by independent variables

Independent variable	Unstandardised regression coefficient	SE	Significance
Age	−0·0966	0·03	0·002
Sex	0·2212	0·03	0·000
Religion	−0·0988	0·05	0·046
Mother's education	0·0483	0·01	0·003
Family annual income	0·000014	0·00	0·000
Fuel	0·1976	0·06	0·001
Defecation	0·0836	0·04	0·076
Birth order	−0·0053	0·01	0·552
Roof	0·0066	0·02	0·778
Constant	−2·5486	0·25	

used for cooking (dung or fire wood), and defecating within the premises were significantly associated with severe malnutrition. The coefficient of determination (R^2) of the regression model was 47·25%.

Discussion

Steinhoff *et al.* (1986) studied the prevalence of malnutrition in pre-school children in the same study area. The data on 5–10 years was not available for this study area in South India. Since it was planned to follow them up for 5 years, 5–7-year-olds were included in this study. The existing prevalence of severe malnutrition was about 8% among 5, 6 and 7-year-old children. Steinhoff *et al.* (1986) reported that the prevalence of severe malnutrition (severely wasted and stunted) was 9·6% among pre-school children in the same rural study area. Use of weight for age criteria alone cannot distinguish acute from chronic malnutrition (Waterlow *et al.*, 1977). Steinhoff *et al.* (1986) showed a greater deviation of height for age *Z* scores from NCHS standards than weight for age in pre-school children. Thus there is a possibility that height for age of NCHS standard may over-estimate the prevalence of stunting. Dixit *et al.* (1992), using standards of mid arm circumference, reported that the prevalence of malnutrition among 5–6-year-old children was 13·5% and 14·5% in rural and urban areas, respectively.

Data of ordinal outcome are often dichotomised and analysed using binary logistic regression analysis although this approach loses information by combining some categories of the original scale (Armstrong & Sloan, 1989). For the present study, the cumulative odds model was chosen instead of the continuation ratio model as it gives the cumulative probability for malnutrition. The importance of ordinal logistic regression analysis is slowly gaining attention among researchers.

Children whose mothers were illiterate or had studied only up to middle school had

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a higher risk of malnutrition. Lower maternal education was also reported as a risk factor for malnutrition (Asokumar & Enahoro, 1991; Henry *et al*., 1993). Children from families with annual income < Rs 4000 had a significantly higher risk for malnutrition as compared to families with annual income of Rs 8000 or more. Annual family income was estimated from cultivation of crops, agricultural labour, selling of milk, poultry, traditional crafts, trade and commerce, service and others, but there was a possibility that the heads of households could have under-reported the income due to fear of taxes or to gain other subsidies. Even so, the reporting bias should be similar in the different socioeconomic status groups. Bairagi (1980) showed that there was an interaction between literacy and increasing income. However, the difference between the means of nutritional status was not clinically appreciable despite the statistical significance. The findings of the present study did show interaction between education of mother and the family annual income.

Children of higher birth order had a higher risk of becoming malnourished. Children who lived in thatched roof houses, defecated within the premises and those from families using dung or fire wood as fuel to cook had a significantly higher risk of developing malnutrition. The World Health Organization's (1981) recommendation on enhancing the delivery of interventions to high risk households needs to be evaluated. Among the severely malnourished, 17·6%, 6·9% and 14·2% respectively were from pukka roofed houses, families using gas or kerosene and were first born. Thus, the WHO recommendation on high risk approach would possibly miss a good number of severely malnourished children. Henry *et al*. (1992) were also of the same opinion.

The significant risk factors related to house and hygiene implied that the children were from low socioeconomic status. The attributable risks for thatched roof, fire wood for cooking and defecating within the premises was about 18%, 26% and 12% respectively. The intervention programme, therefore, should focus on educating and supporting the heads of households to design good ventilation within the thatched roof house and to construct a low cost toilet facility within the premises, besides educating mothers on low cost but nutritious locally available foods.

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