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Prevalence of protein energy malnutrition among 2-5 year old children, based on anthropometry

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ABSTRACT

Background: The level of child under nutrition remains unacceptable throughout the world, with 90 per cent of the developing world's chronically undernourished (stunted) children living in Asia and Africa. 159 million and 50 million children are still affected by stunting and wasting, respectively. Although the prevalence of stunting has declined from 39.6% to 23.8% between 1990 and 2014, it is not fast enough.

Methodology: The study began by visiting different anganwadis to get the anthropometric measurements of the children to find out the prevalence (N=257) of PEM. Stratified sampling was undertaken and a total of 22 anganwadi centres were visited. A detailed semi-structured questionnaire regarding the child's birth history, clinical and dietary history was filled out along with a food-frequency questionnaire. Weight, height and MUAC were considered indicators of nutritional status along with dietary factors like macronutrient and micronutrient sufficiency. The children were classified into different groups based on their Z scores and nutrient adequacy of their diet was assessed in comparison to the age-specific RDA.

Objective: To assess the prevalence of Protein Energy Malnutrition (PEM) in children between the age of 2-5 years in and around Udupi based on anthropometry measurements and classify them into grades of PEM.

Results: The prevalence of PEM was assessed according to Gomez classification. 33.5% of the samples were normal, 52.5% had 1st degree PEM, 13.6% had 2nd degree PEM and 0.4% had 3rd degree PEM. The overall prevalence of PEM was 66.5%. When nutrient adequacy was assessed, protein intake seemed to be significantly higher than the RDA (p<0.001) while consumption of carbohydrates, fat, energy, calcium, phosphorus, iron, zinc, vitamin A and dietary fiber was found be significantly lower than the RDA (p<0.001). Energy (p<0.05), carbohydrate (p<0.01) and zinc (p<0.01) content of the diet had a significant positive correlation to weight status of the child.

Conclusion: Although the prevalence of undernutrition in India is high, there are discrepancies in terms of standards of assessment of undernutrition on a global basis and in an Indian scenario. This study also indicated that although the protein intake was sufficient, a large proportion of the population was lacking in terms of micronutrients. Protein energy malnutrition in India may be contributed to a state of micronutrient deficiency rather than macronutrient insufficiency.

Key Words: Nutritional intake, PEM, Protein energy malnutrition, Nutritional status

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INTRODUCTION

Undernutrition is defined as the outcome of insufficient food intake and repeated infectious diseases. It includes being underweight for one's age, too short for one's age (stunted), dangerously thin for one's height (wasted) and deficient in vitamins and minerals (micronutrient malnutrition) (UNICEF, n.d.). The term protein-energy malnutrition (PEM) applies to a group of related disorders that include marasmus, kwashiorkor, and intermediate states of marasmus-kwashiorkor. The term "marasmus" means withering or wasting. It involves inadequate intake of protein and calories and is characterized by emaciation. The term "kwashiorkor" refers to an inadequate protein intake with reasonable caloric intake. Edema is characteristic of kwashiorkor but is absent in marasmus.

A collaborative document from UNICEF, WHO and World Bank Group released in 2015 stated that 159 million and 50 million children worldwide are still affected by stunting and wasting, respectively. South Asia, including India is home to more than half the wasted children under 5 years (UNICEF, WHO, World bank Group, 2015). The prevalence of child undernutrition in India is among the highest in the world, nearly double than that of Sub-Saharan Africa. Child malnutrition is responsible for 22% of the country's burden of disease (Gragnolati *et al.*, 2005). The prevalence of underweight in children in India (48%) is almost twice as high as the average prevalence for the 26 sub-Saharan African countries that have similar data (25%) (NFHS III, n.d.).

Under-5 undernutrition has been a long-standing problem in India and has far-reaching effects if appropriate and timely measures are not taken to curb it. Despite of the Government schemes that are deployed to combat child malnutrition, the statistics show very little improvement. Undernutrition not only affects the child's present health status, but also affects his/her future growth pattern and in turn, has an effect on the country's economic and social growth as a population.

PEM was significantly higher in children belonging to Hindu religion, schedule caste, nuclear family, among =3 siblings, illiterate father, lower socioeconomic status, poor housing and environmental sanitation (Prasot *et al.*, 2014).

METHODOLOGY

Ethical clearance :

Ethical clearance was obtained from the Institutional Ethics Committee of Kasturba Hospital, Manipal. Written informed consent was obtained from the informants involved in the study (primary caretakers of the child).

Study design and sampling technique :

This study is a community-based cross-sectional study where a stratified sampling technique was used. An optimum samples size for study was obtained by $4PQ/d^2$ assuming PEM prevalence (P) of 63% in children between 2-5 years of age with 10% of relative precision and 95% confidence interval. Expecting a non-response rate of 10%, 257 was set as a target sample size.

Selection of samples :

Anganwadi centres were visited till the said sample size was reached. A total of 22 ICDS anganwadi centres in and around Udupi were visited.

Data collection :

Anthropometric data like height, weight, head circumference (HC) and mid-upper arm

PREVALENCE OF PROTEIN ENERGY MALNUTRITION AMONG 2-5 YEAR OLD CHILDREN, BASED ON ANTHROPOMETRY

circumference (MUAC) were recorded using measuring tape (to nearest mm), digital weighing scale (nearest 100 g) and MUAC tapes, respectively.

Personal interview method was used to fill a semi-structured questionnaire. Primary caretakers of the children were interviewed in order to obtain information about socio-economic status, birth history, personal hygiene, family size, clinical history, dietary preferences, supplementary nutrition, etc. Modified Kuppuswamy scale was used to estimate socio-economic status of the family. Dietary assessment was performed using 24-hour dietary recalls and a detailed food-frequency questionnaire.

Data analysis :

Anthorpometric data was fed into WHO Anthro software (v 3.2.2, January 2011) and Z scores were obtained for each child and they were classified into suitable groups. The children were also classified on the basis of Indian Academy of Pediatrics (IAP) cutoffs, Gomez and Waterlow classification. Nutrient content of diets was assessed using DietCal software (v.5). SPSS Software (v. 16) was used for tabulation and analysis of the recorded data.

RESULTS AND DISCUSSION

Table 1 shows the socio-demographic profile of the study population. A total sample of 257 children were covered of which 48.6% were male and the remaining 51.4% were females. 21.8% of the study population were 2-3 years old, 45.9% were 3-4 years of age and 32.3% were 4-5 years of age. Majority of the subjects (91.4%) belonged to Hindu religion, 47.9% were living in nuclear families while 27.6% were living in 3 generation families. 3.1% of the fathers were illiterate while 41.2% had a high school certificate (passed 7th grade). 60.3% of the families fell under the upper lower SES, according to Kuppuswamy scale.

Table 2 depicts the birth history and child rearing practices of the study subjects. Majority of the subjects (88.3%) were born at full-term of the pregnancy while 97.3% were fed colostrum. 37% were not exclusively breastfed. It was found that the children were fed water along with breastmilk. 34.6% subjects were exclusively breastfed for 4-6 months. 43.6% mothers fed weaning foods with the help of a spoon while 28% used a feeding bottle

Table 3 classifies the subjects on the basis of Z scores. A total of 164 (63.8%) subjects were underweight out of which 12 (7.3%) were severely underweight. 143 (55.6%) subjects were stunted out of which 14 (9.8%) were severely stunted. 127 (49.4%) study subjects were found to have wasting out of which 11 (8.7%) had severe wasting. 158 (61.5%) subjects had an MUAC reading below 13.5 cm out of which 3 (1.9%) had severe acute malnutrition (SAM). In a study done in 2011, in Dhaka, Bangladesh, a sample of 380 preschoolers were assessed for PEM. The overall stunting was 39.5%. 14% had mild stunting while 25% had severe stunting. (Jesmin, Shelby, Malik, and Haque, 2011) Although, the study done shows worse statistics than the study in Bangladesh, it is proof enough to show that the Indian subcontinent is under imminent threat of child malnutrition of epidemic proportions.

Table 4 classifies study subjects based on Indian Academy of Pediatrics' (IAP) classification of PEM. 83 (32.3%) subjects fell in the undernourished category. In a prevalence study done in 2016, in Gurgaon, Haryana, the prevalence of PEM based on IAP classification was 43.86%. (Kumar and Singh Deswal, 2016) In a prevalence study done in 2014, in Lucknow, on 400 samples between 1-6 years, the prevalence of PEM was found to be 54.8% overall (Prasot *et al.*, 2014). This goes to show that statistics may vary region-wise but it does not negate the fact that protein-

Table 1 : Socio-demographic profile of study subjects		
Characteristics	n	%
Age		
24-36 months	56	21.8
36-48 months	118	45.9
48-60 months	83	32.3
Gender		
Male	125	48.6
Female	132	51.4
Family size		
< 4	130	50.6
5 -7	91	35.4
8 - 10	22	8.6
>10	14	5.4
Family type		
Joint	54	21
Nuclear	123	47.9
3 generation	71	27.6
Extended	9	3.5
Religion		
Hindu	235	91.4
Muslim	17	6.6
Christian	5	1.9
Father's education		
Professional degree, Postgraduate and above	1	0.4
BA or B.Sc.	0	0
Intermediate/Past high school diploma	40	15.6
High school certificate	106	41.2
Middle school certificate	70	27.2
Primary school certificate	32	12.5
Illiterate	8	3.1
Socio-economic status		
Lower SES	9	3.5
Upper lower SES	155	60.3
Lower middle SES	89	34.6
Upper middle SES	4	1.6

energy malnutrition is a major problem in the country and will have varied and far-reaching effects.

Table 5 classifies subjects based on Gomez criteria of PEM, according to age and sex. 171 (66.5%) samples fell under varying degrees of PEM. 78 (62.4%) male and 93 (70.5%) female subjects were undernourished. In another study done in Gurgaon, Haryana, prevalence of PEM was found to be higher in females (50%) compared to males (37.73%) (Kumar and Singh, 2016). Prevalence of PEM was found to be highest in the age group of 4-5 years with 68 (81.9%) out of 83 subjects falling under the undernourished category.

Table 6 assesses and compares intake of various food groups compared to the age-specific

Table 2 : Birth history and child rearing practices				
Characteristics	n	%		
Term of pregnancy				
Full term	227	88.3		
Pre-term	30	11.7		
Colostrum given				
Yes	250	97.3		
No	7	2.7		
Exclusive breastfeeding				
Not done	95	37		
< 4 months	57	22.2		
4-6 months	89	34.6		
6 months	15	5.8		
6 months – 1 year	1	0.4		
Method of giving weaning foods				
Bottle	72	28		
Katori	54	21		
Spoon	112	43.6		
Paladai	11	4.3		
Other	8	3.1		

PREVALENCE OF PROTEIN ENERGY MALNUTRITION AMONG 2-5 YEAR OLD CHILDREN, BASED ON ANTHROPOMETRY

Table 3 : Nutritional status based on WHO growth charts					
Z Score categories	n	%			
Weight-for-age					
Normal (1 to -1 SD)	90	35			
Underweight (-1 to -2 SD)	93	36.2			
Moderate underweight (-2 to -3 SD)	59	23			
Severe underweight (< -3 SD)	12	4.7			
Overweight (1 to 2 SD)	3	1.2			
Height-for-age					
Normal (1 to -1 SD)	114	44.4			
Mild stunting (-1 to -2 SD)	80	31.1			
Moderate stunting (-2 to -3 SD)	49	19.1			
Severe stunting (< -3 SD)	14	5.4			
Weight-for-height					
Normal (1 to -1 SD)	123	47.9			
Mild wasting (-1 to -2 SD)	83	32.3			
Moderate wasting (-2 to -3 SD)	33	12.8			
Severe wasting (< -3 SD)	11	4.3			
Risk of overweight (1 to 2 SD)	7	2.7			
MUAC-for-age					
Normal $(>-1$ SD)	99	38.5			
Mild under nutrition (-1 to -2 SD)	111	43.2			
Moderate under nutrition (-2 to -3 SD)	44	17.1			
Severe under nutrition (< -3 SD)	3	1.2			

Table 4 : IAP classification of PEM		
Categories	Ν	%
Normal	174	67.7
Mild Under nutrition	69	26.8
Moderate Under nutrition	13	5.1
Severe Under nutrition	1	0.4

Table 5 : Classificat	tion of subjects b	ased on sex an	d age, into PE	M categories ba	sed on Gomez	classification
Category	Total [n(%)]	Male	Female	2-3 years	3-4 years	4-5 years
	(N=257)	[n(%)] (N-125)	[n(%)] (N-132)	[n(%)] (N-56)	[n(%)] (N-118)	[n(%)] (N-83)
		(11=125)	(11-132)	(11=30)	(11-110)	(11-05)
Normal	86 (33.5%)	47 (37.6%)	39 (29.5%)	24 (42.9%)	47 (39.8%)	15 (18.1%)
1 st degree PEM	135 (52.5%)	68 (54.4%)	67 (50.8%)	25 (44.6%)	60 (50.8%)	50 (60.2%)
2 nd degree PEM	35 (13.6%)	10 (8.0%)	25 (18.9%)	7 (12.5%)	10 (8.5%)	18 (21.7%)
3 rd degree PEM	1 (0.4%)	-	1 (0.8%)	-	1 (0.8%)	-

RDA. It was found that the cereal, pulse and refined sugar consumption was significantly higher than the RDA (p < 0.01) while consumption of all other food groups, *i.e.* visible fat, milk products, green leafy vegetables, other vegetables and fruits were significantly lower than the RDA.

Table 6 : Consumption of food groups compared with age-specific RDAs (N=257)						
Food group		Mean \pm SD	SD	t-value	p-value	
Cereals	Intake	119.46 ± 28.61	28.61	17.480**	0.000**	
	RDA	79.38 ± 28.11	28.11			
Pulses	Intake	35.02 ± 6.29	6.29	12.788**	0.000**	
	RDA	30.00	0.00			
Sugar	Intake	20.03 ± 4.52	4.52	11.230**	0.000**	
	RDA	16.61 ± 2.34	2.34			
Fats	Intake	14.41 ± 3.71	3.71	-45.750**	0.000**	
	RDA	25.00	0.00			
Food group		Median (Q	1, Q ₃)	Z	p-value	
Milk	Intake	105.00 (100.00	, 155.00)	-14.009	< 0.001**	
	RDA	500.00 (500.00	, 500.00)			
GLV	Intake	2.50 (1.6621,	5.8307)	-13.708	< 0.001**	
	RDA	50.00 (50.00,	50.00)			
OV	Intake	73.9286 (63.2143	3, 81.9021)	-13.287	< 0.001**	
	RDA	100.00 (100.00	, 200.00)			
Fruits	Intake	13.2143 (7.1429	, 25.7143)	-13.287	< 0.001**	
	RDA	50.00 (50.00,	50.00)			

Table 7 represents correlation of food group intake with nutritional status of the child in terms of Z scores. There was a statistically significant positive correlation between cereal intake and weight-for age (0.229), height for age (0.207) and MUAC for age (0.204). Other food groups did not have a significant effect on the anthropometric indices.

Table 8 assesses nutrient intake and compares it to the age-specific RDA. The intake of protein was significantly higher as compared to the RDA (p<0.001) whereas the intake of fat,

Table 7 : Corr	elation of food group intake	with Z scores (N=257	()		
Food Groups		WAZ	HAZ	WHZ	MUACZ
Cereals	Correlation	0.229**	0.207**	0.121 ^{NS}	0.204*
	P value	0.000**	0.001*	0.052^{NS}	0.001*
Pulses	Correlation	-0.086^{NS}	-0.055^{NS}	-0.058 ^{NS}	-0.115 ^{NS}
	P value	0.171 ^{NS}	0.381 ^{NS}	0.358^{NS}	0.065 ^{NS}
	Correlation	-0.036 ^{NS}	0.002^{NS}	-0.049^{NS}	0.066 ^{NS}
Sugar	P value	0.565^{NS}	0.970 ^{NS}	0.430 ^{NS}	0.294 ^{NS}
Fats	Correlation	-0.017 ^{NS}	0.012 ^{NS}	-0.030 ^{NS}	-0.012 ^{NS}
	P value	0.785^{NS}	0.849 ^{NS}	0.633 ^{NS}	0.852 ^{NS}
Milk	Correlation coefficient	0.002^{NS}	0.041 ^{NS}	-0.068 ^{NS}	0.012 ^{NS}
	p value	0.970^{NS}	0.517^{NS}	0.276 ^{NS}	0.843 ^{NS}
GLV	Correlation coefficient	-0.018 ^{NS}	0.056^{NS}	-0.071 ^{NS}	-0.037 ^{NS}
	p value	0.773 ^{NS}	0.367 ^{NS}	0.257^{NS}	0.557 ^{NS}
OV	Correlation coefficient	0.096 ^{NS}	0.093 ^{NS}	0.048 ^{NS}	0.040^{NS}
	p value	0.124 ^{NS}	0.136 ^{NS}	0.444 ^{NS}	0.525 ^{NS}
Fruits	Correlation coefficient	-0.004 ^{NS}	0.034^{NS}	-0.047 ^{NS}	-0.058 ^{NS}
	p value	0.943 ^{NS}	0.582 ^{NS}	0.452 ^{NS}	0.355 ^{NS}

PREVALENCE OF PROTEIN ENERGY MALNUTRITION AMONG 2-5 YEAR OLD CHILDREN, BASED ON ANTHROPOMETRY

[NS = Not significant, * = Significant at 5% level (p <0.05), ** = Significant at 1% level (p <0.01)]

carbohydrates, energy, calcium, phosphorous, iron, zinc, vitamin A and dietary fiber was significantly lower than the RDA. (p<0.001) This result was in accordance with a study done in 2014, in Ukhrul district, Manipur, India where the influence of diet was seen on body composition of 270 malnourished

Table 8 : Comparison of nutrient intake versus RDA (N=257)						
Nutrient		Mean	SD	t-value	p-value	
Protein	Intake	22.25	4.86	22.926**	0.000**	
	RDA	15.08	1.97			
Fat	Intake	20.23	5.62	-28.893**	0.000**	
	RDA	32.90	4.82			
Carbs	Intake	125.92	20.89	-24.135**	0.000**	
	RDA	165.48	23.63			
Energy	Intake	776.55	126.79	-23.443**	0.000**	
	RDA	1018.34	145.43			
Calcium	Intake	308.02	112.38	-41.652**	0.000**	
	RDA	600.00	0.00			
Phosphorus	Intake	459.02	99.05	-119.930**	0.000**	
	RDA	1200.00	0.00			
Iron	Intake	3.52	1.22	-56.086**	0.000**	
	RDA	11.38	1.97			
Zinc	Intake	2.27	0.48	-52.474**	0.000**	
	RDA	5.66	0.94			
Food Group		Median (Q ₁ ,	Q ₃)	Ζ	p-value	
Vitamin A	Intake	106.00 (79.50, 159.00)		-13.902	< 0.001**	
	RDA	3200.00 (3200.00, 3200.00)				
Dietary Fiber	Intake	7.6750 (6.5535, 8.8050)		-13.681	< 0.001**	
	RDA	19.00 (19.00, 25.00)				

[NS = Not significant, ** = Significant at 1% level (p <0.01)]

children. Intake of all nutrients, including protein were significantly lower than the RDA (Lunghar *et al.*, 2014).

Table 9 correlates nutrient intake with anthropometric indices of the study population. Carbohydrate intake had significant and positive correlation with all Z scores- Weight for age (0.203), height for age (0.129), Weight for height (0.155) and MUAC for age (0.151). Energy intake was significantly and positively correlated to weight for age (0.160). Phosphorus and Zinc had a positive, significant correlation with weight for age (0.125, 0.167). Zinc also had a significant, positive correlation to weight for height (0.149).

Table 9 : Correlation of nutrient intake with Z scores (N= 257)						
Nutrient		WAZ	HAZ	WHZ	MUACZ	
Protein	Correlation	0.093 ^{NS}	0.074 ^{NS}	0.047 ^{NS}	0.025 ^{NS}	
	P value	0.138 ^{NS}	0.235 ^{NS}	0.451^{NS}	0.692 ^{NS}	
Fat	Correlation	0.031 ^{NS}	0.046^{NS}	-0.005 ^{NS}	0.031 ^{NS}	
	P value	0.616 ^{NS}	0.461 ^{NS}	0.942^{NS}	0.619 ^{NS}	
СНО	Correlation	0.203**	0.129*	0.155*	0.151*	
	P value	0.001**	0.039*	0.013*	0.016*	
Energy	Correlation	0.160*	0.114 ^{NS}	0.108 ^{NS}	0.110^{NS}	
	P value	0.010*	0.069^{NS}	0.083 ^{NS}	0.079 ^{NS}	
Calcium	Correlation	0.047 ^{NS}	0.042^{NS}	0.015 ^{NS}	0.023 ^{NS}	
	P value	0.449 ^{NS}	0.507 ^{NS}	0.807 ^{NS}	0.713 ^{NS}	
Phosphorus	Correlation	0.125*	0.101 ^{NS}	0.068 ^{NS}	0.054 ^{NS}	
	P value	0.045*	0.106^{NS}	0.275^{NS}	0.388 ^{NS}	
Iron	Correlation	0.062^{NS}	0.091 ^{NS}	-0.004 ^{NS}	-0.020 ^{NS}	
	P value	0.320 ^{NS}	0.144 ^{NS}	0.947 ^{NS}	0.748 ^{NS}	
Zinc	Correlation	0.167**	0.088 ^{NS}	0.149*	0.108^{NS}	
	P value	0.007**	0.160^{NS}	0.017*	0.084 ^{NS}	
Vit A	Correlation coefficient	0.091 ^{NS}	0074^{NS}	0.038 ^{NS}	0.054 ^{NS}	
	p value	0.147 ^{NS}	0.240^{NS}	0.543 ^{NS}	0.391 ^{NS}	
Dietary Fiber	Correlation coefficient	-0.073 ^{NS}	0.020^{NS}	0.107 ^{NS}	-0.044 ^{NS}	
	p value	0.243 ^{NS}	0.750^{NS}	0.087 ^{NS}	0.484 ^{NS}	

Table 10 depicts a binary logistic regression that was done to predict the risk factors of PEM. The odds of developing PEM are 4.655 times more in 4-5 year old children compared to 2-3 years. In accordance to our results, the prevalence in another study was significantly linked to the age group. Older age groups (> 3 years) showed a higher prevalence of underweight and stunting (Reddy *et al.*, 2016), The maximum prevalence of undernutrition was seen in the 4-5 year age group (68.9%) (Shreyaswi *et al.*, 2013). The odds of developing PEM are 2.141 times more in females. In another study, one of the main reasons of PEM was attributed to female sex (Kumar and Singh, 2016). The family type, family size, SES class, mother's occupation, pregnancy term, type of delivery, colostrum, duration of exclusive breastfeeding and food habits is not a significant risk factor in development of PEM. In agreement with our results, exclusive breastfeeding did not seem to affect the nutritional status of the children (Rashmi and Kiran, 2013). For every unit decrease in quantity of daily cereal intake, the odds of PEM increase by 1.6%.

Table 10 : Risk factors for PEM by binary logistic regression					
Characteristics	Frequency	Unadjusted Odds Ratio	95% CI		
Age group					
2-3 years	56				
3-4 years	118	0.910	(0.446-1.855)		
4-5 years	83	4.655	(1.965-11.029)		
Sex					
Male	125				
Female	132	2.141	(1.167-3.927)		
Residence					
Rural	149	0.447	(0.215-0.929)		
Urban	42	1.156	(0.441-3.030)		
Semi-urban	66				
Cereal intake	-	0.984*	(0.972-0.996)		

[*= significant at 5% level (p<0.05)]

Conclusion :

Although it is fairly obvious that the prevalence of undernutrition in India is high, there are discrepancies in terms of standards of assessment used in India as compared to the world. This is evident when the proportion of undernourished children is compared between WHO standards with the IAP's. This study also indicated that although the protein intake was sufficient, the caloric and micronutrient intake of the population was significantly lower than the RDA. Thus, protein energy malnutrition in India may be contributed to a state of micronutrient deficiency rather than macronutrient insufficiency. A bigger, multi- centric study may be done to evaluate this cause-effect relationship. Biochemical analysis pertaining to nutritional status may also be done to improve reliability of the study and get a clearer picture of the effect of dietary factors on nutritional status.

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